Pre- and postoperative nutritional status and dietary intake in patients undergoing gastroenterological surgery at St. Olavs Hospital

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Master's Thesis in clinical nutrition

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ABSTRACT

Introduction and aim: The prevalence of malnutrition in hospital ranges between 10%-60%. Patients undergoing gastrointestinal surgery are at risk for malnutrition both because of insufficient food intake pre- and/or postoperatively and because of stress from surgery with following increased metabolism. Malnutrition in surgery has been found to be an independent risk factor affecting the postoperative outcome negatively. Finding suitable, validated and standardized methods to screen for malnutrition risk is an essential step towards improving perioperative nutritional status. The aim of this study was to describe nutritional status and diet before gastroenterological surgery and one month after surgery, and to compare the use of two nutritional screening tools in predicting postoperative outcome.

Method: This was a prospective observational study recruiting patients from preoperative outpatient clinic before upper- or lower gastrointestinal surgery. At the outpatient clinic, patients were screened with the two nutritional screening tools NRS-2002 and PG-SGA. Postoperative outcomes, such as complications and length of hospital stay, were registered. The predictive value of nutritional risk (NRS-2002) and malnutrition (PG-SGA) on complications and LOS was evaluated using univariate and multivariate regression analyses. Dietary intake was assessed before surgery at the outpatient clinic, and one month after surgery over phone, using 24 h recall method.

Results: The study recruited 101 surgical patients with a mean BMI of 26±5 kg/m^2 and mean age of 60±17 years. NRS-2002 identified 24 % at nutritional risk and PG-SGA identified 28 % as malnourished. The impact of nutritional risk (NRS-2002) on the likelihood of postoperative complications recorded an OR of 2.71 (95% CI: 0.95-7.73; p=0.063) and nutritional status (PG-SGA) recorded an OR of 2.03 (95% CI: 0.73-5.68; p=0.176). The respective adjusted effect recorded an OR of 3.88 (95% CI: 1.07-14.06; p= 0.039) and 3.07 (95% CI: 0.90-10.54; p= 0.075), respectively. Neither of the two screening tools contributed significant in predicting length of hospital stay. Overall, mean energy- and protein intake did not differ significant pre- and postoperatively. Patients at risk or malnourished consumed significant less energy and protein before surgery compared to one-month after surgery.

Conclusion: Two screening tools revealed that nutritional risk and malnutrition are frequent in patients before gastrointestinal surgery, even in a population with average BMI indicating overweight. NRS-2002 defining patients at risk presented the strongest predictor of complications in the adjusted analysis controlling for age, surgery, and co-morbidities.

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ABBREVATIONS

ESPEN	The European Society for Clinical Nutrition and Metabolism
A.S.P.E.N	The American Society for Parenteral and Enteral Nutrition
Academy	The Academy of Nutrition and Dietetics
BMI	Body mass index
FFMI	Fat free mass index
GP	General practioner
BAPEN	The British Association for Parenteral and Enteral Nutrition
NRS-2002	Nutritional Risk Screening 2002
MNA	Mini Nutritional Assessment
SGA	Subjective Global Assessment
PG-SGA	Patient-Generated Subjective Global Assessment
GI	Gastrointestinal
IBD	Inflammatory bowel disease
ERAS	Enhanced Recovery After Surgery
ONS	Oral nutritional supplements
LOS	Length of hospital stay
TSF	Triceps skinfold thickness
MUAC	Mid-upper arm circumference
HGS	Hand grip strength
MUAMC	Mid upper arm muscle circumference
BMR	Basal metabolic rate
PAL	Physical activity level
IQR	Inter quartile range
APACHE	Acute physiologic and chronic health evaluation

1. INTRODUCTION

The prevalence of malnutrition in hospitalized patients is high and often underdiagnosed in the western world. Tangvik et al. (2014) found in a point prevalence survey at Haukeland University Hospital that 29 % of hospitalized patients were classified as being at nutritional risk, and that these patients had significantly increased morbidity, mortality, length of hospital stay and readmissions (1). Surgery causes physiological stress, increased energy expenditure and can cause negative nitrogen balance (2). The postoperative course will depend on the type and magnitude of the operation, other co-existing diseases, complications, the patients age and nutritional status (3). Patients undergoing surgery have a higher risk for malnutrition, which further can affect the postoperative outcome negatively (2, 4).

1.1 Malnutrition

The terms "Malnutrition" and "Undernutrition" are used interchangeably in clinical practice and scientific literature. Members of The European Society for Clinical Nutrition and Metabolism (ESPEN) have been asked to vote for which term they prefer – a slight preference for the term malnutrition was seen (5). The term malnutrition will be used in this thesis.

1.1.1 Definition of malnutrition

There is an ongoing process to provide international consensus diagnostic criteria for malnutrition. At present, there are multiple definitions for adult malnutrition syndrome found in the nutritional and medical literature. The Norwegian Directorate of Health gives the following definition of malnutrition: "A nutritional state where lack of protein, and/or other nutrients causes a measurable adverse effect on body composition and function, and clinical outcome" (6). This definition is based on the definition given from the European Society for Clinical Nutrition and Metabolism (ESPEN): "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" (7).

An International Guideline Committee was formed to develop a consensus approach to defining malnutrition syndrome for adults in the clinical setting. Through several meetings at The American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.) and ESPEN Congresses in 2009, the committee agreed that an etiology-based approach, taking into account the role of inflammation on the incidence and progression of malnutrition, would be the most convenient

way to define malnutrition syndrome for adults in clinical settings, and proposed the following terminology (8):

- "Starvation-related malnutrition": when there is chronic starvation without inflammation (e.g. anorexia nervosa).
- "Chronic disease-related malnutrition": when inflammation is chronic and of mild to moderate degree (e.g. organ failure, pancreatic cancer, sarcopenic obesity).
- "Acute disease or injury-related malnutrition": when inflammation is acute and of severe degree (e.g. major infections, burns, trauma).

The Academy of Nutrition and Dietetics (Academy) and A.S.P.E.N. accepted these definitions (9), and made a work group to try identify and standardize characteristics reflecting nutritional status vs the inflammatory response seen in diseases. Identification of two or more of the following six characteristics was recommended for diagnosis: weight loss, nutrition intake, functional status, muscle wasting, fat loss, and edema (9, 10). These recommendations to diagnose malnutrition are dynamic and still in progress.

New initiative from ESPEN challenges the definition based on etiology. ESPEN has tried to provide malnutrition diagnostic criteria independent of etiology and clinical setting. The objective is to unify international terminology of the condition, which makes it possible to make comparisons between countries and clinical settings, and to bring clarity to the nutritional terminology (5). ESPEN suggests the following two alternatives to diagnose malnutrition:

Step 1. Risk screening by a validated screening tool

Step 2. Diagnosis (two alternative diagnostic trajectories)

Alternative 1:

- BMI <18.5 kg/m^2

Alternative 2:

- Weight loss (unintentional) > 10% indefinite of time, or > 5% over the last 3 months combined with either
- BMI <20 kg/m^2 if <70 years of age, or <22 kg/m^2 if ≥ 70 years of age or
- Fat free mass index (FFMI) <15 and 17 kg/m^2 in women and men, respectively.

The four largest global parenteral and enteral nutrition societies (ESPEN, ASPEN, Parenteral and enteral nutrition society of Asia, and Latin America Federation of Parenteral and Enteral Nutrition) have started a Global Leadership Conversation to develop consensus approaches to malnutrition diagnosis. First meeting took place in 2016, and more meetings are planned the following year. Weight loss will likely become one of the consensus criteria, as well as dietary intake, inflammation/disease, and functional components (11) .

Despite all the terminology disagreement, there are some malnutrition-related concepts that are well-established: cachexia, sarcopenia, and frailty (5). These will not be further explained in this thesis.

1.1.2 Prevalence and consequences of malnutrition

Norwegian Directorate of Health reports that the prevalence of malnutrition in hospital patients and/or patients in nursing home care ranges between 10 % to 60 % (6). The prevalence of malnutrition will vary depending on which diagnostic criteria and/or screening method is used and patients' characteristics. Malnutrition at readmission affects the prognosis negatively; leading to longer hospital stay, higher risk for complications and infections, reduced convalescence and wound healing, increased morbidity and mortality and reduced quality of life (6, 12). During hospital stay additional weight loss has been seen for more than half of malnourished patients, which further leads to more physician visits (GP-visits), need for homecare and readmissions (6). Malnutrition is also an economical issue – longer hospital stay and readmissions cost more. The British Association for Parenteral and Enteral Nutrition (BAPEN) estimated that the cost of disease-related malnutrition is over 7 billion pounds per year in United Kingdom, corresponding to about 10 % of total health costs (13). Figure 1 presents the malnutrition carousel, a term introduced by Dr. Mike Stroud, a previous Chair of BAPEN, and sums up the prevalence and consequences of malnutrition (6, 14).

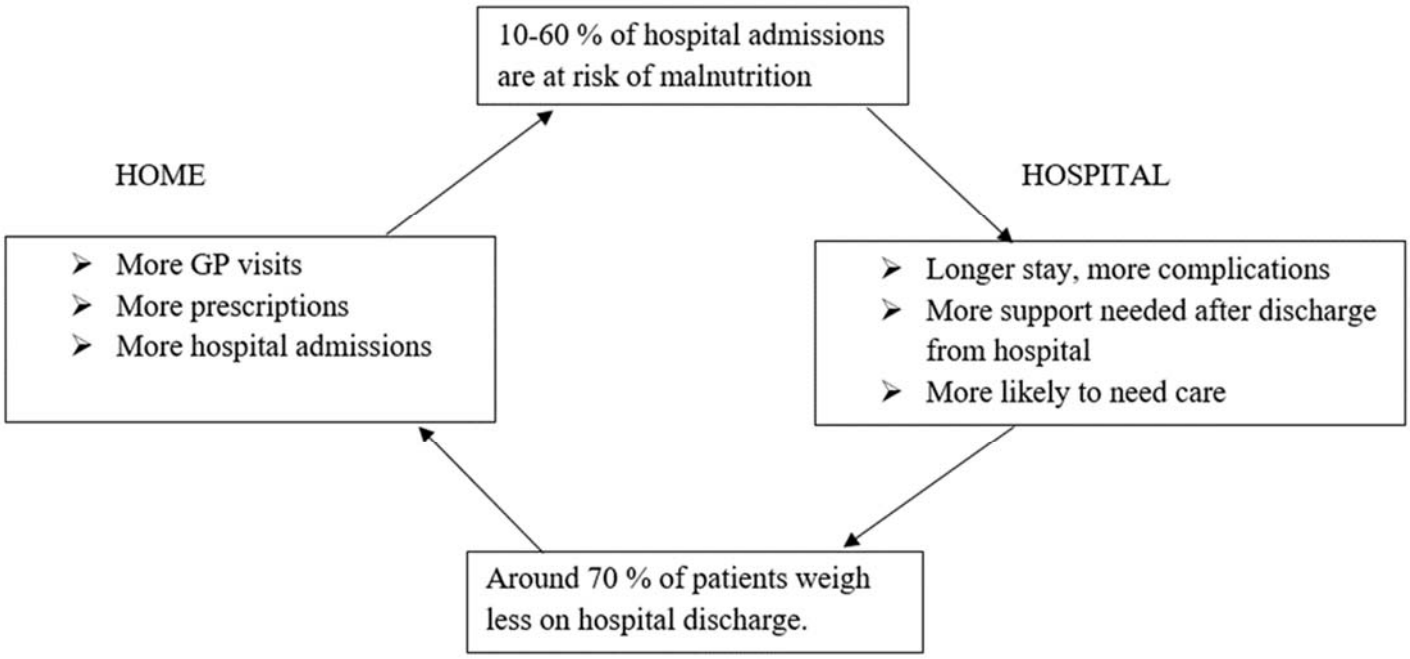


Figure 1: Malnutrition carousel

1.1.3 Causes of malnutrition

Malnutrition in developed countries is mainly caused by disease, but poor awareness and lack of education of hospital staff is attributable factors for the deterioration of nutritional status during hospital stay (12, 15). Causes of malnutrition in disease are multifactorial. Decreased nutritional intake, increased energy and protein requirements, increased losses together with inflammation probably play the central role in disease-related malnutrition (12). Increased requirements are due to altered metabolism caused by infection/inflammation. Lower appetite may be due to obstruction in digestive tract, inducing nausea or pain when eating. Anorexia may be a cause of drug-related side effects (e.g. chemotherapy, antibiotics).

1.2 Identify malnutrition

1.2.1 Nutritional risk screening

To prevent malnutrition in hospitals The European council recommends implementing nutritional screening to detect patients at nutritional risk. Patients at nutritional risk must be identified by a validated screening tool before any diagnose can be set – there is a strong worldwide consensus that malnutrition risk screening is the first step in the nutrition evaluation (11). Validated screening tools include Nutritional Risk Screening 2002 (NRS-2002) (16), Mini Nutritional Assessment (MNA) (17), Subjective Global Assessment (SGA) (18) and PG-SGA (19, 20). NRS-2002 is a screening tool recommended to use in hospital to identify patients at nutritional risk (6). The evaluation starts with an initial screening containing four simple questions (21):

- Is BMI < 20,5?
- Has the patient lost weight within the last 3 months?
- Has the patient had reduced dietary intake in the last week?
- Is the patient severely ill? (e.g. in intensive therapy).

If the answer is YES on one or more of these questions, the main screening shall be completed. If the answer is NO on all four questions, the initial screening shall be repeated weekly as long as the patient is hospitalized. In the main screening the nutritional risk is determined by the patient's nutritional state and risk of impairment of nutritional state, due to increased requirements (clinical state causing stress metabolism) (21). A nutritional care plan should be created for patients at nutritional risk (16).

1.2.2 Nutritional assessment

PG-SGA is a screening tool that covers all the domains of the definition for malnutrition by assessing nutritional balance, metabolic needs, muscle status, fat stores and fluid status (22). It can therefore work as a tool for both screening and assessing malnutrition (23). PG-SGA contain two parts, where part one is filled out by the patients and concerns weight, weight changes, food intake, nutrition impact symptoms, activity level and function. Part two is filled out by a health personnel and concerns diagnosis, age, metabolic stress, and a physical examination. All information is gathered in an overall assessment which categorizes the patients in three different categories A, B or C. Category A= well-nourished, B= moderately malnourished/suspected malnourished and C= severely malnourished (24). The PG-SGA was

adapted from SGA and developed specifically for oncological patients (19). SGA is a tool developed for assessing nutritional status of hospitalized surgical patients (24). Part two in PG-SGA also specifies nutritional recommendations based on PG-SGA point score, providing clinicians with clearer guidelines for level of nutrition therapy needed. Score > 9 indicates a critical need for improved symptom management and/or nutrient intervention.

Physical examination – evaluation of loss of muscle- and fat mass:

The Academy and A.S.P.E.N. suggest that a standardized diagnosis of malnutrition should include an evaluation of muscle and fat, and have established guidelines describing how to classify the loss of muscle and fat mass (10). Severe loss of muscle mass will result in very prominent bones around clavicle, shoulder (acromion), shoulder blade (scapula) and thigh region (10). Severe loss of fat mass can give a hollow look, dark circles and loose skin in the orbital region, very little space between folds in triceps, and ribs and iliac crest become very prominent. Clinicians must understand techniques identifying fat- and muscle wasting for it to be included in a malnutrition diagnosis (10). Proper training is essential for a reliable, consistent, and reproducible assessment. It is recommended that dietitians, as well as other clinicians, should incorporate these practices in the treatment of patients (10). Identifying fat- or muscle loss in overweight or obese patients can be challenging. Even though they are malnourished, there might not be any visible signs of it. Edema is another source of assessment error, therefore the upper body is most often used to identify losses of fat and muscles, as it is less affected by edemas, and more convenient assessable (10).

1.3 Nutrition in the surgical patient

1.3.1 Metabolic response in starvation and injury or surgery

Starvation due to fasting can be one cause of malnutrition in the surgical patient. The brain needs 100 g glucose every day – the blood glucose not used by the brain is stored as glycogen in the liver (approximately 200 g glycogen) and in skeletal muscles, and the rest is converted into fat (25). After 12 h of fasting the major fuel for the brain will be glucose from the liver storage. The reduced blood glucose levels lead to decreased insulin secretion and increased glucagon levels, which stimulate the breakdown of glycogen in liver (gycogenolysis) (25). Glycogen from skeletal muscles has to be converted into lactate within the muscle and then exported to the liver for conversion to glucose (Cori cycle) before it can be fuel for the brain (26). In starvation beyond 24 hours, glucose will be available from the breakdown of muscle protein for contribution of amino acids in hepatic gluconeogenesis. After a couple of days approximately 75 g of muscle protein will be broken down each day. The body desires to preserve body protein, so with a longer fast the liver gradually increase its capacity to produce ketone bodies from fatty acids (25) stimulated by the increasing glucagon levels (26). The brain adapts to use ketone bodies, thus reducing the need for gluconeogenesis and preserving vital muscle and visceral protein as much as possible (muscle breakdown up to 55 g/d) (25). Even though rates of protein breakdown decrease, the lack of substrate leads to reduced anabolism and a net catabolism. The metabolic adjustments that occurs in starvation causes a decreased resting energy expenditure (26).

Traumatic injury or major surgery is associated with negative nitrogen balance, and a higher loss muscle mass compared to the uncomplicated starvation. This is due to an accelerated catabolism (26). Metabolic stress, the response to surgery or injury, is associated with elevated levels of stress hormones like glucagon, catecholamine (adrenalin), cortisol, as well as increased glucose production and free fatty acids release (26). Insulin levels fall initially, but rise to excessively levels compared to what is normally needed for a given glucose concentration (25). The release of stress hormones and mediators contribute to an increase of gluconeogenesis, proteolysis and resting energy expenditure (26). All these mechanisms result in insulin resistance, glucose intolerance, loss of adaptive ketogenesis and breakdown of muscle protein (25). Nutrition is important during periods of inflammation and metabolic stress, but energy- and protein supplementation alone can only partly reverse or prevent muscle protein loss in active inflammatory states (10, 27, 28).

1.3.2 Malnutrition in gastrointestinal (GI) surgery:

Patients with GI-diseases are very prone to develop malnutrition, especially those with underlying cancer (29). Patients undergoing GI-surgery are at risk for malnutrition both because of insufficient food intake pre- and/or postoperatively and of stress from surgery with following increased metabolism (30). For patients undergoing surgery for GI-cancer, the cancer and the surgery will raise the metabolism, and increase the risk for malnutrition (30). Cancer has been estimated to cause at least 5% involuntary weight loss for approximately one-third of patients with cancer (31, 32). Weight loss associated with cancer or cancer cachexia is thought to be mediated by the production of cytokines such as tumor necrosis factor-a and interleukin-6, and other factors suppressing the appetite and promoting breakdown of muscle and fat (33). Patients with solid tumors, especially gastrointestinal, pancreatic, and lung cancers seems to have a greater weight loss and increased mortality (32, 34). Weight loss can be a consequence of malabsorption caused by different gastrointestinal conditions such as pancreatic insufficiency, celiac disease, diarrheal illness, inflammatory bowel disease (IBD) or peptic ulcer disease (31). Medications with gastrointestinal side effects, such as antibiotics, may cause weight loss through diarrhea. (31).

Several studies have shown that malnutrition in surgical patients results in more complications, a significant longer hospital stay, increased morbidity and mortality (30, 35-37).

1.3.3 Perioperative nutrition

Preoperative fasting:

The traditional preoperative fast has been used to prevent aspiration of gastric contents during anesthesia. Recent studies have found no scientific support that traditional fasting before midnight prevents pulmonary aspiration (38), it has, however, an adverse metabolic effect (39). Up to date the practice guidelines for preoperative fasting are more liberal; intake of clear fluids are allowed up to two hours before anesthesia and surgery, and light meals up to six hours before surgery (40). Intake of carbohydrate-rich drink preoperatively has shown to prevent the transition into fasting metabolism before surgery, reduce postoperative insulin resistance, be beneficial in patient's psychosomatic status, and has not been associated with increased risk for complications (39).

Enhanced Recovery After Surgery (ERAS):

ERAS is a term referring to a systematization and optimization of a perioperative care pathway, and is based on evidence-based practices for surgical patients. The aim is to reduce the stress

response following surgery and achieve early recovery after surgical procedures; improve it qualitatively, make it faster and more economically (41). Basic principals in perioperative patient care is preoperative counselling, preoperative nutrition, no bowel preparation, no preoperative fasting, avoidance of fluid overload (fluid restriction), reduction of stress (thoracic epidural anesthesia), avoidance of hypothermia, and early postoperative nutrition (41). Pain control is an essential part of perioperative phase, whereas acute severe pain can contribute to insulin resistance by decreasing the insulin sensitivity (42).

Nutritional supplementation:

Patients receiving postoperative nutritional supplementation has shown to lose less weight, require less antibiotic prescriptions, and have a better physical and mental health compared to control group (43). Cawood et al. (2011) concludes in their systematic review involving 36 randomized controlled trials and a series of meta-analyses of high protein oral nutritional supplements (ONS) that "There are clinical, nutritional and functional benefits resulting from high protein ONS use and the available evidence suggests little suppression of normal food intake, with ONS being mostly additive to food intake" (44). ONS has led to significant decreases in length of hospital stay (LOS), cost and readmission (45). It has been estimated that for every dollar spent on ONS saves $52.63 in hospital costs (45). Postoperative complications can be significantly reduced by supplementation and tube feeding in several patients group, e.g. surgical patients, elderly, and liver disease (46). Enteral tube feeding is used when oral intake is contraindicated, or patient cannot consume adequate food and/or ONS orally. There are several reviews and meta-analyses highlighting the benefits of tube feeding in patients with or at risk of malnutrition: GI surgical patients have earlier return of GI function, lower rate of reoperations and postoperative complications, lower mortality, shorter LOS, improved wound healing and less parenteral nutrition use (46).

1.3.4 Preoperative practice

Over the last century there has been a great improvement in the clinical management for surgical patients; with the availability of prophylactic antibiotics, intravenous fluids and colloids, increased understanding of anesthetic agents and analgesics, specialist critical care units and an increased understanding of organ function preoperatively (2). Nutrition has also become an integrated component of surgical care, but still a gap between recommended nutrition care and the actual practice of nutrition care is observed (15, 30). An essential step towards improving

perioperative nutritional status is finding good, validated and standardized methods to screen for malnutrition risk that is also quick and easy to use.

Patients at the gastroenterological surgical department at St. Olavs Hospital come to preoperative counselling and examination at the outpatient clinic for preparations for surgery, where the aim is to reduce the length of stay in hospital. At the outpatient clinic, the patients are seen by the surgeon, anesthesiologist, pharmacist, nurse, physiotherapist and other clinicians for consultations, information about the elective surgery and the course of treatment is given, blood tests will be taken, and some patients have to take radiograph. Information about the importance of good nutritional status from a dietitian is not routinely practiced. Patients arrive the hospital in fasting condition same day as the surgery. There is no knowledge of publications from Norway about nutritional status in patients with gastrointestinal diseases attending the outpatient clinic for preoperative preparations.

1.4 Aim of the study

The aim of this study is to describe the nutritional risk, nutritional status, and diet before upper and/or lower gastroenterological surgery and one month after surgery in patients at preoperative gastroenterological outpatient clinic at St Olavs Hospital in Trondheim.

1.4.1 Research question:

The project has three research questions:

1) What is the prevalence of nutritional risk (NRS-2002) and malnutrition (PG-SGA) for patients undergoing elective upper or lower GI-surgery?
2) Which screening tool (NRS-2002 and PG-SGA) can predict postoperative complications and length hospital stay best?
3) How does the diet change from before surgery to one month after surgery (energy intake, protein intake and meal pattern)?

2. METHODS

2.1 Study design

The study was a prospective observational study and was carried out at the department for gastroenterological surgical section, St Olavs Hospital, Trondheim, in collaboration with the University of Bergen (UiB). The project was approved by the head of the clinic Birger Endreth at the clinic of surgery and the department manager for the outpatient clinic and bed units Nina Hassel. Data collections were carried out from September 2016 to January 2017.

2.2 Recruitment

Study participants were recruited consecutively among patients at the preoperative outpatient clinic for gastroenterological surgery at St. Olavs Hospital from September 2016 to December 2016. In cooperation with the admission office the patients received information about the study and the consent form along with the admission letter. The master student was responsible for contacting the admission office, and to write the information paper and consent form. Some patient admissions were sent out prior to the study start-up, hence some patients received the information papers the day they met at the outpatient clinic.

2.2.1 Inclusion and exclusion criteria

Inclusion criteria:

- Meeting at preoperative outpatient clinic for elective gastroenterological surgery
- Adult patients (>18 years)
- Written consent form

Exclusion criteria:

- Patients with difficulties communicating orally
- Patients with cognitive impairment

2.3 Course of the study

The patients were interviewed before surgery at the preoperative outpatient clinic, and about one month (4-6 weeks) after surgery over the phone.

Table 1: Overview of data collection in the survey period

	Preoperative outpatient clinic	One-month after surgery
Consent form	✓	
Clinical data from journal	✓	✓
Patient characteristics	✓	
Blood tests	✓	
Nutritional screening (NRS-2002) and nutritional assessment (PG-SGA)	✓	
Height	✓	
Weight	✓	✓
Triceps skinfold thickness (TSF)	✓	
Mid upper arm circumference (MUAC)	✓	
Waist circumference	✓	
Hand grip strength (HGS)	✓	
24 hours recall (Appendix 4)	✓	✓

2.4 Data collection

2.4.1 Clinical data

Patients' characteristics were collected from the patients' medical records: Age, gender, marital status, smoking, alcohol, primary diagnosis, type of surgery, comorbidities, medications, neoadjuvant treatment, clinical-chemical blood tests. Smoking and alcohol habits were also requested in conjunction with the 24 h recall. Comorbidities selected were heart disease, diabetes mellitus type 1 and 2, chronic obstructive lung disease, chronic kidney disease. Medications that could have an impact on food intake, such as steroids, insulin and Ciproxin were registered. Neoadjuvant treatment includes radiotherapy, chemotherapy or radiochemotherapy. Blood tests were taken routinely at the outpatient clinic and values were collected from the medical records. Blood tests registered included hemoglobin, creatinine, albumin, and C-reactive protein. Type of surgery was controlled postoperatively, since some planned surgeries were changed. Final surgical intervention was described in the patients' electronic journals epicrisis along with length of hospital stay (LOS) and postoperative complications. However, not all complications were documented in the epicrisis, and had to be collected from the doctors' notes. Postoperative complications after GI-surgery such as wound infection, sepsis, intra-abdominal abscess, pneumonia, intestinal fistula, postoperative ileus, wound dehiscence, chylous leakage, anastomotic leakage, postoperative bleeding, cardiac infarction, mortality, were selected.

2.4.2 Nutritional assessment

Anthropometry:

The anthropometric measurements were done at the outpatient clinic, and were carried out by the master student. Pre- and postoperative weight were measured by the patients at home. Different weight scales will vary dependent on type and brand, and time since last calibration, and it was desired that patients were weighed on same scale for both measurements. Patients were therefore requested to weight themselves at home ahead of the outpatient clinic in the information paper, and they were also requested to weight themselves the same week as the follow-up telephone call. The master student relied on the self-reported weights. When patient had not weighed him-/herself at home, weight was measured at the outpatient clinic using a Seca scale. When weighed with clothes 0.5 kg was subtracted from the measurement, when weighted with clothes and shoes 1.0 kg was subtracted from the measurement. Weight change

(-kg and -%) pre- to postoperatively was calculated for all participants. A weight loss of 5% (weight change of -5%) or more will be referred to as a potentially significant weight loss (31).

Height was also self-reported, and only measured when the patients did not know or had not been measured recently, using a Seca mechanical wall-tape with graduation 1 mm. Waist circumference is often used as an indication of intraabdominal fat to evaluate the risk for metabolic syndrome, diabetes, and coronary heart disease (47), and was measured using a measuring tape between lowest rib and iliac crest. Mid-upper arm circumference (MUAC) was measured at the mid-point between the tip of the shoulder and the tip of the elbow (olecranon process and the acromium) using a measuring tape. Triceps-skinfold thickness (TSF) was measured at the same point as MUAC with a Holtain caliper, using the mean of three measurements. TSF is a measure of subcutaneous fat. Mid-upper arm muscle circumference (MUAMC) can be used as an estimate of muscle mass and is calculated from MUAC and TSF (MUAMC = MUAC – (3.14 x TSF x 0.1) (48).

Table 2: Reference values for Triceps skinfold thickness (TSF) and mid-upper arm muscle circumference (MUAMC).

	All ages (> 19)	**Mean**	**Moderate malnutrition (10-percentile)**	**Severe malnutrition (5-percentile)**
TSF (mm)	Men	11.3	6	5
	Women	20.1	12	10
MUAMC	Men	25.7	22	22
	Women	21.2	19	18

Reference values from Symreng et al. (1982) (49).

Hand grip strength:

Hand grip strength (HGS) has been demonstrated to independently predict nutrition status (50). HGS was measured for all patients using Jamar hydraulic hand-dynamometer. Patients performed the test sitting in a chair, with relaxed shoulders and elbow joint in a 90 degrees' angle. The patient's dominant hand was used for the assessment. Patients were asked to complete a maximal isometric contraction. The master student gave a demonstration and then

asked the patient to “squeeze as hard as you can, harder, harder, relax”, saying relax after 3 seconds. The mean of three measurements were calculated.

Nutrition intake:

A dietary interview, using the 24-hour recall method (51), was done in all patients at the outpatient clinic, and 4 weeks after surgery. Weight and amount of food were estimated using a picture booklet of different serving sizes, developed by NORKOST. Patients received a copy of the booklet for the follow-up interview. The follow-up dietary interview over the phone was done approximately one-month after surgery.

NRS-2002

Patients were screened for nutritional risk determined by NRS-2002 screening tool (Appendix 2). The main screening was done for all patients. In the main screening points from 0-3 is given for nutritional status (determined by the patients BMI, percentage of weight loss the last three months and food intake the last week) and for degree of stress metabolism which is evaluated based on disease category. Patients aged 70 years and above get one additional point for age. Patients who scored ≥ 3 were classified as being at nutritional risk (at risk). A score < 3 was classified as not at nutritional risk (not at risk).

PG-SGA

Patients were screened for nutritional status determined by PG-SGA (Appendix 3). Page one was filled out by the patients. The master student assisted the patients, who had reading and writing difficulties. Page two was filled out by the master student. The diagnose, age and metabolic stress were found in the patients’ medical record, while the physical examination was evaluated during the consultation with the patient. The master student examined the patients’ temple, clavicle, shoulder and interosseous to score muscle status, and observed bony legs and/or thighs. Triceps skinfold, orbital fat clavicle, and fat overlying lower ribs were examined for the fat status score, and ankle edema for fluid status score. The overall assessment involves weight, food intake, symptoms, function, and physical examination, and determine whether the patient belongs to category A= well nourished, B= moderately malnourished/suspected malnourished or C= severely malnourished. The category is decided based on to what degree the patient meets the different factors. Category B and C were merged together for simplicity. From now on the categories will be referred to as PG-SGA A or well-nourished and PG-SGA B+C or malnourished.

2.5 Data analysis

2.5.1 Calculation of energy and protein intake

The data from the 24 h recalls (Appendix 4) were entered into the software "Kostholdsplanleggeren" (Dietary planner), and energy- and protein intake were calculated by means of the Dietary planner using the Norwegian National Food composition tables. Amount and weight of food were estimated using the picture booklet with an associated codebook, where participants point out the pictures that corresponds best to their amount. Each picture has an associated code with amount in grams for each code. The standard portions suggested by "Kostholdsplanleggeren" were used when amount and weight of a food item were difficult to estimate using the picture booklet. Preoperative energy and protein intake were registered and compared to the postoperative energy and protein intake. Nutritional supplements like omega-3 fatty acids were included. Intake of water and other non-caloric beverages were not registered.

2.5.2 Meal pattern

Total meals for the two days (pre- and postoperative 24-hours recall registration) were registered. Meals were classified into two categories, main meals and snacks. Breakfast, lunch, dinner, and evening meals were in general classified as a main meal, whereas smaller meals such as fruit, caloric beverages, sweets, cake, or other in-between meals were classified as snack.

2.5.3 Energy intake vs. energy need

Estimated basal metabolic rate (BMR) was calculated using the "Harris-Benedict formula". For patients with BMI >30 kg/m^2, Mifflins equation (48, 52) was used to correct for obesity. Estimated physical activity level (PAL) was calculated for each participant using estimated BMR and actual energy intake preoperatively (estimated PAL= Kcal/BMR). PAL is a way to express a person's daily physical activity, and is used to estimate a person's total energy expenditure. PALs are expressed as numbers representing different lifestyles: 1.2 indicate a person bedridden or inactive, 1.4 indicate a sedentary lifestyle (e.g. office worker getting no exercise), 1.6 indicate sedentary work and some physical activity, and 1.8 indicate moderately active and work consisting of standing/walking most of the day (48).

2.6 Statistical analysis

All data were plotted into IBM SPSS Statistics version 24 which also was used to perform statistical analysis. Shapiro Wilk normality test, QQ-plot and histogram were used to test for data normality. Continuous data were presented as mean ± SD and range, or as median/IQR (interquartile range) when not following a normal distribution. Categorical data were presented as frequencies. Chi-square test was performed to study the relationship between categorical variables, or Fischer's exact test if violation of the assumption that at least 80 % of cells should have expected frequencies of 5 or more. Independent sample t-test was used to compare means of two groups, paired t-test was used to compare means of two sets of data. When not following a normal distribution Mann Whitney U test or Wilcoxon test was used, respectively. Spearman's rank order correlation was used to study the relationship between LOS and several variables. Multiple and logistic regression were used to study the ability of several variables to predict complications and LOS. A p-value of 0.05 or less was considered significant.

2.7 Ethics

The study protocol was approved by Regional Ethics Committee in September 2016 (Appendix 6). All participants signed a written consent. Information about participants was stored on a secured area on the intranet where only the master student and the supervisor had access. This way the confidentiality was ensured.

3. RESULTS

3.1 Study population

Participant flow is described in a flowchart in Figure 2. In total, 191 patients were asked to participate in the study. Sixty-five patients did not want to participate. Reasons given for not participating were exhaustion, had enough to think about concerning their disease, or believing the inclusion would take a lot of time. Ten patients were excluded before inclusion; five patients had their surgery canceled, and the remaining five patients had difficulties communicating. A total of 116 patients gave their consent. Fifteen patients were excluded after inclusion because of canceled surgery after visiting the preoperative outpatient clinic. At inclusion, the 24 h recall method was not performed on four patients, due to difficulties communicating over phone postoperatively. The reason for their inclusion was that with help from family coming with them, the information concerning nutritional screening and -assessment was considered valid. Another 15 patients did not answer for the follow-up telephone call.

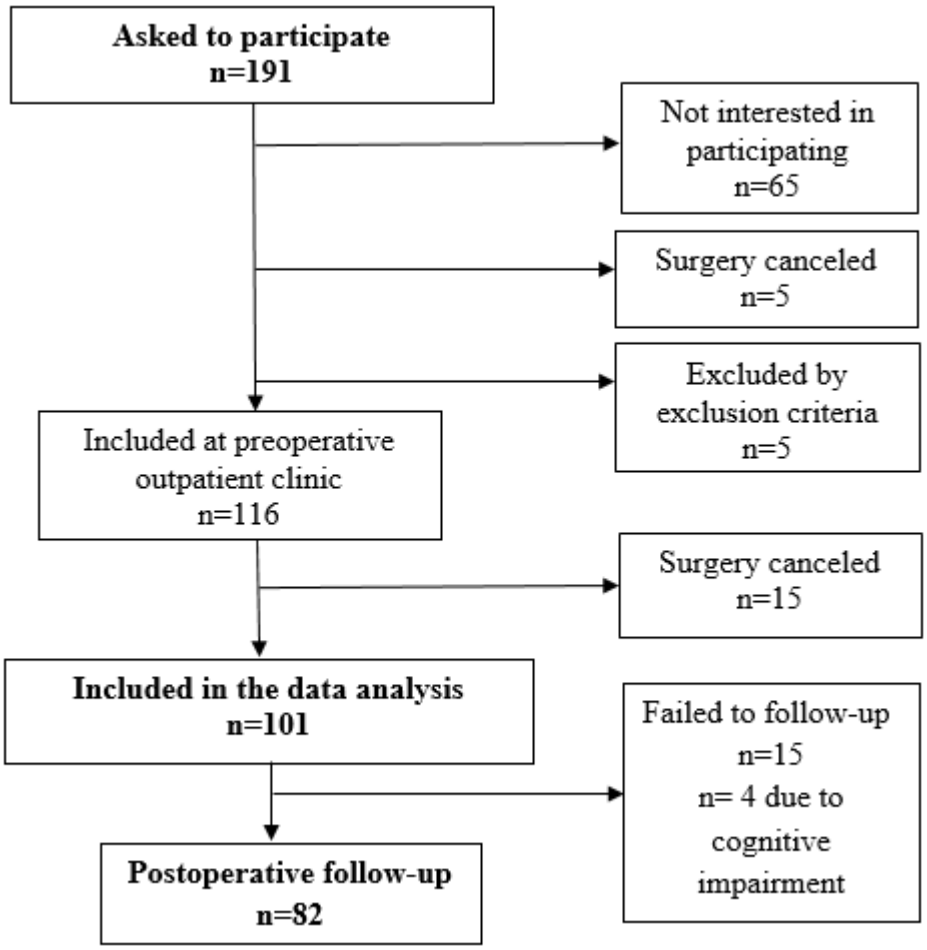


Figure 2: Flowchart. Overview of participant recruitment from preoperative gastroenterological outpatient clinic.

A description of the study population is presented in Table 3. There were 59 males and 42 females. Mean age was 60 years, and mean BMI was 26 kg/m^2. Number of patients living alone was 22. Eleven patients were active smokers. Some variables have missing values, as for one patient who could not measure height due to amputated legs, and one patient could not hold the hand-dynamometer because of pain in both hands. In addition, certain blood tests were not taken for all patients (e.g. C-reactive protein). Loss to follow-up caused missing values for food intake and weight after surgery in 15 patients.

Table 3: Patients' characteristics at inclusion, all patients (n=101), performed 24 h recall (n=97) and available for follow-up (n=82).

Variable	Total (n=101)	Preop[1] (n=97)	Preop[2] (n= 82)
GENDER (M/F)	59/42	57/40	49/33
AGE (years) [mean ± SD, range]	60 ± 17 19-93	59 ± 16 19-86	59 ± 16 19-86
BMI (kg/m^2) [mean ± SD, range]	26 ± 5 16-40	26 ± 5 16 – 40	26 ± 5 16-40
MARITAL STATUS			
Married/Domestic relationship	79	77	66
Living alone	22	20	16
SMOKING			
Yes	11	11	11
No	90	86	71
COMORBIDITIES			
Diabetes mellitus type 1 and 2	13	11	10
Osteoporosis	6	6	6
Heart disease	42	38	34
Chronic kidney disease	5	5	4
Chronic obstructive lung disease	6	6	6
Other [a]	12	12	10
MEDICATIONS [b]			
Steroids	7	7	7
Antidepressant	6	6	5
Insulin	4	4	3
Ciproxin	3	3	3
NEOADJUVANT TREATMENT			
Radiotherapy	1	1	1
Chemotherapy	5	5	2
Radio chemotherapy	10	9	9
BLOOD TESTS [c]			
Albumin, Alb (g/L) [mean ± SD, range]	42 ± 2.3 37 - 48	42 ± 2.3 37 - 48	43 ± 2.3 37 - 48
Creatinine (umol/L) [median/IQR]	74/28 37-743	73/23 37 - 743	73/23 42 - 743
Hemoglobin, Hb (g/dL) [mean ± SD, range]	14 ± 1.7 8.8 - 18	14 ± 1.7 8.8 - 18	15 ± 1.7 8.8 - 18
C-reactive protein, CRP (mg/L) [d] [range]	<5 - 81	<5 – 81	<5 – 81
Estimated basal metabolic rate, BMR (kcal) [mean ± SD, range]	1518 ± 240 1014 -2221	1525 ± 239 1014 - 2221	1533 ± 246 1014 - 2221

Data are presented as n, mean ± SD, median/IQR, range.

1: Performed 24h recall; 2: Available for follow-up.

a: Other comorbidities: 4 hypothyreosis, 2 metastasis liver and intrahepatic bile ducts, 1 acute myeloid leukemia, 1 chronic leumfocytic leukemia, 2 depression, 1 liver steatosis, 1 Mb. Crohns.

b: medications that can affect food intake

c: Reference values: Alb (18-39 years: 36-48 g/L, 40-69 years: 36-45 g/L, >70 years: 34-45 g/L); Creatinine umol/L (Men > 15 years: 60-105 umol/L, Women > 15 years: 45-90 umol/L); Hb (Men > 14 years: 13,4-17,0 g/dL, Women > 14 years: 11,7-15,3 g/dL); CRP (< 5 mg/L)

d: CRP< 5 (n=17); CRP>5 (n=10).

Primary diagnoses were cancer (n= 47), tumor unspecified (n=20), IBD (n= 13), and other diseases (n=21). Tumor unspecified involves adenomatous/benign polyps and/or tumor unspecified. Other diseases include diagnoses not included in the other categories. For details, see Appendix 1. Figure 3 and 4 illustrates the distribution of nutritional risk (NRS-2002) and nutritional status (PG-SGA), respectively, in patients with different primary diagnosis.

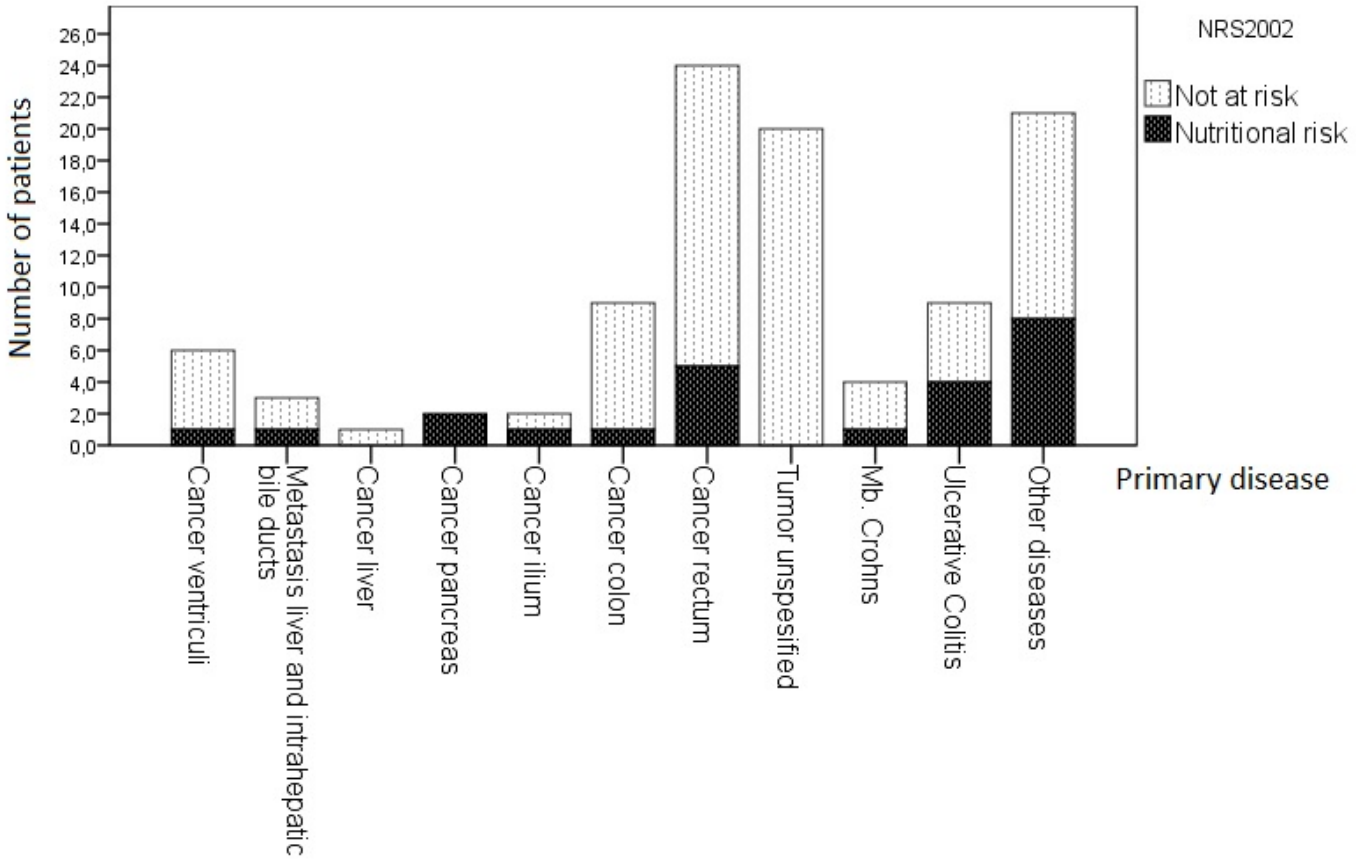


Figure 3: Primary diagnosis for all patients (n=101), and distribution of NRS-2002 (not at risk (n= 77) and at risk (n=24)).

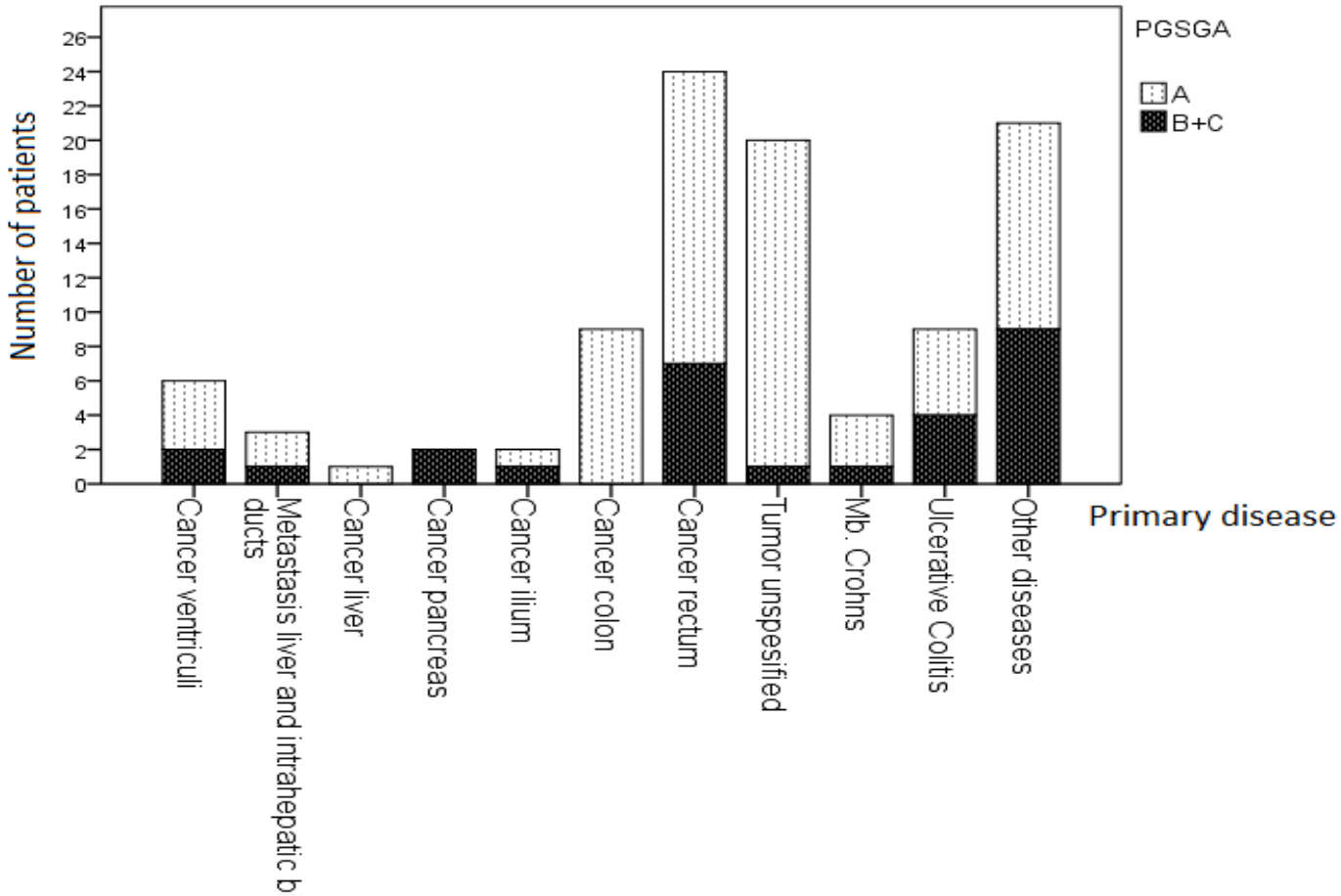
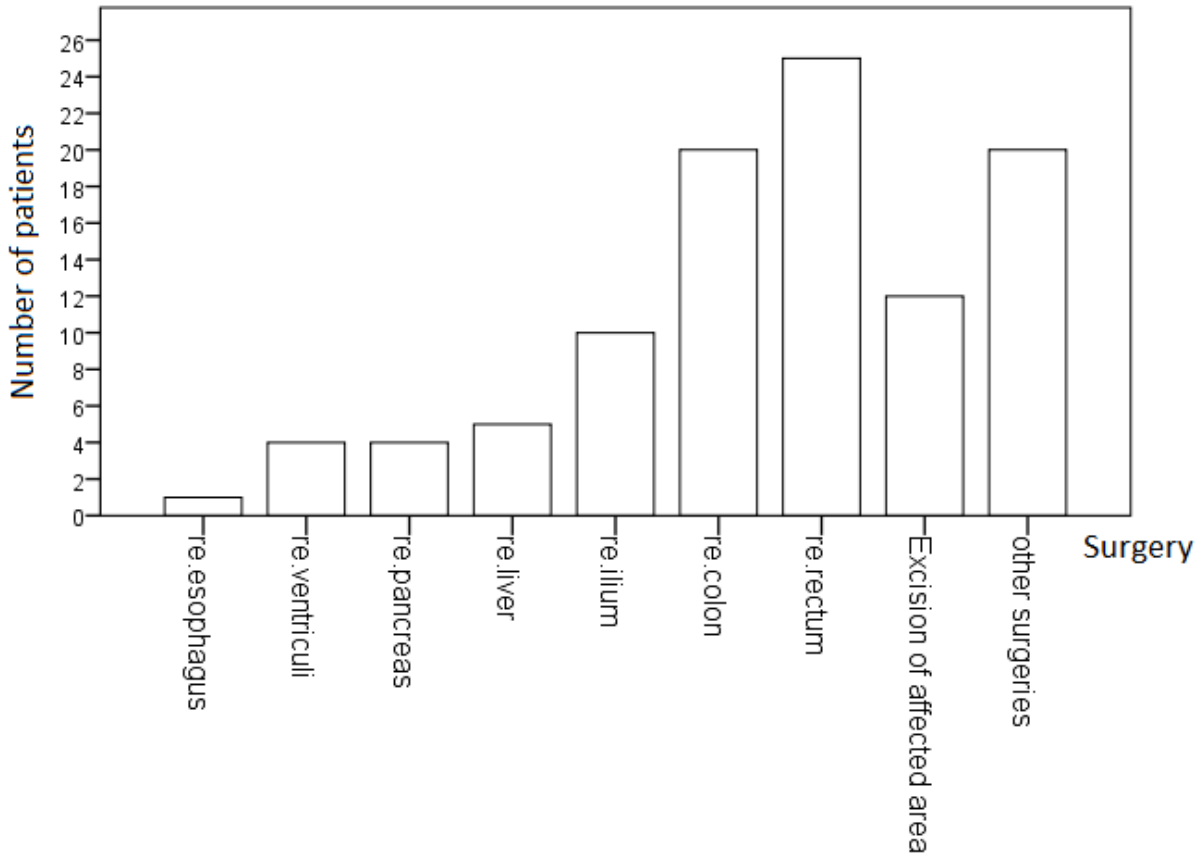


Figure 4: Primary diagnosis for all patients (n=101), and distribution of PG-SGA (A (n=73) and B+C (n=28)).

Figure 5 presents distribution of the different GI-surgeries for all patients. For statistical purposes type of surgeries were categorized into four categories: "Upper GI-surgery" (esophagus, ventricular, pancreas, liver, ileum), "lower GI-surgery" (colon, rectum), "excision of affected area" and "others". Excision of affected area involves sling and biopsy. Other surgeries include minor surgeries not included in other categories (Appendix 1). Eighteen patients had in addition to the resection a stoma surgery (temporarily ileostomy (n=8), terminal colostomy (n=7), permanent ileostomy(n=3)). Six patients had in addition a cholecystectomy (n=3), cystoprostatectomy (n=1) or hysterectomy (n=2).



Re= resection.

Figure 5: Distribution of GI-surgeries for all patients (n=101).

Age was approximately equally distributed in the groups of nutritional risk and nutritional status. The prevalence of patients ≥ 60 years ranged from 57% to 60%. The prevalence of women was higher in groups of nutritional risk (54 %) and malnutrition (61 %), compared to those not at risk (38 %) and well-nourished (34 %). A significant lower mean MUAMC and median HGS were measured in patients at risk and malnourished, compared to patients not at risk and well-nourished (Table II-A1, Appendix 1). An overview on the anthropometric measurements, and MUAMC and HGS in men and women are presented in Table I-A1 (Appendix 1), and shows however that MUAMC and HGS are significant lower in women compared to men.

3.2 Preoperative nutritional status determined by NRS 2002 and PG-SGA

There were 24 patients (24 %) at nutritional risk (NRS ≥ 3) when using NRS-2002 (Table 4). Twelve of 24 patients (50 %) at risk scored on age (≥ 70 years), and 22 of 77 patients (29 %) not at risk scored on age. None scored 3 on severity of disease (head injury, bone marrow transplantation, intensive care patients).

Table 4: Distribution of NRS-2002 main screening scores for patients defined at risk (≥ 3) and not at risk (< 3).

Main screening	**Score**	**Score < 3 n=77**	**Score ≥ 3 n= 24**
1. Impaired nutritional status	0	62	-
	1	15	11
	2	-	10
	3	-	3
2. Severity of disease	0	29	-
	1	48	21
	2	-	3
	3	-	-
3. Age	0	55	12
	1	22	12

Data are presented as n.

When using PG-SGA there were 28 malnourished patients (28 %), where n=27 were moderate or suspected malnourished (PG-SGA B) and n=1 was severely malnourished (PG-SGA C). The relation between numerical PG-SGA-score and categorical score (A and B+C) is illustrated in Figure 6. Numerical PG-SGA-score for malnourished patients (B+C), ranged from 6-16. Well-nourished patients present a numerical score of 0-7. Twenty-two patients obtained a numerical score of 9 or more. A total of 31 patients (31 %) had symptoms affecting food intake (box 3 in PG-SGA). Information about type and number of symptoms obtained from box 3 is presented in Table III-A1 (Appendix 1). Eighteen patients ticked off for two or more symptoms, and three patients had as much as five symptoms, contributing to a high numerical PG-SGA score. "No appetite or just did not feel like eating" (n=10) and "subjected to pain" (abdominal or anal pain)

(n=11) were symptoms reported most frequently. Four out of 28 malnourished (B+C) patients reported “no problem eating”.

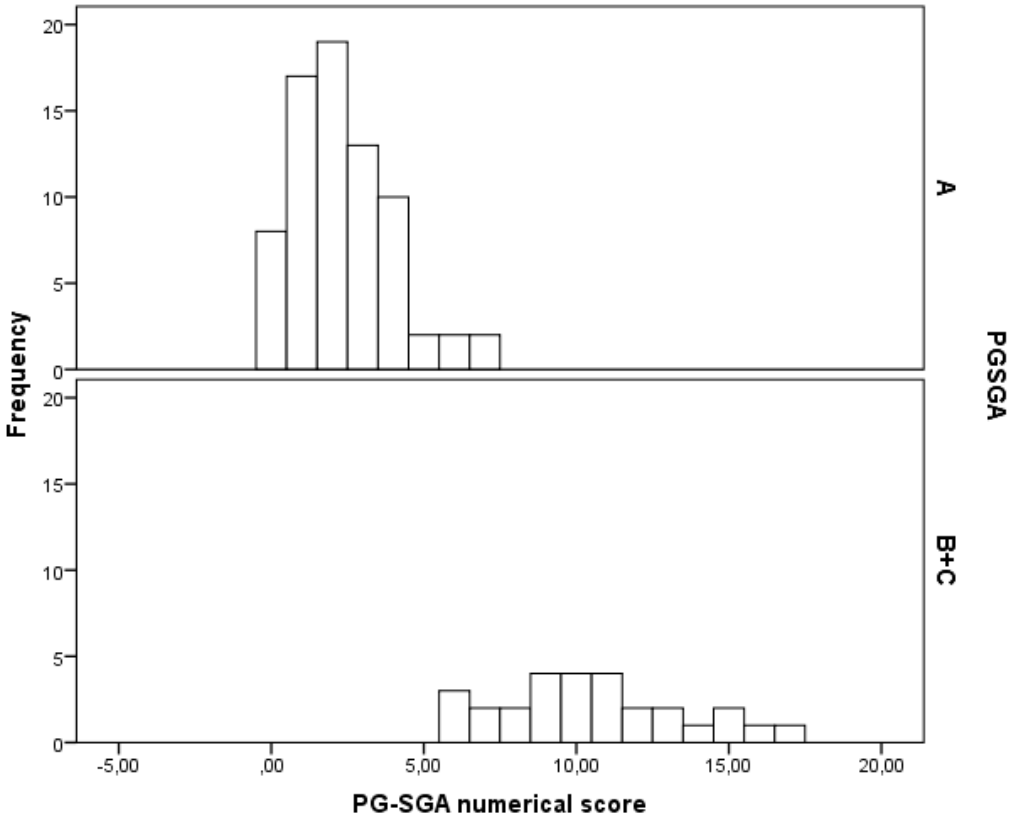


Figure 6: Relation between PG-SGA numerical score and PG-SGA categorical score.

Patients with GI-cancer were 47, of which 11 patients (23 %) were at risk and 13 patients (28 %) malnourished. A Venn diagram of NRS-2002 and PG-SGA for all patient (n=101) is illustrated in Figure 7. Six patients were characterized as malnourished, but not at risk. Description of these patients:

- Five had cancer,
- High score for symptoms in box 3 (Table III-A1) in PG-SGA,
- Four were 65-69 years, one was ≥ 70 years,
- Five had a NRS-2002 score of 2: Impaired nutritional status score (= 1), and disease severity score (= 1).

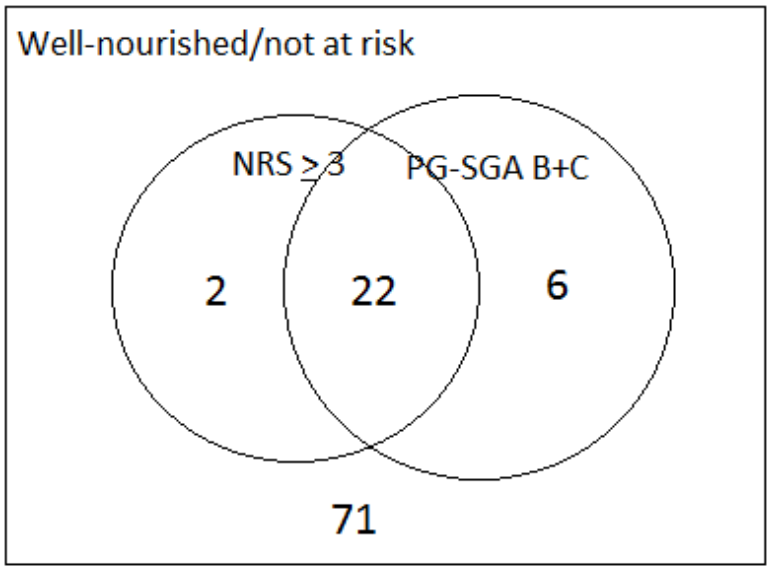


Figure 7: Venn diagram of NRS-2002 and PG-SGA.

3.3 Postoperative complications and LOS

Postoperative complications were documented in 20 patients, and 11 of them had more than one complication. The most common complication was infection (pneumonia, urinary tract infection, wound infection) affecting 11 patients. There were 4 patients with postoperative inflammation (cystitis, gastritis, tubule interstitial nephritis), 5 patients with postoperative bleeding, 5 patients with anastomotic leak, 1 patient with urosepsis, and 9 patients with other complications not specified in the other categories (wound dehiscence, stoma complication, unspecified abdominal pain and obstruction, urinary retention, complete heart block, respiratory failure, hypotension). One patient died because of uncontrolled bleeding during surgery.

Eight patients having a complication were at nutritional risk, and eight patients were malnourished. One patient with anastomotic leakage was not categorized as malnourished, and one patient with gastritis was not categorized at risk. More details of type and number of complications, and its' distribution in NRS-2002 and PG-SGA can be found in Table IV-A1 (Appendix 1).

Reoperation and readmission were not classified as complications, but as an outcome or a result of a complication. Six patients had a reoperation, five of them due to anastomotic leak. One was due to a stoma complication. One patient had a readmission.

Figure 8 and 9 illustrate the distribution of LOS for patients at risk compared to not at risk (NRS-2002) and patients malnourished compared to well-nourished (PG-SGA), respectively.

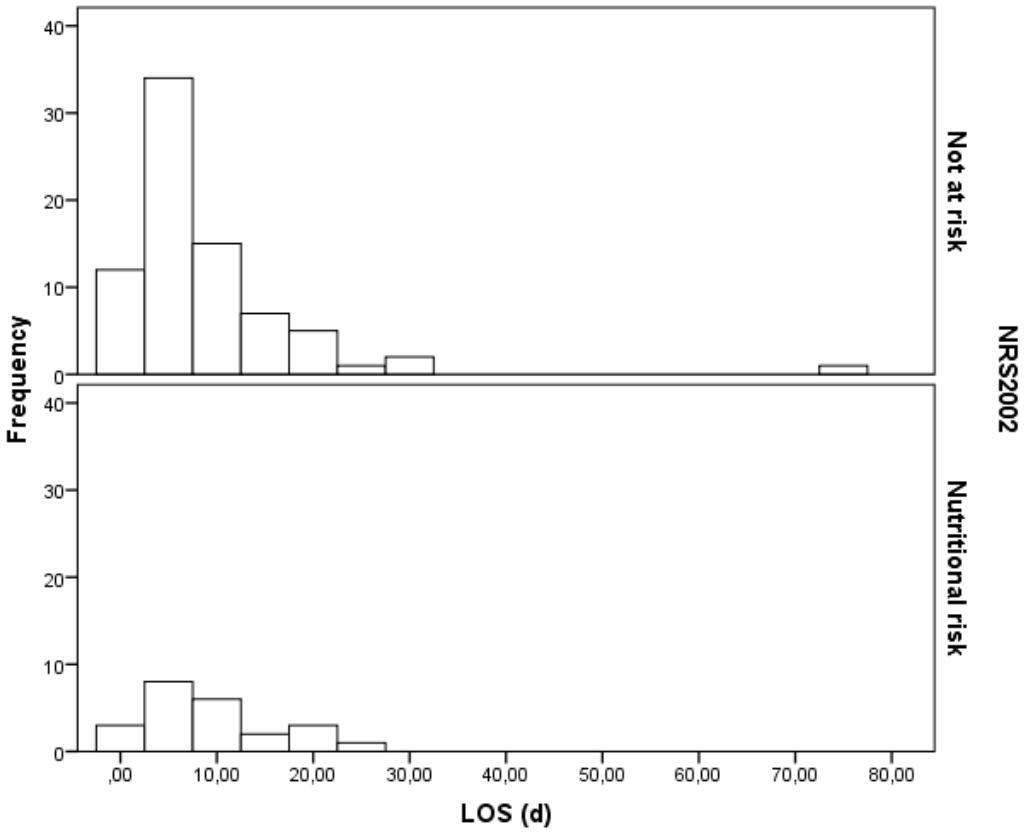


Figure 8: The distribution of length of hospital stay (LOS) in nutritional risk group and not at risk group for NRS-2002.

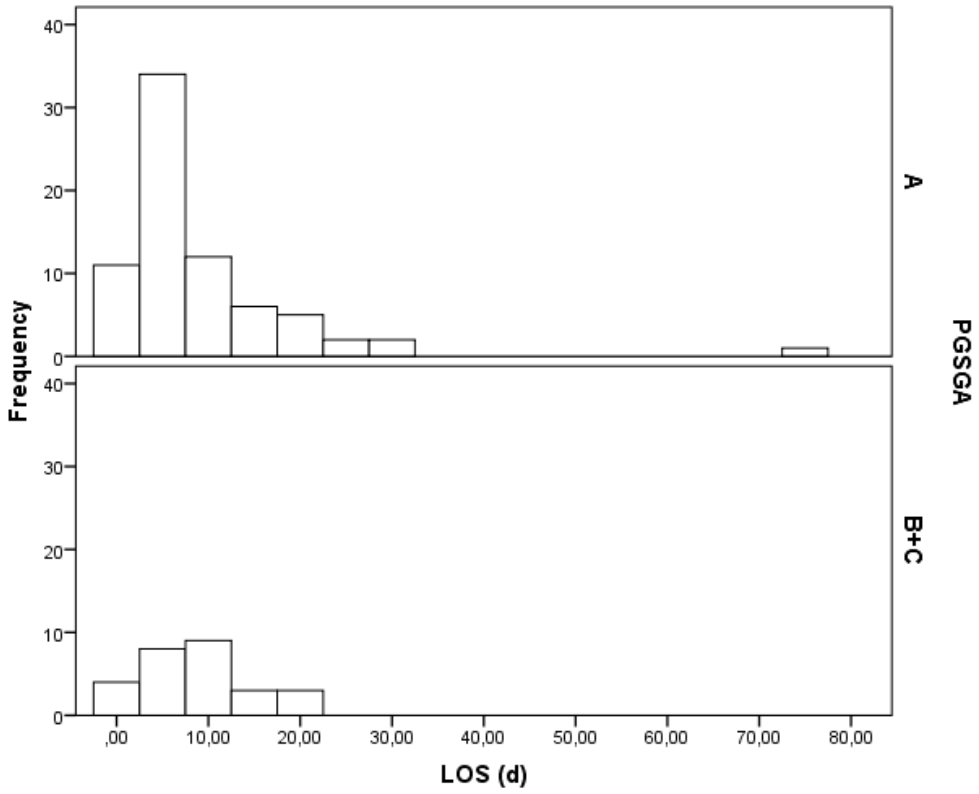


Figure 9: The distribution of length of hospital stay (LOS) in group A and group B+C for PG-SGA.

Descriptive statistics (median/IQR, range) of LOS for different influencing factors (nutritional risk, nutritional status, surgery, co-morbidity, age group, BMI group, significant weight loss) are presented in Table 5 and Table 6. No significant differences in median LOS were observed between patients at risk compared to not at risk, or malnourished compared to well-nourished. Significant differences in LOS were seen for type of surgery, and weight loss. A weight loss ≥ 5 % (from outpatient clinic to one-month after surgery) was significantly associated with longer LOS compared to weight loss < 5% or no weight loss. Complication incidence for different influencing factors is also presented in Table 5 and 6. Age ≥ 60 years and having two or three co-morbidities were the only factors significantly associated with higher incidence of complications.

Table 5: Influencing factors (NRS-2002 and PG-SGA) on LOS and complication incidence.

Influencing factors	**N**	**LOS (days)***	***p-value[a]***	**Complication Yes (%)**	***p-value[b]***
Total					
	101	6.0/8.0 0-74		20 (20 %)	
Nutritional risk (NRS-2002)					
< 3	77	6.0/7.0 0-74		12 (16 %)	
≥ 3	24	8.0/9.0 0-26	*0.330*	8 (33 %)	*0.078*
Nutritional status (PG-SGA)					
A	73	6.0/7.5 0-74		12 (16 %)	
B + C	28	8.0/9.0 0-22	*0.521*	8 (29 %)	*0.171*

Data are presented as n (%), median/IQR, range.

* LOS: missing value for one patient.

a: Testing difference in mean for LOS (Mann Whitney U test) between different influencing factors.

b: Testing difference in incidence complications (Chi-square test, Fischer's exact test) between different influencing factors

Table 6: Other influencing factors on LOS and complication incidence.

Influencing factors	**N**	**LOS (days)***	***p-value*[a]**	**Complication Yes (%)**	***p-value*[b]**
Surgery					
Other	20	3.0/3.0 0-22		2 (10 %)	
Excision of affected area	12	2.0/3.8 0-17		1 (8 %)	
Lower-abdominal	45	8.0/8.5 0-28		13 (29 %)	
Upper-abdominal	24	9.0/6.0 4-74	*< 0.0001*	4 (17 %)	*0.196*
Co-morbidities					
0	46	6.0/7.0 0-23		6 (13 %)	
1	28	6.0/8.0 0-31		4 (4 %)	
2-3	27	8.0/10.0 0-74	*0.224*	10 (37 %)	*0.032*
Age group					
< 60 years	41	6.0/6.0 0-23		3 (7 %)	
≥ 60 years	60	6.0/11.0 0-74	*0.138*	17 (28 %)	*0.009*
BMI group					
> 25 kg/m^2	58	8.0/10.0 0-31		11 (19 %)	
≤ 25 kg/m^2	40	6.0/7.0 0-74	*0.221*	9 (23 %)	*0.670*
Weight loss %**					
< 5 %	58	6.0/6.3 0-22		8 (14 %)	
≥ 5 %	22	9.5/15.0 4-74	*0.001*	7 (32 %)	*0.105*

Data are presented as n (%), mean ± SD, median/IQR, range.

*LOS missing value for one patient.

**Weight loss (from before surgery to one month after surgery) missing value for 21 patients.

a: Testing difference in median LOS (Mann Whitney U test, Kruskal-Wallis Test) between different influencing factors.

b: Testing difference in complication incidence (Chi-square test, Fischer's exact test) between different influencing factors.

The impact of nutritional risk (NRS-2002) and nutritional status (PG-SGA) on the likelihood of postoperative complications are shown in Table 7. Multivariate analysis was performed to identify potential confounders (surgery, co-morbidities and age) and to determine the adjusted effect of nutritional risk and nutritional status on the occurrence of complications. The full model containing all predictors, including NRS-2002, was statistically significant (X^2 (7) = 18.83; p=0.009). The explained variation in complications based on the model containing NRS-2002 ranged from 17.0% (Cox and Snell R^2) and 27.0% (Nagelkerke R^2), and correctly classified 79.2% of cases (percentage accuracy). The full model containing all predictors, including PG-SGA, was also statistically significant (X^2 (7) = 17.75; p=0.013), and the full model explained between 16.1% and 25.6% of the variance in complications, and correctly classified 80.2 % of cases (percentage accuracy).

Increasing age was associated with an increased likelihood of having a complication in both adjusted models OR=1.05 (95% CI: 1.00-1.10; p= 0.048). The impact of types of surgeries on complication were in relation to "other surgeries", after adjusting for the other factors. Lower-abdominal surgery recorded an OR of 5.97 (95% CI: 0.93-38.28; p=0.060) and upper-abdominal surgery recorded an OR of 2.09 (95% CI: 0.29-15.33; p=0.468) in the model including NRS-2002. The respective ORs in the model including PG-SGA were 5.35 (95% CI: 0.86-33.31; p=0.072) and 1.96 (95% CI: 0.27-14.02; p=0.505), respectively. The impact of one or two to three co-morbidities were in relation to having none of the co-morbidities described in Table 3. Two to three co-morbidities recorded an OR of 1.26 (95% CI: 0.27-5.76, p=0.770) in the model including NRS-2002, and an OR of 1.43 (95% CI: 0.32-6.41, p=0.638) in model including PG-SGA.

Table 7: Effect of nutritional status on complications.

	Univariate analysis			**Multivariate analysis** [b]		
	OR[a]	**95 % CI**	***P-value***	***OR***[a]	***95 % CI***	***P-value***
At risk (NRS-2002)	2.71	0.95-7.73	*0.063*	3.88	1.07-14.06	0.039
Malnourished (PG-SGA)	2.03	0.73-5.68	*0.176*	3.07	0.90-10.54	0.075

a: Odds ratio from binary logistic regression
b: adjusted for age, surgery, and co-morbidities.

Spearman's rank order correlation was used to study the relationship between LOS and NRS-2002 and PG-SGA (Table 8). There was no significant correlation between LOS and NRS-2002, nor between LOS and PG-SGA. There was a strong positive correlation between LOS and surgery, and LOS and complications ($p<0.0001$).

Table 8: Spearman's ranks order correlations with LOS.

	Correlation coefficient	***p-value***
NRS-2002	0.098	*0.333*
PG-SGA	0.065	*0.523*
Surgery	0.541	*<0.0001*
Co-morbidities	0.165	*0.100*
Age	0.159	*0.114*
Complications	0.525	*<0.0001*

Multiple regression analyses were used to assess the ability of NRS-2002 (at risk) or PG-SGA (malnutrition) to predict LOS when adjusting for age, surgery, and co-morbidities. The models reached statistical significance ($p<0.0001$), and the analyses determined that none of the variables age, co-morbidities, PG-SGA and NRS-2002 were significant predictors of LOS. The standardized coefficient Beta value of NRS-2002 was 0.135 ($p=0.152$) and for PG-SGA 0.069 ($p=0.463$). Only one independent variable contributed statistically significant to the models; surgery with a beta value of 0.394 ($p<0.0001$) in the final model including NRS-2002 and 0.383 ($p =0.001$) in the final model including PG-SGA.

3.4 Pre- and postoperative dietary intake assessed with 24 h recall method

Eighty-two patients replied to the follow-up telephone call and were dietary interviewed postoperatively. Out of these were 18 patients (22 %) at risk and 21 patients (25 %) malnourished. There are missing values for 19 patients (loss to follow-up, or not included for the 24 h recall), where 6 were categorized at risk and 7 malnourished.

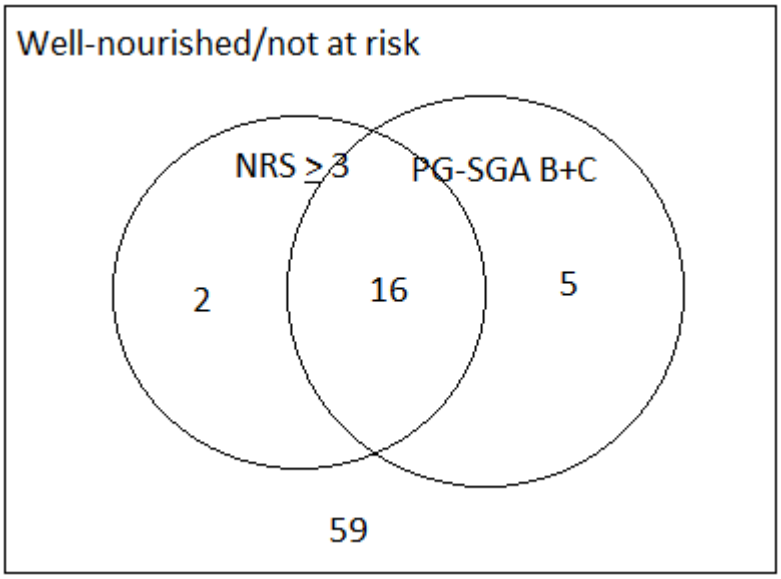


Figure 10: Venn diagram of NRS-2002 and PG-SGA in follow-up patients (n=82).

Mean preoperative energy and protein intake for all patients were 1713±721 kcal/day and 74±33 g/day, respectively. There were no significant differences when comparing preoperative intake with postoperative intake of energy or protein. Median main meals increased from three meals before surgery to four meals after surgery (p=0.002). Median snacks were one both pre- and postoperatively. More details about pre- and postoperatively dietary intake for all patients can be found in Table V-A1 (Appendix 1).

Nutrient intake and dietary pattern before and after surgery by different nutritional groups are presented in Table 9. Preoperatively energy- and protein intake were significantly lower in patients at risk compared to patients not at risk (p= 0.006) and malnourished compared to well-nourished (p=0.003). These differences were not seen postoperatively. Moreover, patients at risk and malnourished reported a significant higher consumption of energy- and protein one-

month after surgery. Patients not at risk and well-nourished did not present any significant differences for pre- and postoperatively energy- and protein intake.

Mean estimated PAL for both patients at risk and malnourished was 1.0 (Table V1-A1, Appendix 1). Patients not at risk and well-nourished represented a mean estimated PAL of 1.2. Pre- and postoperatively daily protein intake ranged from 0.9 ± 0.4 g/kg to 1.0 ± 0.4 g/kg.

Table 9: Nutrient intake and meal patterns before and after surgery by groups of nutritional risk (NRS-2002) and nutritional status (PG-SGA).

		Energy intake (kcal)	***p-value*[a]**	**Protein intake (g)**	***p-value*[a]**	**Main meals (n)**	***p-value*[b]**	**Snacks (n)**	***p-value*[b]**
NRS-2002									
Score < 3 (n=64)	Preop*	1832 ± 724 505-3600		78 ± 34 18-168		3		1	
	Postop	1737 ± 688 664-3535	*0.223*	75 ± 31 21-162	*0.593*	4	*0.024*	1	*0.329*
Score ≥ 3 (n=18)	Preop*	1306 ± 554 457-2753		60 ± 25 20-103		3		1	
	Postop	1811 ± 854 635-3493	*0.033*	71 ± 29 25-127	*0.163*	4	*0.020*	1	*0.464*
PG-SGA									
A (n=61)	Preop*	1844 ± 730 505-3699		79 ± 34 18-168		3		1	
	Postop	1739 ± 736 637-3535	*0.195*	75 ± 32 21-163	*0.502*	4	*0.068*	1	*0.166*
B+C (n=21)	Preop*	1345 ± 560 457-2914		59 ± 26 19-103		3		1	
	Postop	1795 ± 698 635-3299	*0.029*	72 ± 25 41-127	*0.095*	4	*0.004*	1	*0.914*

Values are presented as mean ± SD, median, range

*preop: preoperative values for follow-up patients.

a: Paired t-test (energy intake, protein intake) preop2 vs. postop

b: Wilcoxon test (main meals, snacks) preop2 vs. postop

Changes in BMI and weight pre-and postoperatively:

Table 10 presents differences of weight and BMI within the groups, as well as difference of weight and BMI pre- and postoperatively. Patients at risk and malnourished had a significant lower mean weight and BMI pre- and postoperatively, compared to those not at risk and well-nourished. All groups presented a significant lower mean weight after surgery compared to before surgery. Moreover, no significant differences of mean weight change were observed between the groups (Table 11).

Twenty-two patients had a weight loss ≥ 5% from preoperative outpatient clinic to one-month after surgery, with a mean ± SD weight loss of -8.3% ± 3.2%, ranging from -17.2% to -5.0%. Of those 22 patients, three patients were at risk and 19 patients not at risk when using NRS-2002, whereas PG-SGA defined six of them malnourished and 16 as well-nourished. Fifty-eight patients had a weight loss < 5 % or no weight loss, with a mean ± SD weight loss of -1.4% ± 2.5% and range from -4.9% to +5.7%. There were not registered any postoperative weights from patients not responding to the 24 h recall after surgery.

Table 10: Pre- and postoperatively weight and BMI for nutritional risk (NRS-2002) and nutritional status (PG-SGA).

	NRS-2002			**PG-SGA**		
	< 3 (n =77)	**≥ 3 (n=24)**	***p-value*[a]**	**A (n=73)**	**B+C (n=28)**	***p-value*[a]**
Weight preop (kg)	79 ± 13	70 ± 13	*0.005*	80 ± 14	69 ± 12	*<0.0001*
Weight post (kg)	77 ± 12	67 ± 13	*0.006*	78 ± 12	66 ± 12	*<0.0001*
p-value [b]	*<0.0001*	*0.101*		*<0.0001*	*0.016*	
BMI preop (kg/m^2)	27 ± 4	24 ± 5	*0.021*	27 ± 4	24 ± 5	*0.004*
BMI post (kg/m2)	26 ± 4	23 ± 5	*0.033*	26 ± 4	23 ± 5	*0.003*
p-value[b]	*<0.0001*	*0.095*		*<0.0001*	*0.015*	

Values are presented as mean, median.

a: Difference of mean weight and BMI (Independent sample t-test) within groups of NRS-2002 and PG-SGA.

b: Difference of mean weight and BMI (paired sample t-test) pre- and postoperatively

Table 11: Weight change from before surgery to one-month after surgery for nutritional risk (NRS-2002) and nutritional status (PG-SGA).

	N	**Weight change (kg)** [a]	***p-value*** [c]	**Weight change-%** [b]	***p-value*** [c]
Total	80	-2.5 ± 3.2		-3.3 ± 4.1%	
		-15.3 – 3.5		-17.2% – 5.6 %	
NRS-score < 3	63	-2.9 ± 3.2		-3.6% ± 4.0%	
		-15.3 – 3.5		-17.2 % – 5.6%	
NRS-score ≥ 3	17	-1.3 ± 3.0		- 2.1% ± 4.4%	
		-9.0 – 3.5	*0.069*	-13.0% – 4.6%	*0.163*
PG-SGA A	59	-2.7 ± 3.1		- 3.3% ± 3.7%	
		-15.3 – 3.5		-12.6% – 5.7%	
PG-SGA B+C	21	-2.0 ± 3.5		- 3.1% ± 5.2%	
		-11.2 – 3.5	*0.380*	- 17.2% – 4.6%	*0.849*

Data is presented as mean ± SD, range

a: weight change (kg) (weight post – weight preop);

b: weight change (%) (Weight post-weight preop/weight preop);

c: testing difference between mean weight change (in -% and kg) for at risk/malnourished vs. not at risk/well-nourished (Independent sample t-test).

4. DISCUSSION

4.1 Main findings

This prospective observational study was performed to look at the prevalence of nutritional risk (NRS-2002) and malnutrition (PG-SGA) in patients undergoing elective upper- or lower GI-surgery, and to see which screening tool can predict LOS and complications best. Preoperative dietary intake and intake one-month after surgery were also studied to see whether there were any differences in energy- and protein intake, and meal pattern.

There were 24 patients (24 %) at nutritional risk (NRS-2002) and 28 patients (28 %) malnourished (PG-SGA). NRS-2002 defining patients at risk was the strongest significant predictor of complications in the adjusted analysis controlling for age, surgery, and co-morbidities, recording an odds ratio of 3.88 (p=0.039). PG-SGA defining patients malnourished recorded an odds ratio of 3.07 (p=0.075) in the adjusted analysis assessing the likelihood of complications. Neither NRS-2002 nor PG-SGA made a significant unique contribution to the prediction of LOS. Patients with a potentially significant weight loss one-month after surgery had significant longer median LOS compared to those not having a significant weigh loss (10 days vs 6 days; p=0.001). No significant changes were observed in nutrient intake pre- and postoperatively for all patients. However, patients at risk and malnourished reported a significant lower energy- and protein intake before surgery compared to one-month after surgery. Patients not at risk and well-nourished reported no significant differences of energy- and protein intake pre- and postoperatively. Median number of main meals increased significantly from three to four, whereas median number of snacks was one pre- and postoperatively.

4.2 Discussion of findings

4.2.1 Preoperative nutritional status determined by NRS-2002 and PG-SGA

Results from the present study are in line with other studies using NRS-2002 to screen surgical patients for nutritional risk before surgery (24-28 % at risk) (35, 37). Shpata et al. (2014) screened patients admitted to the intensive care unit (ICU) with NRS-2002 over a three-year period and found a prevalence of 65.3 % at risk (30). The high prevalence of patients at risk can be explained by the selection of patients. Intensive care patients (APACHE score > 10) will automatically score 3 for severity of disease (21). Eide et al. (2015) screened 508 patients over a two-year period at a University hospital in Norway, finding that prevalence of nutritional risk ranged from 20 % to 65 % in the different wards (53). Patients in the ward for upper and lower GI-surgery presented 50 % (22 of 44) at risk. This represents a substantially higher number of patients at risk compared to our study, but it is important to keep in mind that the data in this study is from the preoperative outpatient clinic, and not from the ward units in hospital.

Other studies using PG-SGA found quite high prevalence of malnourished patients before surgery compared to the results in our study (37 of 47 patients (54), 12 of 25 patients (4)). However, these studies do remark that patients included are either in a late stage of cancer disease (54) or that the assessment was done on a small selection of patients (4). Shim et al. (2013) studied the perioperative nutritional status change in GI-cancer patients using PG-SGA. They found a prevalence of malnutrition (category B+C) to increase from 12 % preoperatively to 52 % after surgery (55). Another study also found that prevalence of malnourished patients undergoing major abdominal surgery increased from 44 % at admission to 67 % at discharge using PG-SGA (56). Thus, it is likely that also a higher prevalence of patients at risk or malnourished would be observed in wards after surgery in the current study. Distribution of diagnoses may also influence the prevalence of nutritional status.

4.2.2 Postoperative complications and LOS:

Previous research has shown that malnutrition in patients coming for GI-surgery can predict worse clinical outcome postoperatively, like higher incidence of complications (4, 30, 35, 37). Data in the present study could not detect any significant differences between complication incidence and nutritional status: At risk compared to not at risk (33% vs. 16%, p=0.078), malnourished compared to well-nourished (29 % vs. 16%, p=0.171). The impact of nutritional risk (NRS-2002) and malnutrition (PG-SGA) on the likelihood of complications in the present

study recorded an OR of 2.71 (95% CI 0.95-7.73; p=0.063) and OR of 2.03 (95% CI 0.73-5.68; p= 0.176), respectively. The 95 % CI crosses zero slightly, indicating no significance, however the observed effect of being at risk and malnourished on complications is great, and of clinical relevance. Kwag et al. (2014) found that nutritional risk defined by NRS-2002 in patients admitted for surgery for colorectal cancer was an independent risk factor for postoperative complications (OR 3.05; p=0.045) (37). Shpata et al. (2014) found that malnutrition in GI-surgical patients with malignancy was an independent risk factor for higher complications (OR 6.07, p<0.0001) (30).

The analysis done in the present study indicate that NRS-2002 is a stronger predictor of complications compared to PG-SGA. Though, it is important to keep in mind that there were an equal number of patients having a complication (n=8) within both groups (at risk and malnourished). Neither of the two screening tools made a significant contribution to the prediction of LOS. Other prospective studies, similar to this, have found LOS to be significant longer in patients at risk compared to those not at risk (13 d vs. 7 d (35) and 8.9 d vs. 7.8 d (37)). These studies enrolled more patients (n=1244 (35) and n=352 (37)), hence an increased chance of finding a significant difference.

No other studies have compared the use of PG-SGA and NRS-2002 in patients before undergoing GI-surgery. Previous research has studied the two screening tools in other clinical settings, other groups of patients and/or compared them with other screening tools. Badia-Tahull et al. (2014) studied the association between SGA, PG-SGA and NRS-2002 in non-critically ill GI-surgical patients at the moment of parenteral nutrition initiation (57). The screening tool best correlated with the clinical (BMI, age) and analytical variables (albumin, prealbumin, CRP, leukocytes) was NRS-2002 (57). Dubashi et al. (2015) evaluated nutritional status in elderly (mean age of 61 years) cancer patients undergoing surgery, and compared PG-SGA and MNA (54). PG-SGA classified 37 patients of 47 to be in category B + C. MNA classified 42 of 47 patients at risk and malnourished. Both screening tools were significant in predicting average duration of antibiotics and duration of stay for malnutrition. Dubhashi et al. (2015) found that PG-SGA could more precisely predict the postoperative outcome, and recommends the use of PG-SGA for elderly, cancer patients (54). However, the study was based on a small sample size drawn from an Indian population.

Probst et al. (2017) screened 279 patients, using 11 different nutritional assessment scores that are in use in surgical patients, to evaluate the prognostic value of the scores in pancreatic

surgery (NURIMAS-study) (58). The identification of patients at risk varied greatly from 1.0 % to 79.6 % (58). NRS-2002 identified 69.2% patients at risk and SGA identified 18.3% to be malnourished (58). Thus, the proportion of patients screened for nutritional risk and malnutrition differed utterly to the present study. The cut-off values for SGA were not specified any places in NURIMAS though. Furthermore none of the nutritional assessment scores were significantly associated with major complications after pancreatic surgery, recording ORs from 0.75 to 1.80 in the univariate analyses (58). NURIMAS included exclusively patients having a pancreatic surgery. As pancreatic operations are major procedures with associated risks and complications, nutritional status may only play a secondary role on postoperative outcomes. The present study included only two patients having a pancreatic operation. NURIMAS recorded postoperative complications according to the Clavien–Dindo classification (59), and studied the association between malnutrition and major complications for each score. Moreover, the outcome assessor was blinded to nutritional status of patients. The current study did neither of this.

Sun Z et al. (2015) presented a meta-analysis, including a total of 3527 pooled patients from 11 different cohorts, to examine whether a preoperative evaluation of nutritional risk by NRS-2002 provided prediction of postoperative outcomes in patients undergoing abdominal surgery. They found higher incidence of postoperative complications (pooled OR 3.13; 95% CI=2.51-3.90; p<0.00001), higher mortality (pooled OR 3.61; 95% CI= 1.38-9.47; p = 0.009)), as well as significant longer LOS for nutritional risk group compared to not at risk (weight mean difference 5.58; 95% CI= 4.21-6.95; p<0.0001) (60). However, the statistical findings within the cohorts were not always consistent: Seven of nine cohorts studying nutritional risk as a predictor of postoperative complications were significant, only two of four cohorts studying the association between nutritional risk and LOS were significant, and none of the three cohorts studying the association between nutritional risk and mortality were significant. Thus, larger samples of patients undergoing GI-surgery is needed to validate NRS-2002 predictive value of postoperative outcomes (60).

Other influencing factors on complications and LOS:

Co-morbidities were significantly associated with complication incidence. A greater number of associated co-morbidities in patients at risk on admission to hospital has been found in earlier studies (61). Patients ≥ 60 years presented a significant higher incidence of complications compared to patients < 60 years (28 % vs. 3 %; p= 0.009). Age was also a significant associated risk factor on complication (OR= 1.05, p=0.048). Thomas et al. found that complications were

more frequent among patients with advanced age and malnourished condition (35). Elderly patients are at increased risk for malnutrition (61), and age > 65 years has been found to be an independent risk factor on malnutrition (OR: 2.18; 95% CI 1.58-3.01; p < 0.0001)) (30). However, the prevalence of patients ≥ 60 years in the present study was approximately the same in all nutritional groups, ranging from 57-60%.

Patients undergoing upper- and lower GI-surgery had longer median LOS (9 and 8 days) compared to patients having minor surgeries, such as "excision of effected area" and "other surgeries" (2 and 3 days) ($p<0.0001$). Surgery was the strongest unique contribution to explaining LOS, when the variance explained by all other variables in the model was controlled for. Severity of surgical intervention has been identified as an independent risk factor for occurrence of complication associated with longer LOS (35). Even though surgery did not contribute significantly to the prediction of complications in the present study, it is worth mentioning that "lower-abdominal surgery" had six times higher risk-, and "upper-abdominal surgery" had two times higher risk of complication compared to "other surgeries".

Weight loss ≥ 5% was also significantly associated with longer LOS, which will be furthered discussed below, under "*Pre- and postoperative weight*".

4.2.3 Pre- and postoperative dietary intake assessed with 24 h recall method

No other studies describing any changes in food intake before and after GI-surgery has been found. The present study observed no significant differences in overall energy- and protein intake before and after surgery. However, patients at risk and malnourished ate significantly more of both energy and protein one-month after surgery, while patients not at risk and well-nourished showed no significant differences for energy- and protein intake. Garth et al. (2010) found malnourished patients more likely to be seen by a dietitian both pre- and postoperatively compared to well-nourished patients, and that intake of energy and protein were significantly higher on the second day of a soft ward diet if seen by a dietitian postoperatively compared to if not seen by the dietitian postoperatively (4). The present study did not register if the patients were in contact with a dietitian and received dietary counseling and/or medical nutrition therapy in addition to standard postoperatively nutritional procedure for each surgery/diagnosis. However, cancer patients are advised and given oral nutritional supplements (ONS) to drink the day before surgery as a part of the perioperative care following the ERAS regime. Reduced food intake before surgery can be related to the diagnoses such as hernia, achalasia,

diverticulitis, constipation, abdomen, and pelvic pain. Symptoms seen for such diagnoses are difficulties swallowing or loss of appetite due to pain, nausea, or bloating.

All patients reported a lower energy intake compared to their estimated energy requirement, which was observed from the estimated PAL of 1.0-1.2 indicating a population bedridden. Most patients came walking to the outpatient clinic, and would have a PAL of at least 1.4 (sedentary lifestyle) (48). Underestimation of food intake is common, and was expected (51). Mean protein intake for all patients, ranging from 0.9-1.0 g/kg/d, are in line with the recommendations for daily protein intake in healthy subjects (0.8-1.0 g/kg/d) given of The Norwegian Directorate of Health. However, patients with severe injuries, such as burn injury, and surgical patients may have significant higher need for energy, proteins and liquid compared with healthy subjects (48). Recommendations for daily protein intake in ill subjects are 1.0-1.5 g/kg/d, and 1.5-2.0 g/kg/d in critically ill subjects (48). It can be discussed whether four weeks is sufficient time to return to normal eating habits and appetite. A dietary interview three weeks after surgery could have presented a different picture – seeing that many patients reported they had just started eating normal compared to the first couple of weeks after surgery.

Pre- and postoperative weight:

All patients, and groups of nutritional risk and nutritional status, had a significant lower mean weight one month after surgery compared to before surgery. There were no significant differences in weight changes between the groups. However, weight changes observed cannot always be relied on due to body weight fluctuations and hydration status. A three days' record of body weight fluctuation in older well-hydrated hospitalized patients was found to range from 1.1% to 3.6% (62). A weight loss of ≥ 5 % has been defined as potentially significant weight loss in earlier studies (18). An important finding in present study was that most patients having a postoperative weight loss of ≥ 5 % (n=22), were patients not at risk (n=19) or well-nourished (n= 16). It was further observed that patients with a potentially significant weight loss one-month after surgery also had significant longer median LOS compared to those not having a significant weigh loss (10 days vs 6 days; p=0.001). These findings are of clinical relevance, and demonstrate the importance of preventing weight loss also after surgery.

Possible explanations, that patients at nutritional risk or malnourished did not lose as much weight postoperatively, can be due to their increased energy- and protein intake, as well as receiving more dietary counseling or medical nutrition therapy during their hospital stay. Karlsson et al. (2009) reported that patients with colorectal cancer were generally unaware of

the importance of good nutritional status before surgery, and even some patients thought that losing weight before surgery could be beneficial if they were obese or normal weight (63). Obesity has long been considered a major risk factor for poor outcomes after surgery. However, recent studies challenge this attitude, finding obesity alone not to be a risk factor for postoperative complications (64), and the underweight patient to be most at risk of major postoperative complications and long-term mortality (65). Involuntary recent weight loss before surgery for obese people is, on same level as with normal weight, a risk factor for complications (66).

4.3 Strength and limitations

4.3.1 Recruitment:

From the 191 patients requested to participate were 101 patients included. Patients included represent heterogenous groups of diagnoses, and there may be an uneven distribution of diagnoses in participants compared to those who chose not to participate. Moreover, the prevalence of malnutrition may also be different in those not included compared to participants included. Causes preventing patients to not be included in the study or not wanting to be included can be physical, cognitive, and/or emotional problems.

4.3.2 Study design:

The current study was a prospective Cohort study with a one-month follow-up, recruiting patients between September 2016 and December 2016. Advantages of Cohort studies is that it can describe incidence of exposure, calculate rates of outcome in exposed and unexposed individuals over time, examine various outcome variables, permit calculation of the effect of each variable on the probability of developing the outcome of interest, and it can assess causality (67). When studying rare exposures, large numbers of subjects are however required. Prospective cohorts are as well susceptible to selection bias, mainly introduced by loss follow-up or withdrawals (67). Method used to minimize loss to follow-up in the present study was sending a text message to patients with a reminder about the follow-up telephone call. Loss to follow-up rate did not exceed 20 % of the sample. Recruiting patients consecutively, as done in the current study is also a strength, reducing bias. The major disadvantage of cohorts is the inability to control for all other factors that might differ between the two groups, known as confounding variables. Four factors were controlled for in the present study, when analyzing the effect of nutritional risk and nutritional status on postoperative outcome.

It is important to recognize strength and weaknesses of different study design when comparing results from different studies. Certain study designs may influence the prevalence of nutritional risk, type of diagnoses included, severity of surgery, LOS, i.e., and the results from the different studies are therefore not directly comparable. Cross sectional designs can compare different population groups at a single point in time (e.g. Tangvik et al. and Eide et al. studying prevalence of patients at risk). However, when applied to hospital cross-sectional studies tend to include more patients with longer LOS and less patients with shorter stays, providing biased estimators such as patients at risk (68).

4.3.3 Methods

Some of the strengths of NRS-2002 for use in hospital is that it combines nutritional components with grading of severity for the underlying disease (35), and it is simple to use. A limitation is that the answers obtained were found to be very dependent on how you formulate the questions. One example from NRS-2002 initial screening: «Has the patient had reduced dietary intake in the last week? ». Some patients answered "no" for this, and then they answered for PG-SGA Box 2 (Food intake: As compared to my normal intake, I would rate my food intake during the past month as): "less than usual". This was because their dietary intake had been lower over time, and not only lower within the last week. Some patients could not reckon last time he/she had eaten normal. A better way to evaluate whether the patient has eaten normal or not the last week would be to ask them to grade their dietary intake the last week from 1 to 10, were 10 is their normal intake. The nutritional screening tool used by the nurses in preoperative outpatient clinic at St Olavs Hospital is almost equivalent to NRS-2002. Though, it was observed from the medical records that many patients were not screened or not classified at risk. Reasons for this can be many. Kondrup et al. (2002) found that a common reason given by the nurses for why patients were not screened at admission was that there were no instructions to do so (15). Another limitation of NRS-2002, which also accounts for PG-SGA, is the uncertainty of earlier weight; some patients found it difficult to recall previous weight.

An interesting finding in our study was that 6 patients were characterized as malnourished (PG-SGA), but not at nutritional risk (NRS-2002). However, five of those 6 patients had cancer. PG-SGA was developed specifically for oncological patients (69), and includes questions about nutrition impact symptoms that is typically at present in cancer patients (20). The scored-PG-SGA has been shown to be a valid tool to identify and assess malnutrition in patients with cancer with high sensitivity (98%) and specificity (82%) (19). The patients complete the first page, which makes it less time consuming and is an advantage in clinical settings. Another advantage is that the scored-PG-SGA allows prioritization of nutritional therapy for patients (20). The physical examination part is valuable, though also challenging. It is difficult to evaluate whether a patient has lost muscle mass and/or fat free mass after a first meeting, as you have not seen the patient before. For a clinician to fulfill this task properly it is important with proper training and experience (10).

Systematic error may appear when measuring MUAC, TSF, HGS and waist circumference due to instrument wrongly used by the experimenter or there is something wrong with the instrument. A strength of this study is that a master student in Clinical Nutrition did the

measurements and subjective assessments of all patients. Another source of error is that weight and height were mostly self-reported, and pre- and postoperative weight could sometimes be from two different scales (outpatient clinic and home). We were prepared for this to be a source of error, and requested patients to weight themselves at home in the information paper. Nevertheless, not all patients had read the paper at home, and some patients did not receive the information paper before coming to the outpatient clinic.

The 24 h recall is a retrospective method that provide information of food consumption for a single day (51). Strength of the method is low burden on the patient, it is suitable for large scale surveys and can be administered by telephone. Limitations of the method is that it is dependent on memory of intake to be accurate, and relies on the respondent not to under-/overestimate or misreport. Another weakness is that the respondent has to estimate portion size. The use of picture booklet is a strength in this study, making it easier to estimate portion sizes, although the booklet has not yet been validated. Due to day-to-day variations, a single 24 h recall is not necessarily representative to describe a person's usual intake. A more accurate version of this method is a multiple 24 hour recall of the same individual (51), but this would be to extensive to do in this study because of limitation of time and personal resource to perform the interview.

There will also be sources of error when using a food composition database based on the Norwegian food composition table (51). The nutritional value for a food item will vary dependent of the producer, and the Norwegian dietary planner "Kostholdsplanleggeren" does not contain all food items on the market. This was solved by choosing similar food items or adding new mixed dishes based on foods and ingredients already registered.

Weaknesses of the data collection method are, outcome assessor was not blinded to nutritional status of the patients, and postoperative complications were not recorded according to a validated classification.

Statistical methods used in the present study is comparable to other similar studies, such as univariate and multivariate analysis, and chi-square test. Multiple regression analysis was used to analyze the relative contribution of NRS-2002 and PG-SGA on LOS, controlling for other variables. We were interested to know which of the variables included in the model contributed most to the prediction of the dependent variable (LOS), and we therefore compared the Standardized coefficients (beta value) of each independent variable. These values have been converted to the same scale for each variable, so they are comparable. Multiple regression is very sensitive to outliers. The present study dealt with one outlier for LOS (=74 days), changing

it to the second highest value that existed for LOS (=31 days). However, LOS for total study population presented a skewed distribution, and correlated little with many of the variables used in the model, thus the results from the multiple regression analyses must be interpreted with caution. Logistic regression analysis was used to study the ability of NRS-2002 and PG-SGA to predict complications, with and without controlling for other variables. Having at least one complication (no=0, yes=1) was determined as the endpoint of the dependent variable. Odds ratio (OR) and 95% confidence interval (95% CI) of OR were used to explain the impact of influencing factors on complications.

4.3.4 Participants

Height and BMI were missing for a patient in wheelchair with amputated legs, as well as postoperative weight. HGS was not measured for one patient who did not want to use the hand-dynamometer because of pain. There are no data from those 65 patients who did not want to participate in this study. Data from the journal (e.g. nutritional risk, type of surgery, complications, and LOS) would be useful to have for these patients, to be able to describe them, but this was not possible without a written consent. It can be speculated whether this group of patients did not want to join the study due to reduced general health, and that those who wish to attend have more energy and a general better health. There were relatively few patients included that had major upper-abdominal surgery (e.g. esophagectomy, gastrectomy, whipples/pancreatectomy) compared to patients having lower-abdominal surgery. Patients with excessive body fat affect the clinical judgment by hiding loss of muscle mass and make screening difficult, thus malnutrition in obese patient can be underrecognized. We do not know who received nutritional treatment or nutritional supplements before and/or after surgery, and the effect of this on the patients. We also have no data of previous, if any, surgeries and/or resections done in the patients. Moreover, we do not know whether patients already had parts of GI that were missing, nor whether they already had a stoma. These are all factors that will impact the nutritional status and postoperative outcome. However, this information was not gathered as it was not included in the protocol to look through the whole journal, in addition to limitations of personal resources.

4.4 Conclusion and future aspects

In summary, more than 1/4 of the patients coming to preoperative outpatient clinic before GI-surgery at St Olavs Hospital were at nutritional risk or malnourished. Nutritional risk, determined by NRS-2002, almost tripled the risk of postoperative complications, whereas malnutrition, determined by PG-SGA, doubled the risk of complications. Neither of the two screening tools were significantly associated with LOS. However, a weight loss ≥ 5%, from before surgery to one-month after surgery, was strongly associated with longer median LOS.

The data in the present study indicate that NRS-2002 can potentially predict postoperative complications better than PG-SGA. NRS-2002 is an easier and quicker screening tool to use compared to PG-SGA, and can be a good alternative for screening patients at nutritional risk before GI-surgery. An advantage of PG-SGA is that it includes important aspects such as registration of nutrition impact symptoms and physical examination. Identifying loss of muscle and fat mass should be included in a malnutrition diagnosis, but it can be challenging and requires proper training. More studies evaluating the use of different screening tools, identifying malnutrition risk before GI-surgery, are required to describe the better alternative in predicting complication and LOS.

Patients at nutritional risk and malnourished patients consumed significantly less energy- and protein preoperatively compared to one-month postoperatively. There exist great scientific evidence proving the importance of good nutritional status before surgery, and routinely information to all patients about this should be practiced. Patients at malnutrition risk should be offered dietary counseling and medical nutrition therapy before surgery.

5. REFERENCES

1. 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. Clinical nutrition (Edinburgh, Scotland). 2014;33(4):634-41.
2. Barlow R. Surgery. In: Gandy J, editor. Manual of Dietetic Practice. 5th ed: Wiley Blackwell; 2014. p. 905-13.
3. Kosthold ved ulike diagnoser og sykdomstilstander. Kosthåndboken: Helsedirektoratet; 2012. p. 180-5.
4. Garth AK, Newsome CM, Simmance N, Crowe TC. Nutritional status, nutrition practices and post-operative complications in patients with gastrointestinal cancer. Journal of human nutrition and dietetics : the official journal of the British Dietetic Association. 2010;23(4):393-401.
5. Cederholm T, Bosaeus I, Barazzoni R, Bauer J, Van Gossum A, Klek S, et al. Diagnostic criteria for malnutrition - An ESPEN Consensus Statement. Clinical nutrition (Edinburgh, Scotland). 2015;34(3):335-40.
6. Guttormsen AB, Hensrud A, Irtun Ø, Mowé M, Sørbye LW, Thoresen L, et al. Nasjonale faglige retningslinjer for forebygging og behandling av underernæring. In: Helsedirektoratet, editor. 2009. p. 14-6.
7. ESPEN. Basics in clinical nutrition. 4th ed. L. S, editor: House Galén; 2011.
8. 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. JPEN Journal of parenteral and enteral nutrition. 2010;34(2):156-9.
9. White JV, Guenter P, Jensen G, Malone A, Schofield M. Consensus statement of the Academy of Nutrition and Dietetics/American Society for Parenteral and Enteral Nutrition: characteristics recommended for the identification and documentation of adult malnutrition (undernutrition). Journal of the Academy of Nutrition and Dietetics. 2012;112(5):730-8.
10. Fischer M, JeVenn A, Hipskind P. Evaluation of muscle and fat loss as diagnostic criteria for malnutrition. Nutrition in clinical practice : official publication of the American Society for Parenteral and Enteral Nutrition. 2015;30(2):239-48.
11. Cederholm T, Jensen GL. To create a consensus on malnutrition diagnostic criteria: A report from the Global Leadership Initiative on Malnutrition (GLIM) meeting at the ESPEN Congress 2016. Clinical nutrition (Edinburgh, Scotland). 2017;36(1):7-10.
12. Norman K, Pichard C, Lochs H, Pirlich M. Prognostic impact of disease-related malnutrition. Clinical nutrition (Edinburgh, Scotland). 2008;27(1):5-15.
13. Elia M. Nutrition and health economics. Nutrition (Burbank, Los Angeles County, Calif). 2006;22(5):576-8.

14. (BAPEN) Bafpaen. Malnutrition/undernutrition: BAPEN; 2016 [updated 02-22-2016. Available from: http://www.bapen.org.uk/malnutrition-undernutrition/introduction-to-malnutrition?start=1.
15. 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 (Edinburgh, Scotland). 2002;21(6):461-8.
16. Kondrup J, Rasmussen HH, Hamberg O, Stanga Z. Nutritional risk screening (NRS 2002): a new method based on an analysis of controlled clinical trials. Clinical nutrition (Edinburgh, Scotland). 2003;22(3):321-36.
17. Vellas B, Guigoz Y, Garry PJ, Nourhashemi F, Bennahum D, Lauque S, et al. The Mini Nutritional Assessment (MNA) and its use in grading the nutritional state of elderly patients. Nutrition (Burbank, Los Angeles County, Calif). 1999;15(2):116-22.
18. Detsky AS, McLaughlin JR, Baker JP, Johnston N, Whittaker S, Mendelson RA, et al. What is subjective global assessment of nutritional status? 1987. Classical article. Nutricion hospitalaria. 2008;23(4):400-7.
19. Bauer J, Capra S, Ferguson M. Use of the scored Patient-Generated Subjective Global Assessment (PG-SGA) as a nutrition assessment tool in patients with cancer. European journal of clinical nutrition. 2002;56(8):779-85.
20. Ferguson M. Patient-generated subjective global assessment. Oncology (Williston Park, NY). 2003;17(2 Suppl 2):13-4; discussion 4-6.
21. Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. ESPEN guidelines for nutrition screening 2002. Clinical nutrition (Edinburgh, Scotland). 2003;22(4):415-21.
22. Ottery F, Jager-Wittenaar H. PG-SGA 2014 [Available from: http://pt-global.org/?page_id=13.
23. Abbott J, Teleni L, McKavanagh D, Watson J, McCarthy AL, Isenring E. Patient-Generated Subjective Global Assessment Short Form (PG-SGA SF) is a valid screening tool in chemotherapy outpatients. Supportive care in cancer : official journal of the Multinational Association of Supportive Care in Cancer. 2016.
24. 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.
25. Loftus I. CARE OF THE CRITICALLY ILL SURGICAL PATIENTS. 3rd ed2010.
26. Winkler MF, Malone AM. Medical Nutrition Therapy for metabolic stress: sepsis, trauma, burns, and surgery. In: Alexopoulos Y, editor. Krause's Food and the Nutrition Care Process. 13 ed2012. p. 884-98.
27. Jensen GL. Inflammation as the key interface of the medical and nutrition universes: a provocative examination of the future of clinical nutrition and medicine. JPEN Journal of parenteral and enteral nutrition. 2006;30(5):453-63.

28. Zoico E, Roubenoff R. The role of cytokines in regulating protein metabolism and muscle function. Nutrition reviews. 2002;60(2):39-51.
29. Mariette C, De Botton ML, Piessen G. Surgery in esophageal and gastric cancer patients: what is the role for nutrition support in your daily practice? Annals of surgical oncology. 2012;19(7):2128-34.
30. Shpata V, Prendushi X, Kreka M, Kola I, Kurti F, Ohri I. Malnutrition at the time of surgery affects negatively the clinical outcome of critically ill patients with gastrointestinal cancer. Medical archives (Sarajevo, Bosnia and Herzegovina). 2014;68(4):263-7.
31. Wong CJ. Involuntary weight loss. The Medical clinics of North America. 2014;98(3):625-43.
32. Tan BH, Fearon KC. Cachexia: prevalence and impact in medicine. Current opinion in clinical nutrition and metabolic care. 2008;11(4):400-7.
33. Fearon KC, Glass DJ, Guttridge DC. Cancer cachexia: mediators, signaling, and metabolic pathways. Cell metabolism. 2012;16(2):153-66.
34. Utech AE, Tadros EM, Hayes TG, Garcia JM. Predicting survival in cancer patients: the role of cachexia and hormonal, nutritional and inflammatory markers. Journal of cachexia, sarcopenia and muscle. 2012;3(4):245-51.
35. Thomas MN, Kufeldt J, Kisser U, Hornung HM, Hoffmann J, Andraschko M, et al. Effects of malnutrition on complication rates, length of hospital stay, and revenue in elective surgical patients in the G-DRG-system. Nutrition (Burbank, Los Angeles County, Calif). 2016;32(2):249-54.
36. Zhang M, Gao X, Chen Y, Zhi M, Chen H, Tang J, et al. Body Mass Index Is a Marker of Nutrition Preparation Sufficiency Before Surgery for Crohn's Disease From the Perspective of Intra-Abdominal Septic Complications: A Retrospective Cohort Study. Medicine. 2015;94(35):e1455.
37. Kwag SJ, Kim JG, Kang WK, Lee JK, Oh ST. The nutritional risk is a independent factor for postoperative morbidity in surgery for colorectal cancer. Annals of surgical treatment and research. 2014;86(4):206-11.
38. Ljungqvist O, Soreide E. Preoperative fasting. The British journal of surgery. 2003;90(4):400-6.
39. Kaska M, Grosmanova T, Havel E, Hyspler R, Petrova Z, Brtko M, et al. The impact and safety of preoperative oral or intravenous carbohydrate administration versus fasting in colorectal surgery--a randomized controlled trial. Wiener klinische Wochenschrift. 2010;122(1-2):23-30.
40. Soreide E, Eriksson LI, Hirlekar G, Eriksson H, Henneberg SW, Sandin R, et al. Pre-operative fasting guidelines: an update. Acta anaesthesiologica Scandinavica. 2005;49(8):1041-7.
41. Varadhan KK, Neal KR, Dejong CH, Fearon KC, Ljungqvist O, Lobo DN. The enhanced recovery after surgery (ERAS) pathway for patients undergoing major elective open colorectal surgery: a meta-analysis of randomized controlled trials. Clinical nutrition (Edinburgh, Scotland). 2010;29(4):434-40.

42. Greisen J, Juhl CB, Grofte T, Vilstrup H, Jensen TS, Schmitz O. Acute pain induces insulin resistance in humans. Anesthesiology. 2001;95(3):578-84.
43. Beattie AH, Prach AT, Baxter JP, Pennington CR. A randomised controlled trial evaluating the use of enteral nutritional supplements postoperatively in malnourished surgical patients. Gut. 2000;46(6):813-8.
44. Cawood AL, Elia M, Stratton RJ. Systematic review and meta-analysis of the effects of high protein oral nutritional supplements. Ageing research reviews. 2012;11(2):278-96.
45. Philipson TJ, Snider JT, Lakdawalla DN, Stryckman B, Goldman DP. Impact of oral nutritional supplementation on hospital outcomes. The American journal of managed care. 2013;19(2):121-8.
46. Stratton RJ, Elia M. Who benefits from nutritional support: what is the evidence? European journal of gastroenterology & hepatology. 2007;19(5):353-8.
47. Helsedirektoratet. Nasjonale faglige retningslinjer for forebygging, utredning og behandling av overvekt og fedme hos voksne. In: Helsedirektoratet, editor. 2010.
48. God ernæringspraksis. In: Helsedirektoratet, editor. Kosthåndboken2012. p. 77-96.
49. Symreng T. Arm anthropometry in a large reference population and in surgical patients. Clinical nutrition (Edinburgh, Scotland). 1982;1(3):211-9.
50. 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 (Edinburgh, Scotland). 2014;33(1):106-14.
51. Gibson RS. Methods for measuring food consumption of individuals. Principles of nutritional assessment 2nd ed. New York, United States of America: Oxford University Press; 2005. p. 41-64.
52. Mifflin MD, St Jeor ST, Hill LA, Scott BJ, Daugherty SA, Koh YO. A new predictive equation for resting energy expenditure in healthy individuals. The American journal of clinical nutrition. 1990;51(2):241-7.
53. Eide HK, Saltyte Benth J, Sortland K, Halvorsen K, Almendingen K. Prevalence of nutritional risk in the non-demented hospitalised elderly: a cross-sectional study from Norway using stratified sampling. Journal of nutritional science. 2015;4:e18.
54. Dubhashi SP, Kayal A. Preoperative Nutritional Assessment in Elderly Cancer Patients Undergoing Elective Surgery: MNA or PG-SGA? The Indian journal of surgery. 2015;77(Suppl 2):232-5.
55. Shim H, Cheong JH, Lee KY, Lee H, Lee JG, Noh SH. Perioperative nutritional status changes in gastrointestinal cancer patients. Yonsei medical journal. 2013;54(6):1370-6.
56. Sungurtekin H, Sungurtekin U, Balci C, Zencir M, Erdem E. The influence of nutritional status on complications after major intraabdominal surgery. Journal of the American College of Nutrition. 2004;23(3):227-32.

57. Badia-Tahull MB, Cobo-Sacristan S, Leiva-Badosa E, Miquel-Zurita ME, Mendez-Cabalerio N, Jodar-Masanes R, et al. Use of Subjective Global Assessment, Patient-Generated Subjective Global Assessment and Nutritional Risk Screening 2002 to evaluate the nutritional status of non-critically ill patients on parenteral nutrition. Nutricion hospitalaria. 2014;29(2):411-9.
58. Probst P, Haller S, Bruckner T, Ulrich A, Strobel O, Hackert T, et al. Prospective trial to evaluate the prognostic value of different nutritional assessment scores in pancreatic surgery (NURIMAS Pancreas). The British journal of surgery. 2017.
59. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Annals of surgery. 2004;240(2):205-13.
60. Sun Z, Kong XJ, Jing X, Deng RJ, Tian ZB. Nutritional Risk Screening 2002 as a Predictor of Postoperative Outcomes in Patients Undergoing Abdominal Surgery: A Systematic Review and Meta-Analysis of Prospective Cohort Studies. PloS one. 2015;10(7):e0132857.
61. Burgos R, Sarto B, Elio I, Planas M, Forga M, Canton A, et al. Prevalence of malnutrition and its etiological factors in hospitals. Nutricion hospitalaria. 2012;27(2):469-76.
62. Vivanti A, Yu L, Palmer M, Dakin L, Sun J, Campbell K. Short-term body weight fluctuations in older well-hydrated hospitalised patients. Journal of human nutrition and dietetics : the official journal of the British Dietetic Association. 2013;26(5):429-35.
63. Karlsson S, Andersson L, Berglund B. Early assessment of nutritional status in patients scheduled for colorectal cancer surgery. Gastroenterology nursing : the official journal of the Society of Gastroenterology Nurses and Associates. 2009;32(4):265-70.
64. Dindo D, Muller MK, Weber M, Clavien PA. Obesity in general elective surgery. Lancet (London, England). 2003;361(9374):2032-5.
65. Tjeertes EK, Hoeks SE, Beks SB, Valentijn TM, Hoofwijk AG, Stolker RJ. Obesity--a risk factor for postoperative complications in general surgery? BMC anesthesiology. 2015;15:112.
66. Choban PS, Flancbaum L. Nourishing the obese patient. Clinical nutrition (Edinburgh, Scotland). 2000;19(5):305-11.
67. Song JW, Chung KC. Observational studies: cohort and case-control studies. Plastic and reconstructive surgery. 2010;126(6):2234-42.
68. 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.
69. Ottery FD. Definition of standardized nutritional assessment and interventional pathways in oncology. Nutrition (Burbank, Los Angeles County, Calif). 1996;12(1 Suppl):S15-9.

6. APPENDIX

Appendix 1: Tables and information not presented in the results

Appendix 2: NRS-2002

Appendix 3: PG-SGA

Appendix 4: Dietary recording form used for 24-h recall method

Appendix 5: Information and consent form in Norwegian

Appendix 6: Approval from Regional Ethics Committee in Norwegian

Appendix 1: Tables and information not presented in the results:

Other diseases: hernia (n=5), achalasia (n=2), diverticulitis (n=2), anal fistula (n=2), anal incontinence (n=3), constipation (n=2), abdomen and pelvic pain unspecified (n=2), gallstone with chronic cholecystitis (n=1), granulation polyp (n=1) and reoperation because of anastomotic leak (n=1).

Other surgeries: include removal of implant and new ileostomy, ileostomy reversal, antireflux surgery, peroral endoscopic myotomy (POEM), endoscopic diverticulo-esophagostomy, hernia repair, reconstruction and replacement of new esophagojejunostomy, replacement of ileostomy, ligations of intersphincteric fistula tract (LIFT), surgery for intestinal obstruction unspecified, excision of ileorectal reserve

Table I-A1: Anthropometric measurements and HGS and MUAMC in all patients (n=101), and Men and Female.

Measurements	**Total (n=101)**	**Men (n=59)**	**Female (n=42)**	***p-value*[b]**
Height (cm) [a]	172 ± 9 155-197	177 ± 5 165-197	165 ± 6 155-182	
Weight (kg)	77 ± 14 46-125	80 ± 13 49-125	73 ± 14 46-119	
Waist circumference (cm)	92 ± 12 68-132	94 ± 11 70-132	90 ± 12 68-120	
Triceps skinfold thickness (TSF) (mm)	15/9 6-37	12.5/6.3 6.2-26.7	21.5/10.9 9.9-37	*<0.0001*
Mid-upper arm muscle circumference (MUAMC)	26 ± 3 18-34	27 ± 3 22-35	24 ± 3 18-30	*<0.0001*
Hand grip strength (HGS) (kg)[b]	30/21 8-66	40/14 16-66	21/8 8-35	*<0.0001*

Data are presented as mean ± SD, median/IQR, range.

a: Missing height for one male, b: missing hand grip strength for one male

b: Testing difference of mean MUAMC (independent sample t-test) and median TSF and HGS (Mann Whitney U test).

Table II-A1: TSF, MUAMC, and HGS for nutritional risk (NRS-2002) and nutritional status (PG-SGA).

	NRS-2002			PG-SGA		
	< 3 (n =77)	**≥ 3 (n=24)**	***p-value[a]***	**A (n=73)**	**B+C (n=28)**	***p-value[a]***
TSF (mm)	15.8	14.9	*0.643*	15.8	14.9	*0.453*
MUAMC	26.3	24.9	*0.039*	26.4	24.8	*0.013*
HGS (kg)	32.6	27.0	*0.034*	33.0	26.7	*0.009*

Values are presented as mean, median.

a: Testing difference of mean MUAMC (Independent sample t-test), and of median TSF and HGS (Mann Whitney U test) within groups of NRS-2002 and PG-SGA.

Table III-A1: TSF, MUAMC, and HGS for nutritional risk (NRS-2002) and nutritional status (PG-SGA).

Symptoms: I have had following problems that have kept me from eating during the past two weeks (points):	Total (n= 101)	SGA-A (n=73)	SGA-B (n= 28)
No problems eating (0)	70 (70 %)	66 (90 %)	4 (14 %)
No appetite, just did not feel like eating (3)	10	2	8
Nausea (1)	5	-	5
Constipation (1)	4	-	4
Mouth sores (2)	1	-	1
Things taste funny or have no taste (1)	1	1	-
Problems swallowing (2)	3	2	1
Pain, where? [a] (3)	11	1	10
Other ** (1)	3	-	3
Vomiting (3)	2	-	2
Diarrhea (3)	3	-	3
Dry mouth (1)	2	1	1
Smells bother me (1)	5	2	3
Feel full quickly (1)	11	1	10
Fatigue (1)	5	1	4

a: majority of patients reported abdominal pain.

** Examples: depression, money, or dental problems.

Table IV-A1: Overview of type and number of complications, and distribution for NRS-2002 and PG-SGA

Complications		Total (n=101)	NRS-2002<3 (n=77)	NRS-2002≥3 (n=24)	PG-SGA=A (n=73)	PG-SGA=B+C (n=28)
	Hematuri	1	1	-	1	-
	Bleeding and hematoma	2	1	1	1	1
	Hematemesis	1	1	-	1	-
	Rectal bleeding	1	1	-	1	-
Postoperative bleeding	Total	5	4	1	4	1
	Wound infection	6	3	3	3	3
	UVI	3	3	-	3	-
	Pneumoni	2	1	1	1	1
Infection	Total	11	7	4	7	4
	Cystitis	2	1	1	1	1
	Gastritis	1	1	-	-	1
	Tubulo interstitiell nephritis	1	-	1	-	1
Inflammation	Total	4	2	2	1	3
Anastomotic leak	Total	5	3	2	4	1
Sepsis (urosepsis)	Total	1	1	-	1	-
	Wound dehiscence	1	1	-	-	1
	Stoma complication	2	1	1	1	1
	Unspecified abdominal pain and obstruction	1	-	1	-	1
	Urinary retention	2	2	-	2	-
	Complete heart block	1	1	-	1	-
	Respiratory failure	1	1	-	1	-
	Hypotension	1	-	1	1	-
Other	Total	9	6	3	6	3
Mortality	Total	1	-	1	-	1

Data shown as n.

Some patients have more than one complication

Table V-A1: Overview dietary intake preoperatively for all patients dietary interviewed (preop1), for all follow-up patients (preop2) and nutritional intake postoperatively (postop).

	Preop1 (n= 97)	**Preop2 (n = 82)**	**Postop (n= 82)**	***p-value*** [a, b]
Energy intake (kcal)	1713 ± 721 457-3699	1716 ± 721 457-3699	1752 ± 723 635-3535	*0.653*
Protein intake (g)	74 ± 33 18-168)	74 ± 33 18-168	74 ± 31 21-162	*0.898*
Main meals (n)	3 ± 1 0-4	3 ± 1 0-4	4 ± 1 1-4	*0.002*
Snacks (n)	1 ± 1 0-6	1 ± 1 0-6	1 ± 1 0-4	*0.295*

a: Paired t-test (energy intake, protein intake) preop2 vs. postop

b: Wilcoxon test (main meals, snacks) preop2 vs. postop.

Table VI-A1: Estimated physical activity level (PAL), and protein g/kg preop and postop

	NRS-2002		**PG-SGA**	
	Score < 3	Score > 3	A	B+C
	n= 74	n= 23	n= 70	n= 27
Estimated PAL[a]	1.2 ± 0.5	1.0 ± 0.5	1.2 ± 0.4	1.0 ± 0.5
Protein g/kg preop1	1.0 ± 0.4	1.0 ± 0.4	1.0 ± 0.4	0.9 ± 0.4
	n= 62	n= 17	n= 58	n= 21
Protein g/kg postop	1.0 ± 0.4	1.1 ± 0.4	1.0 ± 0.4	1.1 ± 0.4

Data are presented as mean ± SD

a: estimated PAL = kcal preop1/BMR.

Appendix 2: NRS-2002

Screening av ernæringsmessig risiko (NRS 2002)

INNLEDENDE SCREENING			
VEKT (KG)			
HØYDE (CM)			
BMI			
		JA	**NEI**
1	Er BMI < 20.5?		
2	Har pasienten tapt vekt i løpet av de 3 siste månedene?		
3	Har pasienten hatt redusert næringsinntak den siste uken?		
4	Er pasienten alvorlig/kritisk syk?		
JA: DERSOM SVARET ER JA PÅ NOEN AV DISSE SPØRSMÅLENE, GJENNOMFØRES HOVEDSCREENINGEN. NEI: DERSOM SVARET ER NEI PÅ ALLE SVARENE, GJENNOMFØRES INNLEDENDE SCREENING UKENTLIG. DERSOM PASIENTEN SKAL GJENNOMGÅ PLANLAGT STØRRE KIRURGI, SKAL EN FOREBYGGENDE ERNÆRINGSPLAN VURDERES FOR Å UNNGÅ DEN FORVENTEDE ERNÆRINGSRISIKO.			

Hovedscreening					
Vekttap	Forrige vekt:	Dato:	Vekt nå:	**Vekttap i %**	
Matinntak i % **(På en skala fra 0-10, hvor mye spiser pasienten nå mot normalt? 4 = 40 %)**					
Ernæringsstatus *(= grad av svekkelse)*					Score
Normal ernæringsstatus					0
Vekttap > 5 % ila. 3 mnd. *eller* matinntak 50-75 % av normalt behov i siste uken.					1
Vekttap > 5 % ila. 2 mnd. e*ller* BMI 18.5-20.5 + nedsatt almenntilstand *eller* matinntak 25-50 % normalt behov i siste uken.					2
Vekttap > 5 % siste ila. 1 mnd. (> 15 % siste 3 mnd.) *eller* BMI < 18.5 + nedsatt almenntilstand *eller* matinntak 0-25 % av normalt behov siste uke.					3
Sykdommens alvorlighetsgrad *(= økt behov)*					
Normal ernæringsbehov					0
Lårhalsbrudd*, kronisk syke pasienter*, spesielt de med akutte komplikasjoner: leverchirrose, KOLS*, *kronisk hemodialyse, diabetes, kreftsykdommer.*					1
Omfattende abdominal kirurgi*, Slag* ***Alvorlig lungebetennelse, maligne blodsykdommer***					2
Hodeskade*, benmargstransplantasjon* ***Intensivpasienter (APACHE skår >10)***					3
Er pas. Over 70 år, gi ett score					
Total score for ernæringsmessig risiko					

Appendix 3: PG-SGA

Scored Patient-Generated Subjective Global Assessment (PG-SGA)

Boks 1 - 4 skal fylles ut av pasienten

(Boks 1 - 4 heter PG-SGA Short Form (SF))

Pasient ID

1. Vekt *(se arbeidsark 1)*

Oppsummering av min nåværende og tidligere vekt

Jeg veier nå ca. _____kilo
Jeg er ca _____ cm høy

For én måned siden veide jeg ca. _____ kilo
For seks måneder siden veide jeg ca _____ kilo

I løpet av de siste to ukene har vekten min:

☐ gått ned (1) ☐ ikke endret seg (0) ☐ økt (0)

Boks 1 ☐

2. Matinntak: sammenlignet med mitt vanlige inntak vil jeg anslå matinntaket den siste måneden som:

☐ uendret (0)
☐ høyere enn vanlig (0)
☐ lavere enn vanlig (1)

Jeg inntar nå

☐ *normal mat*, men mindre enn vanlig mengde (1)
☐ lite fast føde (2)
☐ bare væske (3)
☐ bare næringsdrikker (3)
☐ svært lite av noe som helst (4)
☐ kun sondeernæring eller intravenøs ernæring (0)

Boks 2 ☐

3. Symptomer: Jeg har følgende problemer som har hindret meg i å spise nok I løpet av de siste to ukene (kryss av for alt som passer)

☐ ingen problemer med å spise (0)
☐ ingen appetitt, følte ikke for å spise (3)
☐ kvalme (1)
☐ forstoppelse (1)
☐ sår i munnen (2)
☐ ting smaker rart eller ingenting (1)
☐ problemer med å svelge (2)
☐ smerter; hvor? (3) _____
☐ oppkast (3)
☐ diaré (3)
☐ munntørrhet (1)
☐ lukter plager meg (1)
☐ føler meg raskt mett (1)
☐ utmatthethet (1)

☐ annet** (1) _____
Eksempler: depresjon, økonomiske problemer, tannproblemer

Boks 3 ☐

4. Aktiviteter og funksjon: I løpet av den siste måneden vil jeg beskrive aktivitetsnivået mitt som:

☐ normalt uten begrensninger (0)
☐ ikke mitt vanlige jeg, men i stand til å være oppe og gjøre normale aktiviteter (1)
☐ føler ikke for å gjøre noe særlig, men jeg tilbringer mindre enn halve dagen i stol eller seng (2)
☐ liten evne til å utføre aktivitet, og tilbringer det meste av dagen i sengen eller i en stol (3)
☐ stort sett sengeliggende, er sjelden ute av sengen (3)

Boks 4 ☐

Resten av dette skjemaet skal fylles ut av lege, sykepleier, klinisk ernæringsfysiolog, eller terapeut. Tusen takk!

Sammenlagt skåre for Boksene 1-4 ☐ **A**

email: faithotterymdphd@aol.com or info@pt-global.org

Scored Patient-Generated Subjective Global Assessment (PG-SGA)

Sammenlagt skåre fra Boksene 1-4 (side 1) ☐ **A**

Arbeidsark 1 – Skåre for vekttap

For å bestemme skåren bruker du vekttap for 1 måned, hvis tilgjengelig. Bruk data for 6 måneder kun hvis det ikke finnes vektdata for 1 måned..Bruk poengene nedenfor for å skåre vektendring. Legg til ett poeng hvis pasienten har tapt vekt i løpet av de 2 siste ukene. Registrer den totale skåren i Boks 1 PG-SGA.

Vekttap på 1 måned	Poeng	vekttap på 6 måneder
10% eller mer	4	20% eller mer
5-9.9%	3	10- 19.9%
3-4.9%	2	6- 9.9%
2-2.9%	1	2- 5.9%
0-1.9%	0	0- 1.9%

Numerisk skåre fra Arbeidsark 1 ☐

5. Arbeidsark 2 – Sykdom og dens påvirkning på ernæringsbehov

Ett poeng gis for hver av de følgende tilstander.

- ☐ Kreft
- ☐ AIDS
- ☐ Pulmonal eller kardial kakeksi
- ☐ Kronisk nyresvikt
- ☐ Liggesår, åpent sår eller fistel
- ☐ Traume
- ☐ Alder over 65 år

Andre relevante diagnoser (spesifiser) _____

Primær sykdomstadium (sette en ring rundt hvis kjent) I II III IV Annet _____

Numerisk skåre fra Arbeidsark 2 ☐ **B**

6. Arbeidsark 3 – Metabolsk behov

Skåre for metabolsk stress bestemmes av flere variabler som er kjent for å øke protein- og kaloribehov. **NB:** Ved feber gis den høyeste skåre av feber varighet eller temperatur**.** Skåren legges sammen slik at en pasient som har feber på > 38.8 °C (3 poeng) i < 72 timer (1 poeng) og er på 10 mg prednisolon fast (2 poeng), vil få en sammenlagt skåre på 5 poeng.

Stress	ingen (0)	lavt (1)	moderat (2)	høyt (3)
Feber	ingen feber	> 37,2 og < 38.3	≥ 38,3 og < 38.8	≥ 38,8 °C
Feber varighet	ingen feber	< 72 timer	72 timer	> 72 timer
Kortikosteroider	ingen kortikosteroider	lav dose (< 10 mg prednisolon-ekvivalenter/dag)	moderat dose (≥ 10 og < 30 mg predisolonekvivalenter/dag)	høy dose (≥ 30 mg prednisolon-ekvivalenter/dag)

Numerisk skåre fra Arbeidsark 3 ☐ **C**

7. Arbeidsark 4 – Fysisk undersøkelse

Fysisk undersøkelse omfatter 3 aspekter ved kroppssammensetning: fett, muskel og væske. Undersøkelsen er subjektiv, hvert aspekt av undersøkelsen er vurdert i grader. Tap av muskelmasse påvirker poengskåre mer enn tap av fettmasse. Definisjon av grader: 0 = ingen underskudd, 1+ = lett underskudd, 2+ = moderat, 3+ = alvorlig. Skåren legges ikke sammen. Man gjør en subjektiv klinisk vurdering av totalt underskudd, inkludert forekomst av væskeoverskudd/ødem. **Maks total skåre for fysisk undersøkelse er 3 poeng**.

Muskelstatus				
tinninger (temporalis)	0	1+	2+	3+
krageben (pektoralis & deltoid)	0	1+	2+	3+
skuldre(deltoid)	0	1+	2+	3+
interosseus	0	1+	2+	3+
skapula (latissimus dorsi, trapezius, deltoid)	0	1+	2+	3+
lår (quadriceps)	0	1+	2+	3+
legg (gastrocnemius)	0	1+	2+	3+
Skåre for muskelstatus	**0**	**1+**	**2+**	**3+**

Fettlager				
orbitalt fett	0	1+	2+	3+
triceps hudfold	0	1+	2+	3+
fett over nedre ribben	0	1+	2+	3+
Skåre for fettunderskudd	**0**	**1+**	**2+**	**3+**
Væskestatus				
ankeløedem	0	1+	2+	3+
sakralt ødem	0	1+	2+	3+
ascites	0	1+	2+	3+
Skåre for væskestatus	**0**	**1+**	**2+**	**3+**

Poengskåren for den fysiske undersøkelsen bestemmes av en total subjektiv klinisk vurdering
Muskelmasseunderskudd har større effekt på poengskåren enn fettmasseunderskudd eller væskestatus

Ingen underskudd	skåre = 0 poeng
Lett underskudd	skåre = 1 poeng
Moderat underskudd	skåre = 2 poeng
Alvorlig underskudd	skåre = 3 poeng

Numerisk skåre fra Arbeidsark 4 ☐ **D**

Total PG-SGA Skåre (Total numerisk skåre for A+B+C+D) ☐

Global PG-SGA kategori skåre (A, B eller C) ☐

Klinikers underskrift _____Yrke _____Dato_____

Arbeidsark 5 – PG-SGA Global vurderingskategorier

	Kategori A	Kategori B	Kategori C
Kategori	**Velernært**	**Moderat underernært/ mistenkt underernært**	**Alvorlig underernært**
Vekt	Ingen vekttap **ELLER** nylig vektøkning som ikke **skyldes væskeretensjon**	≤ 5% vekttap på 1 måned **ELLER** (≤10% in 6 months) **ELLER** progressivt vekttap	> 5% vekttap på 1 måned **ELLER** (>10% in 6 months) **ELLER** progressivt vekttap
Matinntak	Ikke redusert inntak **ELLER** nylig forbedring	Noe redusert inntak	Sterkt redusert inntak
Symptomer	Ingen **ELLER** nylig forbedring som gir adekvat matinntak	Symptomer (PG-SGA Boks 3**)**	Symptomer (PG-SGA Boks 3**)**
Funksjon	Normalt funksjonsnivå **ELLER** nylig forbedring	Moderat redusert funksjonsnivå **ELLER** nylig forverring	Alvorlig redusert funksjonsnivå **ELLER** nylig forverring
Fysisk undersøkelse	Ingen mangel **ELLER** nylig forbedring	Mild til moderat tap av muskelmasse /subkutant fett/muskeltonus ved palpering	Alvorlig tap av muskelmasse eller subkutant fett eventuelt ødemer

Ernæringstiltak: Den sammenlagte skåren brukes til å definere spesifikke ernæringsmessige intervensjoner, inkludert opplæring av pasienter og familie, symptombehandling, inkludert farmakologisk intervensjon og egnet ernæringsmessig intervensjon (mat, ernæringstilskudd, enteral- eller parenteralernæring).

Førstelinjes ernæringsmessig intervensjon omfatter symptombehandling.

Ernæringstiltak basert på poengskåre for PG-SGA

0-1	Ingen intervensjon nødvendig nå. Revurdering på rutinemessig og regulær basis under behandling.
2-3	Opplæring av pasient og familie av klinisk ernæringsfysiolog, sykepleier eller annen klinikkmedarbeider med farmakologisk intervensjon som indikert ved symptomgjennomgang (Boks 3) og labtorieverdier etter behov
4-8	Krever intervensjon av klinisk ernæringsfysiolog i samarbeid med sykepleier eller lege som indikert av symptomene (Boks 3)
≥ 9	Indikert et kritisk behov for forbedret symptombehandling og/eller alternativer for ernæringsmessig intervensjon

email: faithotterymdphd@aol.com or info@pt-global.org

APPENDIX 4: Dietary registration form used for 24-h recall method

Tidspunkt, sted*	**Måltid/mat**	**Merke/type**	**Kode/mengde**	**Drikke**	**Merke/type**	**Kode/mengde**
Kosttilskudd??						
Røyk?						
Alkohol?						

Appendix 5: Information and consent form in Norwegian

Ernæringsstatus og kostinntak hos pasienter før og etter kirurgi

Dette er et spørsmål til deg om å delta i et forskningsprosjekt for å kartlegge ernæringsstatus og kostinntak hos pasienter før og etter kirurgi i øvre eller nedre del av mage-tarmkanalen. To ulike metoder for vurdering av ernæringsstatus vil benyttes for å se om en av dem passer bedre for denne pasientgruppen. På sikt ønsker vi at resultatene kan bidra til bedre ernæringsbehandling for pasienter som skal gjennom planlagt kirurgi.

Du forespørres om å delta nettopp fordi du skal gjennomføre en planlagt operasjon ved gastroenterologisk kirurgisk avdeling ved St. Olavs Hospital. Studien foregår ved preoperativ poliklinikk for planlagt gastroenterologisk kirurgi, i samarbeid med Avdeling for klinisk ernæring. Resultatene tilhører Gastroenterologisk kirurgisk avdeling ved St. Olavs Hospital, men vil også benyttes i en masteroppgave i klinisk ernæring. Masterstudent Tonja Ulvenes Ystaas vil gjennomføre studien.

Hva innebærer prosjektet?

Deltagelse i studien innebærer at du vil møte masterstudenten samtidig som du kommer til preoperativ poliklinikk for operasjonsforberedelser. Utover standardutredning ved preoperativ poliklinikk, vil du bli spurt om ditt daglige kostinntak, aktivitetsnivå, og vi vil måle håndgripestyrke og vurdere kroppssammensetning. Tidsbruk er ca. 45 minutter, og pårørende kan være tilstede om ønskelig. Vi ønsker at du **veier deg hjemme dagen før preoperativ poliklinikk og tar med deg resultatet til timen.** Vi avtaler på poliklinikken en tid for telefonoppfølging ca 1 mnd etter operasjonen. Da vil du igjen bli spurt om kostinntak, endringer i matinntak, vektendringer og aktuell vekt. Informasjon om sykdomsforløpet ditt og preoperative blodprøvesvar vil hentes anonymt fra din elektroniske pasientjournal etter operasjonen.

Mulige fordeler og ulemper

Det er ingen risiko forbundet ved å delta i studien.

Frivillig deltakelse og mulighet for å trekke sitt samtykke

Det er frivillig å delta i prosjektet. Dersom du ønsker å delta, undertegner du samtykkeerklæringen på siste side, tar med denne på Preop poliklinikken og leverer til sekretær/sykepleier når du kommer. Du kan når som helst og uten å oppgi noen grunn trekke ditt samtykke. Dette vil ikke få konsekvenser for din videre behandling. Dersom du trekker deg fra prosjektet, kan du kreve å få slettet innsamlede prøver og opplysninger, med mindre opplysningene allerede er inngått i analyser eller brukt i vitenskapelige publikasjoner. Dersom du ønsker å trekke deg eller har spørsmål til prosjektet, kan du kontakte.

Prosjektleder Lene Thoresen, tlf 72 82 85 54
Masterstudent Tonja Ulvenes Ystaas, tlf 98885333

Hva skjer med informasjonen om deg?

Informasjonen som registreres om deg skal kun brukes slik som beskrevet i hensikten med studien. Du har rett til innsyn i hvilke opplysninger som er registrert om deg og rett til å få korrigert eventuelle feil i de opplysningene som er registrert.

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. Det vil ikke være mulig å identifisere deg i resultatene av studien når disse publiseres.

Masterstudent har ansvar for den daglige driften av forskningsprosjektet og at opplysninger om deg blir behandlet på en sikker måte. Informasjon om deg vil bli anonymisert eller slettet senest fem år etter prosjektslutt.

Godkjenning

Prosjektet er godkjent av Regional komite for medisinsk og helsefaglig forskningsetikk, REK 2016/1252.

Du er når som helst velkommen til å stille spørsmål til oss vedrørende deltakelse i prosjektet, og vi vil svare etter beste evne.

Takk for din interesse.

Vennlig hilsen

Tonja Ulvenes Ystaas

Kontaktinformasjon:
Tonja Ulvenes Ystaas, tlf 98885333, tonja.ystas@student.uib.no

Lene Thoresen, prosjektleder, tlf 72828554, lene.thoresen@stolav.no

Samtykke til deltakelse i prosjektet

Jeg er villig til å delta i prosjektet

Sted og dato

Deltakers signatur

Deltakers navn med trykte bokstaver

Appendix 6: REC-approval in Norwegian

REK
REGIONALE KOMITEER FOR MEDISINSK OG HELSEFAGLIG FORSKNINGSETIKK

Region:	Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
REK nord	Lill Martinsen	77646140	15.09.2016	2016/1252/REK nord
			Deres dato:	Deres referanse:
			04.09.2016	

Vår referanse må oppgis ved alle henvendelser

Lene Thoresen
Olav Kyrres gate 17

2016/1252 Ernæringsstatus og kostinntak hos pasienter før og etter kirurgi på fordøyelseskanalen

Forskningsansvarlig: St. Olavs hospital **Prosjektleder:** Lene Thoresen

Vi viser til tilbakemelding av 04.09.2016, vedlagt revidert informasjonsskriv og forskningsprotokoll.

Vurdering:

Søknaden ble behandlet av Regional komité for medisinsk og helsefaglig forskningsetikk (REK nord) i møte den 18.08.2016. Komiteen hadde merknader til søknaden vedrørende dataoppbevaring, kontaktinformasjon i samtykkeskriv, samt prosjektets design og ba om å få tilsendt revidert protokoll iht. komiteens merknader.

Tilbakemelding av 04.09.2016. er vurdert å være i tråd med de merknader REK nord hadde til prosjektsøknaden.

Etter fullmakt er det fattet slikt

Vedtak

Med hjemmel i helseforskningsloven §§ 2 og 10 godkjennes prosjektet.

Sluttmelding og søknad om prosjektendring

Prosjektleder skal sende sluttmelding til REK nord på eget skjema senest (et halvt år etter prosjektslutt), jf. hfl. § 12. Prosjektleder skal sende søknad om prosjektendring til REK nord dersom det skal gjøres vesentlige endringer i forhold til de opplysninger som er gitt i søknaden, jf. hfl. § 11.

Klageadgang

Prosjektleder kan klage på komiteens vedtak, jf. forvaltningslovens § 28 flg. Klagen sendes til REK nord. Klagefristen er tre uker fra mottak av dette brevet. Dersom vedtaket opprettholdes av REK nord, sendes klagen videre til Den nasjonale forskningsetiske komité for medisin og helsefag for endelig vurdering

Besøksadresse: MH-bygget UiT Norges arktiske universitet 9037 Tromsø
Telefon: 77646140
E-post: rek-nord@asp.uit.no
Web: http://helseforskning.etikkom.no/

Med vennlig hilsen

May Britt Rossvoll,

Sekretariatsleder

Lill Martinsen, Rådgiver