Prevalence of Risk of Malnutrition in Hospitalised Adult Patients in a Tertiary Hospital Setting in South Africa

by
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DECLARATION

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ABSTRACT

Introduction: Hospital malnutrition was first identified by Charles Butterworth in 1974, referring to malnutrition often being overlooked, underdiagnosed and consequently undertreated. This is still a current problem, with worldwide prevalence of malnutrition ranging from 15–76% among adults. Hospital malnutrition is associated with increased cost of care, complications, increased length of stay, mortality and poor quality of life compared to well-nourished patients. South Africa's hospitalised population is at an increased risk of malnutrition, due to high poverty levels and the quadruple burden of disease. The aim of this study was to determine the prevalence of risk of malnutrition in hospitalised patients in a South African Hospital setting.

Methods: Patients that were admitted (≤48 hours) and (≥18 years old) were eligible for inclusion. The prevalence of risk of malnutrition was assessed using three different screening tools (NRS-2002, SGA and AMDT) on admission and discharge (if hospitalised ≥7days). The prevalence of risk of malnutrition, related outcomes and the number of referrals for nutritional support were documented. The included wards were assessed for availability of nutrition protocols and resources needed to implement nutrition intervention using an observational checklist.

Results: On admission a total of 403 patients were included (males 52.9%). The mean age was 45.5 years ±16.6SD. There was an even distribution between patients from surgical (*n*=192) and medical wards (*n*=190), with gynaecology (*n*=21) contributing a small number of patients. The prevalence of risk of malnutrition on admission ranged depending on the screening tool used: NRS-2002 (59.1%; *n*=237), AMDT (62.9%; *n*=252) and SGA (56.6%; *n*=228). The mean length of stay was 6.9 days ±5.9SD, with a significant difference ($p<0.01$) in length of stay between malnourished patients (mean 7.4 days ±6.1SD) and well-nourished patients (5.2 days ±4.8SD). On discharge, 92 patients were included (males 52.8%). Most patients (64%; *n*=59) endured a complication, with significantly more complications ($p=0.048$) among the malnourished (mean 1.7 ±1.6SD) when compared to the well-nourished (mean 0.8±1.3SD).Patients 'at risk' were diagnosed with infectious and gastrointestinal diseases, cancer, or had abdominal surgery, making these high-risk disease categories for malnutrition. The prevalence of risk of malnutrition was higher within the discharge sample, regardless of which tool was used: NRS-2002 (73.8%; *n*=62), SGA (65.2%; *n*=60) and AMDT (79.3%;*n*=73). Despite the high prevalence of malnutrition, the nutrition referrals were poor, with only 1.3% (*n*=5) being referred on admission, and 9.8% (*n*=9) on discharge.

The AMDT was the only tool that had good validity (sensitivity 83.9%, specificity 80.2%) and inter-rater agreement (k=0.62) when using the SGA as reference. Similarly, the NRS-2002 had fair validity (sensitivity 73.8% and specificity 51.8%) but poor inter-rater agreement (k=0.24).

Lastly, the hospital setting had a poor nutrition-care environment as none of the wards (*n*=28) had nutrition protocols, nor screening tools available at ward level. Scales were available (96.4%; *n*=27), but 22.2% (*n*=6) were not in working condition. Stadiometers were not readily available (42.9%; *n*=12). The mean number of patients per ward was 43 ±17.7SD, with only an average of 11 ±2.5SD nurses on duty per ward, indicating a shortage of nurses for adequate patient care.

Conclusion: The prevalence of nutritional risk and malnutrition is very high in the hospital setting, regardless of screening tool used, and is associated with unfavourable patient outcomes.

OPSOMMING

Inleiding: Hospitaal wanvoeding was onder aandag gebring deur Charles Butterworth in 1974. Hy het verwys na wanvoeding wat gereeld misgekyk, nie gediagnoseer en nie behandel word nie. Dit is steeds die geval vandag met wêreld wye prevalensies van wanvoeding in die omgewing van 15-76% onder volwassenes. Hospitaal wanvoeding word geassosieer met verhoogde behandelingskoste a.g.v. die mediese intervensies benodig, komplikasies verlengde lengte van hospitalisasie, mortaliteit en swak kwaliteit van lewe in vergelyking met goed-gevoede eweknieë. Die hospitaal populasie in Suid-Afrika het 'n verhoogde risiko om wanvoeding te ontwikkel, a.g.v. die hoë voorkoms van armoede en viervuldige siektelas. Die doel van die studie was om die prevalensie van risiko vir wanvoeding in gehospitaliseerde pasiënte in Suid-Afrika te bepaal.

Metodes: Pasiënte wat toegelaat is binne die afgelope 48 uur en ≥18 jaar in ouderdom was geskik vir insluiting. Die prevalensie van risiko vir wanvoeding is bepaal deur drie verskillende siftingshulpmiddels (NRS-2002, SGA en AMDT) met toelating en by ontslag (indien hospitalisasie ≥7dae). Die prevalensie van risiko vir wanvoeding, verwante uitkomste (komplikasies, lengte van hospitalisasie) en die aantal verwysings vir voedingondersteuning is deurlopend aangeteken. Alle sale is evalueer vir beskikbaarheid van voedingprotokolle en hulpmiddele wat gebruik word om voedingondersteuning te implimenteer d.m.v. 'n kontrolelys.

Resultate: 'n Totaal van 403 pasiënte is ingesluit met toelating (mans 52.9%). Die gemiddelde ouderdom was 45.5 ±16.6SD. Daar was 'n gelyke verspreiding tussen pasiënte van chirurgiese (*n*=192) en mediese sale (*n*=190), met 'n kleiner bydrae van ginekologie (*n*=21). Die prevalensie van wanvoeding het gewissel afhangend van die siftingshulpmiddels gebruik; NRS-2002 (59.1%; *n*=237), AMDT (62.9%; *n*=252) en SGA (56.6%; *n*=228). Die gemiddelde lengte van hospitalisasie was 6.9dae ±5.9SD, met 'n beduidende verskil ($p<0.01$) in lengte van hospitalisasie tussen wangevoede (gemiddel 7.4 dae ±6.1SD) en goed-gevoede pasiënte (5.2 dae ±4.8SD). Met ontslag is 92 pasiënte ingesluit (mans 52.8%). Die meerderheid pasiënte (64%; *n*=59) het 'n komplikasie ontwikkel. Wangevoede pasiënte met ontslag het beduidend ($p=0.048$) meer komplikasies gehad (gemiddel 1.7 ±1.6SD) teenoor goed-gevoede pasiënte (gemiddel 0.8 ±1.3SD). Hoë-risiko siektetoestande geassosieerd met wanvoeding in hierdie studie was infektiewe en gastrointestinale siektes, kanker en abdominale chirurgie. 'n Hoër prevalensie vir wanvoeding risiko is gevind met die ontslag-steekproef, ongegag die hulpmiddel gebruik; NRS-2002 (73.8%;*n*=62), SGA (65.2%;*n*=60) en AMDT (79.3%;*n*=73). Ondanks die hoë prevalensie van

wanvoeding, was die voedingverwysings swak met slegs 1.3% (*n*=5) pasiënte wat verwys is met toelating en 9.8% (*n*=9) met ontslag.

Wanneer die siftingshulpmiddels teenoor mekaar evalueer word, was die AMDT die enigste hulpmiddel met goeie geldigheid (sensitiwiteit 83.9%, spesifisiteit 80.2%) en tussen-hulpmiddel ooreenstemming (k=0.62) teenoor die SGA as verwysing. Die NRS-2002 het 'n matige geldigheid getoon (sensitiwiteit 73.8%, spesifisiteit 51.8%) met swak tussen-hulpmiddel ooreenstemming (k=0.24).

Laastens het die hospitaal 'n swak voedingsorg omgewing gehad deurdat geen van die sale (*n*=28) voedingprotokolle in plek gehad het nie, asook geen sigtingshulpmiddels op saalvlak. Skale was teenwoordig (96.4%;*n*=27), waarvan 22.2% (*n*=6) nie in werkende toestand was nie. Lengtemeters was nie geredelik beskikbaar nie (42.9%; *n*=12). Die gemiddelde aantal pasiënte per saal was 43 ±17.7SD, terwyl daar slegs 'n gemiddeld van 11±2.5SD verpleegkundiges aan diens was per saal. Dit dui op 'n verplegingtekort om voldoende pasiëntsorg te kan lewer.

Gevolgtrekking: Die prevalensie van risiko tot en wanvoeding is baie hoog in die hospitaalomgewing ongeag die siftingshulpmiddels wat gebruik is. Wanvoeding was assosieerd met ongunstige pasiëntuitkomste.

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CONTRIBUTIONS BY PRINCIPAL RESEARCHER AND FELLOW RESEARCHERS

The principal researcher, Merel Moens, together with Prof. R. Blaauw and Mrs J. Visser, developed the protocol for this study. Data collection was done by the principal researcher and a fieldworker, both qualified dietitians. The data was captured by the principal researcher and analysed with the assistance of Prof. R. Blaauw, Ms J. Wilson and Prof. D. Nel from Stellenbosch University. Lastly, the data was interpreted by the principal researcher, but was edited and revised at all stages of the research based on the input provided by the supervisors, namely Prof. R. Blaauw and Mrs J. Visser.

Language editing of Chapter 1, 3, 4 and 5 was undertaken by Dr. Elizabeth van Aswegen.

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Analysis of Variance (ANOVA): This statistical test is used when comparing one continuous and one nominal variable. ANOVA is used if the continuous variables are normally distributed.

Bias: When a study has bias, the results of the study do not represent the truth. Bias refers to problems in the design or methodology of epidemiological studies that lead to false results. [1]

Cachexia: 'A systemic pro-inflammatory process with associated metabolic derangements that include insulin resistance, increased lipolysis, increased lipid oxidation, increased protein turnover and loss of body fat and muscle.'[2] Cachexia increases resting energy expenditure and does not respond to nutritional intervention; instead successful intervention requires treatment of the underlying condition or the inflammatory process.[3]

Chi-square Test: A test that uses the Chi-square statistic to test the fit between a theoretical frequency distribution and a frequency distribution of observed data for which each observation may fall into one of several classes. [4]

Concurrent validity: 'This is the degree to which a test corresponds to an external criterion that is known concurrently (i.e. occurring at the same time). If the new test is validated by a comparison with a currently existing criterion, it is known as concurrent validity.[5]

Construct validity: Construct validity is another sub-item of validity and refers to the level of agreement between the diagnostic problem (the construct) and what is actually done. It is made up of two components, namely translation validity and criterion validity. Translation validity refers to the extent to which the measure makes sense to the experts about the subject. Criterion validity refers to evaluating the results of the measuring instruments against the most valid measurement available (the gold standard).[6]

Content validity: This requires that the measure accounts for all of the elements of the variable or subject being investigated.[1]

Criterion validity: This refers to evaluation of the study results of the measurement instrument against the most valid measurement available (gold standard). The gold standard is used as the criterion to establish if the values were identified correctly. The sensitivity and specificity can be calculated to determine the criterion-related validity of variables.[1]

Grade E Evidence: According to the grading of guidelines and levels of evidence, a grade E means that the evidence is supported by nonrandomised cohort with contemporaneous controls, or case series, uncontrolled studies and expert opinion.[7]

Inflammation: 'The act of inflaming, or the state of being inflamed', more specifically heat, redness, swelling and pain as a result of irritation, injury or infection. It consists of an ebb-and-flow phase that is orchestrated by hormones, commonly known as cytokines. [8] Inflammatory disease, illness or injury can alter hormone function by activating a cytokine-mediated response, which has a profound effect on nutrient requirements. [9]

Interquartile range: Quartiles divide a sample value into quarters. The distance between the lower quartile (25^{th} percentile) and the upper quartile (75^{th} quartile) is known as the interquartile range.

Kappa statistic: Kappa indicates agreement between two variables, corrected for chance, presenting agreement or concordance. Kappa may range between -1 and 1, with 1 indicating perfect agreement and -1 perfect disagreement. A kappa value above 0,8 indicates excellent agreement. [1]

Kruskal–Wallis Analysis of Variance (ANOVA): This test is used when comparing one continuous and one nominal variable. Kruskal-Wallis ANOVA is used if the continuous variable is non-normally distributed.

Malnutrition: Malnutrition has been described as any form of a nutrient imbalance, including under- and over-nutrition, resulting in measurable adverse effects on body composition and functioning, and its associated clinical outcomes.[10]

Mann–Whitney U: The Mann–Whitney U test is used to compare a continuous and one binary variable, if the continuous variable is not normally distributed.

Marasmus: Marasmus is also known as the dry form of protein energy undernutrition, which is an energy deficit due to chronic deficiency of all macronutrients. Severity may range from subclinical deficiencies to obvious wasting, to starvation. Marasmus causes weight loss and depletion of fat and muscle, without the presence of inflammation.[11]

Mean: The mean or average is the sum of all values, divided by the number of individuals in the group. It is sensitive to extreme values (outliers), especially in smaller samples. If the distribution is asymmetrical or if there are extreme outliers, the median should rather be used.[1]

Median: The median is also known as the 50th percentile, and is the value that divides the sample values in half, when sorted from small to large. This means that half of the sample values now lie above the median, and half lie below the median. In cases where the sample size is off, the middle value in the sorted series is the median. If the sample size is even, then the median is the average of the two middle values.[1]

Meta-analysis: Meta-analysis is a statistical methodology which enables the pooling of results of multiple studies that are similar in nature, thereby increasing the statistical power and the likelihood of demonstrating an effect or association if one exists.[1]

Nutrition assessment: Nutrition assessment is 'a comprehensive approach to diagnosing problems that uses a combination of the following: medical, nutrition, and medication histories; physical examination; anthropometric measurements; and laboratory data'. [12] A nutrition assessment forms the basis of the nutritional care plan and should be performed by a dietitian as it requires clinical skill. The outcomes must be defined and the patient must be monitored as it is a continuous process of reassessment.[12]

Nutrition screening: This is a rapid, simple process conducted by staff on patients' admission to hospital or a health-care facility and is recommended to help detect patients that are at-risk of malnutrition.[6]

Nutritional Risk: Nutritional risk is defined by the patient's current nutritional status and the risk of impairment of present status due to increased requirements secondary to the impact of underlying disease increasing stress metabolism. Patients categorised to be nutritionally 'at risk' have an increased likelihood to have a positive effect of nutritional intervention. [13]

Predictive validity: Predictive validity is the measure of people correctly diagnosed with and without the condition, confirming a known theoretically hypothesised association. Screening tools must have good predictive validity.[6,14-18]

P-Value: 'A statistical hypothesis is an assumption made about a parameter or one or more populations.' To determine whether these are associated, a null hypothesis is formulated so that the factors can be tested. The null hypothesis is the hypothesis indicating that there is no difference or no association. A test statistic is calculated to determine how likely it is to obtain the observed data if the null hypothesis were true. 'The p-value is the probability of observing the test statistic or a more extreme result if the null hypothesis is true.' If the p-value is large, it means that the data is in agreement with the null hypothesis, and consequently cannot be rejected.[1]

Randomised controlled trial: A randomised controlled trial is a form of experimental studies, and is the most rigorous experimental design in epidemiology. The researcher randomly allocates participants to receive (intervention group) or not receive (control group) one or more of the interventions that are being compared. The control group in turn receives either the standard treatment or a placebo, in cases where there is not a standard treatment. The results are assessed by comparing the occurrence of the outcome of interest between the two groups.[1]

Reliability: Reliability is the degree of agreement or similarity of the results, when they are repeated on the same subject or group. It poses the question whether the same values/results are obtained every time the measurement is taken or whether they vary.

Sarcopenia: Sarcopenia is a term used to describe the progressive loss of lean body mass, which usually starts at the age of 40 years. This ultimately amounts to approximately 10kg muscle loss in men and 5kg in women. Causes of sarcopenia include decreased physical activity, dietary intake, increased level of cytokines, decreased growth hormone and mechano-growth factor levels, and in men decreased androgen levels. Undernutrition plays a role in sarcopenia and is responsible for many of the complications that are associated with undernutrition, such as a decreased nitrogen balance, and increased susceptibility to infections.[11]

Sensitivity: Sensitivity refers to the proportion of people who truly have the disease and appropriately test positive. Sensitivity is very important in screening tests, as the clinician would want to be certain that disease is unlikely if the test is negative.[1]

Sepsis: Sepsis can be defined as an infection that is accompanied by an acute inflammatory reaction that is associated with the release of several endogenous inflammatory mediators. The inflammatory reaction may often present with two or more of the following: Temperate <36 °C or >38 °C, heart rate >90 beats per minute, respiratory rate >20 breaths per minute, white blood cell count >12 000 cell/µl or <4000 cells µL.[11]

Spearman's Rank Order Correlation: A correlation coefficient is the measure of association between two variables. It can be said that two variables are positivity correlated if an increase in one variable is associated with an increase in the other. Two variables are negatively correlated if a decrease in one variable is associated with an increase in the other. The correlation co-efficient can range from -1 to 1, with 0 indicating no correlation. The Spearman's rank correlation coefficient can be used if one or both of the variables has a skewed distribution or outlying values to calculate a non-parametric correlation co-efficient.[1]

Specificity: Specificity refers to the proportion of people who truly do not have the disease and test negative. This is important when confirming the presence of disease, to confidently ensure the disease is present if the test is positive.[1]

Starvation: Starvation describes the complete lack of nutrients, which may occur in the presence of food availability (anorexia nervosa), although it usually occurs when there is no food available (famine).[11]

Systematic review: 'A review in which bias has been reduced by the systematic identification, appraisal, synthesis and if relevant, statistical aggregation of all relevant studies on a specific topic, according to a predetermined and explicit method.'[19]

Validity: Validity refers to the extent to which a measurement instrument measures what it is designed to measure. The measurement instrument has poor validity if the characteristics that it measures are repeatedly higher or repeatedly lower than the real value, introducing bias.

Wasting: Wasting is a form of undernutrition. In wasting disorders (AIDS, cancer, renal failure), catabolism causes excessive cytokine production, resulting in undernutrition due to induced anorexia and cachexia (muscle and fat wasting). Wasting disorders may lead to decreased appetite and impair the metabolism of nutrients.[11]

LIST OF ABBREVIATIONS AND ACRONYMS

ADA	American Dietetic Association
AIDS	Acquired Immune Deficiency Syndrome
AMDT	American Malnutrition Diagnostic Tool
ANOVA	Analysis of Variance
APACHE	Acute Physiology and Chronic Health Evaluation
ARDS	Acute Respiratory Distress Syndrome
ARVS	Antiretroviral drugs
ASPEN	American Society of Parenteral and Enteral Nutrition
BAPEN	British Association of Parenteral and Enteral Nutrition
BIA	Bioelectric Impedance Analysis
BMI	Body Mass Index
BWL	Body Weight Loss
CCU	Cardiac Care Unit
CEO	Chief Executive Officer
CHBAH	Chris Hani Baragwanath Academic Hospital
CM	Centimetres
CRP	C-Reactive Protein
CT	Computed tomography
DEXA	Dual-energy X-ray absorptiometry
EN	Enteral Nutrition
ENASA	Enteral Nutrition Association of South Africa
ENT	Ear, Nose and Throat
ESPEN	European Society for Clinical Nutrition and Metabolism
GIT	Gastrointestinal tract
HCUP	Healthcare Cost and Utilization Project
HIV	Human Immunodeficiency Virus
HOD	Head of Department
IBRANUTRI	The Brazilian National Survey
IBW	Ideal Body Weight
ICD	International Classification of Diseases
ICU	Intensive Care Unit

KG	Kilograms
LBM	Lean Body Mass
LOS	Length of Stay
MAC	Medical Advisory Committee
MNA	Mini Nutritional Assessment
MRI	Magnetic Resonance Imaging
MST	Malnutrition Screening Tool
MUAC	Mid-Upper Arm Circumference
MUST	Malnutrition Universal Screening Tool
NPO	Nil per Os
NRS-2002	Nutrition Risk Screening 2002
NRSTs	Nutrition Risk Screening Tools
ONS	Oral Nutrition Supplements
PG-SGA	Patient Generated Subjective Global Assessment
PN	Parenteral Nutrition
QOL	Quality of Life
RCT	Randomised Controlled Trial
RD	Registered Dietitian
SA	South Africa
SASPEN	South African Society for Parenteral and Enteral Nutrition
SD	Standard Deviation
SGA	Subjective Global Assessment
SNAQ	Short Nutritional Assessment Questionnaire
SR	Systematic Review
TB	Tuberculosis
TSF	Tricep Skinfold
WHO	World Health Organization
WT	Weight

CHAPTER 1

REVIEW OF THE LITERATURE

1 REVIEW OF THE LITERATURE

1.1 INTRODUCTION

This study aimed at providing statistics on the prevalence of patients at nutritional risk in South Africa, as there is currently limited data available in the South African context. In the review of the literature on this topic, the scope of hospital malnutrition is discussed, including the prevalence and causes of such malnutrition, and the consequences for both the patient and healthcare. This is followed by elaboration of the importance and use of screening, with specific focus on the three screening tools included in this study. Lastly the importance of nutritional intervention and actions for the prevention of malnutrition are discussed.

Although there are numerous screening tools available, a brief description is given of the three screening tools used in this study, namely the Nutrition Risk Screening tool (NRS-2002), Subjective Global Assessment tool (SGA) and the American Malnutrition Diagnostic Tool (AMDT). This includes their development, validation process, components, feasibility and use in clinical practice.

The last section of the review describes the positive effects of nutritional intervention in the clinical setting, to illustrate their associated benefits on patient outcome. Key interventions required to combat malnutrition are also discussed, as the way forward.

In conclusion, key arguments for conducting this research are provided.

1.2 HOSPITAL MALNUTRITION

1.2.1 History and Definition

Malnutrition is a common, worldwide problem, with significant effects on health. . [20] In simple terms, malnutrition has been described as any form of a nutrient imbalance, including under- and over-nutrition, resulting in measurable adverse effects on body composition and functioning, and their associated clinical outcomes.[10]

Hospital malnutrition was first identified by Charles Butterworth, when he published 'The Skeleton in the Hospital Closet' in 1974, referring to malnutrition's often being overlooked,

underdiagnosed and consequently undertreated.[21] Butterworth recognised that nutritional care in medical practice for patients was the exception rather than the rule. He also recognised the role that nutrition plays in wound healing and improving patient outcomes[22],and that medical practices should safeguard both the diagnosis and management of the malnourished patient.[23]

In 1997 Roubenoff et al., recognised the lack of standardisation among medical terms, and that a variety of terms were used to describe unintentional weight loss among healthcare professionals. The terms 'wasting', 'cachexia', 'marasmus', 'sarcopenia', 'inertion' and 'malnutrition' were all used interchangeably to describe unintentional weight loss, with or without reference to the changes in body composition, leaving clinicians misled and confused. He proposed and described new definitions for sarcopenia, cachexia and wasting, related to the pathological processes and the condition to standardise future diagnoses. Roubenoff et al. concluded that terms such as 'starvation' and 'malnutrition' should be avoided as they were non-specific.[24]

In a study conducted by Corkins and colleagues, the diagnosis of malnutrition was examined by applying the International Classification of Diseases, Ninth Revision (ICD-9) to the 2010 Healthcare Cost and Utilization Project (HCUP). The data comprised 1051 hospitals in 45 US states and found that only 3.2% of discharged patients were diagnosed as malnourished. [25] These statistics do not correspond with other studies that have assessed the prevalence of malnutrition to ranges between 15–60%.[12]

Owing to the lack of a single global standardised approach to the diagnosis and documentation of malnutrition,[26] there has been uncertainty among healthcare staff. In turn, this has increased the potential for patients to be underdiagnosed and possibly misdiagnosed.[27] Current approaches to diagnosing malnutrition are limited by the absence of a validated diagnostic criterion for malnutrition, resulting in poor specificity, sensitivity and inter-observer reliability.[27,28]Furthermore, historic definitions also tend to overlap.

In 2009, the Academy of Nutrition and Dietetics (Academy), the European Society for Clinical Nutrition and Catabolism (ESPEN) and the American Society of Parenteral and Enteral

Nutrition (ASPEN) organised an International Consensus Guideline Committee to establish an aetiology-based malnutrition criterion for use in the clinical practice setting, so that accurate diagnoses could be made. The committee recognised that inflammation and semi-starvation are the two major risk factors for the development of malnutrition, which may occur simultaneously or independently.[3] Adult malnutrition is therefore now described in the context of acute illness or injury, chronic disease, and starvation-related malnutrition.

Inflammation is defined as 'the act of inflaming, or the state of being inflamed', more specifically heat, redness, swelling and pain as a result of irritation, injury or infection. It consists of an ebb-and-flow phase that is orchestrated by hormones, commonly known as cytokines.[8] Inflammatory disease, illness or injury can alter hormone function by activating a cytokine-mediated response, which has a profound effect on nutrient requirements.[9] The acute-phase response results in an increase in energy expenditure, gluconeogenesis, catabolism, and oedema secondary to decreased albumin levels. Although a cytokine-mediated response is considered to be an appropriate adaptive response to infection or injury, when generalised and sustained, it is associated with unfavourable effects on patient outcomes. In the hospitalised patient it is especially of concern as the presence of cytokines may induce anorexia, and may further compromise the patient's dietary intake.[8]

Although nutrition therapy is a crucial component of treatment in patients with an inflammatory component, inflammation blunts the effectiveness of nutrition therapy and medical intervention.[28] The provision of adequate protein and energy cannot completely spare muscle loss in high inflammatory conditions. Yet it is needed to support organ function.[3] Ideally, nutrition therapy should be provided in conjunction with other treatments, such as physical therapy, antibiotics, anti-inflammatory agents, probiotics and good glycaemic control.[3]

The proposed aetiology-based construct for adult malnutrition has differentiated between acute and chronic malnutrition, taking into consideration the accompanying degree of inflammation present. In acute disease, moderate to severe inflammation may be present. This is common in patients with closed head injury, critical illness, severe acute pancreatitis, burns, trauma or major infection.[28] In chronic disease malnutrition, the patient may

experience moderate inflammation, as would be seen in pancreatic cancer, coeliac disease, diabetes mellitus, cardiovascular disease, organ failure and sarcopenic obesity.

Healthcare professionals should be able to establish whether the inflammatory effect is mild, moderate or severe[3] as disease or injury, in conjunction with a poor nutritional status, may accelerate the negative effects of starvation.[29] Additionally, the presence of inflammation is associated with a poor response to nutrition therapy and an increased risk of mortality.[3,30] This makes recognition of the inflammatory component of vital importance when diagnosing a patient with malnutrition, as it has both diagnostic and therapeutic implications.[3]

Starvation-associated malnutrition describes chronic malnutrition in the absence of inflammation. Conditions associated with this definition would include anorexia nervosa and lack of interest in food, secondary to depression.[28] Over a prolonged period of time, starvation results in weight loss, irritability, poor work capacity, poor wound healing, impaired organ function, apathy, malaise, and an impaired immune function. Death can result within 70 days in a healthy adult if completely starved.[29] As there is no inflammation present, the patient can be effectively treated through nutrition resuscitation.[9]

The Academy of Nutrition and ASPEN have used the proposed aetiology-based construct for adult malnutrition in the clinical practice as the foundation for a further extended proposed approach to malnutrition diagnosis. It comprises new nomenclature for the malnutrition syndromes, that is, ‘malnutrition in the context of social or environmental circumstances’, ‘malnutrition in the context of chronic illness’, and ‘malnutrition in the context of acute injury or illness’.[28](Figure 1.1) The Academy and ASPEN have suggested six clinical characteristics for the diagnosis and documentation of malnutrition, as well a systematic adult nutrition assessment which supports the diagnostic concept. However the feasibility and validity are still to be tested and it is considered a work in progress, which may still evolve in future.[28]

A standardised approach to diagnosis would enable better correlation between best practice in both intervention and treatment to predict clinical outcomes and efficacy of therapy. In turn this could serve as a foundation for advocacy in public policy.

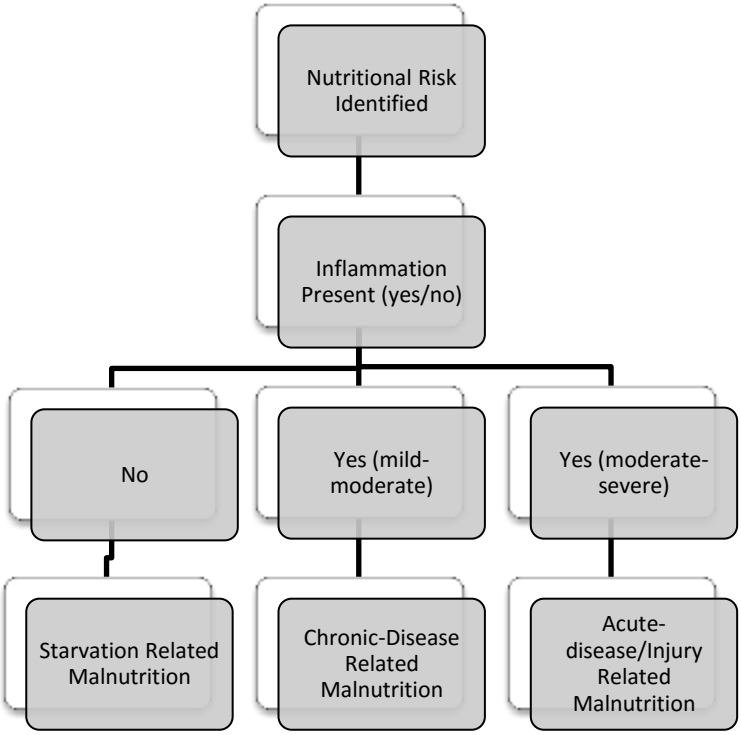


Figure 1.1 Aetiology approach to the diagnosis of malnutrition [3]

1.2.2 Causes of Malnutrition

In the most basic terms, malnutrition amongst adults occurs because of an inadequate dietary intake, increased protein and energy requirements, impaired nutrient absorption, altered transport, and/or altered utilisation of available nutrients.[26]

Historically, the main cause of malnutrition was famine and starvation. This is still a major factor in developing countries, such as South Africa, where the population faces high levels of poverty and food insecurity. Other reasons for malnutrition in public health include the occurrence of natural disasters, which affect food availability, and environmental issues such as drought and global warming, which impact agriculture and food supply.[28,31-35]

However, in the clinical setting, disease is often related to malnutrition owing to underlying inflammatory processes. This was first brought to light in 1992, by the King's Fund Centre document, 'A Positive Approach to Nutrition as Treatment', which recognised that disease is often associated with malnutrition and that nutrition therapy may improve clinical outcomes.[36] Underlying inflammatory process, hypermetabolism and hypercatabolism are associated with disease and/or injury.[26] Cytokines play an important role in regulating muscle stores during inflammation, including muscle catabolism, inhibiting protein synthesis and muscle repair, and influencing muscle function.[8] Conditions associated with mild to moderate inflammation may often result in cachexia, characterised by increased cytokine production and a catabolic state.[8] ESPEN has characterised cachexia as 'a systemic pro-inflammatory process with associated metabolic derangements that include insulin resistance, increased lipolysis, increased lipid oxidation, increased protein turnover and loss of body fat and muscle'.[2] Cachexia increases resting energy expenditure and does not respond to nutritional intervention; instead successful intervention requires treatment of the underlying condition or the inflammatory process.[3]

Patients admitted to hospital due to injury or illnesses often have lost weight prior to admission. The Nutrition Day Care Survey in Australia found that 40% of patients had lost weight three months prior to hospital admission and 50% of patients had a decreased food intake one week prior to admission.[20,37]

Hospitalisation itself is also a risk factor for malnutrition[20] as there are many barriers to the implementation of nutritional intervention. Organisational factors that contribute to the development of malnutrition include (1) nil per os (NPO) status, while awaiting further assessment and medical interventions, (2) absence of nutrition protocols in wards, (3) inadequate number of dietitians at the hospital, (4) ignorance of dietitians nutritional recommendations due to physicians' focus on patients' medical conditions, (5) physicians inadequately educated on product formulation and content available in the hospital, (6) interruptions at mealtimes, (7) inadequate dietary intake due to need of assistance or lack of appetite, (8) failure to recognise malnutrition, (9) lack of nutrition screening and assessments, (10) lack of nutritional training, (11) confusion regarding nutritional responsibility, and (12) ignorance of the importance of nutrition.[8,10,21,23,28,37-48]

Personal factors that may be regarded as risk factors contributing to the development of malnutrition include the inability to cook, buy or consume foods, inability to chew or swallow, limited mobility, sensory loss of taste and/or smell, medical treatment (surgery, ventilation, draining tubes) and drug therapy. Drug therapy may have significant nutritional implications (e.g. chemotherapy, morphine, antibiotics, sedatives, digoxin, antihistamines) as they may induce anorexia or diminish absorption of nutrients.[21]

Geriatric patients are more likely to suffer from dementia, poor dentition, immobilisation, and anorexia, putting them at increased risk of being malnourished.[49] Depression and low quality of life (QOL) is also associated with a lower intake of food.

1.3 PREVALENCE OF HOSPITAL MALNUTRITION

1.3.1 Overview

Generally epidemiologists define any disease with >10% prevalence as a 'common disease'.[50] Malnutrition can therefore be considered a common disease, as it ranges between 15–76% among adults, depending on the approach to diagnosis and patient population studied.[12,33,34,42,42,49,51-60,60-66]

In the 1970s, studies found the prevalence of malnutrition amongst adult hospitalised patients in the general medical wards was 44%,[65] with ≥50% of patients in the general surgical wards.[66] Despite consistent research in understanding and improving hospital malnutrition since the 1970s, the prevalence of hospital malnutrition still ranges between 30–50%, depending on the setting, population and screening criterion used.[67]

In developing countries, at least one-third of admitted patients are estimated to be malnourished.[21] Without nutritional intervention, it is estimated that two-thirds of these patients will have a significant decline in their nutritional status within the hospital stay. [68]

According to recent data collected in 2010 by the Agency for Health Research and Quality's Healthcare Cost and Utilization Project, 773 000 of hospital patient discharges were malnourished.[69] The high prevalence of malnutrition may also be due to the increasing average age of hospital patients, which in turn may counterbalance medical progress

made.[49] Thus, despite the significant advances made in medical research and health-care delivery systems, malnutrition is a common, worldwide problem, with a significantly high prevalence amongst hospitalised patients. Owing to its significance, the ASPEN Research Agenda has included improving the definition of malnutrition, and malnutrition assessment, diagnosis, and intervention in the context of support therapy in the continuum of care, in their recommendations for future research.[67]

1.3.2 Malnutrition in the South African Context

In South Africa (SA), there is limited data on the nutritional status of hospitalised patients. The prevalence of malnutrition was assessed in the 1980s in the medical wards of the King Edward Hospital, an academic hospital in KwaZulu-Natal. It predominantly served the urban black population. The authors wanted to assess the impact of urbanisation on nutritional status and disease profile. Third-World countries, such as SA, were rapidly urbanising, consequently affecting disease profile, inducing a shift from infectious disease to an increase in westernised diseases. They found that 82% of male patients, and 55% of female patients, had significantly low fat stores as measured by triceps skinfold (TSF). However, 12% of male patients, and 33% of female patients were overweight on admission, with a further 12% of female patients being classified as obese. This study highlighted both spectrums of malnutrition, namely undernutrition, and overnutrition.[33]

Later, hospital malnutrition was assessed in rural Zululand, KwaZulu-Natal, following a drought. A total of 207 patients were included from the medical wards, from four different mission hospitals. Objective nutritional markers, namely height, weight and triceps skinfold were used to assess the prevalence of malnutrition. Malnutrition was significantly higher among the black rural population, with 93% of males and 72% of females having triceps skinfold measurement of less than 60% than the normal. However, authors speculated that the nutritional status reflected the poor circumstances of the community.[70]

As there was only data on the nutritional status of the black population, a similar study was conducted at Groote Schuur Hospital, Western Cape, to evaluate the nutritional status of the black, white and coloured populations. The aim of the study was to assess the nutritional status of 700 patients in the medical and surgical wards. Nutritional markers included, weight, height, mid-upper arm circumference (MUAC), and triceps skinfold.

Researchers also documented routine blood tests, if available. It was found that the prevalence of malnutrition was higher among medical patients than surgical patients. Malnutrition was also more common in non-white populations (coloured 38%, black 42%). Among the medical patients, 22% were malnourished, compared with 16% of surgical patients when based on weight (<80% of IBW). However, 10–12% of patients were significantly overweight ((>120% of Ideal body weight (IBW)).[34]

In 1988, nutritional status and incidence of malnutrition were studied at Brooklyn Chest Hospital in the Western Cape. Patients were sampled from all wards, and included a total of 62 adults. Body weight depletion was found in 32.2% of patients, 78.8% had depleted fat stores and muscle depletion was found in 37% of the sample. In further analysis researchers found that malnutrition rates were higher among men than woman.[71]

In more recent studies conducted in 1997 at Tygerberg Hospital, Western Cape, medical patients were assessed for malnutrition. Severely malnutrition was diagnosed in 17% of patients and 77% were considered malnourished. This was followed by research in 1999 in the same hospital, where surgical patients were assessed for malnutrition. Nearly a third of patients were found to be malnourished, with nearly half having experienced weight loss.[71]

Despite limited data, the prevalence of malnutrition appears to be high in South Africa, and urgently needs attention.

1.4 CONSEQUENCES OF MALNUTRITION

The identification of patients 'at risk' of malnutrition is fundamental to its treatment.[21] Poor nutritional status is associated with many adverse outcomes for the patient, and with greater health care costs.[47] A decline in nutritional status impacts the patient on multiple levels: cellular, psychological, and physical. The severity of the impact is dependent on personal factors, including the patient's age, gender, current nutritional intake and duration of the medical condition.[21]

1.4.1 Effect of Malnutrition on Functional Capacity

Muscle function is often reduced in malnourished patients, secondary to deficiencies in activities of glycolytic enzymes, reduced size of muscle fibres, and the number of type-2 muscle fibres.[72] Muscle function is assessed by handgrip strength, which is directly proportional to muscle mass. Muscle function is sensitive to reduced nutritional intake, prior to any loss of muscle mass,[73] and function returns more rapidly through nutritional intervention when compared to tissue replacement. Numerous studies have shown that malnutrition is associated with increased muscle fatigue and reduced function.[29]

1.4.2 Effect of Malnutrition on the Cardiovascular and Respiratory System

Patients with disease-related malnutrition may also have a reduced heart volume and cardiac muscle mass[74-76] with a resultant decreased cardiac output, putting increased strain on renal function (reduced renal perfusion and glomerular filtration rate). Electrolyte and micronutrient deficiencies, specifically thiamine, can also impact the cardiovascular system of the malnourished patient at risk of re-feeding.[10]

Furthermore, malnourished patients often have reduced diaphragm muscle mass, respiratory muscle strength and maximal voluntary ventilation.[74-76] This, consequently, increases the risk of respiratory tract infections and delayed recovery due to reduced cough pressure. [10]

1.4.3 Effect of Malnutrition on the Gastrointestinal Function

The gastrointestinal tract is also affected by malnutrition, in several ways. The gut is a major immune organ, which prohibits the entrance of microorganisms by acting as a barrier. However, for optimal functioning of the gut barrier, adequate provision of nutrition is essential. Owing to a lack of luminal nutrition in chronic malnutrition, unfavourable morphological and functional changes occur, including altered enzyme functions, intestinal

blood flow, transit time, cell turnover, villous height absorption, and intestinal permeability.[77-82] The loss of digestive enzymes is seen in early stages of underfeeding and can result in secondary lactose intolerance, presenting with diarrhoea. [10] During starvation, the ability of the large bowel to reabsorb water and electrolytes may also be lost, although stimulation of colonic secretion is present.[82-84] These patients may experience diarrhoea, which is associated with a high mortality rate in malnourished patients.[84] Injury or stress may further exacerbate damage to the gut because of a decreased mesenteric blood flow. Starvation may also lead to increased gut permeability, enabling translocation of bacteria and endotoxins. Additionally, compromised gut permeability is also associated with the development of sepsis and systemic inflammation.[85,86]

1.4.4 Effect of Malnutrition on Immune Function

Malnourished patients are also at greater risk of complications and infections[21] as nearly all components of the immune systems are compromised,[29] impairing the body's response to malignant disease.[87] The patients' cell-mediated immunity, the complement system and their phagocytic function are most affected.[10] In turn, patients are at high risk of contracting respiratory infections, and parasitic or bacterial infection may progress more rapidly. Early antibiotic treatment is advised, as inflammatory markers may be suppressed.[10]

1.4.5 Effect of Malnutrition on Wound Healing and Pressure Ulcers

Impaired wound healing has also been well established in the malnourished surgical patient.[10] It is associated with infections, discomfort, pain and incurs extra expense due to the necessary medical therapy and staff time needed for extra care (changing dressings). In a study that compared wound healing in well-nourished and malnourished patients, poor wound healing was documented amongst undernourished patients that had undergone amputations.[88] The authors of the same study found that impaired wound healing may be more dependent on the patients' metabolic rate, rather than the amount of tissue lost at the time of wounding, and that wound healing can be impaired from the early stages of malnutrition.[89,90]

Pressure sores also contribute to increased levels of pain and discomfort, as well as medical therapy, and require special mattresses for treatment, increased nursing time, and ultimately cost. Although the pathogenesis of pressure sores is multi-factorial, nutritional

intake and poor nutritional status are considerable risk factors. Furthermore, the increased metabolism associated with injury may further hinder healing of the sore.[91]

1.4.6 Effect of Malnutrition on Complications and Clinical Outcomes

Likewise, poor nutritional status has been associated with longer length of stay (LOS) and treatment durations. LOS has been criticised as a validated outcome parameter as it can be influenced by multiple non-nutritional factors. However, it encompasses the possible consequences of reduced immune function, infections and poor wound healing and can be linked to cost.[92]

A study by Barker et al. in 2011 compared the average LOS between patients admitted 'at risk' of malnutrition and those well nourished. The results indicated that the patients 'at risk' of malnutrition had an average stay of four days longer than those that were well nourished on admission. [93] The average LOS for malnourished patients was found to be 40–70% longer, but was dependent on the severity of malnutrition (mild, moderate or severe). LOS may be increased five-fold in the severely malnourished patient compared with well-nourished patients.[94]

Malnourished patients are also more likely to be re-admitted to hospital within 15 days, independent of gender, race, and age.[95]

Complication rates and the severity of complications are also higher in malnourished patients,[29] and the risk of infectious and non-infectious complications correlate with the degree of malnutrition.[96]Surgical patients with ≥10% weight loss and physiological impairment had both longer LOS and post-operative complications compared with their well-nourished counterparts.[97] Malnutrition is also a risk factor for the development of pressure sores,[98] and is also associated with post-operative complications after cardiac surgery, including acute renal failure, pneumonia, respiratory failure and infections.[99] Furthermore, malnutrition is associated with poorer outcomes in cancer, cardiovascular[100] and gastrointestinal disease.[56]

The association between increased mortality and malnutrition is demonstrated in both acute and chronic diseases.[49] According to research conducted by Lim et al., there was a four-fold and three-fold increase in risk of mortality at one-year and at three-year follow-up

in patients that were malnourished. In this study, only 10% of the well-nourished patients died at the three-year follow up, compared with 50% of the malnourished patients, clearly demonstrating the increased risk of mortality associated with malnutrition.[95] Evidence indicates that a poor nutritional status at discharge is a strong independent factor for mortality in patients in the succeeding 4.5 years of life.[101]

All of the above findings can be summarised and confirmed by the international, multicentre study, EURoOOPS, where the NRS-2002 was implemented in 26 hospital departments in Europe. The researchers assessed the association between patients at nutritional risk and clinical outcomes on 5051 participants, and found that patients classified as 'at risk' had a significantly longer length of stay, number of complications, and mortality, than the patients not 'at risk.'[102]

1.4.6.1 Psychological Effect of Malnutrition

Patients that are malnourished also may suffer psychologically, as poor nutritional status is associated with fatigue and apathy. In turn, this may influence the patients' food intake and consequently delay recovery.[21] Patients are also likely to suffer from depression, anxiety and self-neglect, all having a profound effect on QOL. [10]

1.4.6.2 Economic burden of Malnutrition

As the malnourished patient is associated with increased LOS, and more intensive medical therapy, it significantly contributes to extra costs. In a study conducted by Robinson et al., malnourished patients had a 30% longer length in stay, which translated into double the costs, despite patients' having similar diagnoses.[103] It is clear that malnutrition is a great financial burden to healthcare. This poses a challenge to societies and governments involved in the planning, provision, receipt of, and payment for health services, as available resources must be spent wisely, without compromising quality of care, equity and fairness.[104]

The impact of malnutrition on healthcare costs was also assessed by Russel et al. in 2003 in the UK. Results estimated the economic burden of high-to medium-risk disease-related malnutrition to be a minimum of £7.3 billion, of which £3.8 billion was spent on hospital

treatment and £2.6 billion was for treatment in long-term care, especially for the elderly.[104] Another study found that treatment costs of the malnourished patient may increase up to 300%, compared with those of the well-nourished patient.[105]

There is clear evidence that nutritional status and disease affect patient outcome.[105] To minimise cost, the disease should be treated and the patient nourished, as nutrition therapy is a simple, cost-effective method to improve patient outcome. Recognition of the malnourished patient through screening is thus a crucial first step in the right direction.[105]

1.5 NUTRITION SCREENING AND ASSESSMENT

1.5.1 Screening for Nutritional Risk

Many patients in hospital are already malnourished when admitted to hospital, whereas others become malnourished during their hospital stay. Although patients are routinely screened at their primary diagnosis and treated accordingly (fever and dehydration), this special care is often not sustained towards the patients nutritional status. Instead it is more than often neglected, posing great clinical risks for the patient. Both ESPEN and ASPEN recommend screening for nutrition risk in hospitalised patients (grade E), as it is associated with increased LOS, complications and mortality.[6,12]

Nutrition screening is defined as a rapid, simple process conducted by staff on patients' admission to hospital or to a healthcare facility,[6] and is recommended to help detect patients that are at risk of malnutrition. Since first described in 1979 by Sletzer et al., screening tools have become increasingly complex.[106] Dietitians are often involved in the development of screening tools, although it is usually conducted by other health-care staff.[14]

Without screening, malnutrition is unlikely to be recognised and treated.[107] According to the 2003 ESPEN guidelines, the purpose of nutrition screening is to determine whether the patient is likely to have a good or bad outcome, and if nutritional intervention can alter the outcome.[108] As it is not realistic to conduct a complete nutrition assessment on every patient admitted, there is a need for a simple screening tool that can be used by all staff, in

any clinical setting, across all ages, and that can detect nutritional risk in both over- and undernutrition. A quick and simple screening tool that can accurately identify patients 'at risk' with fewer criteria, could save resources which could allow for the reallocation of resources to areas of higher nutrition priority. Owing to the large number of screening tools available, further research into the development of new screening tools is not recommended.[14]

1.5.2 Nutritional Assessment

A nutrition assessment should follow screening if a patient it deemed to be at nutritional risk. ASPEN defines nutrition assessment as 'a comprehensive approach to diagnosing problems that uses a combination of the following: medical, nutrition, and medication histories; physical examination; anthropometric measurements; and laboratory data'.[12] A nutrition assessment forms the basis of the nutritional care plan and should be performed by a dietitian as it requires clinical skill. The outcomes should be defined and the patient should be monitored, as it is a continuous process of reassessment.[12]

1.5.3 Nutritional Markers

The diagnosis of malnutrition is often based on objective measurements of nutritional status, although subjective measures may also be included. In 1994, the American Dietetic Association (ADA) suggested over 60 criteria for nutrition screening, derived from the literature.[17] Parameters commonly used in screening tools may include a clinical diagnosis, medical history, clinical signs, anthropometry, physical assessment, laboratory indicators, dietary assessment and assessment of functional status. However, as there is no single clinical or laboratory parameter to determine a patient's nutritional status, a variety of domains is recommended for the diagnosis of malnutrition. This should be conducted in a systematic manner. [109]

1.5.3.1 Dietary assessment as a nutritional marker

Common methods to determine a patient's dietary intake include a 24-hour recall, or a diet history. The clinician may obtain this information from the patient, friends, family, medical records, nurses and other health-care staff involved in the care of the patient. Information regarding types of foods, frequency and use of nutritional supplements should be obtained. Ill patients often present with reduced appetite, and consequently poor intake contributing

to a likelihood of becoming malnourished. Meals may also be missed because of medical procedures. The presence of the inflammatory response also induces anorexia, putting patients at increased risk. When a patient receives artificial feeding, dietary assessment should be continued to ensure the patient is meeting his or her requirements, as feeding is frequently interrupted in healthcare settings owing to medical interventions, tube displacements, and perceived intolerance.[109]

1.5.3.2 Anthropometry as a nutritional marker

Weight, height, MUAC and TSF measurements are just a few of the anthropometric measurements commonly used. Anthropometry should be obtained at regular intervals over time to identify trends as self-reported weights are often unreliable.[109] Weight and height measurements provide an inexpensive, practical method to obtain objective data to roughly asses a patient's nutritional status. However, this data is unfortunately not routinely obtained in the hospital.[110] Weight is an easy measurement, that provide information of the patients overall fat and muscle stores, although it may be influenced by the patients fluid status.[71] Weight is preferably taken standing upright on an electronic scale, however for those that cannot stand unassisted on a scale, may be weighed on a chair or bed scale. The reliability of the measurement can be confirmed by a second measurement, which should be similar (within 100g). In some cases obtaining weight may be difficult due to the patients' medical condition, equipment attached to the patients, or lack of resources (chair or bed scale). Weight may therefore need to be estimated. This can be done using various anthropometric measures such as knee height, mid-arm circumference, calf circumference and subscapular skinfold thickness, based on a set of equations. Error can be minimised by using equations with multiple variables, and applying the correct technique when taking the required measurement. Estimations should however only be used for patients that can't be weighed, as estimates may range with 14kg of the actual weight.[111]

Weight and height measurement also enable the clinician to calculate the patient's body mass index (BMI). BMI is used to determine body size and provides an indirect measure of body fatness.[109] However, it may be misleading in the obese patient, where it can classify the patient in the 'normal' range, although the patient may have lost a considerable and clinically relevant amount of weight.[48] Another limitation of the BMI is that patients that

are highly muscular tend to be classified as overweight or obese due to their muscle mass as the BMI cannot distinguish between lean body mass and fat mass.[111]

Weight loss reflects the process of a negative balance[48] and is correlated with poor nutritional status, morbidity and mortality.[110] It is a strong predictor for negative outcomes regardless of the underlying cause, rate or magnitude.[48] Weight loss of 10% or more is also associated with higher morbidity and mortality. However, obtaining actual weight lost may be challenging, as it is often unavailable or unreliable.[109,110] One study showed that the accuracy of weight loss assessments through patient history was 0.67, with a predictive power of 0.75. This means that more than one-third of patients who lost weight would go unnoticed, and a quarter would be diagnosed as having experienced weight loss, when none had occurred.[112] Body weight may also be inaccurate if the patient presents with oedema, ascites, or other fluid derangements often seen in critically ill, renal or cardiac patients.[62]

Height may be required in screening tools that calculate the BMI. However, stature may be difficult to measure in a patient that is very ill, or in the elderly. Instead estimates of height such as demi-span and arm-span have proved to be more user friendly in these populations. Knee height may also be used in the elderly, as it correlates highly with stature, but is considered time consuming.[110] It also requires a large, broad blade sliding calliper which may not always be available. The measurements can then be entered into sex-, age- and race specific equations to estimate stature, but caution must be taken when using these equations as they were based on healthy young people, which are not comparable to hospitalized elderly patients.[110] However, all three alternative measurements (arm-span, demi-span and knee-height) show poor agreement when compared with standing height.[113] Alternatively, stature may be estimated using either the upper-arm or lower-arm length or by measuring recumbent length in those that have no skeletal abnormalities.[111]

Circumferences and skin fold thickness can also be used as a means of assessing body composition (muscle and adipose tissue). Subcutaneous fat measures the amount of fat of an individual. It is practical in clinical settings[44] as recumbent skinfold can be taken, with the patients lying on their right or left side[111], but it does require a calliper, and if changes in body composition do occur it takes three to four weeks to be noted. Its validity is also dependent on the accuracy of the technique, and the repetition of the measurement over time.[44]

The use of circumferences allow for a low cost method of acquiring information about a patient's body composition, which is also not invasive. Dependant on the type of setting and the patient care different sites of the body may be more appropriate than others. In an acute care setting, where it is likely for the patient to experience fluids shifts, and acute pathophysiological changes, the arm circumference and tricep skinfolds are not recommended. However, these measurements would be useful to gain insight into a patient nutritional status in a long term care setting, where patients can be monitored over time.[44] Despite this, both skinfold thickness and arm circumference measurements suffer from the influence of inter-observer and intra-observer errors, and are compared to table that are based on healthy individuals.[110] The use of circumferences and skinfold is also not routine, as it requires clinical skill and training for a reliable measurement.[109]

The use of more advanced methods to determine body composition, including bio-electrical impedance analysis (BIA), dual-energy X-ray absorptiometry (DEXA), computed tomography (CT) and magnetic resonance imaging (MRI) are limited, owing to portability, except BIA.[109] The use of MRI's are also more expensive, and thus require resources for its implementation.[44]

1.5.3.3 Laboratory indicators as nutritional markers

Nutritional markers that are commonly used include albumin, transferrin, retinol binding proteins and pre-albumin. Approximately one-third of albumin is in the intravascular compartment, and two-thirds in the extravascular compartment. Malnutrition leads to a decrease in albumin owing to a lack of nutrients crucial for its synthesis. However, in chronic malnutrition, because of a compensatory effect, the plasma albumin concentration may be normal. Other factors that influence a patient's albumin state include hepatic disorders, extra protein losses (fistulas, peritonitis, nephrotic syndromes), acute infections or inflammation.[110]In acute stress, albumin may be low owing to reduced synthesis, increased degradation, trans-capillary losses and fluid replacement. Based on a physical examination and patient history, serum albumin does not correlate with nutritional status.[114] It lacks specificity and sensitivity as a marker for nutritional status.[3,8] However, it can be used as a tool to predict morbidity and mortality. If the patient's c-reactive protein (CRP) is high, and albumin low, inflammation is likely to be present.[109] Identification of the presence of inflammation is important when applying the aetiology-based definition of

malnutrition. Other markers present during inflammation include leucocytosis and hyperglycaemia. To confirm the presence of inflammation, 24-hour urine urea nitrogen and indirect calorimetry can also be used.[109]

Pre-albumin and transferrin have also been used as nutritional markers and to predict patient outcome. However, like albumin, they are also influenced by non-nutritional events.

Hyper-cholesteraemia occurs in the later stages of malnutrition, and is therefore not useful as a screening tool. However, it may be used as a prognostic tool for complications and mortality. A decrease in serum cholesterol below 160mg/d reflects low lipoprotein levels, and subsequently also low visceral protein levels.[115]

In general, biochemical tests are good markers of the inflammatory response, and subsequently also good predictors of morbidity of mortality. However, they are more expensive and require skill, equipment, laboratories and are subject to interference from diseases other than malnutrition.[110]

1.5.3.4 Clinical signs and physical assessment as nutritional markers.

A physical assessment is conducted using clinical observation. It requires training from experts, and continuous experience to help produce similar results among clinicians. Guidelines have been adapted from the Academy–ASPEN Consensus Paper to provide clinicians with supportive descriptions to determine the severity of muscle wasting and loss of subcutaneous fat.[116] However, it remains a subjective assessment.

Non-specific clinical parameters that indicate the presence of inflammation include tachycardia, fever, and hypothermia. The clinician should also assess hair, skin, tongue and mouth for nutritional deficiencies, which commonly manifest in these areas. Furthermore, the presence of oedema, or fluid overload, should be evaluated.[109]

Muscle wasting can be defined as 'loss of bulk and tone'.[116] The upper body is often used for the assessment of fat loss and muscle wasting, as it is less affected by fluid status, and more sensitive to muscle wasting as it is composed of smaller muscle groups. This area is also more accessible to the clinician, and considered a good reflection of the patient's muscle mass. It can be assessed through clinical evaluation as well as by palpitation.[116] Detsky et al. recommended evaluation of the quadriceps and deltoids for wasting. Other

areas that can be evaluated include the temporalis, pectoralis, trapezius, tissue of the supraspinatus and infraspinatus, deltoid, quadriceps and gastrocnemius.[26,117,118]

Subcutaneous fat loss should be assessed by evaluating the patient's face, arms, chest and buttocks. Detsky et al. suggested evaluation of the triceps and mid-axillary line. The Academy–ASPEN criteria additionally include the orbital region and orbital fat pad for assessment.[26,118]

Physical assessments are not always suitable, such as in the critically ill, haemodynamically unstable, or in patients in severe pain. Those in palliative care or the elderly that are very fragile should also be exempt from a physical assessment.

A patient may also be very uncomfortable in the ambulatory care setting, when they may be expecting counselling. Owing to other medical procedures taking place, the patient may also not always be available. Furthermore, it requires privacy, which may not always be possible, and may lead to a breach of privacy.

Another problem is the assessment of fat and muscle wasting in the obese patient, as muscle tissue is covered under adipose tissue. Obesity may also limit mobility, which may make it difficult for the clinician to do a thorough assessment.[116]

1.5.3.5 Functional status as a nutritional marker

Nutritional status and nutritional repletion may be assessed using a functional test which measures the response of the adductor pollicis muscle to an electrical stimulus, handgrip dynamometer, and change in heart rate during maximal exercise, or work performed in an ergometer. Skeletal muscle function can be altered depending on nutritional status. Handgrip strength serves as a predictor of loss of functional status[119] and correlates with the patient's total body protein losses.[120] Decreased handgrip strength is a good marker for immediate postoperative complications.[121] However, owing to limited availability of equipment and standardised training on the use of these tools, their use is limited.[110]

1.5.4 Nutritional Risk

Nutritional risk is defined by the patient's current nutritional status and the risk of impairment of present status due to increased requirements secondary to the impact of

underlying disease increasing stress metabolism. Patients categorised to be nutritionally 'at risk' have an increased likelihood of a positive effect from nutritional intervention.[13]

1.5.5 The Screening Procedure

In 2003, ESPEN published a special article, 'ESPEN Guidelines for Nutrition Screening 2002', and recommended a course of action and principles that should form part of all screening tools. The recommended course of action includes screening, assessment, monitoring and outcome, communication, and audit.[13]

It is recommended that all patients admitted to hospital or a healthcare facility should be screened using a simple screening tool. If the patient is not at nutritional risk, the patient should be re-screened weekly. Those that are considered to be at nutritional risk should be referred to a registered dietitian (RD) for a thorough assessment.[6]

Patient outcomes can be measured in various ways. These include improvement or prevention of deterioration in mental and physical functioning of the patient, amount and severity of complications experienced, accelerated recovery time from disease, and decreased use of valuable resources through reducing LOS and medical prescriptions.[6] Close monitoring allows for timely adjustments to the nutritional care plan as necessary depending on the patient's history and illness. If the patient is transferred to another facility or is discharged, all the results of the screening, assessment and nutritional care plan must be communicated to all healthcare staff involved in the patient's care as well as the patients' future care plans. Lastly an audit should be carried out in a systematic manner to audit outcomes which may prove beneficial for future policy decisions.[13]

1.5.6 Components of Nutritional Screening

When creating a screening tool to identify patients at risk of malnutrition it is important that it is applicable for use in large heterogeneous adult populations and that the information required is routinely available data. The tool should be convenient and user friendly for completion by non-professional staff members, patients or family. It should be a simple, quick process that does not contribute to an extra workload for staff. The screening should

consist of non-invasive and inexpensive elements, and should be both valid and reproducible. [18] Most importantly, the screening tool should be linked to a course of action.

The four components that should form the basis of a screening tool as recommended by ESPEN 2003 include information on the current actual condition, the stability of the condition, the likelihood of the condition's deteriorating, and if the disease progression will cause a decline in nutritional status.[6]

'What is the condition now?' For information on the actual condition, the weight and height measurement should be recorded to calculate the patient's BMI (kg/m^2). A BMI ≥30kg/m^2 classifies the individual as obese, normal from 20–24.9kg/m^2, borderline underweight if from 18.5–20kg/m^2 and undernourished if <18.5 kg/m^2; however, it's not considered to be accurate in all stages of the lifecycle (e.g., babies, growing children, elderly).[6,13] If a weight and height measurement cannot be obtained, the MUAC can be used and assessed using centiles and tables appropriate for the patient's age, population group and sex. [13]

'Is the condition stable?' The likelihood of the condition's deteriorating refers to whether the patient has had recent weight loss. This can be obtained from previous medical records if available, or from the patient himself. Weight loss of ≥5% in three months or less, is considered significant. This principle is especially designed to identify malnutrition in individuals where it was not previously noted through weight or height measurements, that is, in the obese. Unintentional weight loss may predict further nutritional decline.[6,13]

'Will the condition get worse?' The likelihood of the nutritional status deteriorating can be measured by the patient's food intake. If there is a decrease in food intake, the period needs to be determined as well as the quantity, as this will most likely result in further weight loss.[6,13]

'Will the disease process accelerate nutritional deterioration?' Severe disease, such as a multi-trauma or sepsis, may increase the nutritional requirements of the patient secondary to an increased metabolism. This may accelerate nutritional status decline if not considered in the nutrition plan.[13]

The first three principles should be included in all screening tools, as recommended by ESPEN. The fourth principle is appropriate for hospital-related screening tools, as it describes how disease progression may have an effect on the patient's metabolism and in turn worsen nutritional status more rapidly.[13]

1.5.7 Validity

For a screening tool to be considered valid, it must have both a high sensitivity (i.e., it is positive in those patients who have the condition) and specificity (i.e., it is negative in those patients who do not have the condition).[6] Specificity is especially important where an undetected condition may have a significant effect, for example, mortality. Predictive validity is the measure of people correctly diagnosed with and without the condition, confirming a known theoretically hypothesised association. Screening tools must have good predictive validity to avoid (1) over diagnosing people with a condition that they do not have, (2) unnecessarily increasing anxiety levels, and (3) the risk of providing excessive treatment. A screening tool should have good sensitivity, specificity and predictive validity.[6,14-18]

Construct validity is another sub-item of validity and refers to the level of agreement between the diagnostic problem (the construct) and what is actually done. It comprises two components, namely translation validity and criterion validity. Translation validity refers to the extent to which the measure makes sense to the experts about the subject. Criterion validity refers to evaluating the results of the measuring instruments against the most valid measurement available (the gold standard). [6]

According to the World Health Organization (WHO)'s Principles in Screening for Disease: 'There should be an acceptable treatment for patients with recognisable disease' and 'Treatment at the pre-symptomatic, borderline stage of disease should favourably influence its course and prognosis.'[6]

A screening tool should also be reliable, which means that there should be little inter-observer variability.[6]

1.5.8 Limitations of Screening Tools

It has been established that nutrition screening can improve clinical outcome through nutritional intervention. Nevertheless, nutritional screening tools also have limitations.[6]

Firstly, most screening tools have been evaluated in the hospital setting, with few evaluations done in long-term care settings, and none across the continuum of care. This is a limitation as malnutrition tends to develop over a period of time and a tool that identifies malnutrition within the early phases would allow for earlier intervention. Many diagnostic elements in screening protocols also fail to recognise the role of the inflammatory response on acute phase proteins, which are known to decrease the favourable response to nutritional intervention.[26]

Despite the range of screening tools available, many have been designed for a specific patient population, which may limit applicability to other patient populations not specified.[122] An example of a patient population that needs to be included for the identification of malnutrition risk is the obese patient. Obesity is an escalating problem, and is associated with increased complications and comorbidities.

Screening tools may also include screening parameters based on clinical judgement and intuition. This is not appropriate as screening tools should be simple enough to enable all levels of staff, non-professional staff, patients and family to complete it or they may be invasive and too complicated, requiring training. Consequently this may result in screening practices being conducted only by dietitians, as the tool may be too specialised to be implemented in a hospital-wide basis by nursing or administrative staff.[122]

Many screening tools also include parameters that are not realistic, suitable or routinely available, that is, handgrip strength.[122] The ideal screening tool should incorporate components that have a wide applicability.[14]

Screening tools may rely on obtaining information from the patient. Often, hospitalised patients feel very ill, or may experience high levels of pain which may prohibit them from comprehensively answering questions posed by a health-care professional,leading to

misdiagnosis. Alternatively, information (adequate intake, weight history) may be required from medical files, but these too may not always be available. Consequently the healthcare professional must rely on the patient's recall or historical information which may be compromised.[26]

Other limitations include lack of proven effectiveness in relation to specificity, validity, reliability, and cost effectiveness.[122]

1.6 NUTRITIONAL SCREENING TOOLS.

There is currently no universally accepted, single approach to diagnose and document adults with malnutrition, although there are over 32 screening tools available.[26] There are screening tools that claim they are appropriate for all ages, settings and populations, where others are designed for a target population.[123]

The diagnostic elements between screening tools may vary. Some are considered simple and referred to as 'screening tools'. They often do not require any calculations, blood samples or clinical examinations ((e.g. Malnutrition Screening tool (MST), Short Nutritional Assessment Questionnaire (SNAQ)). However if the patient is deemed 'at risk', an assessment should be conducted by a dietitian to evaluate the severity of nutritional depletion.[123]

Other tools may be more complex, requiring calculations of percentage weight loss or BMI, blood values and a clinical evaluation. Although they are considered time-consuming, they depict a more accurate presentation of the patient's nutritional status (e.g. MUST, NRI).

Tools that encompass nutritional status with clinical observations may be regarded as assessment tools (MNA, SGA).[123]

The use of multiple tools prohibits researchers from making comparisons between studies, and conclusions regarding the 'best tool' for specific populations, ages or settings cannot be defined.[123]

The focus of the nutritional treatment provided is thus also determined by the setting (community or hospital) and patient's age. In hospital malnutrition, there is most likely an underlying disease contributing to under nutrition and so the treatment is focused on the underlying disease and nutritional variables, whereas the cause in the community may be semi-starvation and treatment would focus mainly on nutritional variables.[6]

There are several validated nutrition screening tools available, including the Malnutrition Universal Screening Tool (MUST), Mini Nutritional Assessment (MNA), NRS-2002, SNAQ and SGA. [108]

1.6.1 The NRS-2002

1.6.1.1 Development and validation of the NRS-2002

The NRS-2002 was developed in 2002 by Kondrup et al., together with an ESPEN working group. It is considered the preferred tool to screen malnutrition in European hospital settings.[67]

The tool aims to identify patients that could potentially benefit from nutritional intervention. It was developed by evaluating the nutritional criteria, characteristics and clinical outcomes of randomised controlled trials, retrospectively.[124] It relied on the assumption that indications for nutritional support include the severity of under nutrition and the increase in nutritional requirements secondary to disease severity. It therefore also includes patients that are not currently malnourished, but are 'at risk' owing to disease severity and/or the required treatment. Treatment, such as chemotherapy, can induce anorexia and increases the patient's stress metabolism, increasing the risk of malnutrition. The degree of severity of disease and under nutrition was categorised as mild, moderate or severe from randomised controlled trial (RCT) datasets, and converted into a numeric score that was allocated on the screening form.[124]

The tool is based on a literature overview that included 275 studies that reported on the effectiveness of nutritional intervention.[123] Once the screening tool had been designed, its predictive validity was assessed against 128 RCTs of nutrition support, including a total of

8944 patients.[13] The researchers classified the group of patients within each trial according to nutritional status and severity of disease. The effect of nutritional intervention on clinical outcome was then determined. Positive effects on clinical outcome include reduced rate of infections and complications, improved mobilisation, and reduced length of stay, but excluded improvements merely in nitrogen balance, liver function tests, or biochemical tests.[124] It indicated that patients at nutritional risk were more likely to have a positive outcome from nutritional intervention, than those not 'at risk'.

The analyses showed that the elderly had an increased benefit from nutrition support, or increased susceptibility to malnutrition risk. To eliminate its effect on the logistic regression analysis, a score of one (0.5 to nutritional status and 0.5 to disease severity) was added to all individuals ≥70 years, after the first analysis, recognising advanced age as an additional risk factor for malnutrition.

The content validity of the tool was improved by working with an ESPEN ad hoc working group under the guidance of the ESPEN Educational and Clinical Practice Committee in the literature-based validation.[124]

In spite of the original purpose of the NRS-2002, which is to identify patients that will benefit from nutritional intervention, it is often used to asses a patient's nutritional status.[123] Therefore it does not categorise the level of risk of malnutrition.[108]

1.6.1.2 Components of the NRS-2002

The NRS-2002 comprises two sections: initial screening and final screening (Table 1.1). The first four questions are basic pre-screening questions to assess the patient's nutritional status and evaluate if any of the following clinical parameters are present: BMI <20.5kg/m^2, unintentional weight loss, poor dietary intake, and severe illness. If the answer is 'no' to all four questions, then the patient should be rescreened on a weekly basis. If any of the four questions in 'table 1' are answered with 'yes', then the final screening must be performed.

The final screening section comprises impaired nutritional status and the severity of disease, which are each rated from zero to three. Impaired nutritional status is evaluated based on impaired intake, BMI and increased nutrition requirements.

The severity of disease recognises the need for increased nutrient requirements, and should cover all possible diseases seen in hospital. A score of one is allocated to patients with chronic disease and who are admitted because of related complications. Their protein requirements may be increased but can be met by giving an oral diet and/or nutrient supplement. A score of two is allocated to patients that are immobile, for example, after post-abdominal surgery or a stroke, and have substantial increased protein requirements, requiring supplementation or enteral feeding. A score of three is allocated only to the critically ill, for example, those with a head injury requiring ventilation. In this research study, the critically ill were part of the exclusion criteria and a score of three was therefore never allocated.

A total score is then calculated for the patient based on the final screening. If the patient is ≥70 years, an additional point is added, to give an age-adjusted score. If the age-adjusted score is ≥3, the patient is considered to be nutritionally 'at risk' and a nutritional care plan should be developed and initiated. If the final score is <3, the patient should be screened at a weekly interval.[124]

1.6.1.3 Clinical studies conducted with the NRS-2002

In an international study conducted in Europe by Kondrup et al., the NRS-2002 was implemented in 26 hospital departments to assess the association of nutritional risk with clinical outcomes, including complications, mortality, and length of hospital stay. Multivariate regression analysis was used to adjust for confounding. The researchers found that of 5051 patients, 32.6% of patients were considered to be at nutritional risk when using the NRS-2002. The patients 'at risk' had significantly higher rates of complications, mortality, and length of stay compared with patients 'not at risk'. Based on this study, the NRS-2002 is an independent predictor for poor clinical outcomes.[53]

A randomised control trial, conducted by Johanson et al., aimed to identify patients at nutritional risk using the NRS-2002, and assess the effect of nutritional intervention. If the patient was identified 'at risk', care by a nurse and dietitian was implemented which included motivation, an individualised nutritional care plan and advice on enteral nutrition (EN) and parenteral nutrition (PN) as needed. There was no statistical difference between mortality, LOS and rates of complication between the intervention group and controls, who

received standard care. However, among the patients with complications, the intervention group had a significantly lower LOS than controls. Sixty-two percent of the intervention group also met ≥75% of their requirements compared with only 36% of the controls. This study is of clinical significance as it shows that screening, followed by nutritional intervention, can improve patient intake, and reduce LOS in patients with complications.[125]

In a systematic review (SR), the NRS-2002, was compared to the SGA, MNA and body composition methods for criterion and construct validity to screen for malnutrition among different age groups and hospitalised populations. The NRS-2002 showed good validity against the SGA for adult surgical patients,[126] while the others showed fair validity for a heterogeneous group of hospitalised patients.[127] When compared to the MNA, using a population consisting of adults and the elderly, the NRS-2002 had poor validity in both groups. When compared to body composition assessment, the NRS-2002 had good validity for both the elderly and the adult population. The authors concluded that the NRS-2002 demonstrated inconsistent validity to screen different hospitalised age groups and populations.[123]

In the same SR, the NRS-2002 had fair-to-good predictive validity for mortality, length of stay and complications based on a hospitalised adult population, although this finding was not applicable to the elderly.[123] In comparing the MNA, NRS-2002, SGA and MST for predictive value for the elderly, the NRS-2002 was the only tool to predict LOS in the elderly, and was found to be superior to the other three tools.

1.6.1.4 Feasibility and applicability of the NRS-2002

The NRS-2002 is considered to be a practical screening tool, as 99% of 750 newly admitted patients could be screened using the NRS-2002.[13] It is considered user friendly and quick to conduct, and can be completed in 5–10 minutes.[128,129]

However, as it is a more comprehensive screening tool, similar to MUST, it does require more time and skills than the quick and easy to use screening tools such as MST and SNAQ.[130] The scoring part of the NRS-2002 is considered time consuming and a section where mistakes are commonly made. [131]

The NRS-2002 also requires clinical skills as it relies on accurate anthropometrical measurements such as weight and height, and calculations including percentage weight loss and BMI.[130] Yet, a positive attribute of the NRS-2002 is that the patient's change in weight may be used if the BMI calculation is not possible.[108] It was also suggested to use the MUAC, to interpret the patient's BMI if the patient's weight cannot be obtained or used, because of fluid accumulation. However, no clear cut-off points have been published. For this reason, the authors recommend that all patients should be managed as 'at nutrition risk' until adequate intake is established.[124]

The NRS-2002 also includes a subjective evaluation of disease severity,[130] which may pose challenges for staff and can have an impact on the total score of the patient.[108] However, a study conducted in Denmark, across three hospitals, for two years, indicated that there was good agreement between staff and investigators when assessing patients for nutritional risk. The reliability between physicians, dietitians and nursing staff was also good when validating inter-rater reliability (k=0.67%).[124]

In a study conducted by Neelemaat et al., the NRS-2002 was the best tool for predicting poor clinical outcomes in patients compared to MUST, SNAQ, and MST.[130] Another advantage is that the NRS-2002 is linked to an intervention plan as per the dietitian,[108] which is in line with ESPEN's recommendations for screening tools.[13]

The NRS-2002 is the only screening tool to have a Grade 1 recommendation, with (>83%) sensitivity and (>90%) specificity.[14] For this reason it has been included as a screening tool in this study.

Table 1.1 NRS-2002 Screening Tool [124]

Table 1 Initial Screening		YES	NO
1	Is the BMI <20.5kg/m^2?		
2	Has the patient lost weight within the last 3 months?		
3	Has the patient had a reduced dietary intake in the last week?		
4	Is the patient severely ill?		
Table 2: Final Screening			
Impaired Nutritional Status		Disease severity	
Absent Score 0	Normal nutritional status	Absent Score 0	Normal nutritional requirements
Mild Score 1	Wt loss >5% in 3 months or food intake below 50-75% of normal requirements in preceding week	Mild Score 1	Hip fracture, chronic patients, with acute complications, COPD, DM, oncology
Moderate Score 2	Wt loss >5% in 2 months or BMI 18.5-20.5 + impaired general condition or Food intake 25-60% of normal requirement in preceding week.	Moderate score 2	Major abdominal surgery, stroke, severe pneumonia, hematologic malignancy.
Severe Score 3	Wt loss >5% in 1 months (>15% in 3 months) or BMI <18.5 + impaired general condition to Food intake 0-25% of normal requirement in preceding week.	Severe Score 3	Head injury, bone marrow transplantation, intensive care (APACHE >10)
Score	+	Score	= Total score
Age	If ≥70 years old: add 1 tot total score above		= Age-adjusted score

1.6.2 SGA

1.6.2.1 Development and validation of the SGA

The Subjective Global Assessment tool was first described by Baker et al. in 1982. It was designed to assess surgical patients for malnutrition, at the bedside, without needing precise analysis of body composition, anthropometric and laboratory values (total lymphocyte count and albumin), which was the traditional approach at the time.[132] It is a systematic method that assesses the nutritional status of the patient, which can be defined as well nourished, moderately malnourished or severely malnourished.[110] Despite Despite the name, Subjective Global Assessment tool, it is a screening tool.

The SGA is considered one of the best screening tools, as the focus is patient centred (medical history and physical examination), and associated with patient outcome (length of stay, complications, infections, poor wound healing).[127] The final ranking of the SGA is not linked to nutritional intervention.[108]

The initial validation of the SGA was done between two clinicians on 109 gastrointestinal surgery patients. The results of the validation study showed good correlation between subjective and objective measurements. Despite significant variation between rater pairs, it had a strong inter-rater reproducibility (k=0.784).[108]

The SGA is often considered the gold standard for nutrition screening.[116] It has also been recommended by ESPEN for further nutrition assessment.[127]

1.6.2.2 Components of the SGA

The SGA is composed of two sections: a medical history and a physical examination (Figure 1.2). In the medical history, the patient is assessed on change in weight, dietary intake, presence of gastrointestinal symptoms and functional impairment through questioning the patient. The change in weight is recorded as weight loss in the preceding six months, previous two weeks, as well as a percentage loss. By determining both the rate and pattern of weight change, the clinician has better insight into a trend. The patient's dietary intake is then compared with their usual intake and classified as normal or abnormal. The duration and degree of abnormal eating patterns are also established by determining if the patient was starved, on hypocaloric fluids, full fluid diet, or suboptimal solid diet. The presence of

gastrointestinal symptoms is noted as significant if persistent on a daily basis for ≥2 weeks. Lastly, the patient's functional capacity is assessed. If dysfunctional, the duration and type are noted, a component scarce in screening tools.

The second part of the SGA focuses on physical evidence of malnutrition. A subjective rating is assigned by assessing the patient physically for loss of subcutaneous fat (triceps), presence of muscle wasting (quadriceps and deltoids), presence of ankle oedema, sacral oedema or ascites. A score is allocated for each, ranging from 0–3, (0) normal, (1) mild, (2) moderate, and (3) severe, based on subjective impression.[132]

The final SGA score is not based on numerical scoring, but on a subjective rating of either A, B or C. Based on these ratings a final score is subjectively assigned as overall (A) normally nourished, (B) moderately malnourished (at risk of malnutrition), or (C) severely malnourished (poor nutritional status).[133]

1.6.2.3 Clinical studies conducted with the SGA

The SGA has been widely tested in many different population groups.

In a study by Detsky et al. on surgery patients, 69% (*n*=139) of patients were classified as SGA A, 21% (*n*=44) as SGA B and 10% (*n*=19) as class C. Ten percent of the patients experienced nutrition-related complications (death, wound healing, infection, sepsis).

Studies have also compared the SGA with objective measures in pre-operative patients, such as handgrip strength. Handgrip strength is associated with nutritional status, and muscle strength may be used as an indirect marker to inflammatory activity which is known to increase muscle metabolism. In a prospective study conducted in surgical Vietnamese patients, the SGA was compared to objective measures that predict poor outcome (handgrip strength and mid-upper arm circumference). The study was based on 274 patients of whom 22.3% were SGA-A, 35.3% SGA-B, and 42.3% SGA-C. It was established that the SGA by its self was superior to anthropometric measurements alone, as patients who had an SGA class of B or C had normal anthropometry, indicating that anthropometry and SGA rating did not always compare. Many patients with a low BMI also had normal handgrip strength, indicating that objective measurements should not be interpreted in isolation.[132] In surgical patients, the SGA is considered the best predictor for length of stay in hospital.

It is also well known that oncology patients are at increased risk of malnutrition. The incidence of malnutrition among this population is estimated to range between 40–80%, owing to multiple factors including fatigue, poor appetite, malabsorption, increased metabolism and treatment.[134] As malnutrition is associated with increased risk of complications and decreased quality of life, early diagnosis is crucial. A modified patient-generated SGA (PG-SGA) has been developed by Fox Chase Cancer Center, which evaluates weight loss at baseline and therapy-related weight loss.[135] The PG-SGA relies on the patient to provide detailed physical and medical history. In a study conducted by Bauer et al., the SGA and PG-SGA were compared in 71 patients and had 98% sensitivity and 82% specificity. Patients that were malnourished (SGA B or C) had a longer length of stay of 13 days compared with well nourished patients (SGA- A) who had a median stay of seven days (p=0.024).[136]

Another population at risk of malnutrition comprises those diagnosed with HIV/AIDS, especially in the later stages of disease progression. HIV-wasting syndrome, which is characterised by ≥10% weight loss is now recognised as an AIDS-defining condition. As malnutrition is common in this patient group, close monitoring is essential. In a study conducted by Niyongabo et al., body weight loss (BWL), anthropometry and BIA were compared to the SGA. According to the SGA, 22.7% of patients were classified as malnourished compared with 36.4% using the BWL method. The authors determined that there was a relationship between the SGA, anthropometric measurements and BIA, and concluded that the SGA was a useful tool to identify patients that would benefit from nutritional intervention. The SGA was shown to be a useful tool for determining prognosis, as many of the patients with an SGA-B or -C were diagnosed with wasting syndrome.[137]

Studies where the SGA was used to assess patients' nutritional status in pre-operative surgical patients, show fair validity when compared to pre-albumin. In another study where the SGA was compared to the NRS-2002, but in the elderly, it also had fair validity. Unfortunately it is challenging to determine if the SGA has good construct validity, owing to the chosen reference methods.[123]

As previously described, the SGA can be used to predict clinical outcome.[123] Predictive validity was assessed in the initial development of the study, and found that a longer LOS

was associated with more malnourished patients.[138] A study conducted by Wakahara et al. indicated that the SGA had the highest predictive validity on LOS. Three other studies also reported significant associations between LOS and SGA scores,[139,140] although for one study the association was only found in subgroups,[141] whilst one showed no association for the elderly.[142] A study conducted by Lim et al. showed an independent predictive effect of a poor SGA score on both mortality and re-admission when controlled for gender, race, diagnosis, and age.[95] A systematic review that analysed the predictive validity of the SGA compared with other screening tools, found that the SGA had fair or good predictive validity in some of the outcomes in nearly half of the studies identified and included. In better quality studies, were the researchers adjusted for risk factors, the SGA showed independent predictive validity on LOS, complications and mortality.[123]

1.6.2.4 Feasibility and applicability of the SGA

As the tool is subjective, it has both its related advantages and disadvantages. An advantage of the SGA, considering its subjective approach, is that it allows clinicians to identify subtle patterns of change in the clinical variables, for example, patterns of weight change rather than absolute amounts.[118] However, it also requires capacity to collect information from the patient, family members and to interpret the data.[110] Compared to objective data, the SGA is superior to any biochemical nutritional marker alone for assessing malnutrition.[132]

Clinicians have found the SGA to be an appealing method of assessing nutritional status[118] as it is simple and requires no medical equipment.[132] The technique of performing the SGA is considered to be easy to learn and apply according to both nurses and physicians, although it does require training.[118] It has been recommended that clinicians should attend group training to understand and apply the SGA, followed by a formal test of inter-rater reproducibility. However, the SGA is commonly used among clinicians based on their own interpretation, without formal training, which may introduce bias amongst observers.[110]A disadvantage based on its subjective approach, is that demonstrating reproducibility and determining patient prognosis may be more challenging.[118]

The mean time to conduct the SGA is nine minutes (ranges between 6–14 minutes)[132], which is longer than that of other nutrition screening tools.[67] Some clinicians have found

the tool to be too detailed and time consuming for an effective screening tool. Yet, when compared to other methods of nutrition assessment, it is the fastest and least complicated tool, with high inter-observer reliability and validity.[132] Detsky et al. found a high degree of interobserver agreement with a coefficient k=0.78%, 95% confidence interval 0.624 to 0.944, $p<0.001$ between nurses and physicians.[118]

Although the SGA was initially developed for gastrointestinal surgery patients, it has been validated in a number of different patient groups including surgical, HIV/AIDS, geriatric, rehabilitation, renal and oncology patients.[132] The SGA has also been validated for different settings, including acute, rehabilitation, community and residential aged care settings, making it an accessible tool for a wide spectrum of settings.

As the tool is considered one of the best, the SGA is often used as the 'gold standard' to measure the validity of other screening tools.[67] For this reason, it was included as one of the screening tools in this study to help determine the prevalence of adult hospital malnutrition.

Features of Subjective Global Assessment (SGA)	
A.History: Weight Change	Overall loss in past 6 months=#____kg; %loss=#____ Change in past 2 weeks: ____Increase ____No change ____Decrease
Dietary intake (relative to normal)	____No Change ____Change ____Duration= #____Weeks ____Type:____Suboptimal Liquid Diet ____Full Liquid Diet ____Hypocaloric Liquid, ____Starvation.
Gastrointestinal Symptoms (persisted >2 wks)	____None, ____Nausea, ____Vomiting ____Diarrhoea ____, Anorexia ____
Functional Capacity	____No Dysfunction (e.g. full capacity) ____Dysfunction ____Duration = #____weeks ____Type : ____ Working sub optimally ____Ambulatory ____Bedridden
Disease and its relation to nutritional requirements	Primary Diagnosis (specify):____ Metabolic demand (stress): ____ No stress ____Low stress ____Moderate stress, ____High stress
B.Physical	(For each trait specify: 0=normal, 1+mild, 2+=moderate, 3+=severe) #_____Loss of subcutaneous fat (triceps, chest) #_____Muscle wasting (quadriceps, deltoids) #_____Ankle oedema #_____Sacral oedema #_____Ascites
C. SGA Rating	(Select one) _____A= Well nourished _____B= Moderately (or suspected of being) malnourished _____C= Severely malnourished

Figure 1.2 Subjective Global Assessment Tool [133]

1.6.3 American Malnutrition Diagnostic Tool

1.6.3.1 Development and validation of the AMDT

In 1977, Blackburn et al. published a clear methodology to conduct a nutritional assessment taking into consideration the disease pathophysiology and nutrient metabolism.

This was followed by a change in the reimbursement processes by the Centers for Medicare & Medicaid Services in 2007, which recognised disease severity, including malnutrition, as a comorbidity which received an increased reimbursement, reflecting the increased costs associated with care.[143]

This led to multiple queries from the Academy and ASPEN regarding the criteria by which to define malnutrition. Consequently, an International Consensus Guideline Committee working group was created with ESPEN and ASPEN in 2009 to ensure a standardised approach in the identification and diagnosis of malnutrition, which is aetiology based. The working group aimed to ensure that all characteristics used for the identification of malnutrition should be (1) few in number, (2) support a nutrition diagnosis, (3) characterise severity of malnutrition, (4) change as nutritional status changes, (5) be evidence based, and (6) allowed to change over time as evidence of validity increases.[26]

Since then, the Academy and ASPEN have extended the aetiology-based approach to diagnosis of malnutrition, and have also proposed six clinical characteristics to diagnose and identify malnutrition syndromes. In 2012 ASPEN and the Academy published the Consensus Statement, Academy of Nutrition and Dietetics and the American Society for Parenteral and Enteral Nutrition: Characteristics Recommended for the Identification and Documentation of Adult Malnutrition. The diagnosis of malnutrition is based on the presence of two out of the following six characteristics: (1) insufficient energy intake, (2) unintentional weight loss, (3) loss of subcutaneous fat, (4) loss of muscle mass, (5) localised or generalised fluid accumulation, and (6) diminished functional status measured by handgrip strength.[26] If only one characteristic is present, the patient can be considered at risk of developing malnutrition.[144]

The feasibility of access to the required data was assessed in research conducted by Jensen et al. in a prospective cross-sectional study conducted in two tertiary hospitals: one urban, and one rural with a total sample of 263 participants. Subjective data was obtainable in more than half of the sample, including food intake (76%, *n*=201) and weight loss history (67%, *n*=175). Information pertaining to the physical examination was available for loss of fat mass (94%, *n*=247), loss of muscle mass (94%, *n*=246) and presence of oedema (84%, *n*=222). However, handgrip strength was not available. The authors concluded that the clinical characteristics required for the diagnosis of malnutrition according to the Academy–ASPEN Malnutrition Consensus Guidelines are generally available.[145]

Another objective of the study was to assess the prevalence of malnutrition according to the AMDT in patients referred for nutrition assessment. The diagnosis was categorised according to severity and aetiology, acute illness or injury, chronic illness, and social or environmental circumstances. The results indicated that 6.5% (*n*=17) were moderate and 7.6% (*n*=20) severely malnourished with acute illness; 12.2% (*n*=32) moderate, 11% (*n*=29) severely malnourished with chronic illness; and 0.8% (*n*=2) moderate, 0.4% (*n*=1) severely malnourished due to social circumstances.[145]

However, additional research should be conducted, comprising a larger sample, in multiple healthcare settings, including different patient populations, prior to generalisation of these findings.The researchers also recommended that further research be conducted to assess the relationship between the degree of malnutrition, measured by the number of characteristics present, and risk of adverse clinical outcomes. [145]

A collaborative multisite validation study has since been initiated, where dietitians received training on conducting a physical examination. Patient outcomes will also be measured, including LOS, pressure wounds, infections, readmissions, mortality and ICD coding of discharge diagnosis.[28]

1.6.3.2 Components of the AMDT

The Academy and ASPEN recommend that all patients should be screened by using a validated nutrition screening tool, such as the MST or the NRS-2002.

If the patient is considered to be at nutritional risk, the patient must be assessed for inflammation. Inflammation significantly contributes to disease-related malnutrition; although it is not a marker of nutritional status, it has a profound effect on nutritional status when inflammation is prolonged. The patient's CRP, a positive-acute phase protein, can be used to identify the presence of inflammation. Alternatively, the patient's condition alone may indicate the presence of inflammation, as indicated in the table below:

Table 1.2 Conditions associated with the inflammatory response [146]

Acute and chronic conditions associated with the inflammatory response	
Acute disease Severe Inflammatory response	Chronic disease Mild to moderate Inflammatory response
Adult respiratory disease Closed head injury Critical illness Severe acute pancreatitis Major abdominal surgery	Cardiovascular disease Coeliac disease Chronic pancreatitis Cystic fibrosis Diabetes mellitus Inflammatory bowel disease Metabolic syndrome Obesity Rheumatoid arthritis Solid tumours

Once the presence and severity of inflammation is determined, the patient is further assessed according to aetiology (Figure 1.3 and 1.4). Malnutrition may be starvation-related malnutrition (no inflammation – pure chronic starvation, anorexia nervosa), chronic disease-related malnutrition (mild to moderate inflammation – organ failure, pancreatic cancer, sarcopenic obesity), or acute disease-related malnutrition (marked inflammatory response – major infection, trauma). [3,146]

The identification of two or more of six characteristics is used to diagnose malnutrition. These include insufficient energy intake, weight loss, loss of muscle mass, loss of subcutaneous tissue, localised or generalised fluid accumulation and/or diminished functional status (measured using handgrip strength).[146]

To assess weight loss, the patient's usual weight and current weight are required. Admission weight is often taken or reported, although clinicians must take note of fluid resuscitation on admission, or signs of dehydration. In these cases, a dry weight will be required. The patient may find it difficult to remember his usual weight, and reference can be made to a previous admission weight recorded for a recent procedure, if applicable. If the tool is conducted while the patient is hospitalised, the admission weight may be compared with their current weight for assessment.[146]

Oral questioning is the preferred method of evaluating if a patient has had adequate intake when admitted to hospital. This information may be obtained from the patient himself or from caregivers. If the patient has been hospitalised, his fluid charts may be assessed for intake via the oral, enteral or parenteral route. Periods of inadequate intake should be identified to enable assessment of the patient's energy intake. If objective data was obtained, this can be compared with the patient's estimated energy requirements. Requirements may be calculated via indirect calorimetry, or predictive equations such as the Penn State or Mifflin–St Jeor. The percentage intake from the desired requirements can then be calculated and a severity level for this characteristic can be assigned.[146]

Three of the six characteristics to diagnosis malnutrition are physical assessment components. This aspect of the evaluation should be conducted by a dietitian, who will assess the orbital region, upper arm region and thoracic and lumbar regions for identification of loss of muscle mass, loss of subcutaneous fat and the presence of oedema or ascites. It is important that clinicians be aware of the patient's underlying disease, such as congestive heart disease or renal disease, where fluid accumulation may also be present but not due to malnutrition.

Handgrip strength is included in the assessment as a measure of functional capacity, and can be measured using a dynamometer. Diseases such as arthritis, cerebrovascular accident or dementia may limit a patient's ability to perform this measurement, and should be considered. Other methods to measure functional capacity may also be used, such as

performance status, ability to perform activities of daily living, tolerance of physical therapy, and the ability to wean the patient off mechanical ventilation.

1.6.3.3 Clinical studies conducted with the AMDT

No studies have been conducted to date on the prevalence of malnutrition according to the new Academy–ASPEN clinical characteristics, except for the validation study.[145]

1.6.3.4 Feasibility and applicability of the AMDT

The AMDT incorporates assessment of dietary intake and weight change, which have shown to be predictive of malnutrition in studies conducted on the SGA. In the feasibility study of the AMDT, a change in body weight and dietary intake were also considered characteristics most commonly identified in malnourished patients.[145]

For AMDT to be implemented correctly, all disciplines require training. Although dietitians are fully trained in assessing a patient's weight and diet history, other disciplines are traditionally not. Likewise, support physicians may have extensive training in performing physical assessments; however dietitians may lack these skills. Therefore, to ensure confidence and accuracy in all aspects of the AMDT by all professionals, training sessions should be provided. [145]

To assess the functional status of the patient, the AMDT requires a handgrip-dynamometer. This aspect demands both equipment and training in the use and interpretation of the handgrip-dynamometer.[145] In the feasibility study conducted by Jensen et al., they found that this equipment was not readily available in hospital care settings in the United States, [145] and therefore it is unlikely to be available in a poorly resourced country such as South Africa. It is also not appropriate for all patient populations which may further limit its use, e.g., for rheumatoid arthritis or sedated patients. [146]

When applying the malnutrition characteristics, categorising the aetiology of malnutrition may also be challenging. A patient may fit more than one aetiology, such as both acute illness- and chronic disease-related malnutrition. The aetiology of malnutrition can also change over time, which is why the dietitian should continuously assess the characteristics of each patient (Figure 1.3 and 1.4).[146]

In the research conducted by Jensen et al. to determine the feasibility of accessing data in hospitalised patients and the prevalence of malnutrition, the relationship between the diagnosis of malnutrition and clinical outcome or treatment effects was not evaluated. This limits the ability to examine if the identification of malnourished patients was of significance.[145]

Currently there is also no standardised format for the collection of data, which is a short term goal of the Academy. This is needed for validation studies to identify which of the characteristics are most and least reliable for diagnosing malnutrition. [26] Despite these challenges, The Academy and ASPEN have released multiple articles, guidelines and tutorials including patient cases to guide clinicians in conducting the AMDT and urge health-care professionals to develop implementation strategies within each unique setting in agreement with the institutions' practices and needs.[26,146]

Characteristics to diagnose non-severe (moderate) malnutrition			
Characteristic	**Acute illness or injury–related malnutrition**	**Chronic disease–related malnutrition**	**Social or environmental–related malnutrition**
Weight loss	1-2%/1 week 5%/1 month 7.5%/3months	5%/1month 7.5%/3months 10%/6months 20%/1 year	5%/1month 7.5%/3months 10%/6months 20%/1 year
Energy intake	<75% for >7 days	≤75% for ≥1month	≤75% for ≥3months
Body fat	Mild depletion	Mild depletion	Mild depletion
Muscle mass	Mild depletion	Mild depletion	Mild depletion
Fluid accumulation	Mild	Mild	Mild
Grip strength	Not applicable	Not applicable	Not applicable

Figure 1.3 AMDT Characteristics to diagnose moderate malnutrition [26]

Characteristics to diagnose severe malnutrition			
Characteristic	**Acute illness or injury–related malnutrition**	**Chronic disease–related malnutrition**	**Social or environmental–related malnutrition**
Weight loss	>2%/1 week >5%/1 month >7.5%/3months	>5%/1month >7.5%/3months >10%/6months >20%/1 year	>5%/1month >7.5%/3months >10%/6months >20%/1 year
Energy intake	≤50% for >5 days	≤75% for>1month	≤50% for ≥1month
Body fat	Moderate depletion	Severe depletion	Severe depletion
Muscle mass	Moderate depletion	Severe depletion	Severe depletion
Fluid accumulation	Moderate to severe	Severe	Severe
Grip strength	Not for ICU	Reduced for age/gender	Reduced for age/gender

Figure 1.4 AMDT Characteristics to diagnose severe malnutrition[26]

1.7 NUTRITIONAL INTERVENTION

1.7.1 Benefits

Nutritional intervention for malnourished patients is a low-risk and economical strategy that can be used to improve patients' quality of life as well as hospitals' quality of care. However, it requires interdisciplinary collaboration.[23]

The implementation of clinical nutrition includes nutrition evaluation, optimising food composition, and monitoring dietary intake, and has been shown to increase nutritional intake in patients, while the cost of nutritional care is considered modest and economical.[104,131]

Nutritional intervention can be grouped into four categories:(1) food and nutrient delivery, (2) nutrition education,(3) nutrition counselling, and (4) coordination of nutritional care.[53] Food and/or nutrient delivery includes energy and nutrient-dense foods, complete oral nutrition supplements (ONS), EN that is provided via a tube into the gastrointestinal tract

and/or via PN as the most advanced method of nutrition delivery. All of the above methods of nutrient delivery have been supported with positive effects in select patient populations.[23]

In a meta-analysis of seven studies (*n*=284), a comparison was made between patients that received ONS and controls. Patients receiving ONS had reduced complication rates, including a reduced number of infections, gastrointestinal perforations, pressure ulcers, anaemia, and cardiac complications.[147] In a Cochrane systematic review of 24 studies (*n*=6225), elderly patients at risk of malnutrition had fewer complications, including pressure sores, deep-vein thrombosis, respiratory, and urinary infections in those that received ONS compared with the controls.[148]

Additionally, dietary counselling with or without ONS has also been proved to improve the patient's body weight, lean body mass (LBM) and functional capacity measured by handgrip strength.[149]

Good nutritional care has also been shown to consistently reduce length of hospital stay. In a prospective study conducted at Johns Hopkins, timely screening and early nutritional intervention reduced length of stay by 3.2 days in severely malnourished patients, which translated into cost saving of $1.514.[68] A study where ONS was supplemented showed a reduced length of stay ranging from two days in surgical patients to 33 days in orthopaedic patients. Patients with a BMI <20kg/m^2 showed the most significant improvement.[150]

Nutritional intervention has also been shown to reduce hospital readmissions. A study conducted in a community hospital where a comprehensive malnutrition clinical pathway programme was implemented showed a decrease in 30-day readmission from 16.5% to 7.1%.[151] Another study where patients received the hospital diet and high-protein ONS compared with only a hospital diet had a significantly lower six-month readmission rate of 29% and 40% respectively.[152]

A meta-analysis of 11 studies (*n*=1965) showed that patients receiving supplemental ONS (19%) also had a significantly reduced mortality rate compared with controls (25%; *P*<0.001).[150] Patients receiving ONS, with a lower average BMI, had a greatest risk

reduction in mortality, with a 24% overall reduction in mortality.[150] Similar results were obtained by a systematic review of 32 studies (*n*=3021) where mortality was significantly reduced in elderly persons receiving ONS compared with those receiving routine care.[153]

The above evidence clearly demonstrates the clinical benefit of nutrition support to improve patient outcome and reduce cost of care, especially for those patients that are at risk of malnutrition (i.e., the elderly, BMI <20kg/m^2).

1.7.2 Barriers to Nutritional Support

To advance nutritional care of hospitalised patients, it is crucial to identify and find ways to overcome barriers that impact the provision of nutritional care.[23]

Firstly, although approximately 30% of the adult patient population is admitted to hospital in a malnourished state, the majority of these patients do not receive nutritional therapy and are not screened for intervention.[23] A possible reason for this is lack of availability of screening tools at ward level, lack of training, and confusion about who is responsible for nutrition screening. Nutrition screening should be implemented by any staff member on admission, not only by dietitians. The roles and responsibilities of all healthcare staff must be defined to effectively plan and manage patients. The nutritional care should also not only be limited to the patient's' hospital stay.[71]

Secondly, dietitians are primarily responsible for the nutritional care that the patient receives, although many institutions do not have the staff capacity to manage the large number of patients that may be in need of medical nutritional therapy.[23] Resources need to be carefully allocated to ensure an adequate number of dietitians.

Furthermore, when nutritional therapy is provided to the patients, it is often delayed because of the patients' medical status, medical interventions, and delayed nutrition consultations. Research conducted at Johns Hopkins showed that the average time for a nutrition consultation from admission was five days,[68] which correlates with the average duration of hospital stay for most patients.[23,154]

Another barrier to nutrition therapy is the exclusion of nursing staff in nutrition therapy. Nurses are actively involved in patient care and observe nutritional intake and tolerance, have continuous communication with patients and their relatives, and are key players in the care of the patient. However, nursing staff are often not included in or informed about the nutritional care prescribed.[155]

Owing to illness and pain, many patients also struggle to finish meals without assistance which leads to inadequate dietary intake.[156] Furthermore, there exists a lack of staff co-operation between physicians, dietitians, nurses, and food service staff. This is evident as research found that dietitians' recommendations were only implemented in 42% of cases, as sign-off may be required by the physician in charge. [157]

1.7.3 Effective Management of Malnutrition

For malnutrition to be managed effectively there needs to be a shift from malnutrition being the responsibility of only the dietitian to a collaborative, multi-disciplinary approach, in a holistic manner.

The Alliance Steering Committee (The Alliance) have developed six key principles for advancing patient nutrition that include: (1) create institutional culture, (2) redefine clinicians' roles to include nutrition, (3) recognise and diagnose all patients 'at risk', (4) rapidly implement interventions and continued monitoring, (5) communicate nutritional care plans, and (6) develop discharge nutritional care and education plan.[23]

For change to occur, the culture of an institution must change to one where all stakeholders value nutrition. This principle requires education and understanding on the adverse effect malnutrition has on patient outcomes. Unfortunately nurses and physicians only receive limited nutrition education during their formal training and consequently do not value medical nutrition therapy as much as other medical aspects of patient care. If nutrition is not a priority within an institution, it may be disadvantageous for human resource allocation and could limit the nutritional intervention options available. All staff should be educated in the recognition and diagnosis of malnutrition, and evidence-based nutritional interventions. Interventions should be a core component of a patient's medical therapy and be managed with the equivalent rigor of other medical interventions. Institutional financial data should be reviewed to ensure that budgets support adequate nutritional intervention.[23]

The roles and responsibilities should also be redefined so that the responsibility does not solely lie with the dietitian. For nutritional intervention to be effective, all disciplines involved in patient care should have empowered staff that value nutrition, in order to influence nutrition decisions. Potential barriers and solutions to recognise and treat malnutrition should be discussed in multi-disciplinary teams. Nurses should be equipped to identify malnutrition risk factors such as poor dietary intake and intolerance, as well as to apply a defined course of action when a patient is positively screened to be at risk of malnutrition. Efficient nursing actions can reduce the risk of malnutrition through dedicated mealtimes, assisting patients as necessary, managing the meal environment and staff mealtimes.

The dietitian should also be granted ordering privileges for the ordering of nutrition therapy to facilitate food delivery and prevent delays.[23]

All patients admitted should be screened for malnutrition within 24hours in sub-acute settings and throughout admission.[158,159] This is crucial, owing to the high prevalence of hospital malnutrition and for the early identification of malnourished patients. The screening tool should be easy, practical and validated so that it can be used by all staff members without imposing an extra workload on staff. A defined course of action should follow if the patient is deemed to be at nutrition risk.[13] Nurses must rescreen regularly as hospitalisation itself is a risk factor for becoming malnourished. The screening results must be documented, and an assessment by a dietitian should follow within 48hours of admission.[23]

Comprehensive nutritional interventions should promptly follow diagnosis, and the patient should be monitored. Regrettably there are many possible barriers to implementation, which include: (1) NPO status, (2) lack of a nursing protocol attentive to nutrition, (3) delay in assessment of nutritional status, (4) disregard of nutrition recommendations from the dietitian by the physician, (5) uncertainty of physician with product formulary and/or specific micronutrient therapies available in their setting, and (6) inadequate food consumption due to underlying disease and mealtime environment.[21,23,60,160,161]

Nurses must be vigilant in monitoring and recording actual intake and missed meals, avoid disconnecting EN or PN when the patient is repositioned, identify medications and disease conditions that interfere with nutrient absorption, manage gastrointestinal symptoms while

continuing to feed, and do their best to create a focused mealtime and supportive mealtime environment to maximise nutrient intake. All healthcare staff involved in patient care must respect and follow the nutritional care plan, and deviations should be recorded in the medical file. Close monitoring of patients allows for changes to be made to the nutritional care plan early and as necessary.[23]

Nutritional care plans must be communicated through documentation in the patient's medical file, and directly to healthcare providers to ensure informed participation in patient care. Often nutritional status and dietary intake are not recorded, making it difficult to assess dietary adequacy. Nutrition-related standard operating procedures (SOPS) are often absent in institutions. Additionally, nutritional care plans and medical conditions are often poorly communicated to post-acute facilities, leading to loss in continuity of care.[162,163] It is important that all aspects of nutritional care are formally documented from the initial screening results up to monitoring and the evaluation plan. Nutritional care plan records should be included in the discharge summary to ensure understanding of the patient's nutritional care plan, goals, monitoring, and evaluation in the post-acute facility.[23]

To improve quality of care, nutrition must be managed from admission to discharge in a comprehensive systematic manner. Nutrition goals achieved may be lost if not adequately addressed when patients are discharged.[162,163] Patient education is rarely done by the hospital team, and not all physicians are informed of the elements of a discharge nutritional care plan.[164] Patients also often adhere poorly to these plans, which in turn hinders recovery during recovery post-discharge.[23,165] The Alliance therefore recommends that nutrition should be a key component of conversation with patients and caregivers. The nutritional care plan, including dietary recommendations, should be communicated throughout the patient's hospital stay. A follow-up consultation allowing for continued nutrition education should also be provided.[23]

For the successful management of hospital malnutrition with improved safety and efficacy of care, intersectoral collaboration and a multi-disciplinary team approach are mandatory.[23,166]

1.8 CONCLUSION AND MOTIVATION

From the literature, it is clear that malnutrition has severe adverse effects on patients, health-care staff and resources. Despite no gold standard for the diagnosis of malnutrition, prevalence ranges between 15–76%[12,33,34,42,42,49,51-60,60-66] and has not improved since Butterworth et al. first drew attention to this unrecognised and underdiagnosed disease.

In South Africa, and Africa as a whole, baseline data on the prevalence of adult hospital malnutrition is limited, although it was reported to be as high as 93% in rural KwaZulu-Natal.[70]

The literature also describes disease-related malnutrition as having a severe impact on nutritional status owing to the underlying inflammation.[8] Studies have described South Africa as a country enduring the quadruple burden of disease, which refers to the simultaneous presence of under-nutrition, over-nutrition, communicable disease (e.g., TB, HIV/AIDS) and non-communicable disease (e.g., cardiovascular disease, diabetes).[167] Treatment and prevention of non-communicable diseases in South Africa has not been effective, owing to the overwhelming burden of HIV/AIDS and TB. Given the knowledge of the high prevalence of disease, one can assume the South African population is at even a higher risk of malnutrition.[167]

Poor nutritional status negatively impacts patient outcomes and contributes to healthcare costs. Nutrition therapy is a cost–effective strategy to significantly improve patient outcomes, and can significantly contribute to financial savings. Despite the known clinical benefits of nutritional intervention, the implementation is severely limited. Only the minority of patients have nutrition-related notes recorded in their files.[32]

Since malnutrition is not readily recognised as a disease that requires treatment, financial and administrative resources required for its management are also restricted. Nonetheless, it is the patient's right not to be malnourished, or become malnourished during hospitalisation. Emphasis must be placed on the need for compulsory screening to identify patients at risk of malnutrition so that nutritional intervention can be implemented to reduce poor clinical outcomes such as morbidity and mortality.[32]

This study aims to assess the prevalence of risk of malnutrition in hospitalised adult patients, in a tertiary academic hospital in Gauteng, to provide current baseline statistics on

its prevalence as it pertains to South Africa. The implementation of nutrition support will also be assessed, as this is a vital component in improving patient outcomes.

CHAPTER 2

METHODS

2 METHODS

2.1 AIM AND OBJECTIVES

The aim of this study was to assess the prevalence of risk of malnutrition of adult in-patients, in a tertiary academic hospital in Gauteng, South Africa in 2015.

The objectives of this study included:

I. To assess the prevalence of risk of malnutrition in hospitalised adult in-patients on admission (<48 hours) using three screening tools (AMDT, SGA tool, NRS-2002) in a tertiary academic hospital.
II. To describe any significant differences in the prevalence of malnutrition between different disease categories of adult hospitalised patients.
III. To assess and describe whether there are nutrition protocols, instruments and practices in each ward which can help identify adult patients at risk of malnutrition and if the ward has the necessary items to support the implementation of dietetic interventions, by using a ward checklist.
IV. To determine how many of the malnourished adult patients are referred for a dietetic consultation within their duration of hospitalisation.
V. To assess the change in the prevalence of malnutrition in hospitalised adult patients between admission and discharge.
VI. To assess the outcomes of malnutrition in adult hospitalised in-patients on discharge (or at 28 days' post-admission).
VII. To determine the relative validity of the different screening tools used against one another (i.e. NRS-2002 against SGA, NRS-2002 against the six-character AMDT, and vice versa).

2.1.1 Hypothesis

- H0: There is no difference in the prevalence of risk of malnutrition in adult hospitalised patients between admission and discharge in 2015.
- H0: There is no difference in prevalence of risk of malnutrition between diseases categories included in the study in 2015.

2.1.2 Conceptual Framework

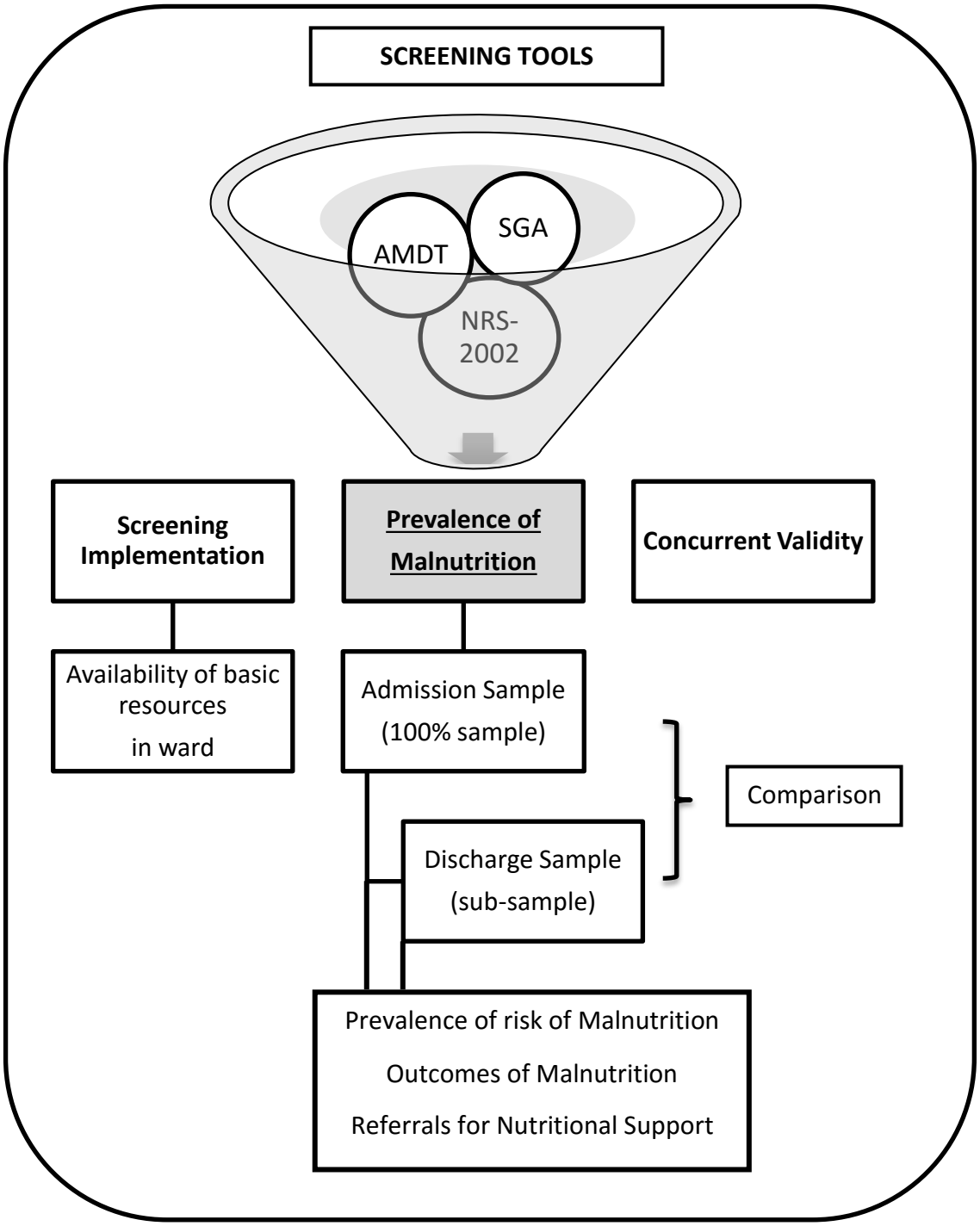


Figure 2.1 Conceptual framework of study aims and objectives.

2.2 STUDY PLAN

2.2.1 Study Type

This study forms part of a multi-centre, multi-country study (SA and Kenya), and is one of the studies that is conducted at an additional four sites in Africa. The design is an observational, descriptive prospective cohort study with an analytical component. This study was conducted on randomly selected adult in-patients admitted to a Chris Hani Academic Hospital (CHBAH), a tertiary teaching hospital in Johannesburg, Gauteng in 2015.

The study will also be conducted at the following sites:

- Tygerberg Hospital, a public teaching hospital situated in Tygerberg, Cape Town, South Africa.
- Groote Schuur Hospital, a public hospital, situated in Cape Town, South Africa.
- Aga Khan University hospital, a private hospital situated in Nairobi, Kenya.
- Mbagathi District Hospital, a public hospital situated in Nairobi,Kenya.

The study described the baseline nutritional status of randomly selected hospitalised adult patients. Participants were followed up on discharge and on 28 days post-admission, making it a prospective cohort design.

The comparison of the nutritional status introduced the analytical component of the study; it provided information of the patient's nutritional status when they were admitted to hospital and how hospitalisation affected the patient's outcomes. Furthermore, data regarding the prevalence of risk of malnutrition was compared between different disease categories to identify which patients were more vulnerable for malnutrition.

This study was an observational study as there was no direct intervention. The data gathered was obtained through anthropometric measurements, observational checklist and interviewer-administered questionnaires (which incorporated the three screening tools). Currently there is no such data in South Africa, which made this observational study worthwhile before conducting an intervention study.

2.3 STUDY POPULATION

2.3.1 Sampling Frame

All participants were randomly selected adult in-patients (≥18 years of age) admitted (<48 hours of admission) to Chris Hani Baragwaneth Academic Hospital, Soweto, Gauteng, South Africa in 2015.

2.3.2 Selection of Sample

Wards: A list of the wards of CHBAH in line with the inclusion criteria was obtained. The eligible wards were stratified into categories; namely medical, surgical, and gynaecology. The number of patients recruited from each ward was weighted according to total number of beds available in each ward-category.

A block selection of ten patients was recruited per ward when possible. Once ten patients in the specific ward were reached, the researchers moved onto the next ward-category. If less than ten (*n*=10) newly admitted patients were recruited in a ward, the researcher continued onto the next ward in the same category. This helped to ensure that a representative sample was obtained. The process was repeated until the sample size number was reached.

A sub-sample was used to determine objective four to seven. The sub-sample was selected using every patient that was identified for follow up.

2.3.3 Participants

On ward level the researcher and the fieldworker, obtained the admission register. Randomised interval sampling was used, selecting patients consecutively in the register, starting at the most recent admission of that day working back in time up to 48 hours until ten patients were recruited. The selected patients were approached and a short screening questionnaire was conducted to determine if they were eligible to participate in the study.

In the case were too few patients were recruited within a ward (i.e., <10 patients), the researcher progressed onto the next ward within a certain ward-category, until the block of ten participants had been recruited.

2.3.4 Sample Size

The researchers aimed to recruit and include 400 participants from CHBAH in the study. The calculation was based on the patient data of Tygerberg Hospital, the mother-site of this

study. As this is a multi-centre study being conducted in five different health institutions, the aim was to yield a total of 2000 participants in the larger study.

2.3.5 Inclusion and Exclusion Criteria.

Inclusion Criteria

- All adult in-patients admitted to CHBAH that have been admitted for less than 2 days (<48hours)
- Subjects 18 years of age or older
- Competent subjects who gave written informed consent.
- Conscious patients
- Wards: medical, oncology, surgical, cardiology, gynaecology, orthopaedic, vascular, urology, ear-nose and throat (ENT) and maxillofacial
- Patients that understood and could communicate in English, Afrikaans, or isiZulu
- Male and female patients

Exclusion Criteria

- Subjects that did not give informed consent or that were not competent to give informed consent
- Day-care patients
- Patients on dialysis
- Patients with dementia
- Psychiatric patients or patients that had eating disorders
- Patients with limb amputees or casts
- Patient's dependant on a ventilator
- Wards: maternity, post natal, high care, Intensive Care Unit (ICU), CCU (Cardiac Care Unit), casualty, all paediatric wards, psychiatry, renal and the adult burns ward

2.4 METHOD OF DATA COLLECTION

Data collection was conducted by the researcher and a trained fieldworker, which both had obtained a Bachelor of Science Dietetics degree. Interviews were conducted in English or Afrikaans. In cases where there was a language barrier, healthcare staff knowledgeable of Isizulu assisted with the data collection. The fieldworker was trained to ensure a standardised method of data collection using SOPS. Training was completed prior to the study by the primary researcher. Data collection was conducted from January to March 2015. If the patient was not discharged by day 28 post-admission, the discharge assessment was completed.

Data measuring instruments included the following:

- Form 1: Participant screening form
- Form 3: Information leaflet and consent form
- Form 4: Admission data collection form
- Form 5: Discharge data collection form
- Form 8: Observational checklist
- Portable electronic scale
- Portable stadiometer

2.4.1 Participant Screening Form

The participant screening form was a short checklist that was based on the inclusion and exclusion criteria to ease identification of eligible patients. After the checklist was completed, the researcher determined if the patient was eligible to participate and subsequently asked if the patient was willing to participate in the study.

Researchers started data collection by obtaining the admission register. Random interval sampling, was used to select patients consecutively from the admission register, starting at the most recent admission, working retrospectively up to 48hours. The name and relevant bed number was obtained and the selected patient was approached. If the potential participant could not understand or speak English or Afrikaans, a translator assisted with data collection by translating into isiZulu.

If the patient met the criteria, was willing to participate, and had approved informed consent with their signature, a unique identity number (ID) was designated to the patient and was written on the screening questionnaire, so that all the patients' documents were linked. All data collection forms, regardless of participation status have been stored by the investigator.

2.4.2 Admission and Discharge Data Collection Form

The admission and discharge data collection forms were interviewer-administered questionnaires, which helped the researcher to obtain information concerning the patient's demographic, medical, dietary, anthropometrical and clinical information. Some of the information was obtained using the patients' medical file, whereas some was obtained through orally questioning the patient. (Table 2.1)

Admission data collection form (complete sample)

- The admission data collection form contained questions on general details of the patient. This included the patient's gender, age, admission ward name and number, diagnosis on admission, dietary intake, anthropometry and clinical information.

Discharge data collection form (discharge sub-sample only)

- The discharge data collection form helped the researcher to gather information regarding the patient's hospital stay and outcomes related to malnutrition. The form helped obtain information on the patients, medical condition on discharge, dietary intake, anthropometry, clinical information, total length of stay and the occurrence of any complications.

The two forms where conducted at different intervals during the study, as appropriate. However, both were conducted by the fieldworker, in the ward, at the patient's bedside. The admission data collection form was completed only on admission (within 48hours) for all patients eligible to participate in the research study. The discharge data collection form was completed if the patient was admitted for at least seven days or longer (within the last 48hours prior to discharge) or on day 28 of admission if the patient was expected to endure a longer length of stay.

To ensure that the patients were not missed for the discharge interview, fieldworkers monitored patients for discharge daily (from date of admission until the day of discharge or day 28 post admission).

If a patient was included in the discharge sub-sample, the fieldworker first re-established informed consent with the participant orally before completing the discharge data collection form. If the patient consented and was for discharge within the next 48hours, the patient was eligible to participate. If the patient was lost for follow-up for any reason this was recorded on the form as the participant could not participate in the discharge assessment.

To ensure anonymity, the unique ID number that was used for the patient was also recorded on both of the data collection forms in order to link the data to the same patient without exposing personal details. All the data was systematically stored.

2.4.3 Observational Checklist

The observational checklist was designed specifically for CHBAH hospital. It was a checklist that consisted of 16 questions that helped to identify the availability of resources on ward level that could support identification and documentation of patients in need of nutritional support. The observational checklist was completed by a fieldworker in all the wards that formed part of the study.

The checklist was completed by means of observation. The fieldworker could ask the nurses for assistance in the ward if there were any uncertainties. The checklist was filled in by marking a cross (x) in the answer column consisting of either ‘yes’ or ‘no’ or ‘not applicable’ as appropriate. This checklist was done once-off in each ward that was included in the study.

The observational checklist was stored in a file that is kept by the principal researcher.

2.4.4 Screening Tools.

The screening tools were completed using the information obtained from the admission and discharge data collection form. Fieldworkers were trained on using these tools according to SOPS, to promote standardised data collection and interpretation. This was important as the tools included subjective elements. (Table 2.1)

Table 2.1 Breakdown of measurements needed to complete the three screening tools

	NRS-2002	SGA	AMDT
Weight and height for BMI	X		
Weight changes	X	X	X
Change in food intake	X	X	X
Severity of illness	X	X	
Age	X		
Decreased muscle mass		X	X
Loss of subcutaneous fat		X	X
Fluid accumulation		X	X
Functional status		X	X
Gastrointestinal symptoms		X	

To complete the screening forms (NRS-2002, SGA and AMDT),the researcher needed to obtain information regarding the patients demography, anthropometry, physical composition, dietary intake and medical information, which was obtained using the (admission and/or discharge) data collection form. The relevant information was obtained using the patients' medical file and orally interviewing the patient. It was conducted on all patients on admission and on the patients that were included in the discharge sub-sample.

2.4.4.1 Demographics:

- Admission date and discharge date.
- Diagnosis on admission.
- Gender, age, contact details.
- Referral to dietitian services.

2.4.4.2 Anthropometry

The anthropometric measurements that were required for this study were weight and height. Anthropometry was required for the AMDT, SGA and the NRS-2002 and was recorded using the admission/discharge data collection form.

Measuring instruments:

- Portable electronic scale
- Calibration set (5kg weights)
- Portable stadiometer
- Measuring tape (non-stretchable)

The anthropometric measurements were required on admission and on discharge to calculate percentage weight loss (SGA and AMDT) and the BMI (NRS-2002). The fieldworker conducted the required measurements in the ward on admission and if applicable, on discharge. Anthropometry was conducted at the patient's bedside.

In the case of a patient being too weak to stand for the weight and height measurement, the fieldworker first looked in the file for a recent weight (done on admission) or height and used this instead, if reliable and realistic. If this was not available, the fieldworker asked the patient for a reported weight and height, which was used if deemed reliable and realistic.

2.4.4.2.1 Height

The patient's height was measured using a portable stadiometer. The same stadiometer was used throughout the study. If a height measurement was not possible, the fieldworker looked in the medical records for a height measurement. If this was not available, the researcher asked the patients their reported height. Alternatively, demi-span was taken in patients that were unable to stand to calculate the patients' height.

Method:Prior to the measurement the patient was asked to remove any footwear and headgear. The height measurement was obtained by having the patient stand on the baseboard with their back facing the vertical axis forming a Frankfort plane 90° angle with the baseboard. The patient was asked to straighten his legs, have their knees together and the patient's arms should be relaxed at his/her sides. The measurement was taken to the nearest 0.1cm.[111]

2.4.4.2.2 Weight

Weight was measured using an electronic portable scale that was used for all the patients during the duration of the study. The scale was calibrated once a day at the beginning of the day, prior to taking any weights, using a known weight.

Method: The patients weight measurement was taken in the hospital gown (light clothes), without shoes, and measured to the nearest 0.5kg.[111] Weight was measured throughout the day and not at a specific time as this was not practical. If weight could not be taken due to functional incapacity, the fieldworker would try to obtain a weight measurement from the patients' medical records. If this was not available the fieldworker asked the patient for a recent weight and used the value if it was deemed realistic by the fieldworker.

2.4.4.3 Functional status

Handgrip strength was used to assess the patient's functional status using a handgrip dynamometer (Takei Physical Strength Dynamometer, model T.K.K 5401, Scientific Instrument Co. Ltd. Japan).This data was needed to complete the SGA and the AMDT. Patients were asked to perform maximal contraction with the dominant hand and to hold it for a few seconds. This was done three times, and all values obtained were recorded. [168]. If the patient was unable to perform this test due to their medical diagnosis this was noted (e.g., rheumatoid arthritis).

Method: Three handgrip strength measurements were obtained using the patients' dominant hand. Patients had to stand upright, shoulders back, with feet even and hip-width apart. The elbow was positioned in complete extension, and the arm was not supposed to touch any part of the body, in neutral position, with the instrument in their dominant hand. The patient would be asked to take a deep breath prior to the squeeze, and blow out all the air during the squeeze. Patients were instructed to squeeze the hand as hard as possible until they could not squeeze any longer, and hold it for a few seconds. The measurement would be taken and after 20 second rest intervals, the measurement was repeated. If the patient was unable to stand, the measurement was taken in the seated position.[169]

2.4.4.4 Clinical examination

The clinical examination assessed three components, namely the presence of subcutaneous fat loss, signs of muscle wasting and the presence of oedema.

2.4.4.4.1 Clinical signs of subcutaneous fat loss

The fieldworkers assessed the patient for subcutaneous fat loss by assessing the patient's lumbar, upper arm, orbital and thoracic regions. Findings were interpreted according to the established SOP to ensure a standardised approach.

2.4.4.4.2 Clinical signs of muscle wasting

Muscle wasting was assessed by evaluating the orbital, clavicle, acromion, scapular bone and dorsal hand regions of the patients. Fieldworkers conducted the assessment according to the established SOP which described and interpreted the findings.

2.4.4.5 Oedema

Fieldworkers assessed the patient for oedema around the orbital, ankle and sacral region. The following oedema correction factors were used by the fieldworkers, when adjusting the weight for oedema. (Table 2.2)

Table 2.2 Body weight correction factors based on severity of oedema [170]

Degree of Oedema	Correction Factor
Mild	Actual body weight minus 1kg
Moderate	Actual body weight min 5kg
Severe	Actual body weight minus 10kg.

2.4.4.6 Dietary intake

In order to standardise the field workers on the assessment of dietary intake, plate models were used as a visual aid when the patient did not understand the question. Four different plates were shown with different amounts of food on it (i.e. a full plate of food, a three-quarter plate of food, half a plate of food, or a quarter-plate or less). The patient was asked to point out which plate most accurately described their current food intake. If the patient consumed less than three-quarter plate for more than seven days (≤75% of usual intake for >7days), it was interpreted as moderate malnutrition. A reported intake of less than half a plate of food (≤50% of usual intake for ≥5days) was interpreted as severe malnutrition.

2.4.4.7 Medical information

Medical information was obtained from the medical file. This included information of date of admission to hospital, date of admission to the specific ward and the patients' primary diagnosis on admission. If the patient was included in the discharge sub-sample any complications were documented from the medical file, as well as the intervention that was used to correct the complication.

2.4.4.8 Gastrointestinal symptoms

Patients were questioned about any gastrointestinal symptoms they may have encountered prior to admission and during their stay in hospital. These included vomiting, nausea, diarrhoea and constipation. The duration and number of gastrointestinal symptoms experienced at one time was documented.

2.5 CLINICAL OUTCOMES

Clinical outcomes were documented and calculated from the admission/discharge data collection form as appropriate. These included the following:

2.5.1 Length of Stay

The total number of days that the patient was admitted to hospital was calculated, by documenting the date of admission and discharge. Length of stay was calculated for all patients that were admitted to hospital and included in the research study.

2.5.2 Complications

The number of complications encountered by hospitalised patients was documented. This information was only collected for the discharge sub-sample that was followed-up for the discharge interview. The number of complications, organ systems involved, and treatment type was documented.

The disease severity was established using the guidelines from the NRS-2002.[124]

2.6 ANALYSIS OF DATA

2.6.1 Body Mass Index (BMI)

The BMI was calculated using the patient's current weight (kg) and height (m) measurement. The fieldworker corrected for oedema before performing the calculation. The cut-off values differ between the WHO and NRS-2002 (Table 2.3)

$$BMI(kg/m^2) = weight/height^2$$

Table 2.3 Cut- off values as per WHO and NRS-2002 for the BMI categories.

WHO (kg/m^2) [171]		**NRS-2002 (kg/m^2) [124]**	
<18.5	Underweight	<18.5	Underweight
-	-	18.5-20	Borderline Underweight
18.5-24.9	Healthy	20-24.9	Healthy
25-29.9	Overweight	25-29.9	Overweight
≥30	Obese class 1	≥30	Obese

2.6.2 Percentage Weight Loss

Percentage weight loss was required for the SGA. The fieldworker recorded the usual weight of the patient as well as their current weight.

If the patient was unsure of their normal weight and could not describe the weight loss in kilograms, the fieldworker evaluated weight loss by asking if jewellery or clothing had become loose fitting or if they have needed to adjust their belt setting. If the patient acknowledged one or more of these questions, the fieldworker interpreted this as significant weight loss (>5%).

$$\% \text{ Weight loss} = [(\text{usual weight (kg)} - \text{current weight}) / \text{usual weight.}] \times 100$$

2.6.3 Determining Handgrip Strength

Handgrip strength was measured three times, of which the average was used to determine whether the patient had an appropriate handgrip strength, based on age and gender

according to Takei Dynamometer average reference ranges. If the patients average handgrip strength was ≤50% of the reference value it was interpreted as having diminished functional capacity. If the patient obtained an average value >50% of the reference values, it was considered to be adequate. (Table 2.4)

Table 2.4 Takei Dynamometer average handgrip strength (Takei Physical Strength Dynamometer, model T.K.K 5401, Scientific Instrument Co. Ltd. Japan).

Age	Male	Female	Age	Male	Female	Age	Male	Female
10	18.5	16.8	**30**	50.2	30.5	**50**	45.0	28.5
11	2101	20.0	**31**	50.1	30.4	**51**	44.7	27.9
12	24.9	22.4	**32**	50.1	30.6	**52**	44.3	27.7
13	30.5	24.6	**33**	50.0	30.7	**53**	43.9	27.4
14	36.0	26.0	**34**	50.0	30.3	**54**	43.5	27.0
15	40.5	26.5	**35**	49.8	30.3	**55**	43.0	26.9
16	43.8	27.5	**36**	49.4	30.7	**56**	42.4	26.6
17	46	27.9	**37**	49.0	30.5	**57**	41.9	26.4
18	47.4	27.7	**38**	48.9	30.5	**58**	41.5	26.3
19	48.4	28.1	**39**	48.5	30.4	**59**	41.0	25.8
20	49.3	28.7	**40**	48.3	30.5	**60**	40.5	25.4
21	49.7	28.7	**41**	48.0	30.2	**61**	39.9	25.0
22	50.0	28.5	**42**	47.7	30.2	**62**	39.3	24.6
23	50.1	28.6	**43**	47.4	30.0	**63**	38.7	24.2
24	50.1	29.3	**44**	47.1	29.5	**64**	38.2	23.8
25	50.2	29.1	**45**	46.8	29.6	**65**	37.5	23.4
26	50.2	29.4	**46**	46.5	29.6	**66**	37.0	23.1
27	50.2	29.7	**47**	46.1	29.4	**67**	36.5	22.7

28	50.2	30.0	**48**	45.8	28.9	**68**	35.9	22.3
29	50.2	30.2	**49**	45.4	28.6	**69**	35.4	21.9
						70	34.8	21.5

2.6.4 Disease Severity

Disease severity was scored according to the NRS-2002 guidelines.[124] These guidelines were extended by the researchers as indicated below, to ensure a standardised approach to scoring. (Table 2.5)

Table 2.5 Adapted NRS-2002 disease severity and allocated scores

Disease Severity	Score	Examples of Conditions
Not Applicable	0	Absent Normal nutritional requirements
Mild	1	Orthopedic: Bone fractures and breaks, hip and knee replacements limb amputations and having a septic limb. Chronic disease: Hypertension, diabetes, chronic obstructive pulmonary disease (COPD), asthma and chronic kidney disease. General Medicine: Dermatology-pemphigus vulgaris, hysterectomy, ectopic pregnancies, prostatectomy, kidney stones, idiopathic thrombocytopenic purpura, blood disorders. Oncology: Cancer- not on active treatment, mycosis fungoides (T-cell lymphoma) not on active treatment. Surgery: Facial surgery not affecting mouth or throat, mandible or facial fractures and surgeries affecting eating (e.g. orif zygoma fracture and repair), vascular surgery, stomaplasty post-laryngectomy, appendectomy, cholecystectomy, hernia repair, stoma closures, facial abscess removal, septic surgical wound, removal vocal cord cysts, gastric ulcer, kidney stones, uncomplicated nutritional deficiencies, or anaemia.
Moderate	2	Stroke with hemiparesis or hemiplegia, aplastic anaemia , cancer on

		active treatment, oral cavity cancer with or without active treatment, throat and oesophageal cancer, TB on active treatment or multi-drug-resistant disseminated TB, HIV/AIDS, septic shock, gangrene, HIV/AIDS with TB and lymphoma, Chron's disease, HIV/AIDS with liver disease, rheumatoid arthritis or lupus.
Severe	3	Head injury, bone marrow transplantation or intensive care patients

2.6.5 Functional Capacity Influenced by Nutritional Factors

Whether the impaired functional capacity was secondary to poor nutritional status or influenced by nutritional factors was determined manually by the researcher. This was based on clinical knowledge, and the patient's diagnosis. However, if there was still uncertainty, the patients BMI and weight status was also assessed to make a decision.

Table 2.6 Scoring of the nutritional risk screening tools

NRST	Factor	Description	Scoring
SGA (133)	Weight change over 6 months	First option: use percentage (%) weight loss based on usual and current weights	>10% =1 5-10% = 3 <5% =5 ≤0% = 7
		Second option: If percentage weight loss was not available, look if clothing has become loose.	Loose clothes = 3 No lose clothes = 7 Not Applicable = 0
		Third option: If the above two options were not available, use the comparison of weight to six months ago.	A lot more = 1 A moderate amount more=3 A little more=5 Same/less= 7
	Dietary intake		No change in take = 7 Eating ¾ of usual =5 Eating ½ usual = 4 Eating ¼ usual = 3 Unable to eat = 1
	Gastrointestinal symptoms	Gastrointestinal symptoms, including nausea, vomiting, and diarrhoea	No symptoms = 7 Infrequent= 6 Almost daily for 1 week = 4 Almost daily for 2 weeks = 1
	Loss of subcutaneous fat	Evaluated the patient's orbital, triceps and biceps area.	The exact scores of 1-7 that were allocated were used

	Loss of muscle mass	Evaluated the patient's temple, clavicle, shoulder, scapular, dorsal hand, knee, quadriceps and calves	The exact scores of 1-7 that were allocated were used
	Total score calculation	Total score was divided by 13. (Not 14, as change in weight in 2 weeks was excluded due to discrepancies) If variables where missing, it would be divided by less (as appropriate) SGA A: ≥6 well nourished SGA B: 3-<6 mild to moderately malnourished SGA C: 1 to <3: severely malnourished	
NRS-2002 (124)	Initial screening	Is the BMI <20.5kg/m^2? Has the patient lost weight within the last 3 months? Has the patient had a reduced dietary intake in the last week? Is the patient severely ill?	Yes or no answers were allocated to each of the questions If any of the questions were answered 'yes' the clinician would proceed to 'final screening'
	Final screening	Impaired nutritional status	None = 0 ; normal nutritional status Mild = 1; wt loss >5% in 3 months or food intake below 50-75% of normal requirements in preceding week Moderate = 2; wt loss >5% in 2 months or BMI 18.5-20.5kg/m^2 and impaired general condition or food intake 25-60% of normal requirement in preceding week Severe = 3; wt loss >5% in 1 months (>15% in 3 months) or BMI<18.5 kg/m^2 and impaired general condition to food intake 0-25% of normal requirement in preceding week
	Final screening	Disease severity	Absent = 0; Normal nutritional requirements Mild = 1; Hip fracture, chronic patients, with acute complications, COPD,

			diabetes mellitus or cancer Increased protein requirements, can be covered with ONS or diet in most cases. Moderate = 2; Major abdominal surgery, stroke, severe pneumonia, hematologic malignancy Confined to bed due to illness. Protein requirements increased significantly, but can be covered. May need artificial feeding. Severe = 3; Head injury, bone marrow transplantation, intensive care (APACHE >10) not included in study. Needs ventilation, very high protein requirements that can't be met. Protein breakdown and nitrogen loss can be significantly attenuated.
	Final score	Final score = disease severity + nutritional impairment If the patient is ≥70 years old = add 1 to give age-adjusted score Age adjusted score	
AMDT	Weight loss	First option: Usual weight and current weight Second option: if not available refer to question if the patient's clothes had become loose.	If patient lost weight = yes If no weight was lost = no If clothes became loose = yes If clothes did not change = no
	Energy intake		No change = no Decrease by ¼, ½, or ¾ or unable to eat = yes
	Oedema/ Fluid accumulation		Oedema present = yes No oedema = no
	Subcutaneous fat	Evaluated the patients: orbital region, upper arm region (triceps, bicep) and thoracic and lumbar regions (ribs, lower	Score for each 1-5 = yes Score of total subcutaneous fat loss ≥2 = yes

		back, mid-axillary line)	
	Muscle mass	Evaluated the following regions: temple, clavicle bone, clavicle and acromion scapular bone, dorsal hand, patellar, anterior thigh and posterior calf	Score for each 1-5 = yes Score for total muscle mass loss ≥4 = yes
	Functional capacity	First choice: handgrip strength Second choice: ambulation	If patient average <50% Takei average = score 1 If patient average ≥50% Takei average = score 0 Experience reduced ambulation: yes = 1
	Final score calculation	AMDT classification: Malnourished? If ≥2 total AMDT score = yes ; If <2 total AMDT score = no	

2.7 DATA COLLECTION

2.7.1 Communication

In the case of communication barriers (broken English or cognitive disabilities) between the patient and the fieldworker, the fieldworker used the help of a translator, information from medical staff involved in the patients care, relatives or the patients' medical file to complete the assessment.

2.7.2 Data Collection

Data collection was supervised by the principal researcher doing spot checks and being available physically or telephonically during the data collection phase of the study. An assessment for possible anticipated problems was done during the pilot study and identified problems in the questionnaire were rectified prior to the study. The fieldworker was instructed to contact the primary investigator if problems occurred, but fortunately this was not experienced.

Audit trail: All original documentation has been stored as evidence.

In the case that screened patients that were eligible but choose not to participate (i.e., patients that refused consent) it was noted on the screening questionnaire. If the patient went missing before the discharge evaluation could be completed this was also documented.

2.8 DATA PROCESSING AND COLLECTION

Data was processed both during and after the data collection phase. All questionnaires and forms were checked for completeness on the day of data collection.

Data was entered manually on the computer, using coding sheets in Microsoft Excel (2010)

Coding: All the answers obtained were coded according to key words relating to the question. Every variable had set codes and any non-response or missing data was left blank. The coding sheets for each form were tested in the pilot study so that the necessary changes could be made if necessary. Ordinal data was entered as numbers and nominal data was entered using letters.

2.9 DATA ANALYSIS AND STATISTICS

Data analysis was tested in the pilot study with the data obtained. Programmes used included Microsoft Word, Microsoft Excel and Statistica Version 12.

The statistics were analysed by the primary investigator, study leaders and the assigned statistician, Professor Nel from the University of Stellenbosch.

The primary objective was descriptive (observational) data; therefore descriptive analysis was used. Summary statistics were used to describe the variables. The spread of the data was presented using histograms. To further describe central location, depending on the spread and variable type, the mode or the mean were used. Spread of data was presented by standard deviations and inter-quartile ranges (IQR).

The observational checklist consists of categorical binary data and was described using frequencies, relative frequencies (%), confidence intervals using histograms.

Regression analysis has been used to describe the relationship between two variables, whilst the strength of the relationship has been determined using the Pearson's correlation or Spearman's correlation test depending on the distribution of the data. Multiple regressions were used when one variable was compared to multiple other variables. The strength of the relationship was then measured using multiple correlations.

Analysis of variance (ANOVA) was used to determine the relationships between continuous and nominal variables or non-parametric statistics.

For all analytical data, a significance level of $p \leq 0.05$ was used at a 95% confidence level.

Validity testing was conducted using specificity and sensitivity testing of the different screening tools compared to one another, with the cut off points as indicated (Table2.7)

Table 2.7 Cut-off values for validity testing [123]

	Good	**Fair**	**Poor**
Sensitivity and specificity	Both >80%	Either <80%, but both >50%	Either <50%
Correlation co-efficient	>0.75	0.40-0.75	<0.40
Kappa	>0.60	0.40-0.60	<0.40

2.10 QUALITY ASSURANCE

Quality was promoted through the design of the study.

Before conducting the study, a pilot study was done to identify any problems with the data collection forms, such as order, readability or spelling. The researcher established flow and the approximate time needed to recruit one patient. This allowed the researcher to plan for adequate fieldworkers and data collection days, to achieve a valid sample size of 400 participants.

With regard to the data collection forms, the study was based on three tools, of which two are validated and reliable screening tools, namely the NRS-2002 and SGA. A quality assurance checklist was also included for researchers to fill in, to ensure that all data collection forms were filled in correctly and complete for each participant.

Fieldworkers were trained before data collection by the researcher on the protocol and the SOPS. They were given an opportunity to fill in the forms themselves according to the SOPS and any questions or uncertainties were clarified.

The anthropometric measurements were taken using the same scale and stadiometer throughout the duration of the study. The electronic portable scale was also calibrated at the beginning of each day, to ensure accurate measurements.

During the data collection phase of the study, the primary researcher was on site, to assist the fieldworker with queries or any encountered problems during the data collection phase. This also helped ensure that the fieldworker stayed focused by providing supervision. The study leader, Professor Blaauw, also came for a site visit for quality assurance during the data collection phase.

As this was a cohort study, a limitation was loss to follow-up. However, to minimise this both fieldworkers followed-up patients for discharge on a daily basis. The patients contact details were also recorded to enable communication between the fieldworker and participant.

Data processing was started during the study so that if any problems occurred with the data collected, the fieldworker was still in the data collection phase.

2.11 PILOT STUDY

A pilot study was conducted following ethics approval from Witwatersrand University, of one-day duration on 26 January 2015, by the primary investigator. One of the eligible wards was conveniently selected for use for the pilot study, and was conducted on five (*n*=5) randomly selected patients.

The informed consent formed was explained to each participant and tested for face validity. The screening questionnaire, observational checklist (wards) and quality assurance checklist was also tested for face validity and the time-taken to complete was recorded on each form.

The admission and discharge data collection forms were conducted at the same time. There was no time lapse in between conducting the two separate forms as it was in the research study.

The results obtained from each form were then entered manually on the computer to pilot data processing. Problems encountered with the data processing and analysis, were discussed and rectified by consulting with the study leaders.

All the problems experienced and identified from the pilot study were documented and identified problems were rectified.

The approximate time taken to complete each form was timed and recorded on the data collection form. The mean time was calculated from the pilot study, in order to realistically plan the number of days needed to recruit enough participants for this study to be valid. As there were no significant changes, there was no need to conduct another pilot study.

2.12 ETHICAL AND LEGAL ASPECTS

2.12.1 Permission

- ✓ Stellenbosch Health Research Ethics Committee

  To conduct this study, the mother- protocol was submitted to the Health Research Ethics committee of Stellenbosch in August, 2014 for ethics approval and was approved on 3 October 2014 (Protocol reference number N14/06/061).

- ✓ University of Witwatersrand Human Research Ethics Committee.

  The protocol was also submitted to the University of Witwatersrand for an Ethics review, as the University is affiliated with the Hospital and their approval was therefore needed for permission to conduct the research at CHBAH. Ethics approval was obtained on 31 October 2014 (Protocol reference number: M141041).

- ✓ Medical Advisory Committee (MAC) of CHBAH and the Committee for Research on Human Subjects of the University of Witwatersrand.

  In order to have conducted this research study at CHBAH and use the patients' medical records, permission was obtained from the MAC and Chief Executive Officer (CEO) of CHBAH. Once ethics approval was obtained from Wits Human Ethics committee, a letter requesting permission to conduct the study at CHBAH, was then submitted to the CEO of CHBAH. As soon as approval was granted from the CEO, permission was obtained from all the departments involved (i.e., clinical manager, Head of Department (HOD) of gynaecology, surgery, medicine , orthopaedics, and nursing).

2.12.2 Informed Consent

Regarding data collection, written informed consent was obtained from all selected, competent participants. The fieldworker explained the following to each participant in layman's terms: The aim of the study, the expected duration of their involvement, the participant's responsibilities, any discomfort and risks that the participant may endure during and after the study, contact details of the researchers, voluntary participation and their right to withdraw at any time without penalties or reason. The fieldworker also explained that there would be no incentive for participation. Disclosure was made in the preferred language of the participants. The informed consent was translated to English, Afrikaans, and isiZulu by the Language Centre of the University of Stellenbosch. The patient population at CHBAH was mainly English and isiZulu speaking.

A copy of the consent form was kept by the researcher, and one was given to the research participant. The consent declaration was signed by the researcher, the participant and a witness. If the patient was included in the discharge sub-sample, informed consent was first re-established orally.

If a patient had given consent, confidentiality of personal information was ensured by allocating a unique identity to the participants name on a separate form, known as the personal contact sheet. This sheet contained the patients name and the allocated identity number on it. However, only the unique patient code was used on the patients' forms to ensure anonymity. All the information that was obtained from each participant was anonymous, and has not been made available to the public nor will it be published in future.

2.12.3 Social Value of Research

The findings of this study may be used as supportive evidence to change health policy's and protocols of both community centres and hospital protocols. The evidence can serve as a basis for decision makers to adopt and implement strategies to meet the identified community health needs, and for allocating resources. The research may also support the importance of the continuum of care from primary health care all the way to tertiary care. It may prove that dietitians need to be more involved in clinics and counsel patients on enriching their meals and or provided with supplements to prevent malnutrition due to the underlying inflammatory state. On the hospital level, the results may support resource allocation directed to, training of nurses on malnutrition, compulsory screening on admission and nutrition i.e., providing extra nutrition for those identified to be vulnerable to malnutrition. This research can therefore help the community's health to be better looked after, as it may provide evidence needed to support demands made by clinicians.

2.12.4 Ethical Responsibility

Patients that were identified as at-risk or malnourished during the course of the study could not be referred for a nutrition consult on admission as it was an observational study, and intervention would have affected the outcomes of the study. Likewise, patients could not be referred on discharge as they formed part of a larger study, and would be followed-up three months post discharge.

2.13 CONFIDENTIALITY AND PRIVACY

2.13.1 Medical Records

All information obtained from the medical files and any patient information was kept confidential. No information that was identifiable to the person was made public. All participants remained anonymous, unless required by the law.

2.13.2 Patient Contact Sheet

If a patient participated in the study, the fieldworker recorded the patients name, surname, and contact details next to the allocated unique identity number on a separate form known as the patient contact sheet. This was done at the patient's bedside, within the ward. Contact information was obtained by asking the patient directly for their details or it was recorded from the medical file.

As patients were recruited, their names were entered on the sheet next to a pre-determined identity number. This unique number was used for all the data collection forms. The personal information was kept confidential, but it was needed for the researcher to enable follow-up the patient if they had been lost-to-follow-up in the study on discharge.

The patient contact sheet was kept separate from the patient data at all times to ensure anonymity. After data processing was completed, this form was destroyed to ensure anonymity and confidentiality of all participants. The details on this form were not shared, nor published.

2.13.3 Obtaining Information and Anthropometry

To ensure patient privacy, the patient's bed curtain was drawn when obtaining patient information. As the anthropometric equipment was portable, this was brought to the patient's bedside and weight and height measurements were obtained behind closed curtains. However, if for any reason this was not possible, the fieldworker asked the sister-in-charge for a private area for anthropometric measurements to be taken.

2.14 STORAGE AND HANDLING OF DATA

All forms have been stored in labelled files by the principal researcher for five years. After data collection, processing and analysis were completed, records that contained the personal details of the participants were destroyed (i.e., the personal contact sheet).

2.15 CONFLICT OF INTEREST

A grant was sponsored by South African Society for Parental and Enteral Nutrition (SASPEN) and granted by Enteral Nutrition Association of South Africa (ENASA) for financial support to conduct the study. A grant was also received from Harry Crossly, Stellenbosch University. The researcher has no conflict of interest to declare.

2.16 BENEFITS AND RISKS

- **Benefits:** The participant did not directly benefit of participating in this research study. However, they were able to assist in obtaining new data in the field of research for South Africa.
- **Incentives:** There was no incentive for participating in this study. The patient was informed of this when requesting informed consent to avoid unjust expectations on the patient's behalf.
- **Risks:** There were no anticipated risks for participating in this study. However, dependant on the patients' medical condition, anthropometric measurement may have been a discomfort (i.e., walking to the scale and getting weight or height measurements taken).

2.17 TIME SCHEDULE

The pilot study was conducted in January 2015. Data collection was started in February and continued until March 2015. Data was therefore collected within three months.

2.18 REPORT

The results of this study will be published in a peer-reviewed journal in 2016 in the format of a journal article. It will also be available online via Stellenbosch University, SUN Scholar.

The results off this study will be given back to the health institution where the research was conducted by doing a presentation of this study to the Dietetics Department at CHBAH in a Journal Club in 2016.

2.19 DEVIATIONS

Minor deviations were made in this study from the original protocol:

1. Data was entered on Excel 2010.
2. Ward categories, namely neurology and orthopaedics were both categorised as surgical patients rather than separate categories, as stated in the protocol.
3. Sampling Frame: The original sampling frame was a maximum of 20 days. However, the researcher obtained data until 400 patients were recruited.
4. Sampling: The researcher deviated from the protocol as the discharge sub-sample, was not sampled using random selection of every second patient. Instead convenient sampling was used, and every patient that was eligible for the inclusion criteria for this phase of the study was included (i.e., hospitalised for ≥7 days). This decision was made, due to the short length of stay of participants.
5. Patient contact sheet: Next of kin details were not obtained as it was already a challenge to obtain the patient's own personal number. Many patients did not know their contact numbers, or did not have it on them.
6. Patients were meant to be contacted via telephone if they were lost to follow-up. However, contact was only sought if there was any data missing.
7. Storage and handling of data: Data was not entered on password-protected sheets, but was stored on personal computers that were only accessible by password.
8. Report: The results of this study cannot be reported to the CHBAH adult team meeting, as it no longer exists.

CHAPTER 3

RESULTS

3 RESULTS

To determine the prevalence of risk of malnutrition, various screening tools were used. Many parameters were measured to calculate scores. The outcomes of the parameters are discussed briefly (for both admission and discharge data) before focusing on the screening scores (Objectives 1 and 5), including the number of referrals made from nutrition support (Objective 4). Thereafter, malnutrition and related outcomes are discussed (Objective 6), followed by the differences observed between admission and discharge samples (Objective 2). Lastly, validity parameters (Objective 7) and data on the availability of nutrition protocols and resources (Objective 3) are reported.

'Admission data' refers to data collected when the patient was admitted, within 48 hours of hospitalisation. 'Discharge data' refers to those patients eligible for inclusion for the discharge assessment (hospitalised for ≥7 days) and successfully followed up from admission.

3.1 STUDY POPULATION

On admission 487 patients were screened. Sixty-eight (*n*=68) patients did not meet the inclusion criteria and 16 patients were not in the bed at the time of data collection and were thus excluded. This resulted in a total sample of 403 patients (Figure 3.1). Patients were eligible for inclusion in the discharge assessment if they stayed in hospital for seven days or longer. A total of 230 patients did not qualify because of this requirement and a further 81 patients were lost to follow up. This resulted in 92 patients included in the discharge component of data collection (Figure 3.1).

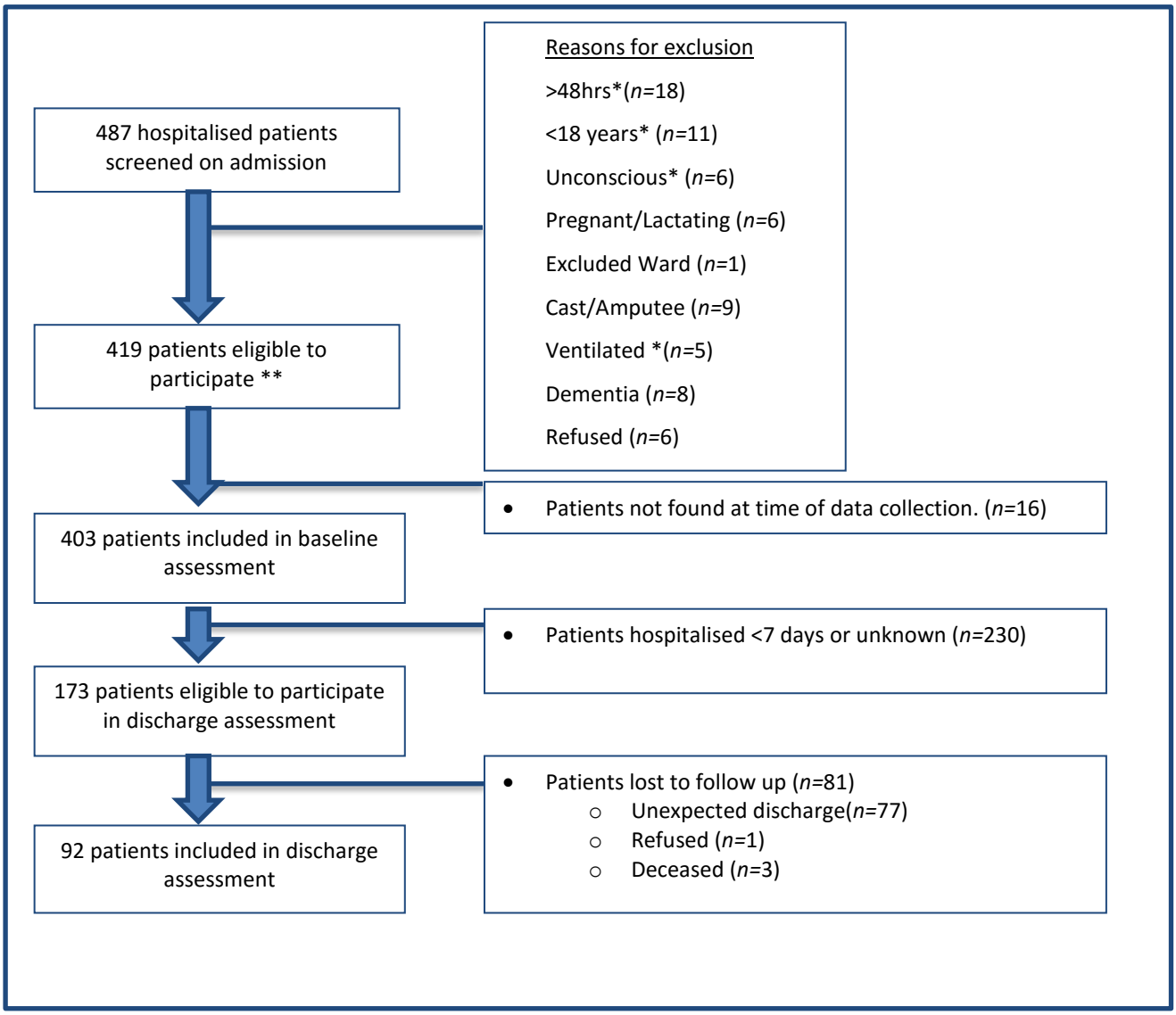


Figure 3.1 Screening Process

*Two patients fitted in more than one exclusion criterion. This resulted in more reasons for exclusion (*n*=70), than actual people excluded (*n*=68)

**Excluded patients: Patients that were admitted for longer than 48hours, under the age of 18 years old, pregnant or lactating, had amputated limbs or casts, suffered from dementia, psychiatric or eating disorders, those that were ventilated, dialysed or day care patients were excluded from participating in this study. Additionally, any patients in the following wards were excluded: maternity, postnatal, high care, ICU, CCU, casualty, all paediatric wards, psychiatry, renal unit, and adult burns.

3.2 ADMISSION DATA

Firstly admission data is reported. This refers to data obtained with 48hours of admission and reflects the period of one to two weeks prior to hospitalisation.

3.2.1 Demographics on Admission

The demographics of the patients included in the study are summarised in Table 3.1. The study included slightly more male patients (52.9%) than female patients (47.2%). The mean age of participants was 45.5 years ±16.6SD (median 43.2, range 18.2–90.2 years).

There was an even distribution between patients recruited from medical wards (47%) and surgical wards (48%), with gynaecology contributing a small percentage of the sample (5%), which is representative of the hospital's patient profile.

Table 3.1 Demographic characteristics of study participants on admission

Category	**Description**	***N***	**%**
Gender	Male	213	52.8
	Female	190	47.2
Ward category	Medical	190	47.0
	Surgical	192	47.7
	Gynaecology	21	5.1

3.2.2 Primary Diagnosis on Admission

The primary diagnosis of most patients included in the study was an infectious disease (13.2%; *n*=53). Figure 3.2 indicates the patients' distribution according to diagnostic category.

Patients that did not fit into any of diagnostic groups were categorised as 'other'. These included patients admitted for attempted suicide, haemophilia, parotid gland cyst, crush injury, bicytopenia, anaemia, critical limb ischaemia, axillary hidradenitis suppurativa, and osteoarthritis.

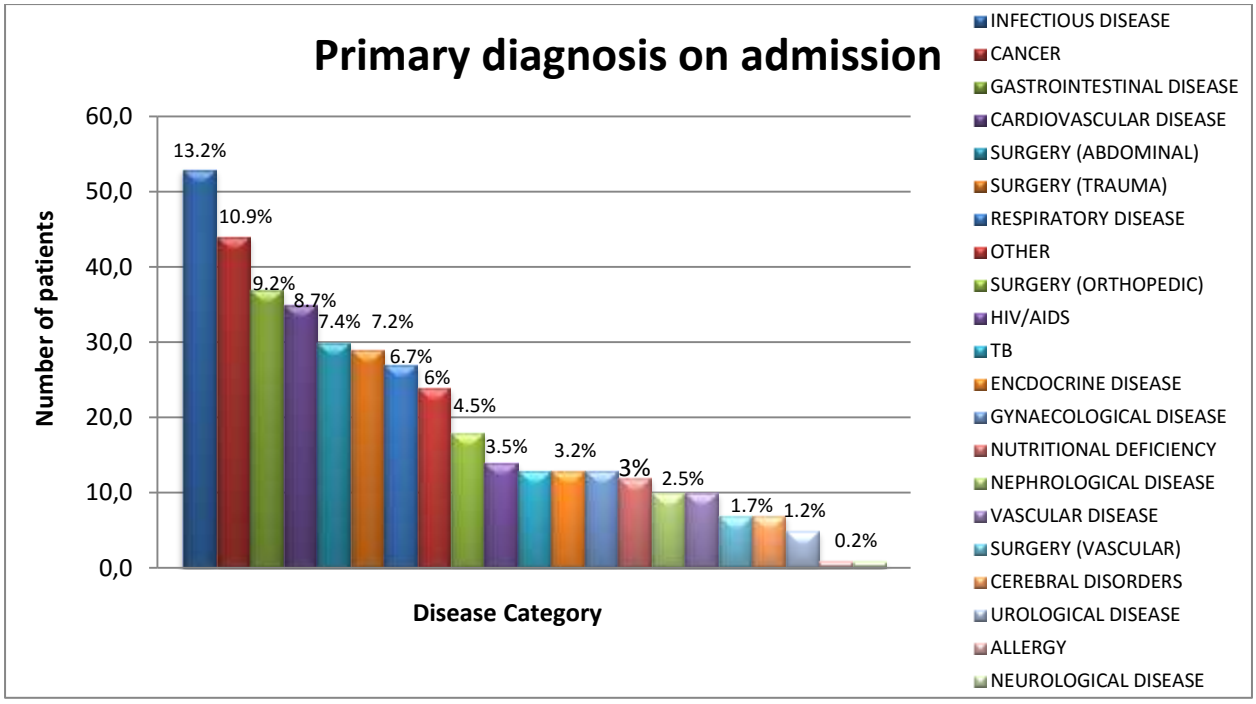


Figure 3.2 Primary diagnosis of patients on admission

3.2.3 Presence of Gastrointestinal Side Effects on Admission

On admission almost two-thirds of patients (59.3%; *n*=239) had experienced a gastrointestinal side effect within the previous one to two weeks. This included anorexia (34.9%; *n*=141), nausea (24%; *n*=97), constipation (22.6%; *n*=91), vomiting (22%; *n*=89), and diarrhoea (11.4%; *n*=46).

The majority of patients (45.2%; *n*=108) suffered from only one gastrointestinal side effect on admission (Figure 3.3). The duration was most often reported to be infrequent (Figure 3.4). However of concern is that patients that suffered from anorexia (24.8%; *n*=35) and/or constipation (23.1%; *n*=21) had endured this for two weeks.

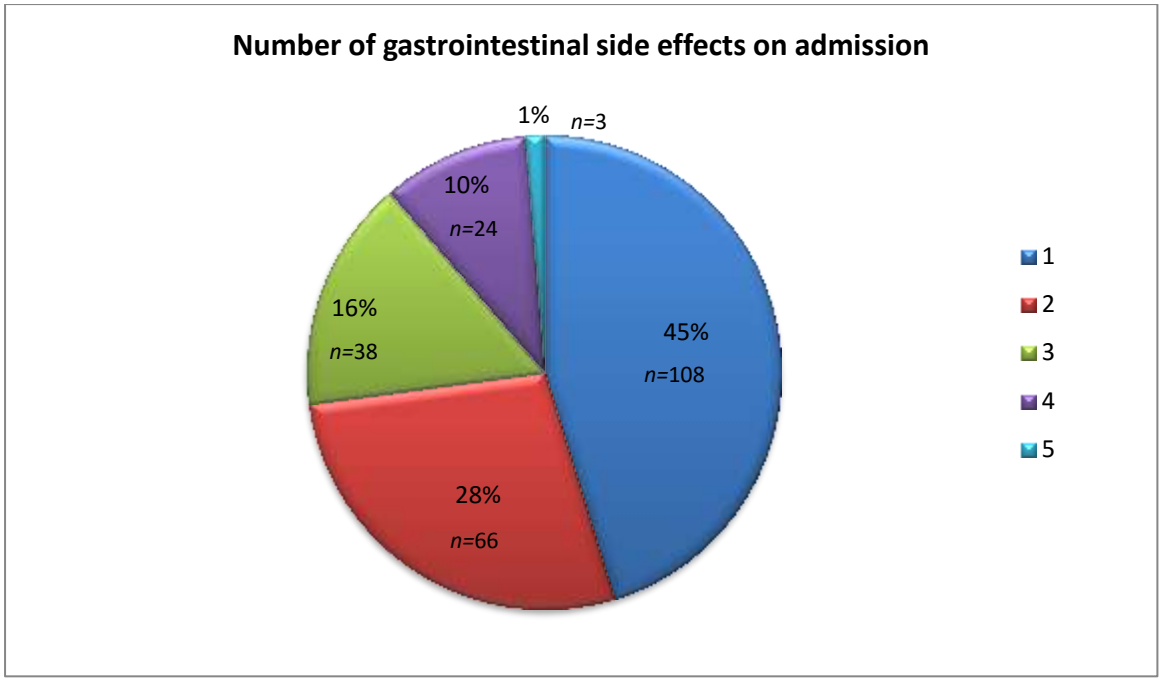
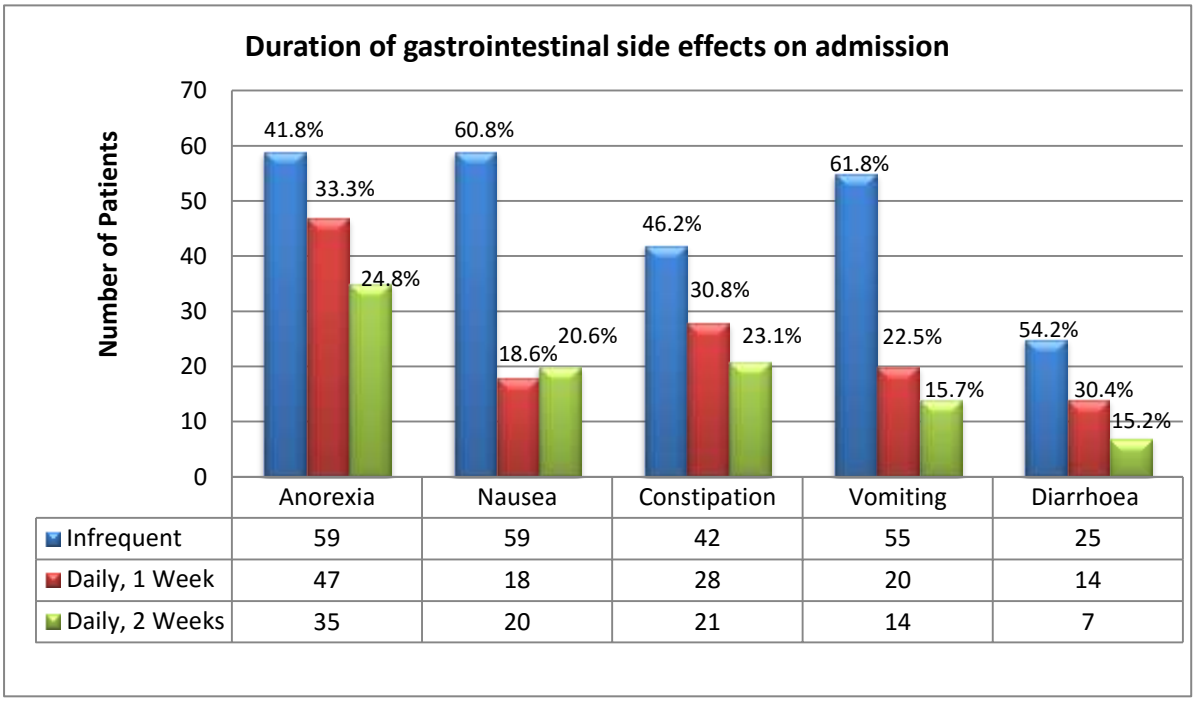


Figure 3.3 Number of gastrointestinal side effects experienced on admission



	Anorexia	Nausea	Constipation	Vomiting	Diarrhoea
Infrequent	59	59	42	55	25
Daily, 1 Week	47	18	28	20	14
Daily, 2 Weeks	35	20	21	14	7

Figure 3.4 Duration of gastrointestinal side effects present on admission

3.2.4 Dietary Intake on Admission

In the week preceding hospital admission, nearly half of the patients (49.1%; *n*=198) experienced a compromised dietary intake. Of those, the majority (47%; *n*=93) could not finish more than half of their usual dietary intake. Figure 3.5 depicts the changes in dietary intake as experienced by patients.

Of the patients that had a decreased dietary intake, the majority of patients (74.7%; *n*=145) had experienced this for less than one month. This was followed by patients' experiencing side effects for one to three months (13.4%, *n*=26). However, of concern are the 11.9% (*n*=23) patients that had experienced decreased food intake for longer than three months.

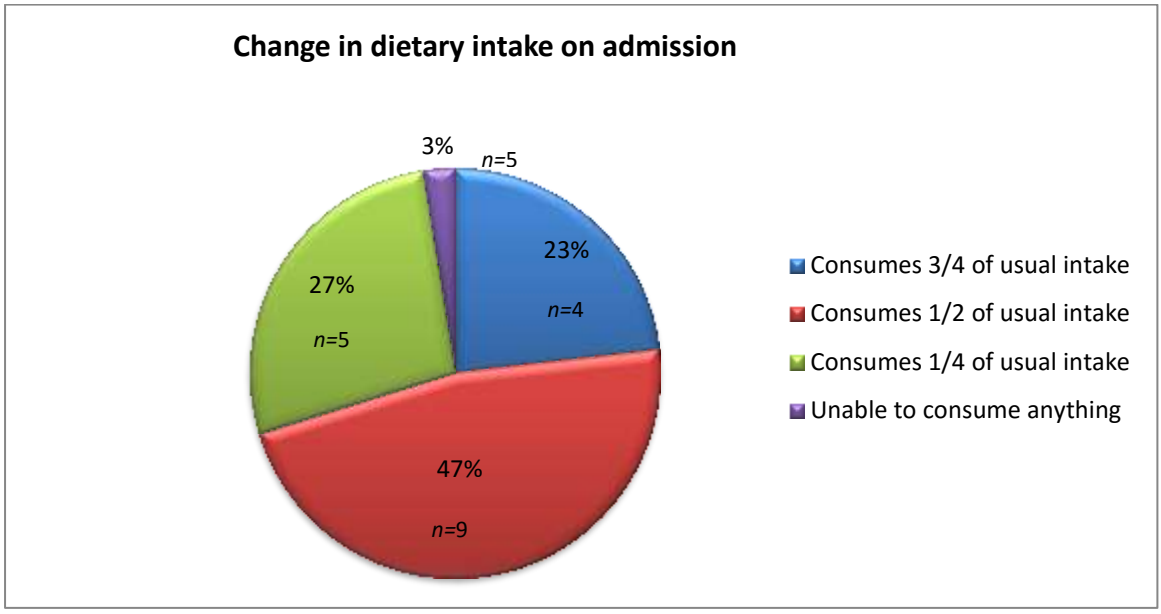


Figure 3.5 Change in dietary intake (1 week) prior to admission

3.2.5 Anthropometry on Admission

Body mass was measured using an electronic scale in the majority of patients (84.6%; *n*=341). However, in some cases it was also estimated (15.4%; *n*=62) since pain and illness made standing impossible. Similarly standing height was measured in most patients (83.4%; *n*=336), but height estimations, using demi-span, were conducted (16.6%; *n*=67) when standing height could not be obtained.

3.2.5.1 Body mass of patients included on admission

Weight was corrected for ascites, oedema, prison chains and other factors that may have influenced weight. Almost a quarter (22.8%; *n*=92) of patients had oedema on admission, including mild (78.3%; *n*=72), moderate (13%; *n*=12) and severe (8.7%; *n*=8). The mean weight of patients was 68.1kg ±19.3SD (median 65kg; range 25–166kg) including both male and female patients. The mean body mass of female patients (mean 70.2kg ±20SD) was higher than those of male patients (mean 66.2kg ±18.5SD).

3.2.5.2 BMI of patients included on admission

The patients' BMIs were classified according to NRS-2002 requirements (see Section 2.6.1 in Chapter 2). Thirty percent (30.3%; *n*=122) of patients were categorised as having a healthy weight (BMI 20.5–24.9kg/m$^{2)}$, with the remainder being either underweight (16.7%; *n*=67), borderline underweight (13.4%; *n*=54) or overweight and obese (19.6%; *n*=79 and 20.1%; *n*=81 respectively). The mean BMI is 24.7kg/m^2 ±7.4SD. (median 23.1; range: 7.9–59.7kg/m^2) (Figure 3.6)

When categorising BMI in terms of the WHO recommendations, 43.7% (*n*=176) of patients may be considered as having a normal BMI (18.5 -24.9kg/m^2).

Corresponding to the differences in body mass between genders, female patients had a higher BMI (27.6kg/m^2 ±7.9SD) compared with that of male patients (22.1kg/m^2 ±5.8SD.)

The mean BMI for malnourished patients was lower (mean 23.5kg/m^2 ±7.2SD) than those not considered 'at risk' or malnourished (mean 28.7kg/m^2 ±6.4SD) and differed significantly (p<0.01; Mann–Whitney U) between patients considered at risk of malnutrition on admission by any of the three tools (*n*=307), compared with those not classified as malnourished.

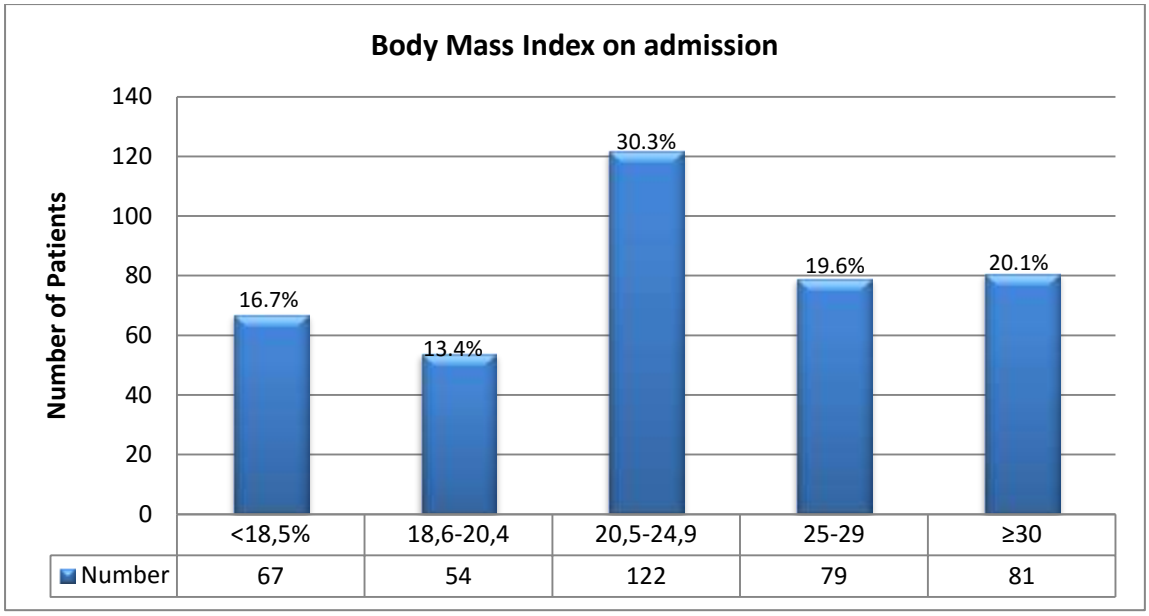


Figure 3.6 Body Mass Index on admission

3.2.5.3 Weight loss of patients prior to admission

Patients were also assessed for significant weight loss (≥5%) as determined by whether clothes or jewellery had become looser fitting or by calculating the actual percentage weight loss. More than a third (36.5%; *n*=147) reported weight loss in the period before admission, although only 46.7% (*n*=188) patients were able to provide an indication of their usual weight measurement.

3.2.6 Physical Assessment

3.2.6.1 Functional capacity of patients on admission

Functional capacity was assessed on admission (<48hours) and pertained to the previous one to two weeks prior to hospitalisation. The daily activities and ambulation were reported to be normal in 71.5% (*n*=288) of patients, with the remaining 28.5% (*n*=115) experiencing difficulty with normal activities. In these patients, daily functioning had regressed in the past two weeks in 87.8% (*n*=101) of patients on admission, with no change in 12.2% (*n*=14) of the sample.

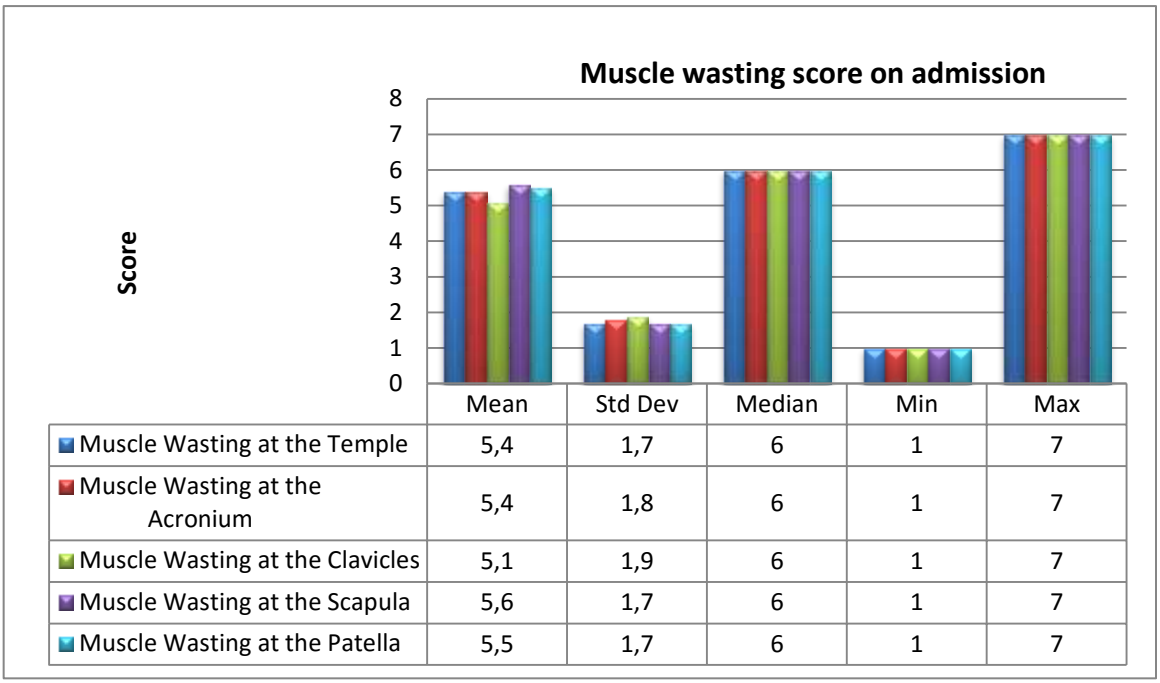
Fewer patients (10.7%; *n*=43) encountered severe dysfunction, being chair- or bedridden. The majority (83.7%; *n*=36) felt that their functional capacity had regressed in the past two weeks, while the minority (16.3%; *n*=7) reported no change.

Whether or not the reduced functional status was influenced by nutritional factors was determined by assessing the patient's diagnosis, BMI, and course of action during hospitalisation (refer to Section 2.6.5 in Chapter 2). Of the patients that experienced reduced functional capacity (*n*=158), almost a quarter of these (23.4%; *n*=37) were influenced by nutritional factors.

Additional to reported functional capacity, muscle function was assessed by taking handgrip strength. The average handgrip strength measurement was compared with the average required values for gender and age (refer to Section 2.6.3 in Chapter 2). Twenty-three percent (23.4%; *n*=93) of patients from the admission sample had poor handgrip strength.

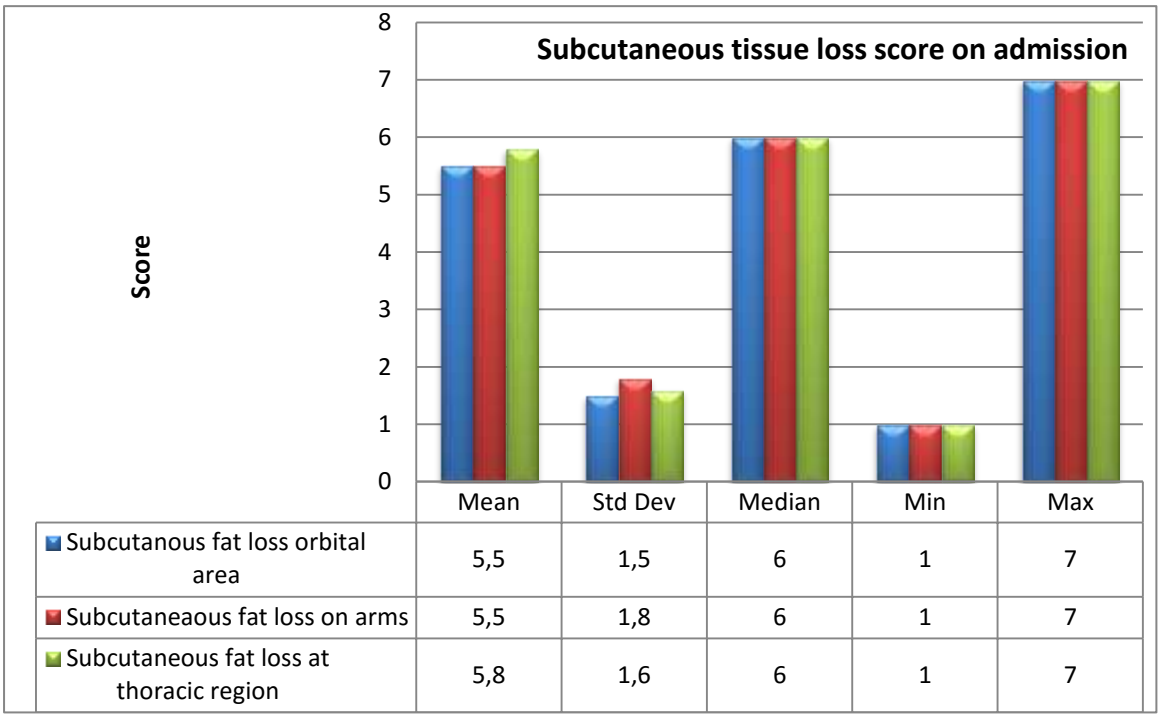
3.2.6.2 Clinical examination of patients on admission

A clinical examination to detect loss of muscle mass and/or subcutaneous tissue was performed on admission (<48hours). The data for both muscle wasting (Figure 3.7) and loss of subcutaneous tissue (Figure 3.8) shows that although the mean indicates adequate subcutaneous and muscle tissue, there were patients with severely depleted stores (score=1) as well as healthy stores (score=7).



	Mean	Std Dev	Median	Min	Max
Muscle Wasting at the Temple	5,4	1,7	6	1	7
Muscle Wasting at the Acronium	5,4	1,8	6	1	7
Muscle Wasting at the Clavicles	5,1	1,9	6	1	7
Muscle Wasting at the Scapula	5,6	1,7	6	1	7
Muscle Wasting at the Patella	5,5	1,7	6	1	7

Figure 3.7 Score allocation for muscle wasting on admission



	Mean	Std Dev	Median	Min	Max
Subcutanous fat loss orbital area	5,5	1,5	6	1	7
Subcutaneaous fat loss on arms	5,5	1,8	6	1	7
Subcutaneous fat loss at thoracic region	5,8	1,6	6	1	7

Figure 3.8 Score allocation for loss of subcutaneous tissue on admission

3.2.7 Prevalence of Risk of Malnutrition on Admission

Assessing of the prevalence of 'at risk ' patients was determined on admission by using two different screening tools (NRS-2002 and SGA). (See Figure 3.9.) The prevalence of malnutrition made by diagnosis was also included and was determined by the AMDT. The prevalence of 'at risk' patients as deemed by any of the three tools was 76.6% (*n*=307) which was the score used to analyse for malnutrition and other factors (age, length of stay, primary diagnosis). The results obtained from each of the three tools are first described individually and then compared.

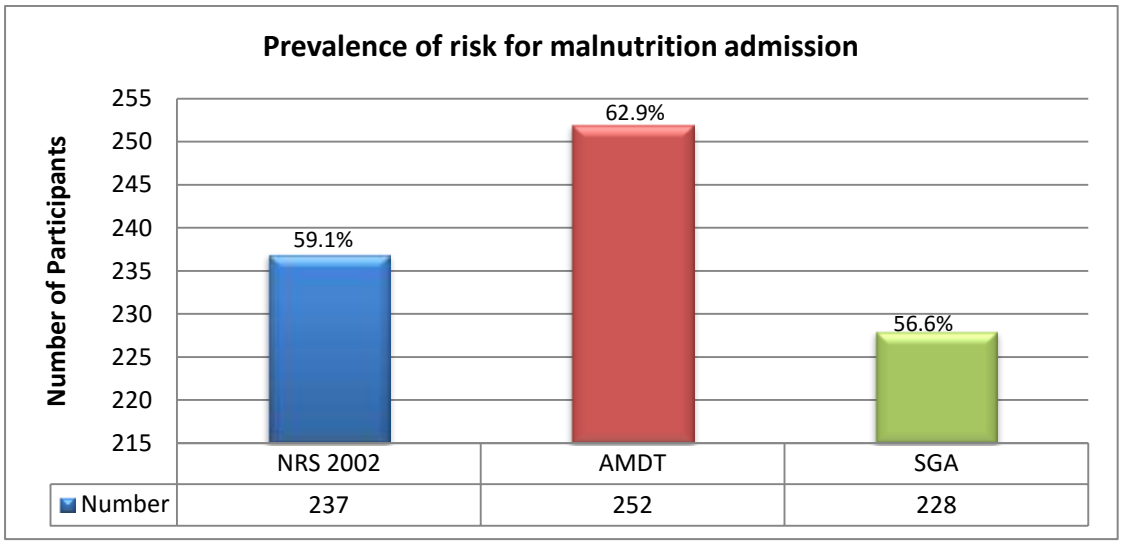


Figure 3.9 Prevalence of risk of malnutrition according to the selected screening tools on admission

3.2.7.1 NRS-2002

A total of 401 patients were included in the NRS-2002 screening. More than three-quarters of the patients included (80.3%; *n*=322) proceeded to the second part of the NRS-2002, indicating the presence of a component putting them at nutritional risk. A score was then allocated for nutritional risk and disease severity. Within this study most patients had a low score for disease severity, 1.1 ±0.4SD (median 1; range 0–3), which may be attributable to the exclusion criteria. Only 7.2% (*n*=29) of patients were ≥70 years old and thus had an age adjusted score (+1).

According to the NRS-2002, 59.1% (*n*=237) of all admitted patients were at nutrition risk (Figure 3.9). The median score obtained was 2 (IQR 1–3), where a score of 3 indicates that the patient is at risk of malnutrition. Therefore, most patients are borderline at risk of malnutrition according to the NRS-2002.

Patients most frequently classified at nutritional risk had infectious disease (12.7%; *n*=30), gastrointestinal disease or cancer (10,6%; *n*=25), respiratory disease (8.9%; *n*=21) and cardiovascular disease or were admitted for surgery (abdominal) (7,6%; *n*=18).

3.2.7.2 AMDT

The AMDT score was also used to diagnose malnutrition in patients (*n*=401). Results indicate that 62.9% (*n*=252) of patients were malnourished (Figure 3.9). The mean score on admission was 2.2 ±1.5SD (median 2; range 0–6) indicating that on average, patients were classified as malnourished. Of these patients the majority were oncology patients (11.5%; *n*=29), followed by patients admitted for infectious disease (10.7%; *n*=27), or admitted for surgery (abdominal) and gastrointestinal disease (9.1%; *n*=23) and respiratory disease (8.3%; *n*=21).

3.2.7.3 SGA

On admission, 403 patients were included for the analyses of nutritional status according to the SGA. More than half of included patients (56.6%; *n*=228) were diagnosed as malnourished, with a varied degree of malnutrition (Figure 3.9). Mild to moderate malnutrition was present in 87.3% (*n*=199) of patients, with the remaining 12.7 % (*n*=29) presenting with severe malnutrition (Figure 3.10). Despite the presence of severe malnutrition, the median score was 5.8 (IQR 4.6–6.5). This indicates that most patients were well nourished. The majority of patients identifed as malnourished had one of the following primary diagnoses: cancer (10.5%;*n*=24), gastrointesintal disease or infectious disease (10.1%; *n*=23) or admitted for surgery (trauma and abdominal) (8.8%; *n*=20).

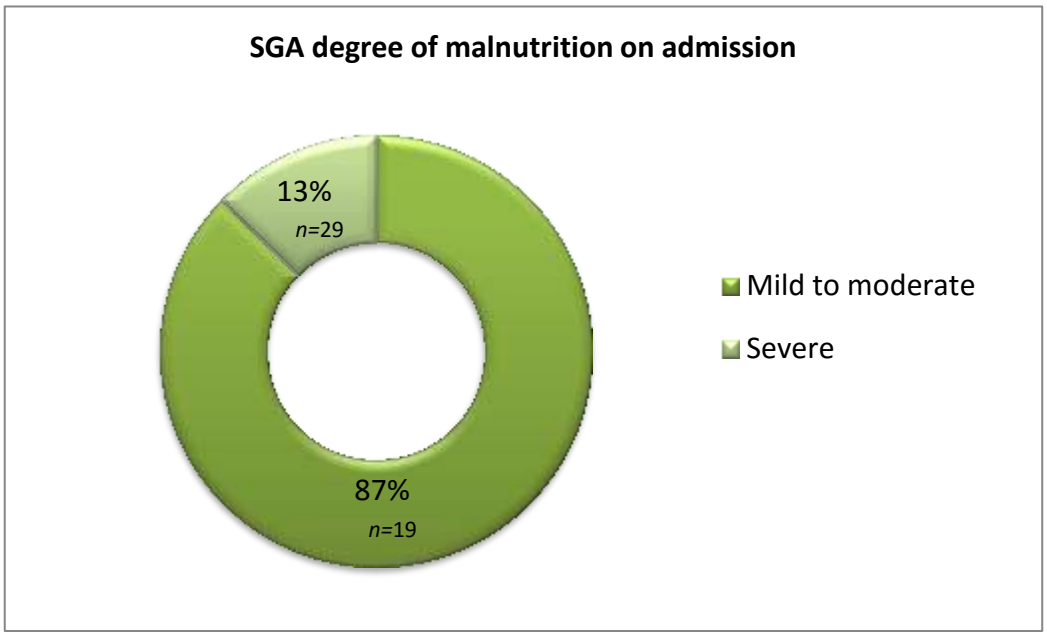


Figure 3.10 Degree of malnutrition according to the SGA on admission

3.2.8 Primary Diagnosis of Patients at Risk of Malnutrition on Admission

On admission the majority of patients considered to be at risk of malnutrition were patients diagnosed with infectious disease (*n*=39), cancer (*n*=34), gastrointestinal disease (*n*=30), heart disease (*n*=23), trauma (requiring surgery) and respiratory disease (*n*=22) (Figure 3.11).

There was a significant difference (*p*=0.001; Chi-square) between patients that were malnourished on admission and those that were well nourished as determined by any of the three screening tools. There were more malnourished patients diagnosed with respiratory disease, HIV/AIDS, nutritional deficiencies, TB, cardiovascular disease, gastrointestinal disease, infectious disease, cancer, or had injuries requiring surgery (orthopaedic, abdominal, trauma).

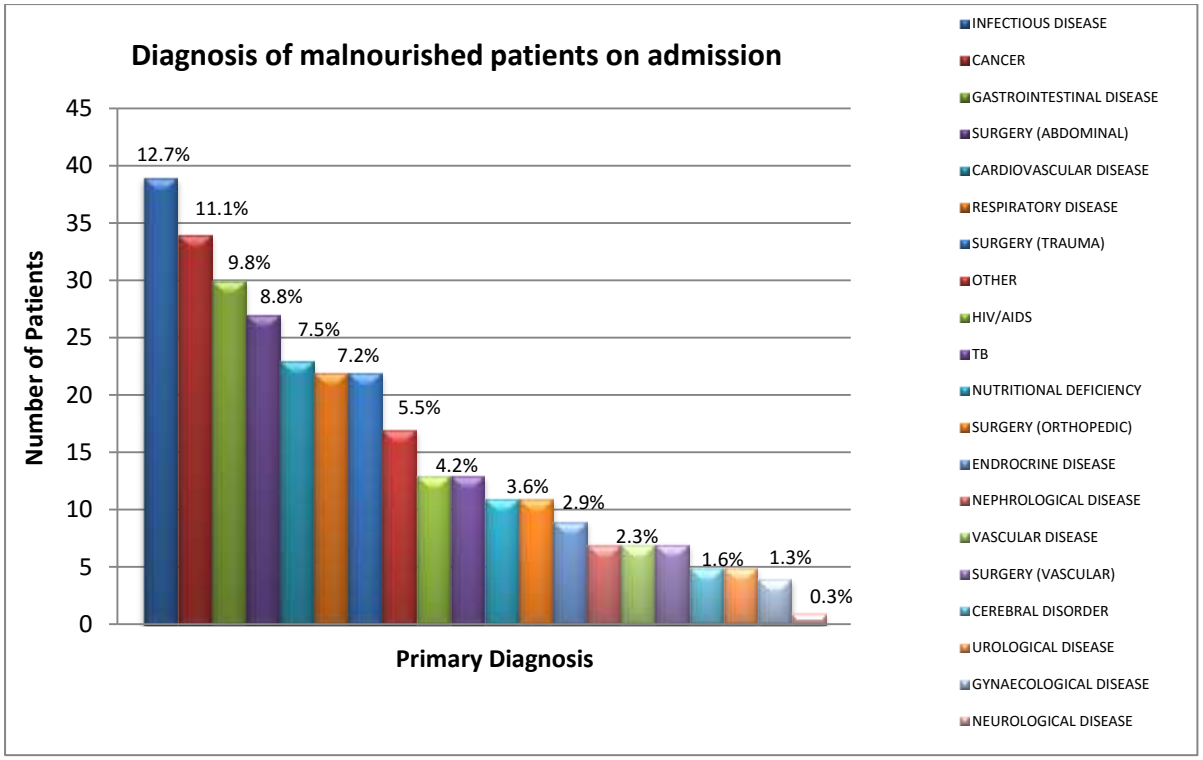


Figure 3.11 Primary diagnoses of patients at risk of malnutrition on admission

3.2.9 Referral for Nutrition Support on Admission

Only 1.3% (*n*=5) of all patients included in the study were referred for nutrition support when admitted to hospital (<48hours). This is alarming, as almost half of patients reported a decreased dietary intake, and more than a third (36.5%; *n*=147) had reported weight loss prior to admission. Health-care workers most commonly making the referrals for nutrition support included physicians (40%; *n*=2), registered nurses (40%; *n*=2) and the dietitian (20%; *n*=1). On closer evaluation of the referrals, 80% (*n*=4) of the referrals made were categorised as 'at risk' patients according to the NRS-2002, and malnourished according to the SGA and AMDT.

3.3 DISCHARGE DATA

A total of 92 patients were included in the discharge interview. Although 173 participants were eligible for the discharge interview (hospitalised ≥7 days), 81 patients were lost to follow up. Seventy-seven (*n*=77) were lost owing to unexpected discharge, three (*n*=3) died in hospital, and one (*n*=1) patient refused to participate (Figure 3.1).

For the deceased (*n*=3) patients, the mean BMI value on admission was 20.7kg/m^2 ±5.1SD which is the lower range of the healthy BMI. Furthermore, all had reported significant weight loss prior to admission to hospital. The primary diagnosis of these patients included gastrointestinal disease, cancer, and nutritional deficiencies.

3.3.1 Demographics on Discharge

The mean age of the patients included in the discharge assessment was 49.2 years ±16.1SD (median 46.7 years; range 21.4–87.3); this therefore differs from the patients included in the baseline assessment, who were slightly younger. Patients identified as at risk of malnutrition by any of the three tools on discharge were older (mean 50 years; ±16.2SD) than those that were well nourished (43.8 years ±14.7SD). The distribution between genders was similar to the baseline assessment where male patients contributed 53% and female patients 47%. Table 3.2 indicates the demographics for the patients included in the discharge assessment.

Table 3.2 Demographic characteristics of study participants on discharge

Category	Description	N	%
Gender	Male	49	53.3
	Female	43	46.7
Ward category	Medical	38	41.3
	Surgical	46	50
	Gynaecology	8	8.7

3.3.2 Primary Diagnosis on Discharge

On discharge the majority of patients had cancer (17.4%; *n*=16) followed by patients diagnosed with gastrointestinal diseases (12%; *n*=12). Figure 3.12 summarises the patient profile according to primary diagnosis included for the discharge assessment.

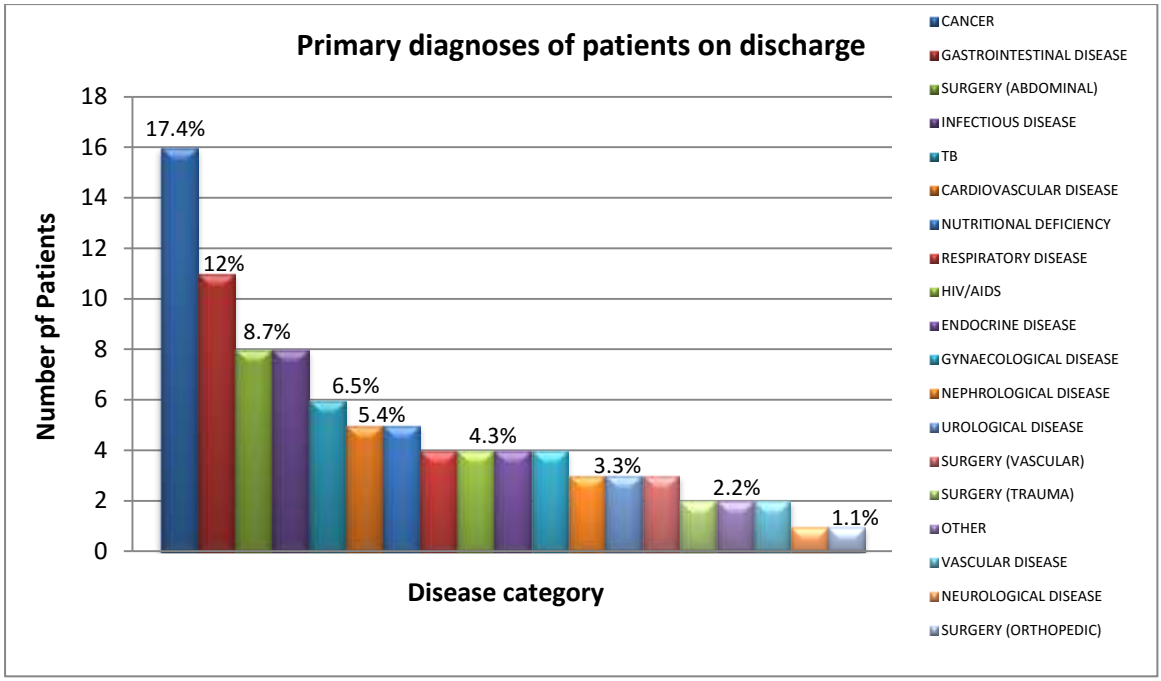


Figure 3.12 Primary diagnoses of patients on discharge

3.3.3 Presence of Gastrointestinal Side Effects on Discharge

During the course of the patients' stay, the number of patients experiencing a gastrointestinal side effect differed from admission sample (77.2%; *n*=71), with the discharge sub-sample experiencing more gastrointestinal side effects. The most common side effect was still anorexia (43.5%; *n*=40), followed by constipation (38%; *n*= 35), nausea (33.7%; *n*=31), vomiting (29.7%; *n*=27), and diarrhoea (26.1%; *n*=24).

The number of gastrointestinal side effects experienced at one time also differed from the baseline group, with more patients enduring multiple side effects in the discharge sub-sample (77.2%; *n*=71). Figure 3.13 represents the number of side effects experienced by patients.

The duration of side effects was usually 'infrequent' to 'daily, for one week'. However, anorexia is of concern, as it was the side effect most often experienced, with 10.9% (*n*=10) reporting the duration to be daily for two weeks (Figure 3.14).

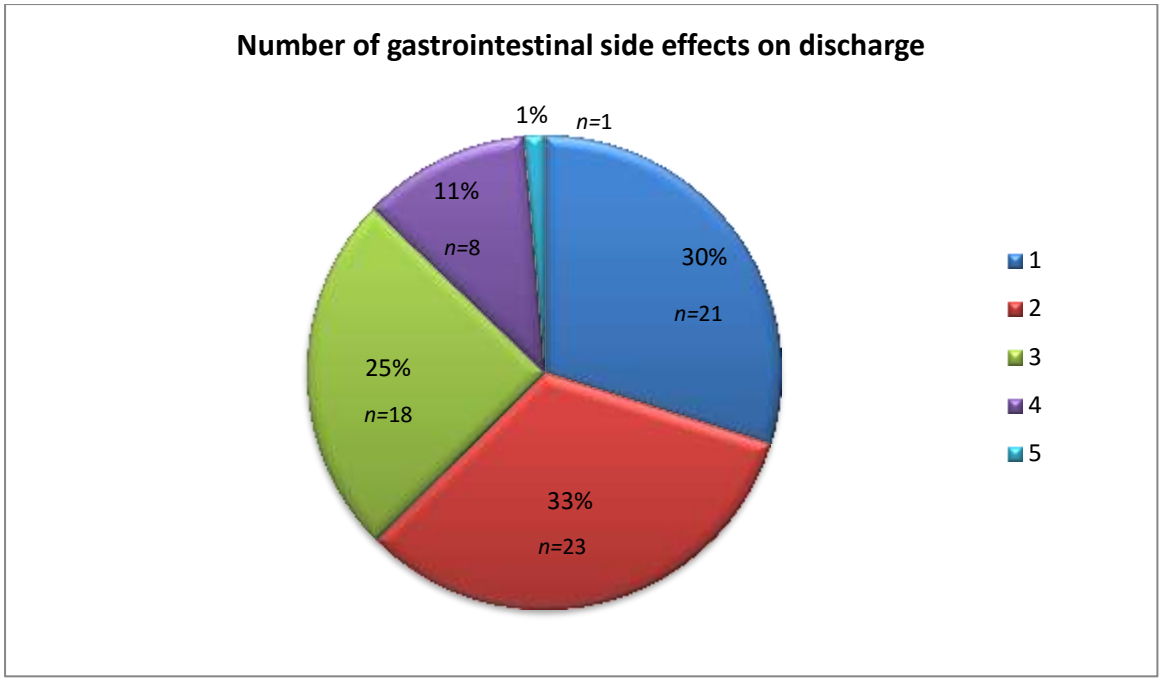


Figure 3.13 Number of gastrointestinal side effects experienced on discharge

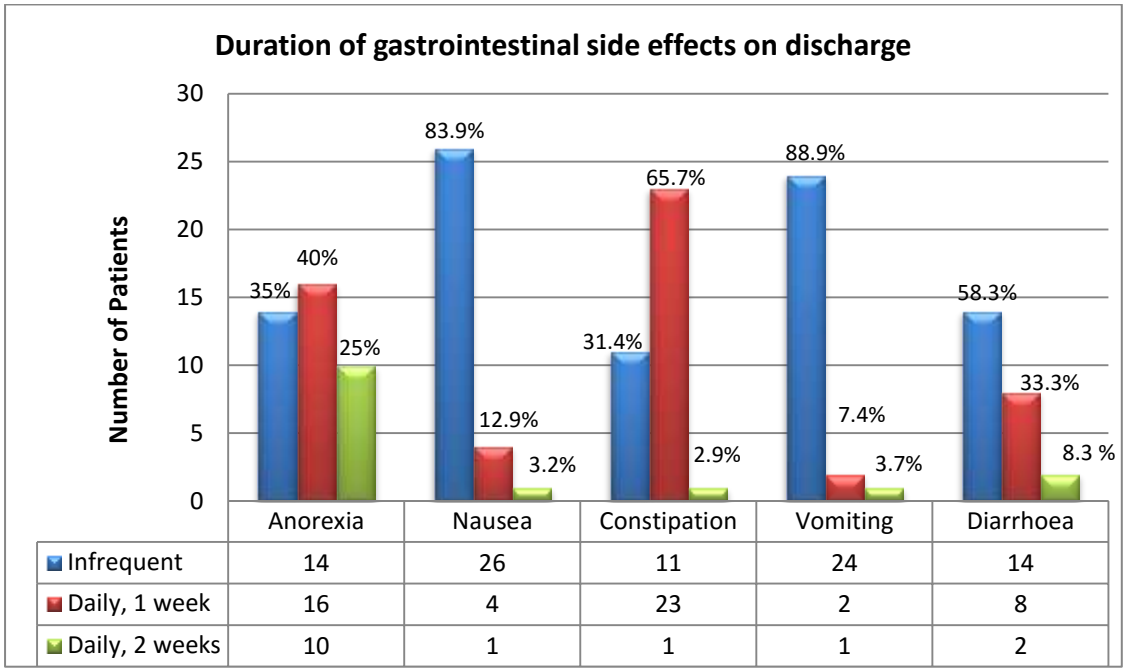


Figure 3.14 Duration of gastrointestinal side effects present on discharge

3.3.4 Dietary Intake on Discharge

In the discharge sub-sample, more than half of the included patients (57.6%; *n*=53) experienced a change in dietary intake during their hospital stay. Of these patients, the majority were able to consume only half their usual dietary intake (54.7%; *n*=29), followed by a decreased intake resembling three-quarters of their intake (35.8%; *n*=19), with the remaining consuming only one quarter of their usual intake (9.4%; *n*=5). The reported anorexia is supported by dietary intake results as presented in Figure 3.15.

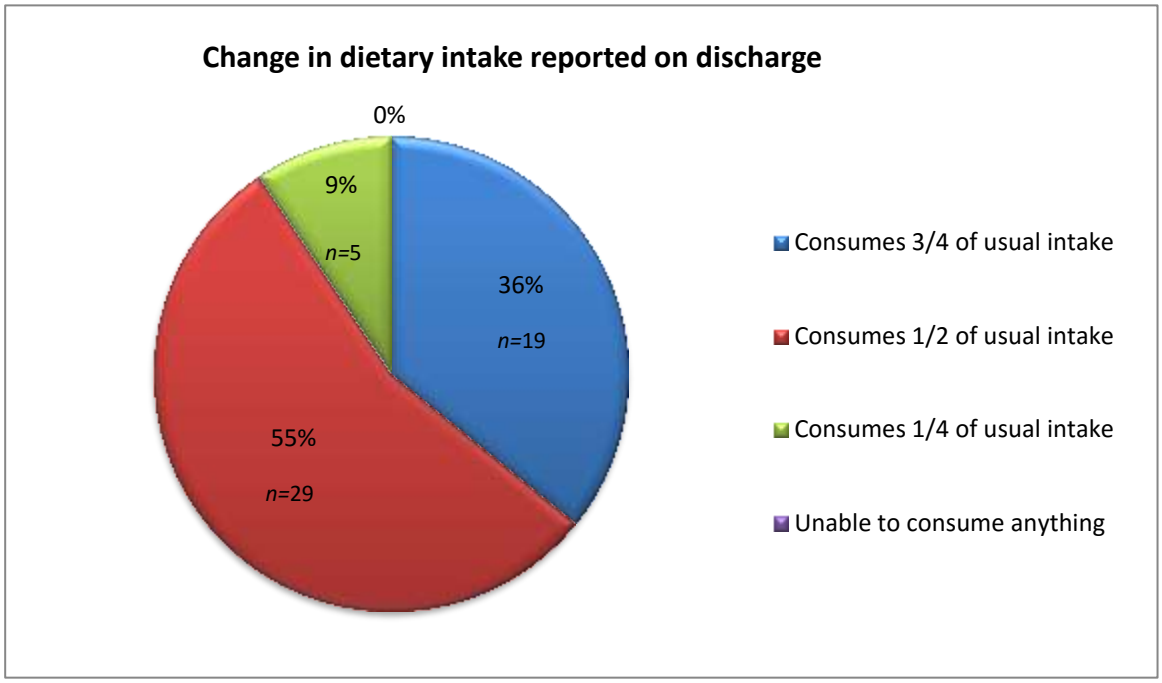


Figure 3.15 Change in dietary intake during hospitalisation

3.3.5 Anthropometry on Discharge

In the discharge sub-group, the majority of patients were measured for weight (84.8%; *n*=78) and height (82.6%; *n*=76). Alternatively the patients' anthropometry was estimated for weight (15.2%; *n*=14) or in case of height, it was calculated using demi-span (17.4%; *n*=16).

3.3.5.1 Body mass on discharge

On discharge, more patients experienced oedema (26%; *n*=24) compared with the patients included on admission. However, the majority of patients still experienced mild oedema (70.8%; *n*=17) followed by moderate oedema (12.5%, *n*=3), although there were more patients included with severe oedema (16.7%, *n*=4) compared to the admission sample.

The mean weight for female patients (mean 65.7kg ±20.2SD) and male patients (mean 65kg ±19.2SD) within the discharge sub-group was also similar to that of the patients included on admission.

3.3.5.2 BMI of patients on discharge

The mean BMI of the patients included in the discharge sub-sample was 23.7kg/m^2 ±7.4SD (median 22.5; range 12.3–48.9kg/m^2). However when differentiating between genders, again the female patients had a higher BMI (mean 25.8kg/m^2 ±7.8SD) than their male counterparts (mean 21.6kg/m^2 ±6.4SD). Regardless, both genders indicated a lower BMI value compared with that of the admission sample.

Figure 3.16 represents the BMI distribution among the patients included in the discharge assessment according to the NRS-2002 categories. A larger percentage of patients fall in more extreme ranges of malnutrition (i.e. <18.5kg/m^2 and ≥30kg/m^2) when compared with the patients that were included in the baseline assessment.

If the BMI had to be distributed according to the WHO categories (refer to Chapter 2, Section 2.6.1), 46.8% (*n*=43) of patients would be considered to have a normal BMI (18.5–24.9kg/m^2).

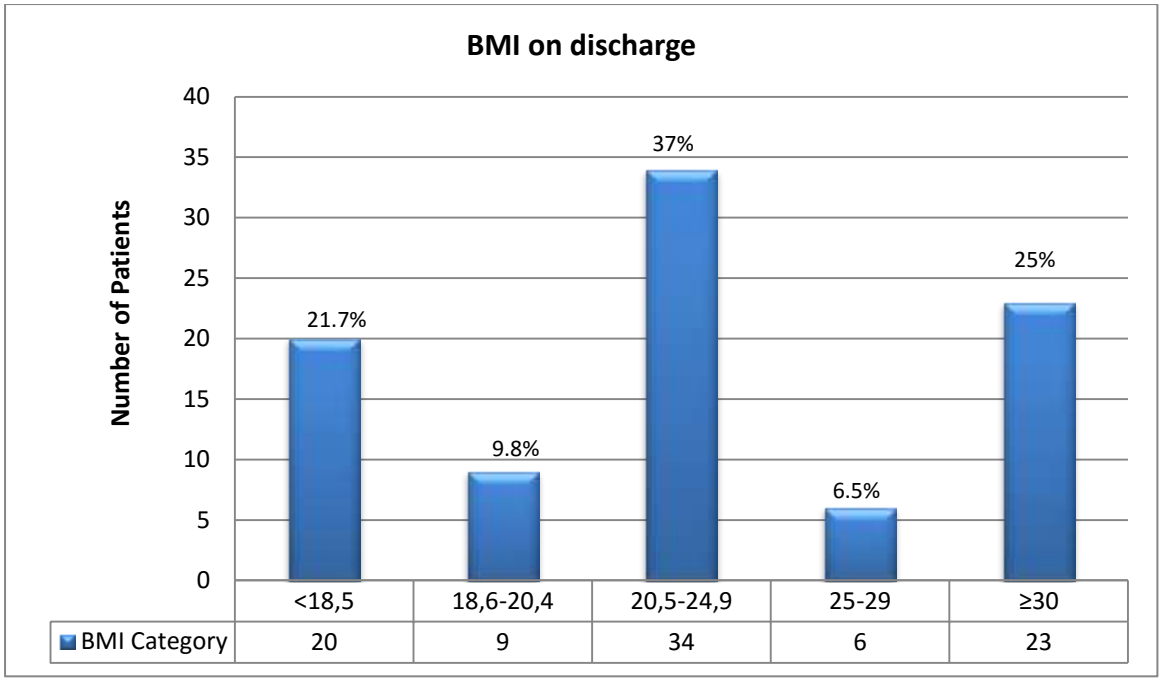


Figure 3.16 Body Mass Index on discharge

3.3.5.3 Weight and weight loss on discharge

Of those patients included in the admission and discharge assessment (*n*=92), more than half (58.7%; *n*=54) had lost weight during hospitalisation, of which male patients (53.7%; *n*=29) predominated. The average weight for male and female patients decreased from the admission sample from 68.1kg ±19.3SD to 65.3kg ±19.6SD in the discharge sub-sample.

Significant weight loss (>5%) was found in 37% (*n*=20) of patients, and was again most often observed in male patients (60%; *n*=12) that were included in the discharge sub-group. Patients that lost >5% weight were most commonly diagnosed with gastrointestinal disease (20%; *n*=4), or were admitted for surgery (abdominal) (15%, *n*=3), surgery (trauma) (10%; *n*=2), cancer (10%, *n*=2), TB (10%; *n*=2) and nutritional deficiencies (10%; *n*=2).

Weight loss of >10% was identified in 9.3% (*n*=5) of patients, of whom the majority were female patients (60%; *n*=3). Here the majority of patients were diagnosed with nutritional deficiencies (40%; *n*=2).

3.3.6 Physical Assessment

3.3.6.1 Functional capacity on discharge

Twenty-eight percent of patients (28.3%; *n*=26) had experienced difficulty with ambulation and normal activities while in hospital. Of those, 15.4% (*n*=4) reported an improvement, 34.5% (*n*=9) did not experience any change, and 50% (*n*=13) felt that they had regressed.

Fewer patients (15.2%; *n*=14) reported to be chair- or bedridden. The majority (42.9%; *n*=6) felt they had regressed functionally, while an equal number of patients (28.6%; *n*=4) reported either 'no change' or 'improvement' in functional capacity.

When further evaluating the patients reporting decreased functional capacity (*n*=40), it was found that in in 47.5% (*n*=19) of cases decreased functional capacity may have been influenced by nutritional factors. (Refer to Section 2.6.5 in methodology chapter.)

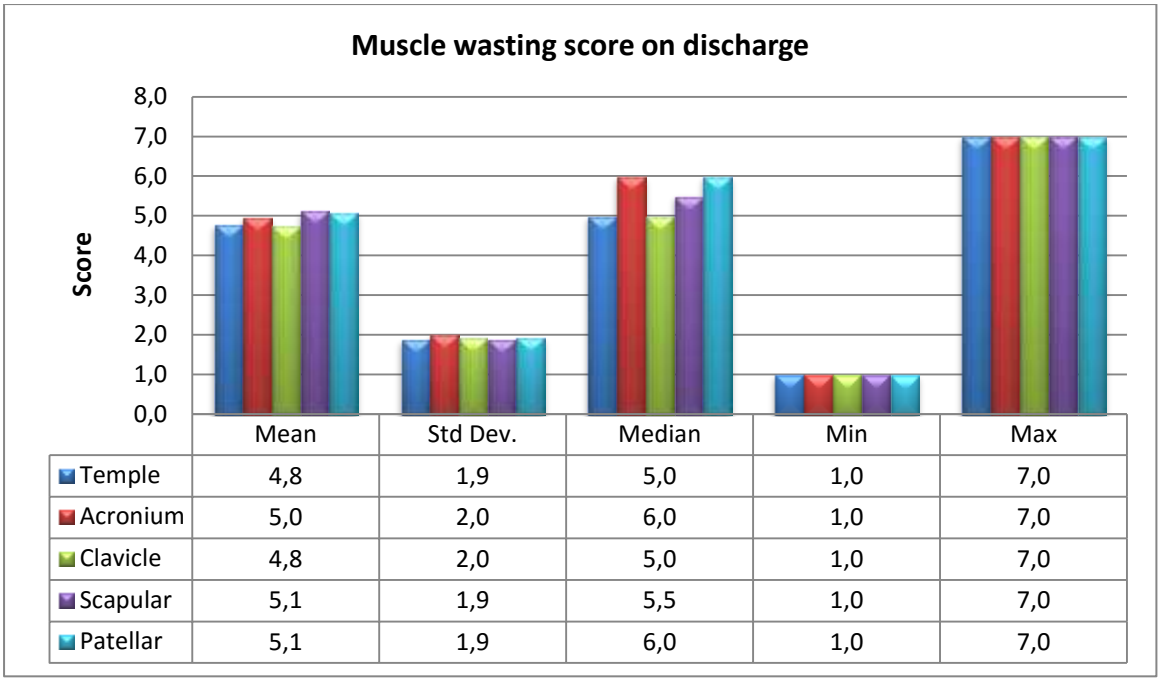
More patients with poor handgrip strength were included on discharge (35%; *n*=32). This may be supported by the evidence of poorer muscle stores in the discharge sub-sample compared with the patients included in the baseline assessment.

3.3.6.2 Clinical examination on discharge

The clinical examination on discharge evaluated both loss of muscle mass and subcutaneous tissue. The mean values for muscle wasting are summarised in Figure 3.17, based on the physical areas assessed. Patients had relatively good muscle stores; however scores for muscle mass and subcutaneous tissue were lower in the discharge sub-group compared with the patients included in the baseline assessment. As there were many overweight and obese patients, as evidenced by the BMI profile of the patients (see Section 2.2.8), the subcutaneous tissue may have masked loss of muscle mass, and influenced the mean value. Loss of muscle mass was most often noted on the temple and the clavicle areas as these areas had the lowest scores allocated to them.

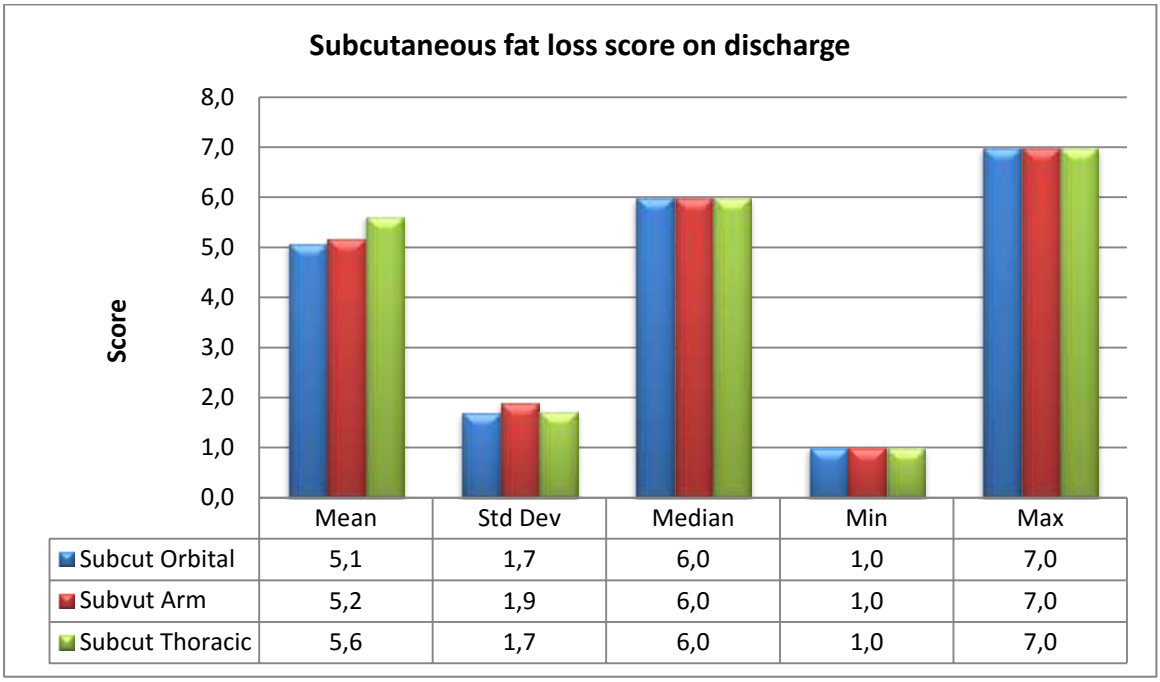
The mean value for loss of subcutaneous fat indicated good stores (Figure 3.18). Loss of subcutaneous tissue was most often identified on the orbital area of the patients.

From the range of scores for both muscle wasting and subcutaneous tissue loss, it is evident that there had been severe under-nutrition and over-nutrition, as well as lower muscle and subcutaneous stores at discharge compared to the admission sample.



	Mean	Std Dev.	Median	Min	Max
Temple	4,8	1,9	5,0	1,0	7,0
Acronium	5,0	2,0	6,0	1,0	7,0
Clavicle	4,8	2,0	5,0	1,0	7,0
Scapular	5,1	1,9	5,5	1,0	7,0
Patellar	5,1	1,9	6,0	1,0	7,0

Figure 3.17 Score allocation for muscle wasting on discharge



	Mean	Std Dev	Median	Min	Max
Subcut Orbital	5,1	1,7	6,0	1,0	7,0
Subvut Arm	5,2	1,9	6,0	1,0	7,0
Subcut Thoracic	5,6	1,7	6,0	1,0	7,0

Figure 3.18 Score allocation for loss of subcutaneous tissue on discharge

3.3.7 Discharge Setting

Most patients were discharged home (81.5%; *n*=75). Few were discharged to another ward, within the same hospital, but did not meet our inclusion criteria, resulting in a discharge interview (5.4%; *n*=5). Discharges were also made to other health institutions – either another hospital (4.3%; *n*=4) or a nursing home (3.3%; *n*=3).

Patients that were not discharged to any of the above options were categorised as 'other'. This was marked when patients (5.4%; *n*=5) were discharged back to prison or to another institution not mentioned.

3.3.8 Prevalence of Risk of Malnutrition on Discharge

On discharge, the patients were assessed once more for risk of poor nutritional status using the same three screening tools, namely the SGA, NRS-2002 and the AMDT. The prevalence of risk of malnutrition as determined by any of the three tools was 76.6% (*n*=307) when based on the admission sample. However, within the discharge sample, 87% (*n*=80) of patients were at nutritional risk. The results from each of the tools are illustrated in Figure 3.19.

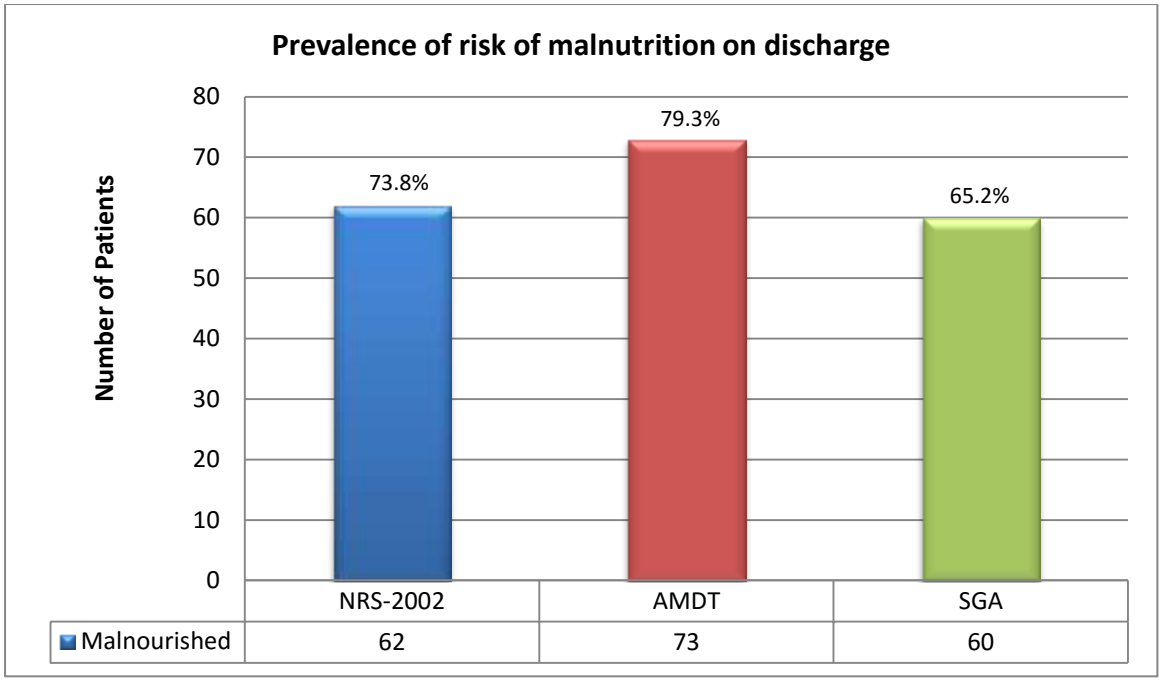


Figure 3.19 Prevalence of risk of malnutrition according to the selected screening tools on discharge

3.3.8.1 NRS-2002

On discharge, 84 patients were included to determine prevalence of malnutrition risk according the NRS-2002. All patients (100%; *n*=84) were categorised as 'at risk' in the initial screening and thus proceeded to the final screening section of the NRS-2002. The mean score for disease severity was 1.2 ±0.4SD (median 1; range 0–2) from the discharge sub-sample. Also, more older patients were included, as 11.9 % (*n*=10) had an age-adjusted score, indicating that they were ≥70 years of age. On discharge, 73.8% (*n*=62) were found to be at nutrition risk (Figure 3.19). The median total score obtained was 2.5 (IQR 0–3).

The NRS-2002 identified 90% (*n*=18) of patients that had lost 5% of their body weight and 100% of patients that had more than 10% weight loss.

Patients that were classified as at risk of malnutrition on discharge by the NRS-2002 were most often diagnosed as patients with cancer or admitted for surgery (abdominal) (12.9%; *n*=8), gastrointestinal disorders (11.3%; *n*=7), and infectious disease or TB (9.7%; *n*=6).

3.3.8.2 AMDT

Malnutrition was diagnosed in 79.3% (*n*=73) of patients on discharge when using the AMDT criteria (Figure 3.19). The median score was 3 (IQR 2–4), indicating a higher score obtained for patients included on discharge, than those included in the baseline assessment.

The AMDT correctly diagnosed 90% of patients that had significant weight loss (5%) as malnourished, and all the patients that had more than 10% weight loss.

Similar to the NRS-2002, most patients that were diagnosed as malnourished by the AMDT were diagnosed with cancer (15.1%; *n*=11), gastrointestinal disease (11%, *n*=8), infectious disease or were admitted for surgery (abdominal) (9.6%; *n*=7) and TB (8.2%; *n*=6).

3.3.8.3 SGA

The SGA categorised 65.2% (*n*=60) of patients as malnourished (Figure 3.19). This tool too showed an increase in the prevalence of patients that were malnourished compared to the admission sample, although not of significance (*p*=0.39; Chi-square). Of the malnourished patients on discharge, 85% (*n*=51) were categorised as mild to moderately malnourished, and 15% (*n*=9) as severely malnourished (Figure 3.20). The median score for SGA on discharge was 5.2 (range 3.9–6.3).

From the patients that lost 5% body weight, the SGA correctly diagnosed 85% (*n*=17) as malnourished. The SGA identified 60% (*n*=3) of patients that had lost more than 10% of their body mass.

Most cases identified as malnourished were patients that were diagnosed with cancer (21,7%; *n*=13), infectious disease (10%; *n*=6), gastrointestinal disease and TB (8.3%; *n*=5), as well as HIV/AIDS (6.7%; *n*=4).

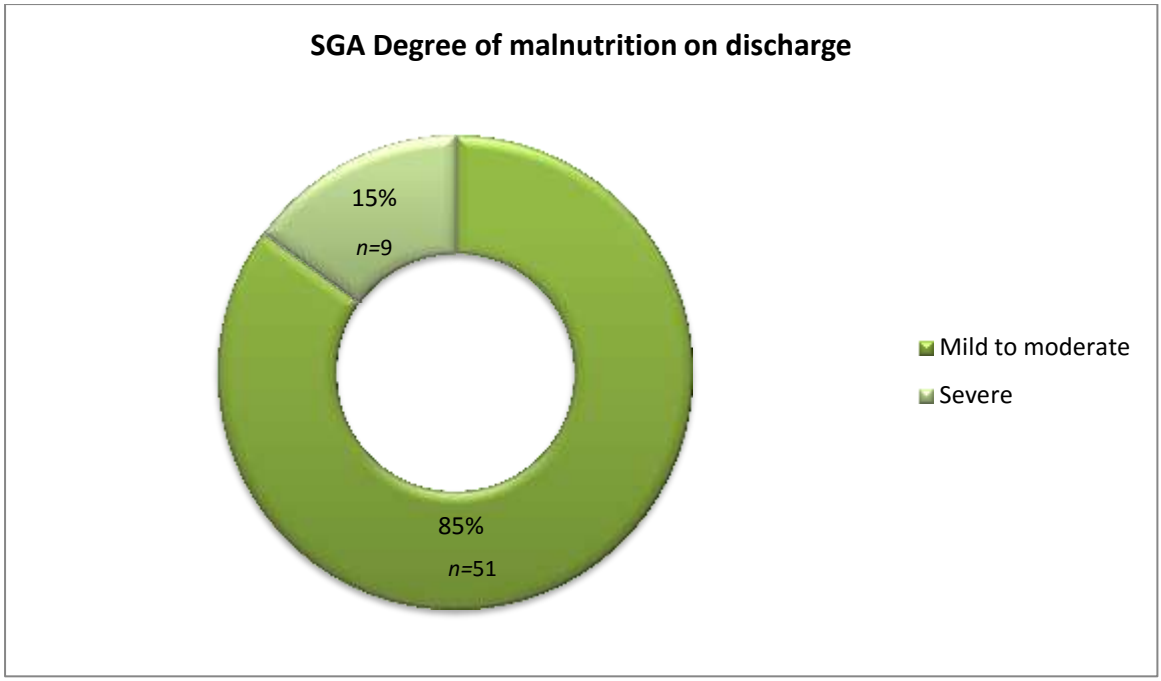


Figure 3.20 Degree of malnutrition according to the SGA on discharge

3.3.9 Primary Diagnosis of Patients at Risk of Malnutrition

On discharge, the majority of patients categorised as at risk of malnutrition according to any of the three tools, had a diagnosis pertaining to cancer (16.3%; =13), gastrointestinal disease (12.5%; *n*=10), or were admitted for surgery (abdominal) (10%; *n*=8), infectious disease (8.8%; *n*=7), or TB (7.5%; *n*=6). Figure 3.21 illustrates the diagnosis of patients that were at risk of malnutrition on discharge.

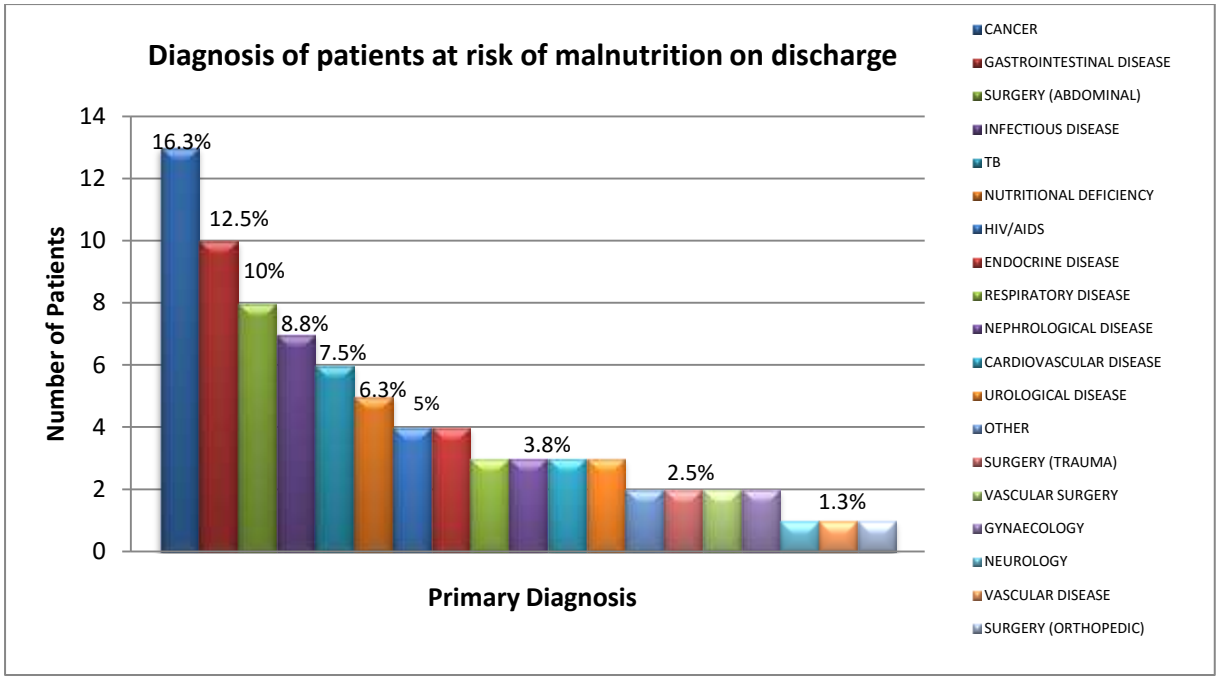


Figure 3.21 Primary diagnoses of patients at risk of malnutrition on discharge

3.3.10 Referral for Nutrition Support on Discharge

From admission until discharge, only 9.8% (*n*=9) of patients were referred for nutrition support during their stay in hospital. Of those, 88.9% (*n*=8) received a form of nutrition support, whilst 11.1 % (*n*=1) did not. In all cases where nutrition support was initiated, oral nutrition supplements were supplied.

When evaluating the patients' dietary intake and nutrition support referrals made, 33.3% (*n*=3) of patients referred had no change in dietary intake, 33.3% (*n*=3) had decreased appetite consisting of half of usual intake, 22.2% (*n*=2) of referrals could only consume three-quarters of their usual intake and only 11,1% (*n*=1) of the referrals were patients that could consume only a quarter of their usual dietary intake.

When basing the referrals only on weight loss experienced by patients, the referrals were not always appropriate. Just over half (55.6%; *n*=5) of patients referred had lost weight in hospital, while the remainder did not (44.4%; *n*=4). Only one patient (11, 1%; *n*=1) that had experienced more than 5% weight loss was referred, and not one of the patients that had more than 10% weight loss was referred for nutrition support, which was undoubtedly needed.

3.3.11 Outcomes of Malnutrition

3.3.11.1 Length of stay

The majority of patients (*n*=375) were included in the evaluation of length of stay (LOS) (the remaining patients were lost to follow-up). The mean length of stay in hospital was 6.9 days ±5.9SD. A significant difference ($p<0.01$; Mann–Whitney U) in length of stay was documented for those patients considered malnourished (mean 7.4 days ±6.1SD) compared with well nourished patients (mean 5.2 days ±4.8SD) (Figure 3.22).

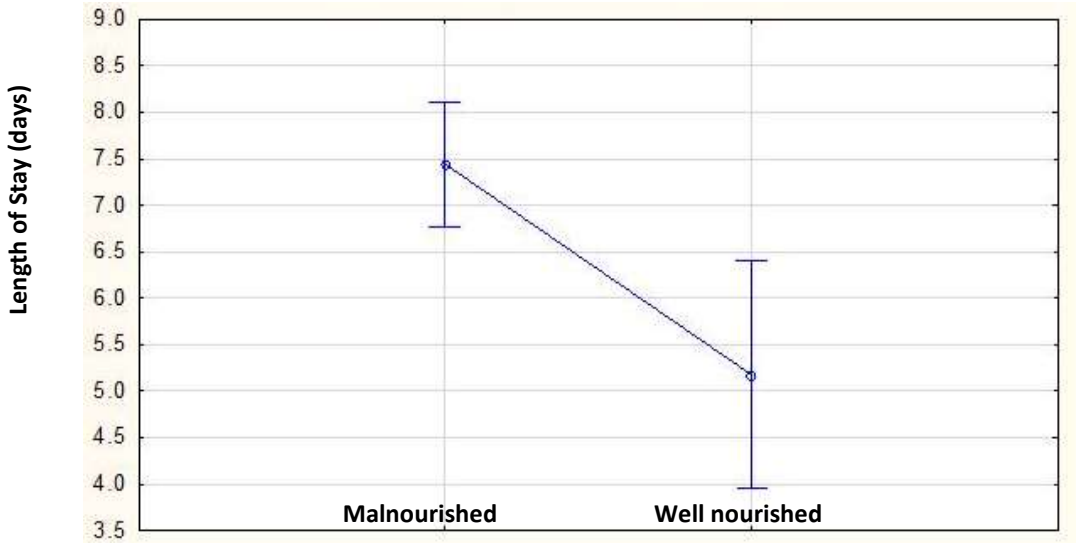


Figure 3.22 Length of stay between patients malnourished and well nourished (*p*<0.01)

There was no significant correlation in LOS and disease severity (r=0.15; *p*=0.54; Spearman's Rank Order Correlation), the number of complications and LOS (r=0.14; *p*=0.18; Spearman's Rank Order Correlation) or discharge BMI and LOS (r=0.08; *p*=0.43; Spearman's Rank Order Correlation). A significant weak relationship was however found between age and LOS, where older patients stayed significantly longer (r=0.15; *p*=0.00 Spearman's Rank Order Correlation).

A significant difference was also found between LOS and whether the patient had lost weight while hospitalised since admission (*p*=0.02; Mann–Whitney U). Patients that had lost weight had significantly longer LOS (mean 10.6 days; ±4.8SD) than patients that did not lose weight (mean 8.6 days ±3.1SD) (Figure 3.23).

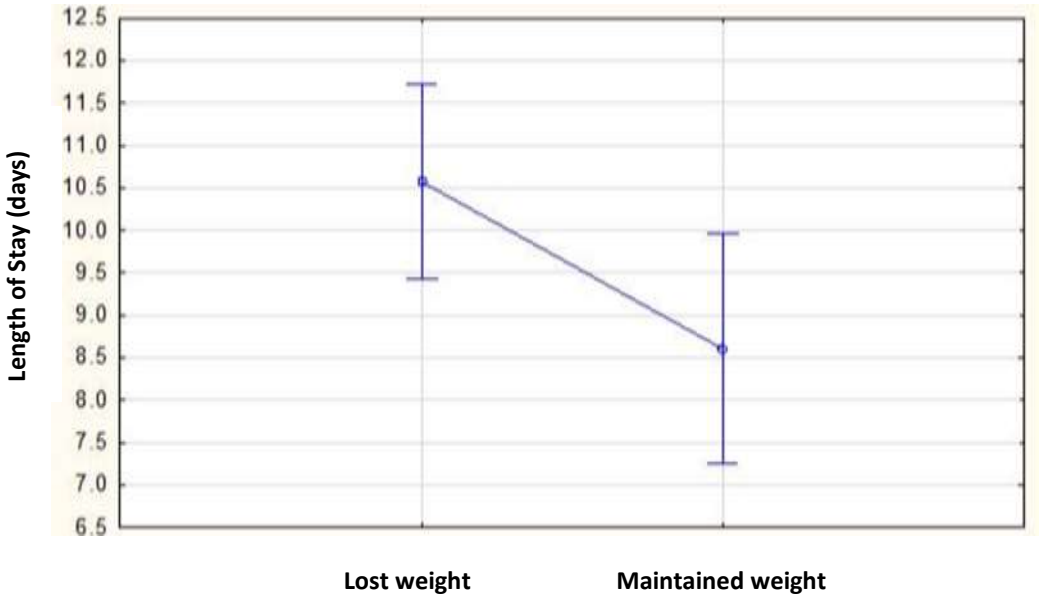


Figure 3.23 Length of stay and weight loss during hospitalisation (p=0.02)

Significant differences were found between diagnostic categories and LOS with patients diagnosed in the following categories: urological disease, TB, nutritional deficiencies, and those admitted for surgery (trauma, vascular and abdominal) presenting with a longer LOS (p<0.01; Kruskal–Wallis).

3.3.11.2 Complications

On discharge the total number of complications that patients experienced during their hospital stay was documented. Almost two-thirds (64%; n=59) of patients experienced some type of complication. The mean number of complications that patients suffered was 1.6 ±1.6SD. Figure 3.24 summarises the number of complications found per patient.

The majority of patients experienced gastrointestinal-related complications (27.4%; n=40). Complications pertaining to haematology and cardiology were also common (13%; n=19) (Figure 3.25).

When comparing the number of patients classified as at risk of malnutrition by any of the three tools on discharge and the number of complications experienced, a significant difference was found (p=0.048; Mann–Whitney U). This shows that there is a relationship between the number of complications and poor nutritional status, where malnourished patients had more complications (mean 1.7 ±1.6SD) than those considered well nourished (mean 0.8 ±1.3SD).

There was no significant difference in the number of complications and patients 'at risk' according to the NRS-2002 (p=0.32; Mann–Whitney U). However near significance was found between the number of patients considered as malnourished according to the SGA (p=0.06; Mann–Whitney U) and number of complications experienced. Nevertheless, the AMDT was the only tool that indicated significantly more complications (p=0.03; Mann–Whitney U) in the patients that were diagnosed as malnourished (mean 1.78 ±1.6SD) versus the well- nourished group (mean 0.95 ±1.3SD).

Treatment type needed for treating complications was documented alongside the complications the patient may have experienced, to determine the grade of the complications. Not all patients received treatment (7.7%, n=11). However of those that did, the majority of patients experienced Grade 1 complications (47.2%; n=67), followed by Grade 2 (40.8%, n=58). The minority of patients experienced Grade 3 complications (4.2%, n=6), which may have been influenced by the exclusion criteria of the study.

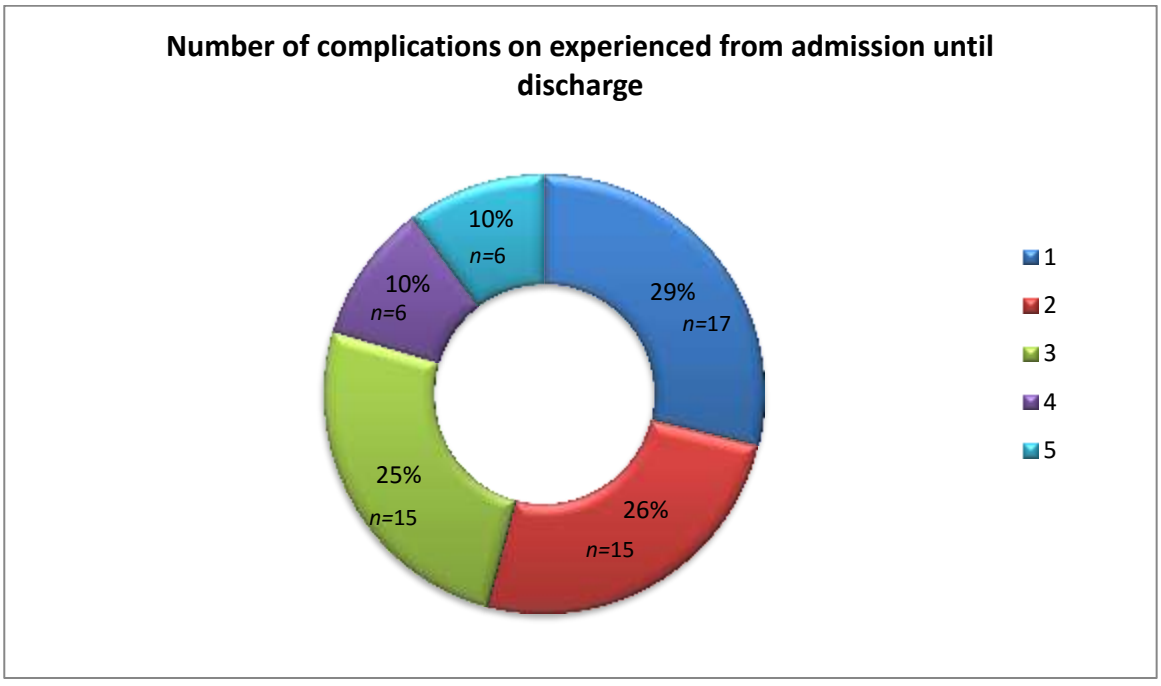


Figure 3.24 Number of complications experienced by patients from admission until discharge

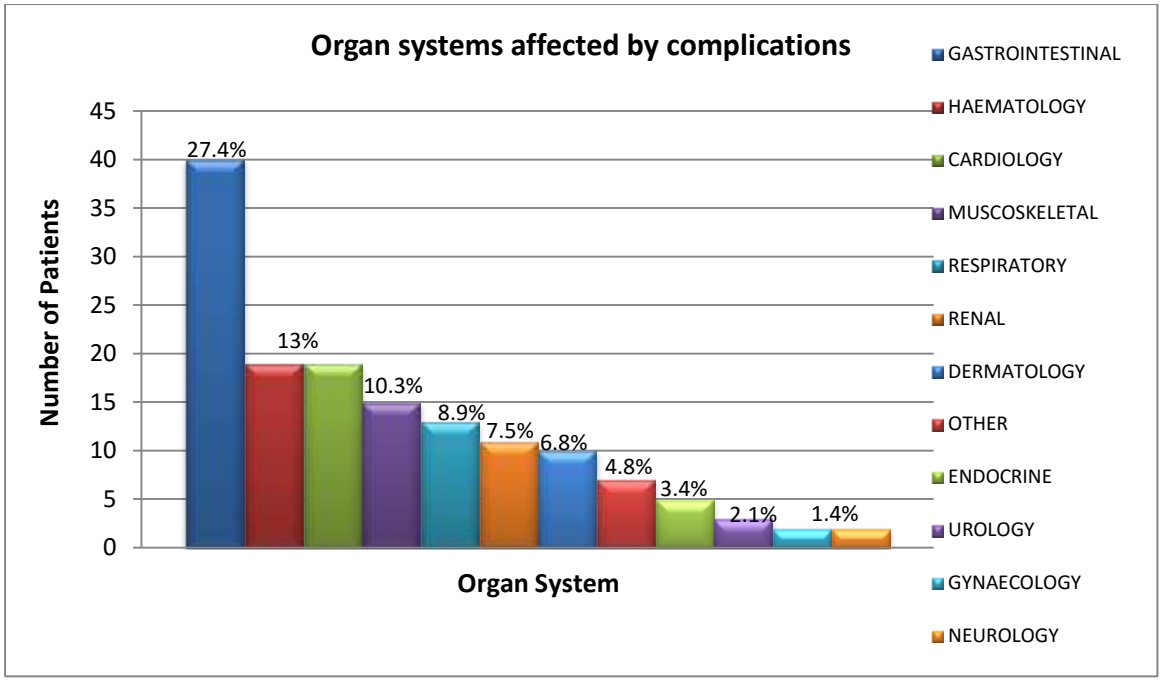


Figure 3.25 Organ systems affected by complications

3.4 COMPARISONS

A few interesting comparisons between the results obtained from the admission and discharge sample are highlighted in the next section. Differences observed between malnourished and well nourished patients are also discussed under the relevant headings, when applicable.

3.4.1 Comparison of Age

On admission, there was no significant difference in age (p=0.34; Mann–Whitney U) between patients considered malnourished (mean 45.8 years ±16.6SD) compared with those who were not (mean 44.2 years ±16.5SD).

However within the discharge sample, patients identified as malnourished by any of the three tools on discharge were older (mean 50 years ±16.2SD) than those that were well nourished (mean 43.8 years ±14.7SD), although not statistically significant (p=0.22; Mann–Whitney U).

3.4.2 Comparison of Primary Diagnosis of Patients at Risk of Malnutrition

The primary diagnoses of patients considered at risk of malnutrition on admission and on discharge by any of the three tools were compared, to identify which diagnostic category included the most 'at risk' patients, so that these could be prioritised in a hospital setting. Patients diagnosed with infectious disease, cancer, gastrointestinal disease and those admitted for surgical intervention (abdominal) contributed most within the admission sample, as well as in the discharge sub-sample, although the percentage differed slightly (Figure 3.26). Owing to many patients lost to follow up, this may be due to chance.

On admission the majority of patients that were at risk for malnutrition were diagnosed with infectious disease, although on discharge, those diagnosed with cancer were most often at risk of malnutrition.

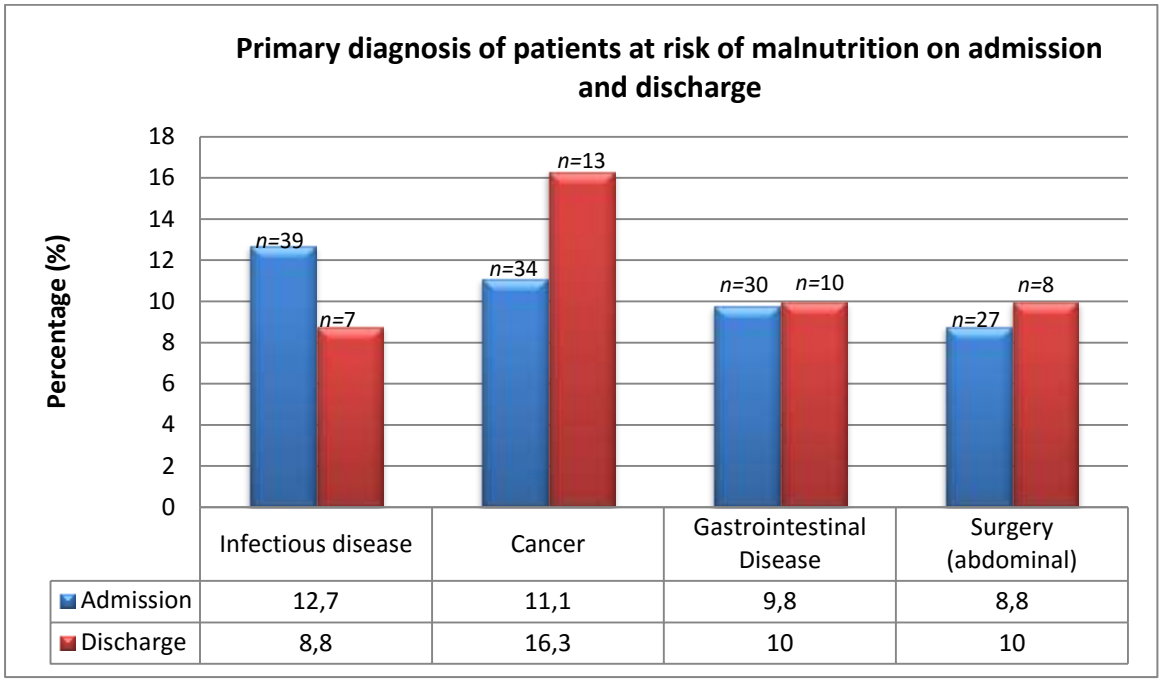


Figure 3.26 Comparison of primary diagnoses between admission and discharge samples of patients at risk of malnutrition

3.4.3 Comparison of the Presence of Gastrointestinal Side Effects

When comparing the presence of gastrointestinal symptoms between the admission and discharge sample, there was a consistent difference in nausea, vomiting, anorexia, constipation, and diarrhoea (Figure 3.27), with more patients experiencing these side effects

in the discharge sub-sample. Of these side effects, there was a significant difference in diarrhoea (p<0.01; Chi-square) compared to the admission sample.

There were significantly more patients included in the discharge sub-sample that reported gastrointestinal side effects (p=0.02; ANOVA) than those included in the baseline assessment on admission (Figure 3.28).

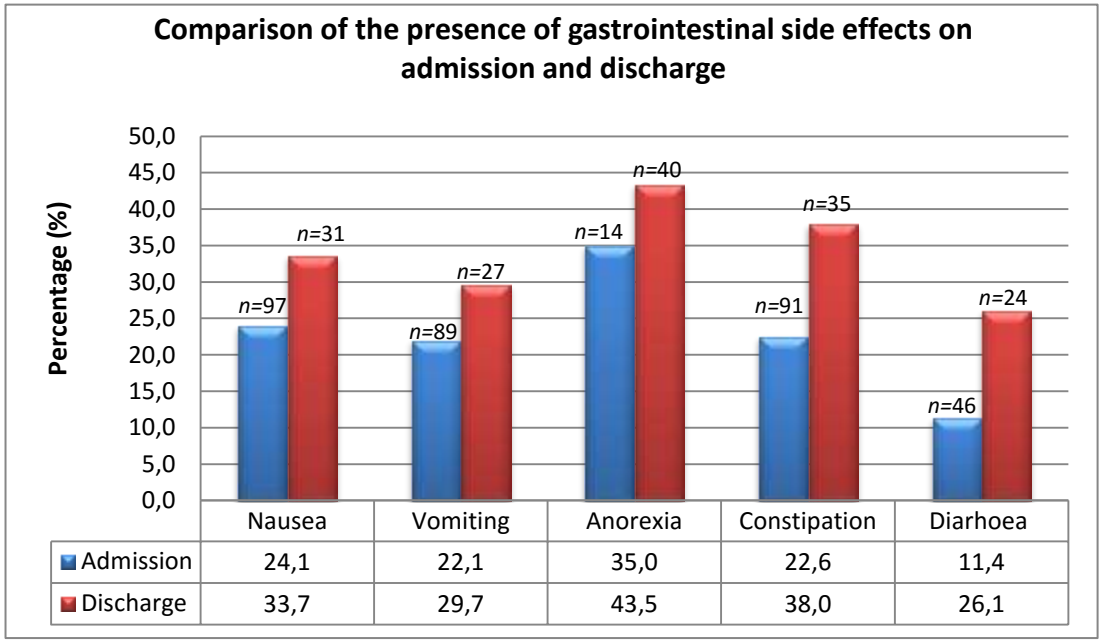


Figure 3.27 Comparison of presence of gastrointestinal side effects between the admission and discharge sample

Furthermore, the number of patients experiencing only one gastrointestinal side effect on admission were fewer when compared with those included in the discharge sub-group (45.2% on admission, 29.6% on discharge). More patients included in the discharge assessment experienced two or more side effects (70.5%) when compared with the admission sample (54.8%) (Figure 3.29).

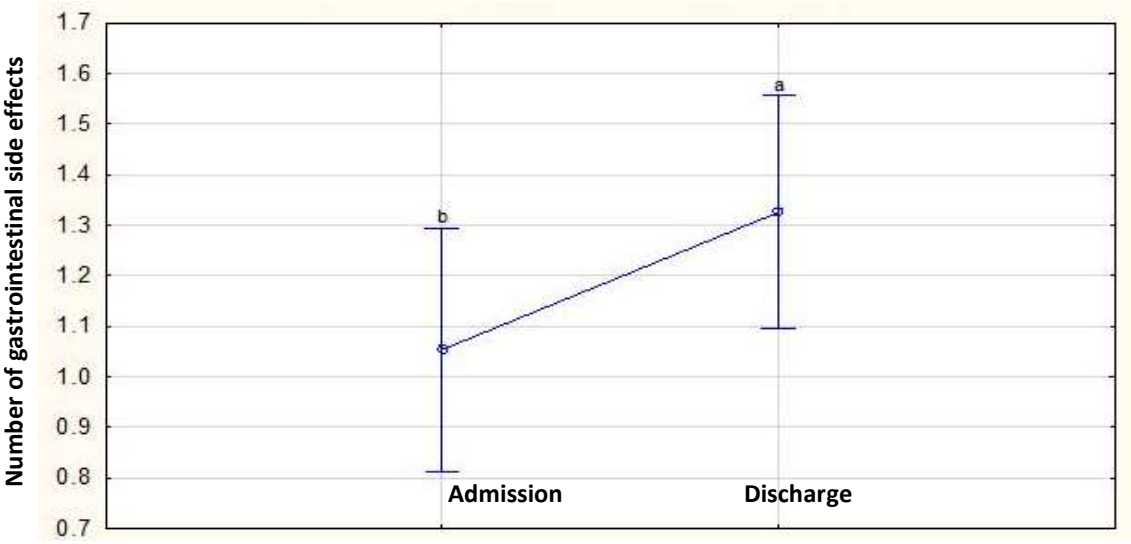


Figure 3.28 Difference in patients experiencing any gastrointestinal side effect between the admission and discharge sample

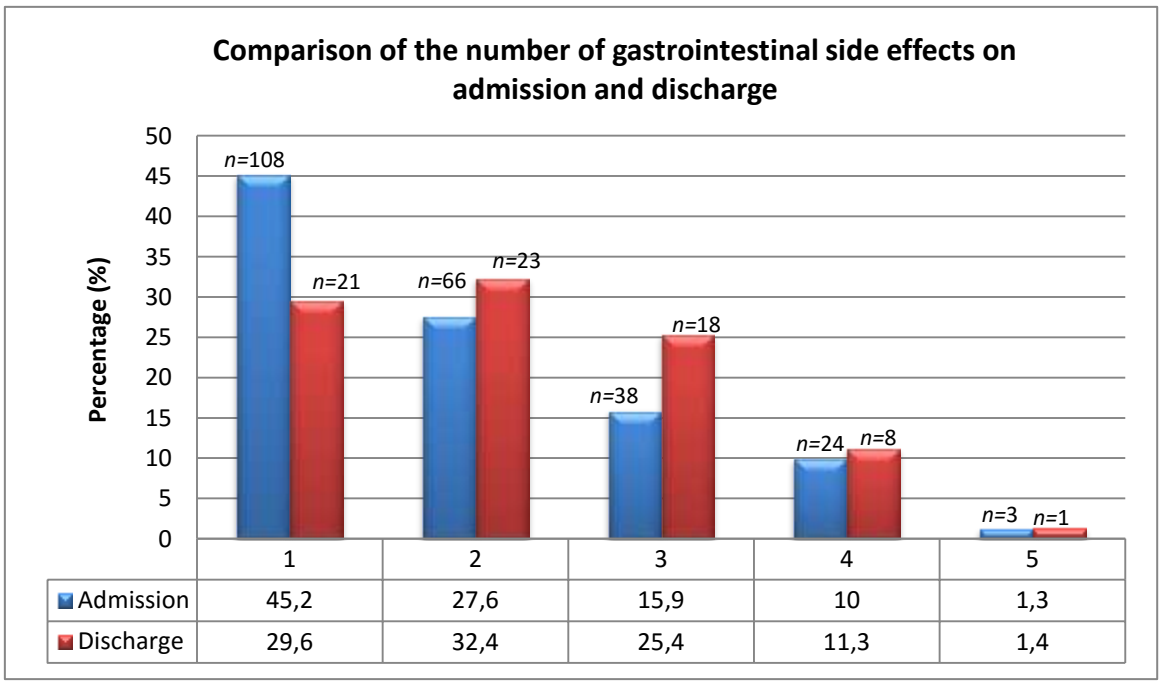
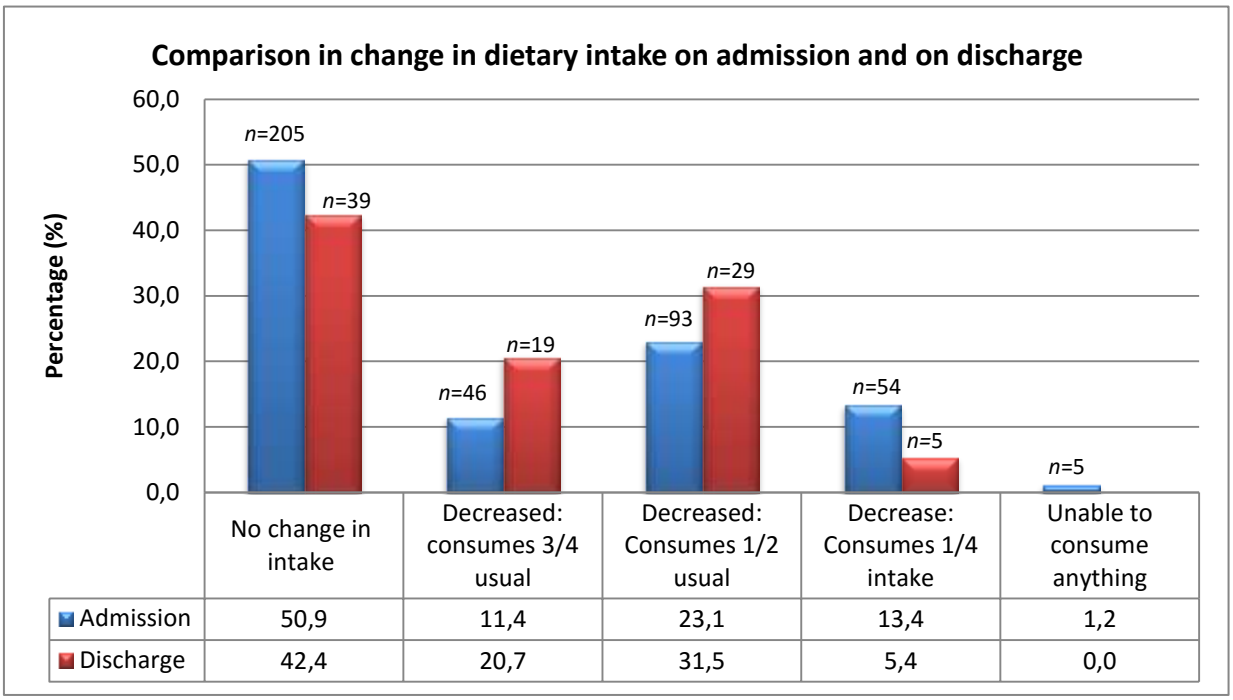


Figure 3.29 Comparison of the number of gastrointestinal side effects reported between the admission and discharge sample

3.4.4 Comparison of Dietary Intake

The comparison of dietary intake from the admission sample and the discharge sample is also of concern, especially when relating this to the number of nutrition referrals made during hospital stay. On admission, half of patients (50.9%; *n*=205) reported no change in dietary intake. However within the discharge sub-sample, only 42.4% (*n*=39) reported no change. Within the discharge sub-sample, there were more patients compared with the admission group that could only consume half or three-quarters of their usual intake (Figure 3.30). However within the discharge sub-sample, there were no patients that were unable to consume anything. Although the change in dietary intake between the two samples was not significantly different (*p*=0.19; McNemer– Bowker test), the presence of anorexia on discharge was also the most reported gastrointestinal side effect.



	No change in intake	Decreased: consumes 3/4 usual	Decreased: Consumes 1/2 usual	Decrease: Consumes 1/4 intake	Unable to consume anything
Admission	50,9	11,4	23,1	13,4	1,2
Discharge	42,4	20,7	31,5	5,4	0,0

Figure 3.30 Comparison of change in dietary intake of patients between the admission and discharge sample

When further analyses were conducted, those that were considered at risk of malnutrition on admission (<48hours) by any of the three tools (76.5%; *n*=307), had a significantly lower dietary intake (*p*=0.0000; Chi-square), compared with those that were considered well nourished. (Significance applies to categories: no change in usual intake, consumes only a

quarter, consumes only half, consumes only a quarter of usual.) Also of interest is that all the patients that reported they were unable to consume anything, were diagnosed as 'at risk' or malnourished on admission. Also not one of the patients that were considered 'well nourished' on admission reported eating less than three-quarters of their usual intake. In fact the majority (89.4%; *n*=84) reported no change in intake, with the remainder (10.6%; *n*=10) reporting a decreased intake consisting of three-quarters of their usual intake (Figure 3.31).

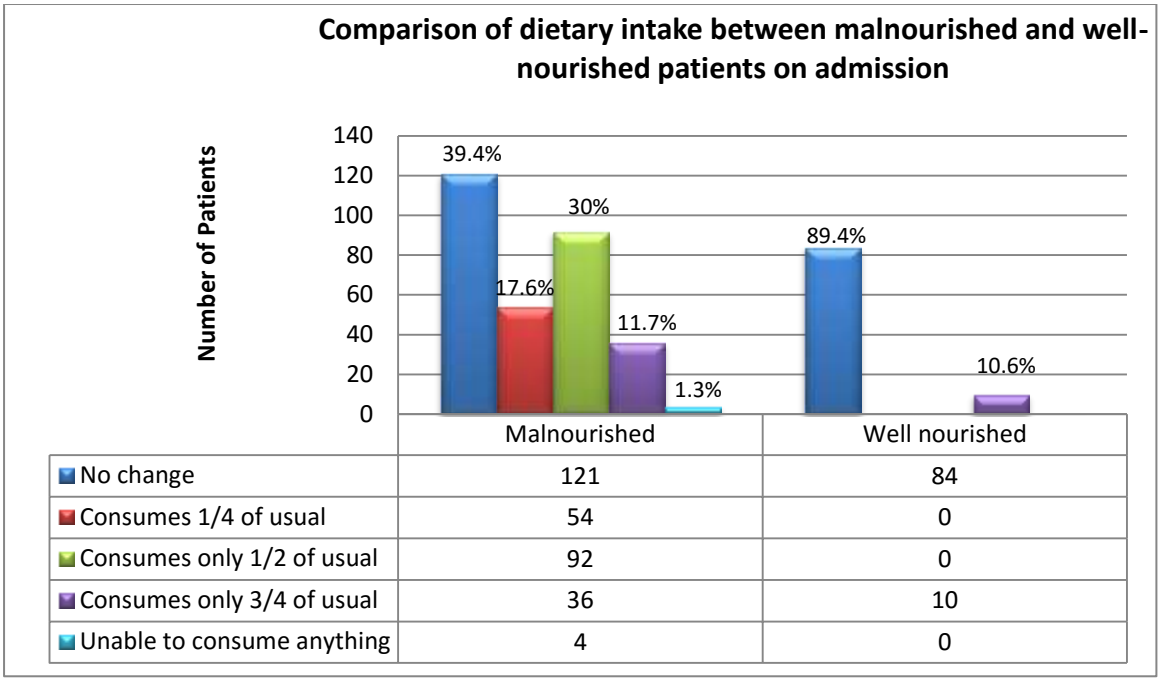


Figure 3.31 Change in dietary intake among malnourished and well nourished patients on admission (*p*<0.01)

On discharge a similar trend was seen (Figure 3.32). However of those at risk of malnutrition, there was an increase in the patients eating only half of their usual intake. Further analyses indicated significant difference in dietary intake for the categories 'no change in intake', 'consumes only half of usual intake', and 'consumes only three-quarters of usual intake' between malnourished and well nourished patients on discharge (*p*<0.01; Chi-square).

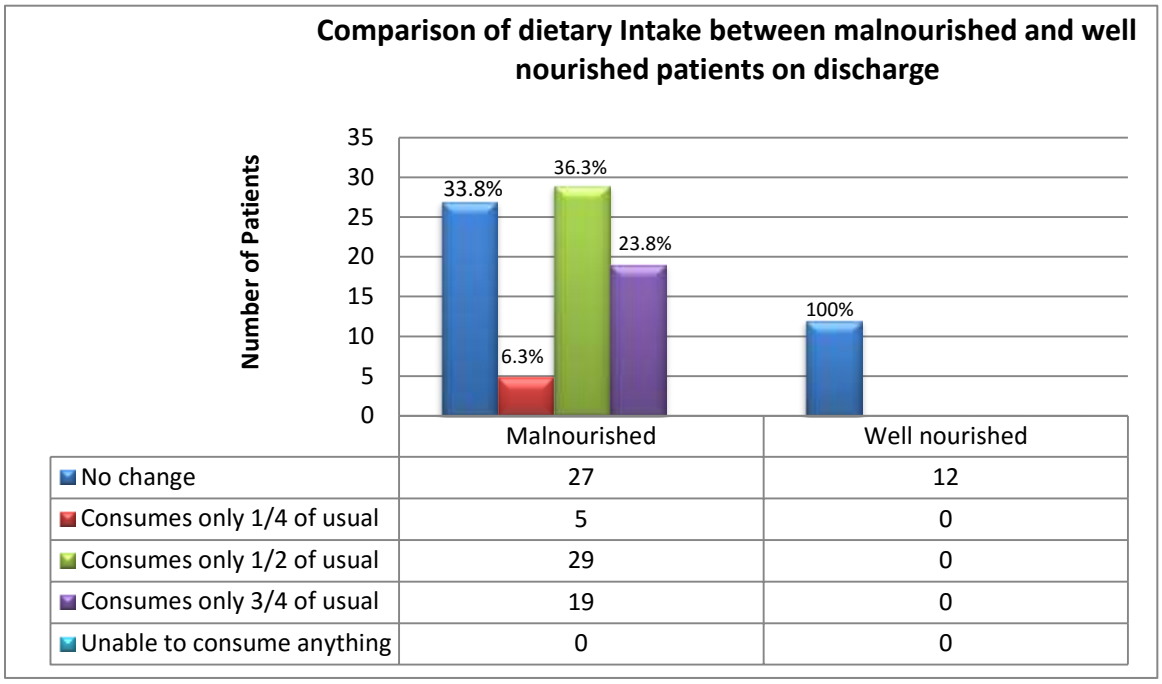


Figure 3.32 Change in dietary intake among malnourished and well nourished patients on discharge (p<0.01)

3.4.5 Comparison of Anthropometry

3.4.5.1 Comparison of BMI

On comparing admission with discharge samples, there was a significant difference in the BMI of the patients (p=0.003; ANOVA). The majority of patients on admission as well as discharge were pooled in the 'healthy' BMI category according to the NRS-2002 distribution (20.5–24.9kg/m^2). However this only contributes to 30–37% of the patients included in the study. This is of concern as a third of patients are categorised as overnourished (BMI≥25kg/m^2) and another third as undernourished (BMI<20.5kg/m^2). These results highlight the double burden of malnutrition. The severity of malnutrition was higher on discharge than admission, that is, undernutrition (BMI<18.5kg/m^2) and obesity (≥30kg/m^2) were higher than on admission (Figure 3.33).

Additionally, the BMI differed significantly (p<0.01; Mann–Whitney U) between patients considered at risk of malnutrition on admission by any of the three tools (n=307), compared with those classified as well nourished. The mean BMI for patients at risk of malnutrition

was significantly lower (mean 23.5kg/m^2 ±7.2SD) than for those not considered at risk or malnourished (mean 28.7kg/m^2 ±6.4SD).

On discharge, there was also a significant difference (p=0.0000, Mann–Whitney U) between the BMI of patients that were at risk of malnutrition (mean 22.4kg/m^2 ±6.2SD) and those that were not (mean 32kg/m^2 ±8.96SD). This indicates that patients included in the discharge sub-sample were in the more 'extreme' BMI categories and had more severe degrees of malnutrition (i.e. undernutrition and overnutrition).

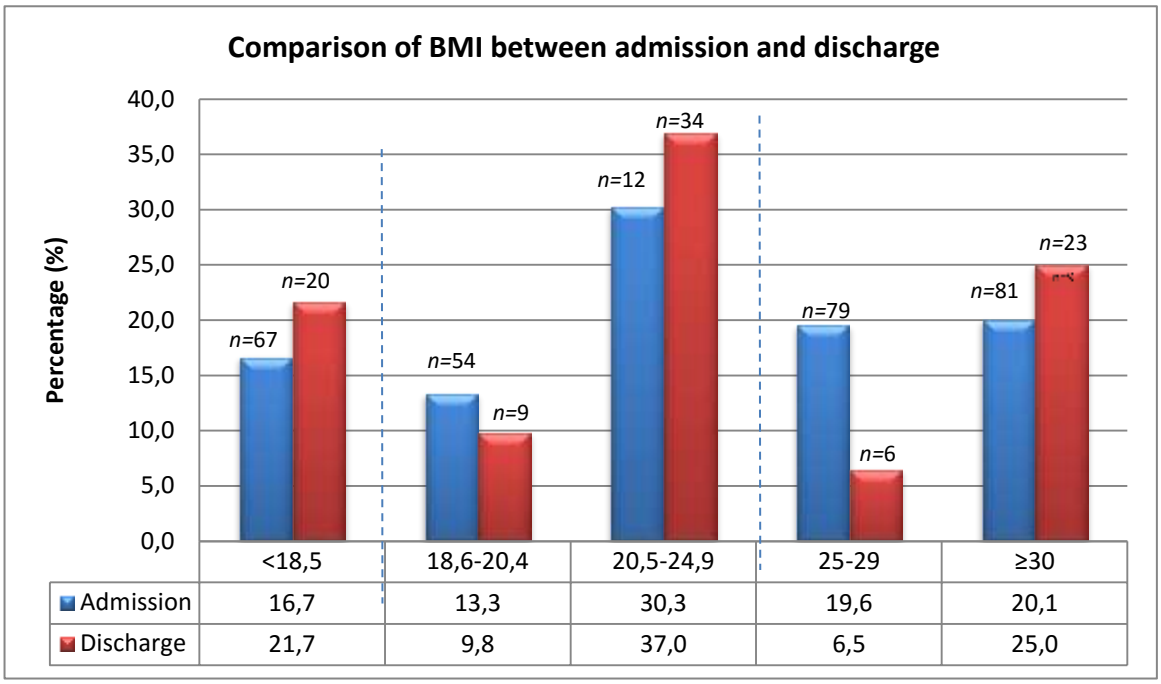


Figure 3.33 Comparison of BMI categories between the admission and discharge sample

3.4.5.2 Comparison of weight and weight loss

After adjustment for oedema, there was a significant difference in the body mass of patients included in the admission sample, compared with those included in the discharge sub-sample (p=0.003; ANOVA) (Figure 3.34).

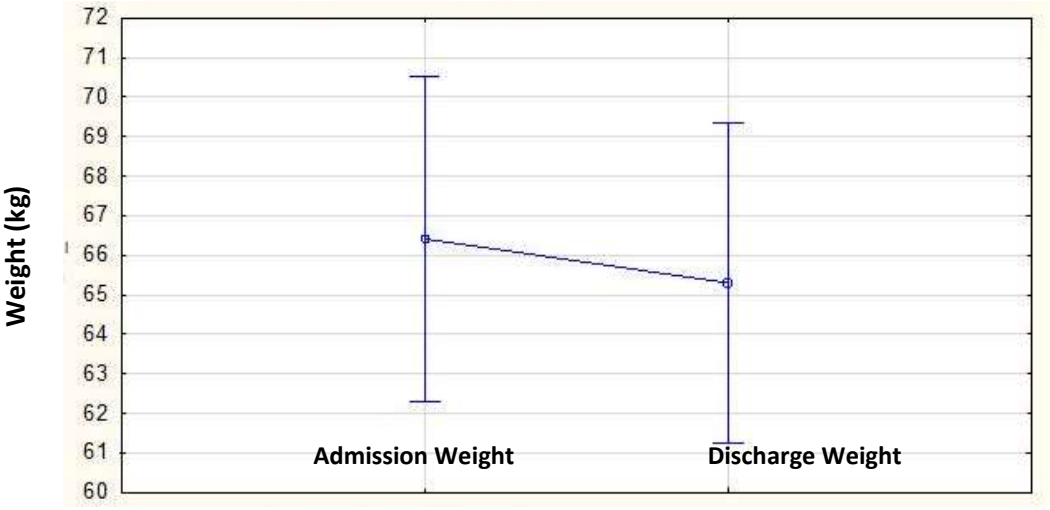


Figure 3.34 Change in body mass between the admission and discharge sample (p=0.003)

Moreover, there was a significant difference (p=0.0000; Chi-square) in patients considered at risk of malnutrition and that had lost weight prior to hospitalisation, compared with those not considered malnourished, and who had not reported weight loss prior to admission (Figure 3.35). Therefore, patients that had reported significant weight loss prior to admission were most often categorised as at risk of malnutrition, whereas those that had not lost weight prior to admission were most frequently classified as well nourished patients.

Similarly, there was a significant difference (p=0.01, Chi-square) among the patients included in the discharge sub-sample in relation to nutritional status and whether they had experienced weight loss since admission. Patients that had experienced weight loss while in hospital were considered at risk of malnutrition by any of the three tools on discharge (63.8%; n=51), which differed significantly from those that had not lost weight and were considered well nourished by any of the three screening tools.

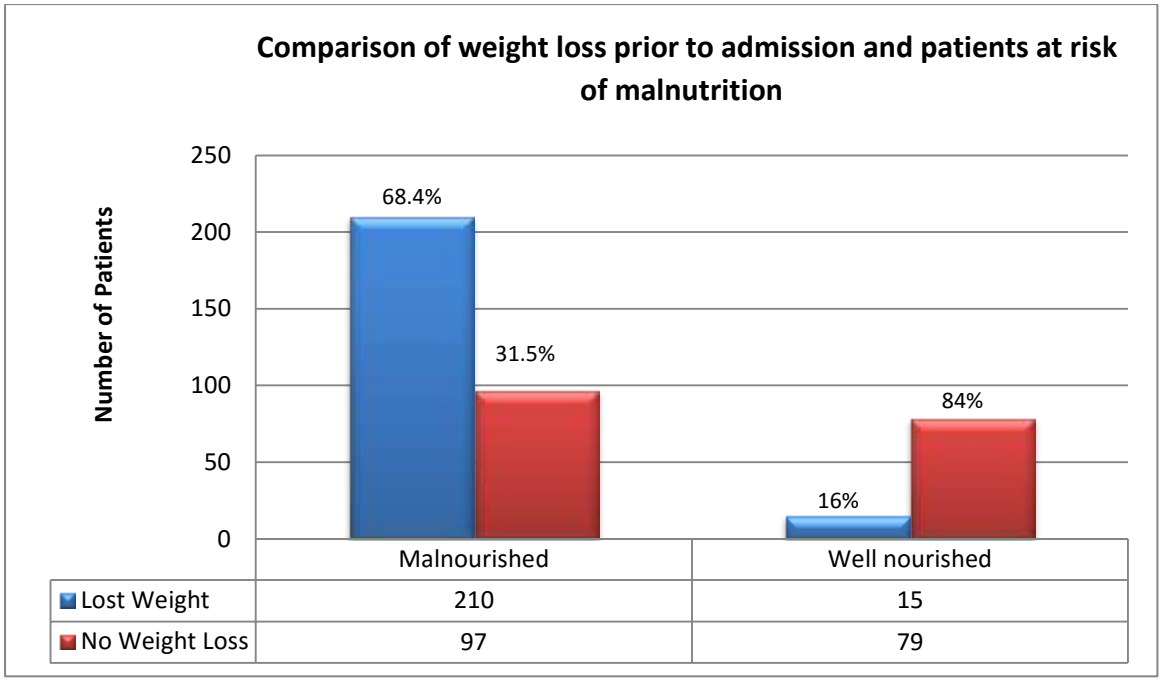


Figure 3.35 Comparison of patients at risk of malnutrition and weight loss experienced prior to hospitalisation (*p*=0.0000)

3.4.6 Comparison of Physical Assessment

3.4.6.1 Comparison of functional capacity

On discharge, reduced functional capacity is similar to the admission sample. However, more patients with severe dysfunction, that is, chair- or bedridden, were reported on discharge. Although the impact of nutritional factors was more evident within the discharge sample, it did not significantly differ from the admission sample. (*p*=0.37; Chi-square). Within the discharge sample almost half (47.5%; *n*=19) of the patients experienced dysfunction relating to nutritional factors (Figure 3.36).

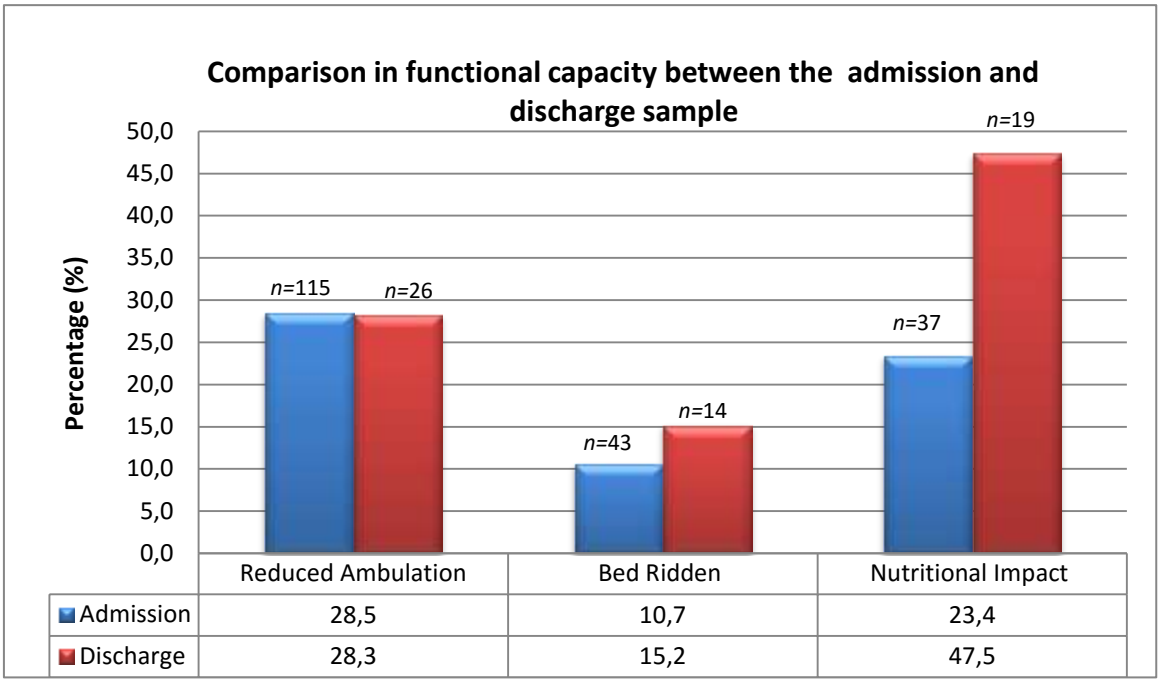
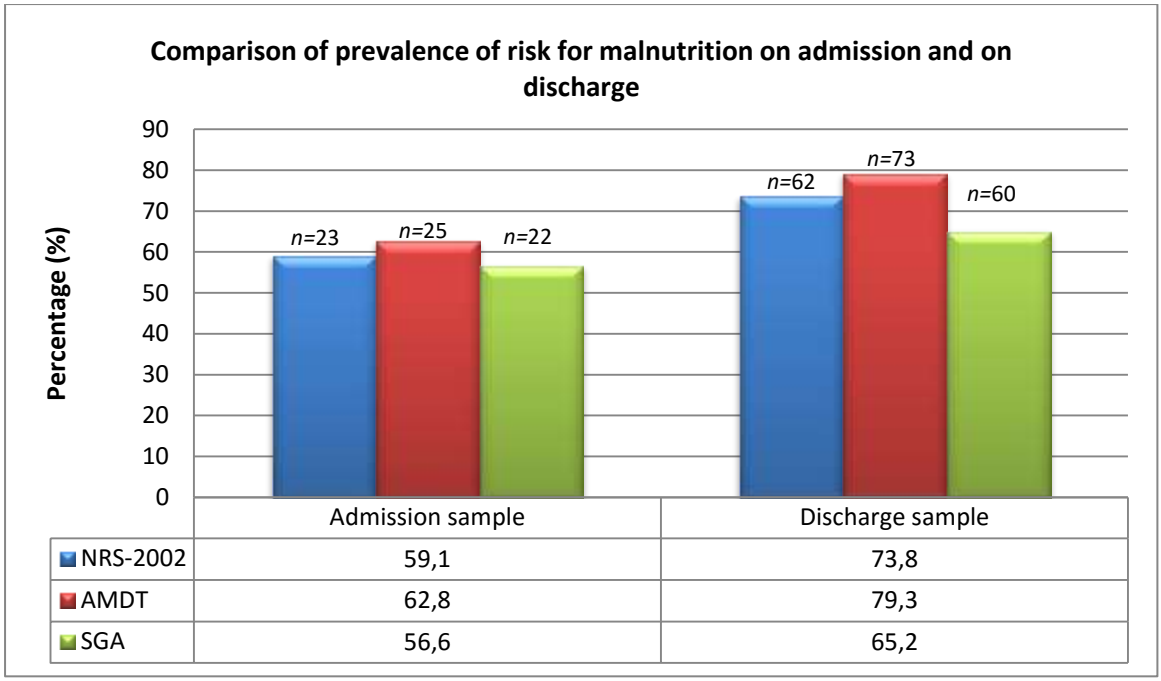


Figure 3.36 Comparison of functional capacity between the admission and discharge sample

3.4.7 Comparison of the Prevalence of Risk of Malnutrition

The prevalence of risk of malnutrition between the three tools (NRS-2002, AMDT, and SGA) between the admission and discharge sample, are shown in Figure 3.37. All three tools indicate a higher rate of risk in the discharge sub-sample compared with the admission sample, although none of them are statistically different. All the patients (100%; *n*=80) considered at risk of malnutrition on discharge, were considered at risk of malnutrition on admission. The AMDT consistently indicates a higher rate of risk, compared with the SGA, which consistently indicates the lowest rate of risk among the three tools. Of concern is that the prevalence of risk of malnutrition ranges from 56.6 % on admission to as high as 79.3% on discharge. This means that based on the discharge sub-sample, four out of every five patients admitted to hospital may be at nutritional risk, and in need of nutrition support.



	Admission sample	Discharge sample
NRS-2002	59,1	73,8
AMDT	62,8	79,3
SGA	56,6	65,2

Figure 3.37 Comparison of scores for patients at risk of malnutrition obtained by different screening tools between the admission and discharge sample

3.5 VALIDATION OF TOOLS

Owing to the lack of a gold standard, all three screening tools were tested for validity against one another. Depending on the percentage obtained for sensitivity and specificity, the tool would be defined as either good (both >80%), fair (either <80%, both>50%) or poor (either <50%) (refer to Section 2.9 in Chapter 2).

3.5.1 NRS-2002 as Reference

When using the NRS-2002 as the reference, the validity was poor for both the AMDT and the SGA. Despite this, the specificity of the SGA (81%) was good and the AMDT (77.3%) was fair. However, sensitivity was poor in both, 41.5 % and 38.5% respectively (Figure 3.38).

The correlation validity was also poor for both SGA (k=0.24) and AMDT (k=0.15).

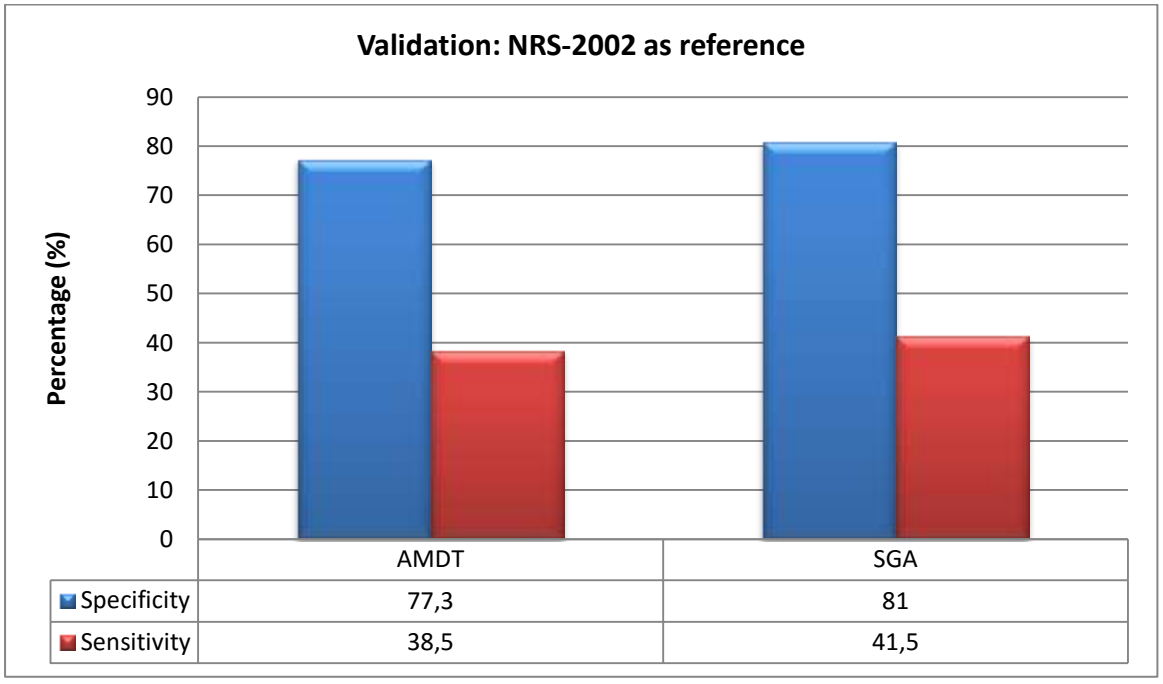


Figure 3.38 Validity of screening tools compared with NRS-2002

3.5.2 AMDT as Reference

Validity was also tested using the AMDT as the reference. The NRS-2002 had poor sensitivity (35.3%) but fair specificity (79.6%), which classifies this as a tool with poor validity. The correlation validity of the tool was also poor (k=0.24) (Figure 3.39).

However, the SGA proved to have good validity as results showed fair sensitivity (71.4%) and good specificity (89.4%) when validated against the AMDT. The correlation validity was also good (k=0.62) (Figure3.39.)

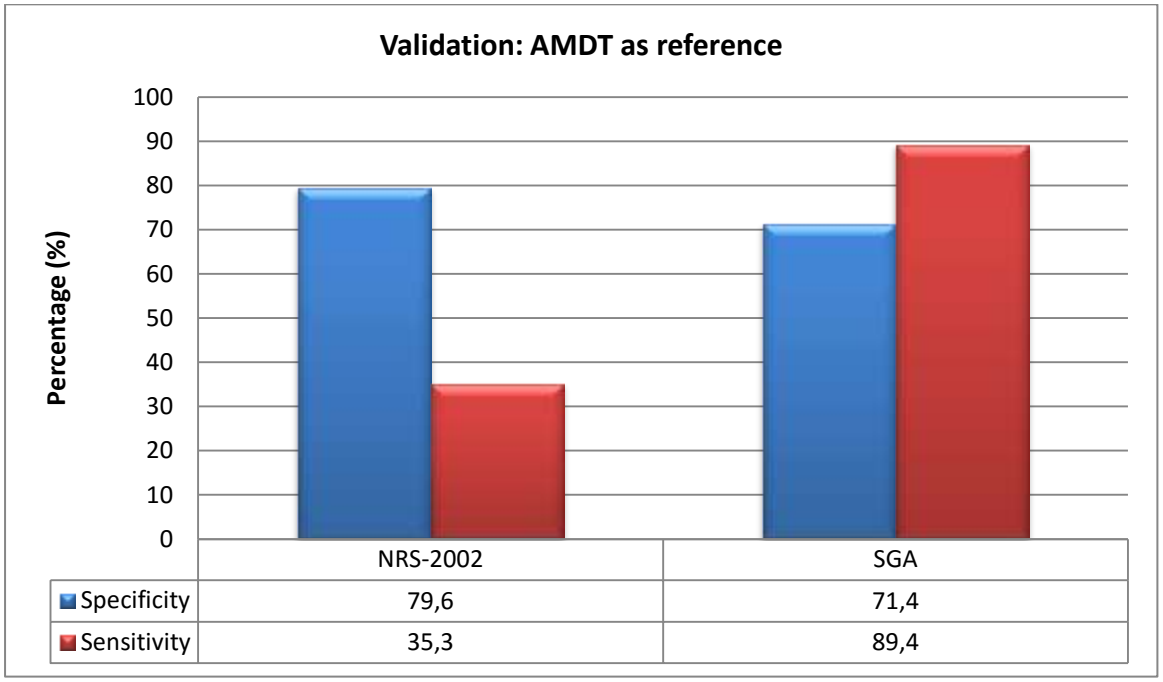


Figure 3.39 Validity of screening tools compared with AMDT

3.5.3 SGA as Reference

The SGA is often used as the gold standard as a screening tool. The NRS-2002 showed fair validity, and the ADMT showed good validity when compared with the SGA.

The NRS-2002 had a fair sensitivity (73.8%) and specificity (51.8%), although poor correlation validity (k=0.24) (Figure 3.40).

However, the AMDT had good sensitivity (83.9%) and specificity (80.2%). It also had good correlation validity (k=0.62) (Figure 3.40).

From the results, it seems the screening tools, NRS-2002 and AMDT, are most valid when compared with the SGA as reference.

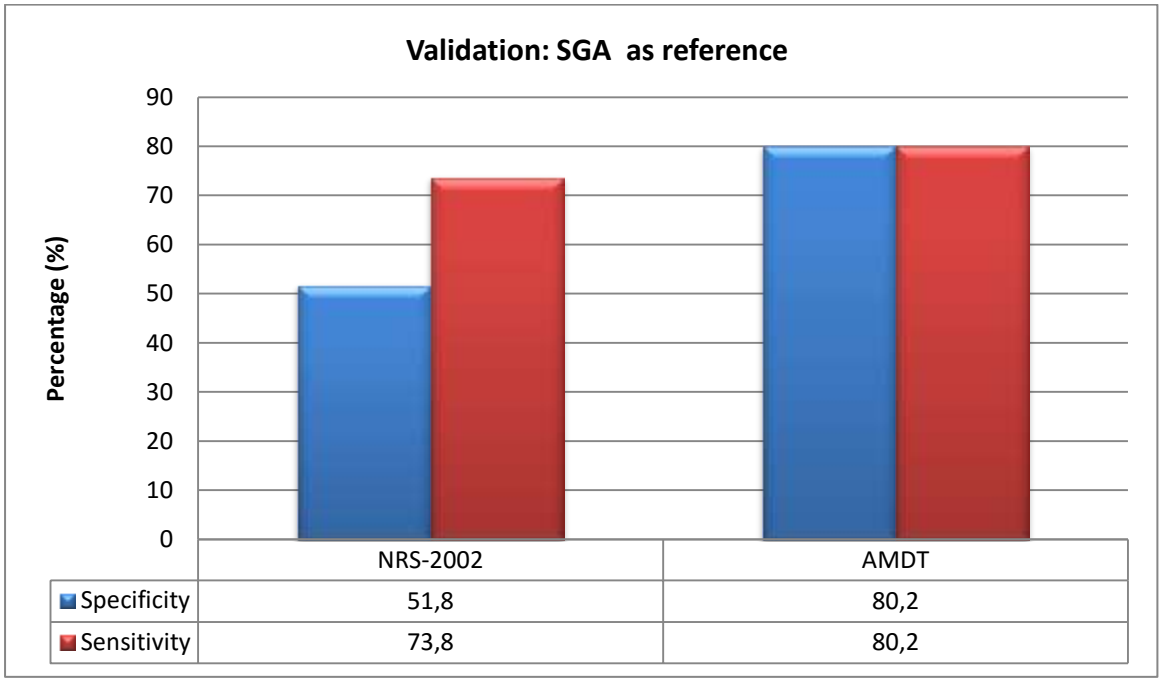


Figure 3.40 Validity of screening tools compared with SGA

3.6 OBSERVATIONAL CHECKLIST RESULTS

The observational checklist was conducted in the wards to assess whether the wards were organised to allow for nutrition screening and intervention. The analysis was based on 28 wards, including 14 surgical wards (50%), 12 medical wards (42.9%) and two gynaecology wards (7.1%).

There were no nutrition policies displayed in any of the wards. Neither was there any type of screening tool available at ward level. CHBAH makes use of telephonic referrals to the dietetics departments. Telephones were available in all the wards, and all were in working order. The telephone number of the dietetics department was displayed in the majority of wards (82.1%; *n*=23).

Wards were also assessed to identify if scales and stadiometers were available to allow for basic anthropometric measurements. A range of different types of scales were available in most wards (96.4%; *n*=27). These included weight-and-height measurement scales (55.6%; *n*=15), analogue scales (18.5%; *n*=5), beam scales (14.8%; *n*=4) and digital scales (11.1%; *n*=3). However, despite the availability, almost a quarter of these scales were not in working condition (22.2%; *n*=6). Overall, the scales were readily available for use at ward level (96.3%; *n*=26).

Stadiometers were not as commonly available at ward level as scales. Only 42.9% (*n*=12) of wards had a stadiometer within the ward. In all cases where there was a stadiometer available, it was also accessible for nurses to use. (Figure 3.41).

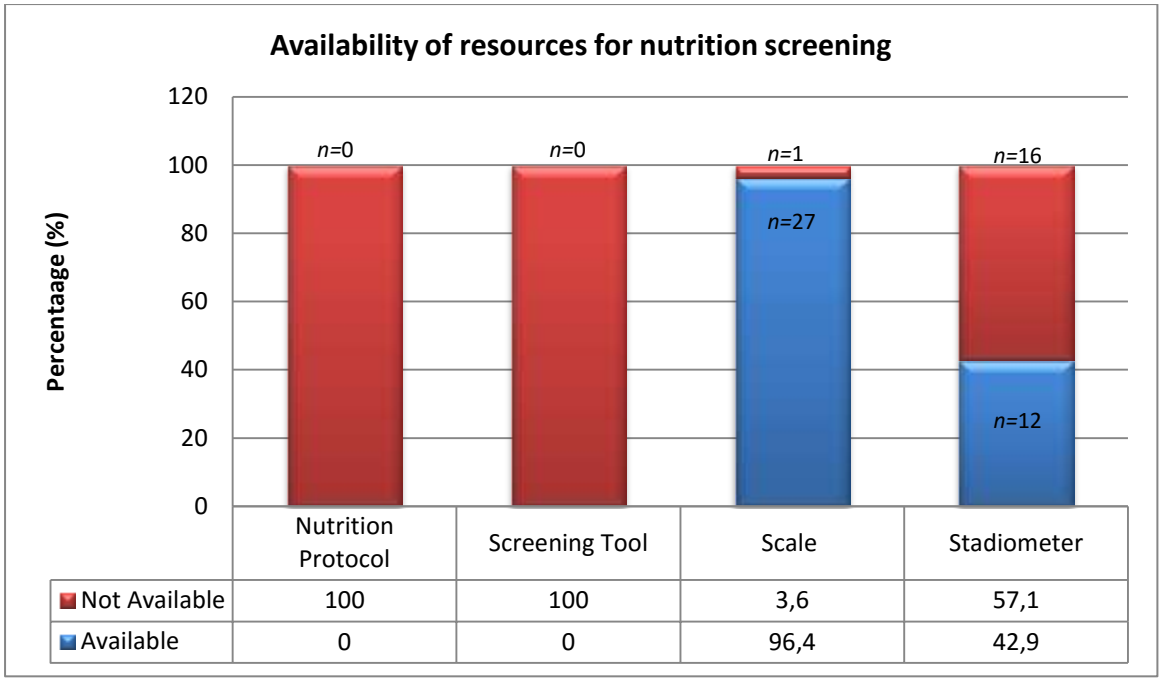


Figure 3.41 Availability of resources required for screening at ward level

For the storage of oral nutrition supplements and feeds, the ward kitchens were assessed for the availability of a refrigerator allocated for the storage of feeds. The majority (78.6%; *n*=22) of the wards had refrigerators, but only 31.8% (*n*=7) were used for their designated purpose. Most commonly refrigerators were used to store medication, or staff meals. Most refrigerators were in working condition (95.5%; *n*=21).

The mean number of patients within each ward was 43 ±17.7SD. The mean number of nurses was 11 ±2.5SD. This included sister-in-charge, professional nurses, nursing auxiliaries, enrolled nurses and student nurses. This resulted in a ratio of nurses to patients of 1:4.

3.7 SUMMARY OF MAIN RESULTS ACCORDING TO OBJECTIVES

VIII. ***To assess the prevalence of risk of malnutrition in hospitalised adult in-patients on admission (< 48 hours) using three screening tools (AMDT, SGA tool, NRS-2002) in a tertiary academic hospital.***

The prevalence of patients at risk of malnutrition on admission to hospital (<48hours) was high, regardless of the screening tool used. The NRS-2002 (59.1%; *n*=237) and the SGA (56.6; *n*=228), which are both screening tools, had lower results than the AMDT (62.9%; *n*=252), which is a diagnostic tool. According to SGA, 87.3% (*n*=199) had mild to moderate malnutrition, with 12.7% (*n*=29) having severe malnutrition.

IX. ***To describe any significant differences in the prevalence of malnutrition between different disease categories of adult hospitalised patients.***

There was a significant difference between patients that were at risk of malnutrition on admission and those that were well nourished as determined by any of the three screening tools. There were significantly more malnourished patients diagnosed with respiratory disease, HIV/AIDS, nutritional deficiencies, TB, cardiovascular disease, gastrointestinal disease, infectious disease, cancer, and those admitted for surgical intervention (orthopaedic, abdominal, trauma) (*p*=0.001; Chi-square).

On admission (*n*=307) and discharge (*n*=80), the majority of patients that were categorised as at risk of malnutrition by any of the three tools were diagnosed with infectious disease , cancer, gastrointestinal diseases or admitted for surgical intervention (abdominal). The order changed slightly between the admission and discharge sample. The top five diagnostic categories of malnourished patients on admission were as follows: infectious disease (12.7%; *n*=39), cancer (11.1%; *n*=34), gastrointestinal disease (9.8%; *n*=30), surgical intervention (abdominal) (8.8%, *n*=27) and cardiovascular disease (7.5%; *n*=23). Within the discharge sub-sample, cancer patients contributed most (16.3%; *n*=13), followed by gastrointestinal disease (12.5%; *n*=10), surgical intervention (abdominal) (10%; *n*=8), infectious disease (8.8%; *n*=7) and TB (7.5%; *n*=6) (*p*=0.001).

The null hypothesis is therefore rejected as there was a difference in the primary diagnosis of those patients considered malnourished compared with those that were well nourished.

X. ***To assess and describe whether there are nutrition protocols, instruments and practices in each ward which can help identify adult patients at risk of malnutrition and if the ward has the necessary items to support the implementation of dietetic interventions, by using a ward checklist.***

Twenty-eight (*n*=28) wards were assessed by using the observational checklist. None of the wards included had a nutrition policy or screening tool available at ward level. Telephones are used to make referrals, and were available in all wards, with the majority (82.1%; *n*=23) in working order. Concerning anthropometrical instruments, 96.4% (*n*=27) of the wards had scales available to measure body mass. However almost a quarter (22.2%; *n*=6) of these were not in working order. Only 42.9% (*n*=12) of wards had a stadiometer available. For the appropriate storage of supplements, the ward kitchens were assessed for the availability of a dedicated refrigerator. Although 78.6% (*n*=22) had refrigerators allocated for this purpose, only 31.8% (*n*=7) were used for their designated purpose. The number of patients within the ward was also counted, as well as the number of nurses on duty to determine if there were enough nurses to care for the patients. The mean number of patients was 43 ±17.7SD, with 11 ±2.5SD nurses in a ward, giving a nurse: patient ratio of 1:4.

XI. ***To determine how many of the malnourished adult patients are referred for a dietetic consultation within their duration of hospitalisation.***

On admission (<48 hours), only 1.3% (*n*=5) of patients were referred for a dietetic consultation. Patients were referred by the physician (40%; *n*=2), nursing staff (40%; *n*=2) or screened by the dietitian (20%; *n*=1) and referred to the dietetics department for a nutrition assessment. On discharge, there were more referrals (9.8%; *n*=9), although this does not compare with the prevalence of malnourished patients on discharge. Only 11.1% (*n*=1) of patients that lost ≥5% were referred and none of the patients that lost >10% were referred for nutrition support.

XII. ***To assess the change in the prevalence of malnutrition in hospitalised adult patients between admission and discharge.***

Within the discharge sub-sample, there were more patients considered at risk of malnutrition, irrespective of the screening tool used. The SGA had the lowest prevalence of malnutrition (65.2%; *n*=60), although there were more patients considered severely malnourished (15%; *n*=9), with fewer categorised as mild to moderately malnourished (85%; *n*=51) in the discharge sub-sample compared with the baseline assessment. The prevalence of patients at nutritional risk or with malnutrition within the discharge sub-sample according to the NRS-2002 was 73.8% (*n*=62), and the highest prevalence score was provided by the AMDT of 79.3% (*n*=73).

The null hypothesis is therefore rejected, as the prevalence of risk of malnutrition was not the same between the admission and discharge sample, regardless of the screening tool used to determine this.

XIII. ***To assess the outcomes of malnutrition in adult hospitalised in-patients on discharge (or at 28 days' post-admission).***

Length of Stay

The mean LOS was 6.9 days ±5.9SD. There was a significant difference ($p<0.01$) in the mean LOS between those considered 'at risk' or malnourished (mean 7.4 days ±6.1SD) compared with those that were well nourished (mean 5.2 days ±4.8SD).

Similarly, a significant difference was found between length of stay and involuntary weight loss ($p=0.02$; Mann–Whitney U). Patients that had lost weight had significantly longer LOS (mean 10.6 days; ±4.8SD) than patients that had not lost weight (mean 8.6 days ±3.1SD).

Significant differences were found between diagnostic categories and LOS with participants diagnosed with urological disease, TB, nutritional deficiencies, or those that were admitted for surgical intervention secondary to trauma, vascular and abdominal complications presenting with a longer length of stay ($p<0.01$). There was also a weak,

but significant relationship between age and LOS, indicating that older participants had a longer length of stay (r=0.15; *p*=0.00 Spearman's Rank Order Correlation).

There was no significant difference in length of stay and disease severity (r=0.15; *p*=0.54; Spearman's Rank Order Correlation), the number of complications and length of stay (r=0.14; *p*=0.18; Spearman's Rank Order Correlation), discharge BMI and LOS (r=0.08; *p*=0.43; Spearman's Rank Order Correlation).

Complications

On discharge the mean number of complications that patients suffered was 1.6 ±1.6SD. Almost two-thirds of patients experienced some type of complication (64%; *n*=59). The majority of patients experienced gastrointestinal-related complications (27.4%; *n*=40), followed by complications related to haematological disorders and the cardiovascular system (13%; *n*=19). Furthermore, a significant difference (*p*=0.048; Mann–Whitney U) between patients at risk of malnutrition and the number of complications experienced was found, where patients at risk of malnutrition had more complications from admission to discharge (mean 1.7 ±1.6SD) than those considered well nourished (mean 0.8 ±1.3SD).

Treatment type needed for treating complications was documented alongside the complications the patient may have experienced, to determine the grade of the complications. Of the patients that were treated, most had Grade 1 complications (47.2%; *n*=67), followed by Grade 2 (40.8%; *n*=58), with the minority of patients experiencing Grade 3 complications (4.2%; *n*=6).

XIV. ***To determine the relative validity of the different screening tools used against one another (i.e. NRS-2002 against SGA, NRS-2002 against the six-character AMDT, and vice versa).***

With the lack of a gold standard, the screening tools were used as a reference to measure validity. When the NRS-2002 was used as the reference method, both the AMDT (specificity 77.3%; sensitivity 38.5%) and SGA (specificity 81%; sensitivity 41.5%)

had poor validity. Inter-rater agreement was also poor for both tools (AMDT k=0.15; SGA k=0.24).

Similarly, when using the AMDT as the reference of measurement, the NRS-2002 had poor validity (specificity 79.6; sensitivity 35.3%) and inter-rater reliability (k=0.15). Yet the SGA did have good validity (specificity 89.4%; sensitivity 71.4%) and inter-rater reliability (k=0.62).

However the best results in terms of validity and inter-rater agreement were observed when the SGA was used as the reference. The NRS-2002 had fair validity (specificity 51.8%; sensitivity 73.8%) although poor inter-rater agreement (k=0.24), whereas the AMDT had both good validity (specificity 80.2%; sensitivity 83.9%) and good correlation validity (k=0.62).

CHAPTER 4

DISCUSSION AND LIMITATIONS

4 DISCUSSION

4.1 INTRODUCTION

Hospital malnutrition is a worldwide problem and its prevalence ranges from 15–76%, depending on the approach used to make the diagnosis and the patient population studied.[12,33,34,42,42,49,51-60,60-66].Hospital malnutrition is aggravated by the inflammatory component associated with disease, increasing this population's risk of malnutrition. [8] Furthermore, malnutrition is associated with increased cost of care[105,172,173] due to medical intervention needed, complications,[174,175] increased length of stay[173,176,177] and mortality [95,175,176,178] it also decreases the patient's quality of life compared with that of their well nourished counterparts.[26,179] South Africa's hospitalised population is at increased risk of malnutrition, due to high levels of poverty and the heavy burden of the presence of both communicable (e.g., HIV/AIDS, and TB) and non-communicable diseases (e.g., diabetes, hypertension, and cancer) largely influenced by socioeconomic disparities with the heaviest burden on those from poor urban communities.[167] The aim of this study was to gain insight into the prevalence of hospital malnutrition in South Africa, as there is currently very limited data available on this.

4.2 PATIENT DEMOGRAPHICS

On admission and discharge there were more males (52.9% and 53.3% respectively) than females (47.2% and 46.7% respectively) included in the study, although distribution between genders stayed similar throughout. This distribution is similar to the Nutrition Day Care Survey 2010 (53% and 47% respectively), where nutritional status and dietary intake was assessed.[47]

The mean age of patients on admission was 45.5 years ±16.6SD, whereas the mean age in the discharge sub-sample was 49.2 years ±16.1SD. The mean age of patients considered malnourished according to any of the three screening tools was higher (50 years ±16.2SD) than that of those considered well nourished (43.8 years ±14.7SD) on discharge, although this was not seen on admission. This is a common trend in international studies also. However the mean age of the study sample was lower in this study compared with that of international studies,[51-53,61,144,180,181] but higher compared with that of another South

African study conducted by O'Keefe et al. where the mean age of patients was 41–42 years.[34] As O'Keefe's study is a comparable study, conducted in a similar setting, it can be speculated that improved age may corresponded to the increased life expectancy since 1983, secondary to the initiation of antiretroviral drugs (ARVS) and improved healthcare in South Africa.

Nevertheless, the tendency that malnutrition increases with advancement in age is identifiable, as in other studies in hospital malnutrition.[51,61,181] The literature also supports this, as the elderly are more likely to suffer from dementia, poor dentition, immobilisation (functional capacity) and anorexia, putting them at increased risk of malnutrition.[49] Moreover a significant difference in malnutrition and age was found in a national cohort study conducted in Spain (*n*=1707), where patients ≥70 years of age were significantly more malnourished than their younger counterparts.[51]

With this in mind, the effect of age may have been underestimated in this study, as older patients are more likely to suffer from dementia or delirium, which were part of the exclusion criteria. These patients are also more likely to suffer from immobility and malnutrition.[44] The results may therefore underestimate the true prevalence of patients at risk of malnutrition due to the study's exclusion criteria.[58]

4.3 DISEASE CATEGORIES

As the study included patients from surgical, medical and gynaecological wards, there was a wide variety of diagnostic specialties.

Conditions such as gut injury, inflammatory bowel disease, wounds or trauma, sepsis, acute respiratory distress syndrome (ARDS), ageing, arthritis, obesity, metabolic syndrome, cardiovascular syndrome, diabetes, HIV/AIDS and cancer are established inflammatory conditions with nutrition implications.[8]

As most patients were admitted with infectious disease, cancer, gastrointestinal disease, cardiovascular disease, gastrointestinal surgery or surgery related to trauma, a poor nutritional status could be expected as these are all inflammatory conditions. The high number of patients admitted with cancer[45,51,52,61,181], digestive disease[34,46,52,61,181,182] cardiovascular disease [46,51,52,61,182] and surgery [45] is also commonly reported in comparable studies. However, the number of admissions relating to infectious and parasitic disease is

fewer.[46] This may be explained by the economic status of the countries where studies were done. As South Africa is a developing country, with rapid urbanisation, there is both a high prevalence of communicable disease and non-communicable disease; these diseases are not successfully prevented and treated owing to the combined burden of disease on healthcare, which explains the high prevalence of both on admission.[183]

Furthermore, there was a significant difference (p=0.001) in the diagnosis of patients that were at risk for malnutrition on admission, and those that were considered well nourished. Patients that were at risk for malnutrition were commonly diagnosed with respiratory disease, HIV/AIDS, nutritional deficiencies, TB, cardiovascular disease, gastrointestinal disease, infectious disease, cancer, or they were admitted for surgery (abdominal, orthopaedic); many of these cases are associated with underlying inflammation. In turn, the effect of the active inflammatory processes may have contributed to patients' malnourished status, as these processes are known to induce anorexia. Consequently patients may have had a reduced dietary intake, increasing their risk of malnutrition.

The main four diagnostic categories on admission and on discharge included cancer,[181] gastrointestinal diseases,[58,61,182] abdominal surgery, and infectious disease.[181] It is known that the elderly and oncology patients are at increased risk of malnutrition (40–80% incidence),[134] owing to inability to meet their nutritional requirements secondary to fatigue, anorexia, cancer cachexia and increased metabolism.[52,57,184] A South African study also reported similar results and that oncology patients (50%) had severe cachexia (muscle wasting). In the same study the most common disease state associated with malnutrition was gastrointestinal disorders,[34]which likewise has been reported in multiple studies.[58,61,182] Furthermore, the malnutrition study in Germany had a similar distribution with the majority of malnourished patients (SGA B + C) diagnosed with cancer or gastroenterological conditions.[52]

The prevalence of risk of malnutrition was lowest among those with cerebral disorders, urological diseases, allergies and neurological diseases.

4.4 RISK FACTORS FOR MALNUTRITION

Factors present in this study known to contribute to the development of malnutrition include underlying inflammatory conditions as discussed, as well as poor dietary intake, anorexia, nausea, vomiting, and diarrhoea, contributing to weight loss and a poor nutritional status.

On admission, the majority of patients experienced a gastrointestinal side effect. In most cases, it consisted of only one side effect present, usually experienced for less than one month. This may indicate the presence of gastrointestinal side effects with acute disease conditions. However 11.9% had had side effects for the last three months, which may have greatly affected their quality of life and dietary intake, and contributed to weight loss. Within the discharge sub-sample, the number of side effects endured was significantly higher than the admission sample, with the majority of patients enduring two or three side effects. Of concern is that all the gastrointestinal side effects that were documented in this study were more prevalent in the discharge sub-sample and included nausea, vomiting, diarrhoea, constipation and anorexia. Of these, anorexia contributed most considerably throughout the study, which correlates with the inflammatory disease conditions of the patients, as cytokines may have contributed to cytokine-induced anorexia, taste aversions and changed eating behaviours.[8,185]

Although the duration of gastrointestinal side effects was mostly infrequent, still 15–25% of participants reported the presence of a gastrointestinal side effect (nausea, or vomiting, constipation or diarrhoea) of at least two weeks' duration. Similarly, within the discharge sub-sample, anorexia was reported for two weeks or longer in 25% of patients, which is of great concern.

Compared with the admission sample, significantly more patients experienced diarrhoea in the discharge sub-sample. This may have been secondary to the poor dietary intake due to anorexia. Gastrointestinal changes can occur when there is a lack of nutrients in the lumen, contributing to changes in enzymatic function, transit time, villous height, intestinal permeability, and often resulting in diarrhoea associated with a high mortality rate in severe malnutrition.[29] Lack of nutrition (starvation) also increases gut permeability and is associated with the development of both sepsis and systemic inflammation[86] which is known to have detrimental nutrition implications, creating a vicious cycle of malnutrition.[8]

Also more patients may have experienced gastrointestinal side effects as both disease processes and malnutrition are known to impair every aspect of the immune defence system, increasing patients' vulnerability to infectious diarrhoea.[186,187]

Reduced dietary intake for one week was reported in almost half (49%) of the sample studied, which is comparable with other studies which range between 17% and 52%.[37,45,182] On discharge it exceeded the range, as it was reported in 57.6% of patients. The majority of the patients in this study could only consume half of their usual intake, followed by patients only consuming a quarter of their usual intake. This is of concern as reduced dietary intake is central in the pathogenesis of weight loss in hospitalised patients,[29] where involuntary weight loss is associated with increased morbidity and mortality.[44]

A significant difference was also found between dietary intake of patients at risk of malnutrition (by any of the three tools) and well nourished patients ($p<0.01$) included in both the admission and discharge assessment. This confirms that patients at risk of malnutrition have poor dietary intake which may have contributed to their poor nutritional status. Sixty percent (60.6%) of patients considered 'at risk' had a decreased dietary intake, compared with 66.4% on discharge. This is the same trend as the prevalence of patients at risk of malnutrition on discharge.

Reasons for decreased intake are beyond the scope of this study, although as previously discussed, anorexia was a common side effect experienced in this study sample. Regardless, the drastic decreased intake is of concern, as Bauer et al. found that patients eating less than half of their meal are four times more likely to be at risk of malnutrition, with those eating less than a quarter at 15 times higher risk, compared with those who consumed more than half their meal.[45]

The Nutrition Care Day Survey by Agarwal et al. confirmed that malnutrition and poor dietary food intake are independently associated with patient outcomes in acute care patients in a developed country,[46] providing another reason to optimise dietary intake in all hospitalised patients. The results from this study confirm the multifactorial reasons for malnutrition in the ill and injured, with decreased dietary intake, increased requirements, and underlying inflammation playing the most central role.[49] In the South African context, patients may be more severely affected, with the added disadvantage of food insecurity and poverty that is known to exist in this developing country.

4.4.1 Anthropometry

4.4.1.1 Body mass

On admission and discharge, body mass was taken and was corrected for factors influencing the weight (including oedema and ascites). The number of patients with oedema on admission to discharge ranged from 22.8–26%, which is similar to the literature where 23% of patients had oedema.[188]

The mean weight of patients in this study was 68.1kg, which is 8.5kg less on average than patients included in the Nutrition Care Day Survey (*n*=3122) where the mean weight was 76.7kg.[46] Similarly, the weight was lower than participants of the EuroOOPS study (*n*=5051), where participants had a mean body mass of 72.5kg.[53] It is important to note that these studies were done in developing countries, and therefore patients from these studies are expected to have a better nutritional status. In fact, body weight does compare to the study conducted by Álvarez-Hernández et al., which was conducted in a developing country. However, it's important to note that 55% of these patients were ≥65 years of age, which influences weight as the elderly are more susceptible to weight loss.[51,61,181]

When differentiating between genders, females had a higher weight on average (70.2kg) compared with that of males (66.2kg). This is supported by South African statistics which reported a higher prevalence of overweight and obesity in women compared with that in men.[167,189] This is also influenced by the South African culture, which embraces curves as a sign of wealth and beauty, opposed to a lean physique, which is associated with HIV/AIDS.

However, on discharge, the mean weight was 65.3kg, indicating a significantly lower weight in the discharge sub-sample compared with the admission sample.

4.4.1.2 Body Mass Index

When classifying the patient's nutritional status according to BMI, the mean BMI (23kg/m^2) is similar to that documented in the literature (range 23–26kg/m^2), although in the lower range.[46,51] However, the distribution between BMI classifications differs, as the study sample had more patients in the 'extremes'.

There was also a significant difference between the BMI values between those considered at risk of malnutrition (mean 23.5kg/m^2 ±7.2SD), compared with those that weren't (mean

28.7kg/m^2 ±6.4SD) within the admission sample. This is similar to reported statistics, where significant differences were observed.[51,181]

When comparing BMI with the WHO cut-off points, the majority of the patients' BMI was in the healthy category (43.7%) which is similar to the findings of a study conducted on the nutritional status of patients in Beijing, China, also a developing country.[58]

However both forms of malnutrition (under- and overnutrition) were of high prevalence in this study, which is representative of the nutritional status of developing countries, such as South Africa.[189]

On admission, 16.7% were classified as underweight, which is much higher in comparison with similar studies where it ranges between 6–11.4%. [37,46,47,51,58,182] Although categorised as 'healthy' according the WHO, the prevalence of patients considered to be at risk of malnutrition as defined by the NRS-2002 categories (BMI 18.6–20.5kg/m^2) was also higher (13.4%) compared with only half in the literature (6%).[132] A low BMI (<20kg/m^2) is a significant predictor of mortality among both young and older hospitalised patients[190] and correlates with frailty and poor outcomes. It is also associated with mortality from non-cancer, non-cardiovascular causes.[191] Furthermore, the undernourished patient has an increased risk of poor wound healing, infections, and pressure ulcer development,[44] which in turn contributes to an increased care load for nursing staff. [21]

In contrast to undernutrition, 19.6% of patients were classified as overweight (BMI 25-29.9kg/m^2) and 20.1% as obese (≥30kg/m^2).Obesity was the main contributor to malnutrition in this study, as the prevalence was higher than that of overweight patients. This does not correspond with similar studies, where overweight patients are the key contributors.[47,58] However, a limitation of the BMI is that it may classify muscular individuals as overweight/obese due to muscle mass and is not sensitive to changes in body composition.[111]

The high prevalence of overweight and obese patients was also identified in the earlier South African study by O'Keefe et al., where 10–12% of patients were significantly overweight (>120% IBW).[34] When comparing the results with the study of O'Keefe et al. in 1986, the number of overweight and obese patients has since doubled. Furthermore, the high prevalence of obesity also correlates with South African statistics, where it is reported

that there is a rising trend in obese patients. This is especially common in the poor urban areas, and in the female population which was confirmed when comparing body mass between genders. In general, this is of great concern as obesity is associated with an increased prevalence of non-communicable diseases such as cancer, diabetes, hypertension, orthopaedic problems and decreased quality of life (QOL).[44]

4.4.1.3 Unintentional weight loss

Weight loss was determined by percentage weight loss, if normal weight was known; otherwise it was determined subjectively, by evaluating any change in the patient's belt setting or loose clothing. The majority of patients did not know their weight, which may be indicative of the lack of routine body measurements (weight) taken at healthcare facilities. However, prior to admission, 36% of patients already reported significant weight loss. Similar results were obtained in a recent hospital survey where it was reported that 40% of patients had lost weight in the three months prior to hospitalisation.[156] This is supported by literature which states that prior to admission, many patients suffer from poor appetite and weight loss.[37,192]

Additional to weight loss prior to admission, more than half (58.7%) the patients experienced weight loss in hospital. Significant weight loss (>5%) was reported in more than a third (37%) of patients. Most alarming is the (>10%) weight loss experienced by 9.8% of the study sample, which is associated with higher morbidity and mortality.[193,194]

The high prevalence of unintentional weight loss suggests the presence of an undesirable condition or pathology, particularly among hospitalised patients. In older adults malnutrition is often characterised by poor dietary intake, loss of appetite, muscle wasting and weight loss [44] of which all were evident in the study sample, supporting the obtained results.

Most of these patients were diagnosed with gastrointestinal disorders, cancer, and nutritional deficiencies or admitted for abdominal surgery or had surgery secondary to trauma. Many of these were inflammatory conditions, indicating the presence of cytokines which contribute to lipolysis, anorexia, muscle protein breakdown and nitrogen loss.[8,44] Furthermore, early satiety, bloating, anorexia, constipation, dental problems, and fatigue are considered 'red flags' for unintentional weight loss.[44] Although not all of these factors

were assessed in this study, many patients did report these, in both the admission and discharge sub-sample: anorexia (34.9%; 43.5% respectively), constipation (22.6%; 38% respectively) and reduced dietary intake for one week (49.1%; 57.6% respectively). In this study a reduced dietary intake was also found to be significantly higher among the malnourished compared with the well-nourished on admission and discharge. In a conducted by Kondrup et al., it was reported that all patients consuming less than 75% of their nutritional requirements experienced weight loss, and therefore poor dietary intake was a probable contributing factor to the exacerbated nutritional status in this study.[195]

The severe weight loss may have also played a role in the regressed muscle function experienced by patients, as weight loss rather than body weight affects muscle dysfunction.[196]

Pablo et al. reported weight loss of 28.9% in patients six months prior to hospitalisation, and found that this was influenced by the clinical disease state, loss of appetite and gastrointestinal symptoms confirmed in this study. Weight loss prior to admission is an important index with prognostic performance. Furthermore they confirmed that both involuntary weight loss and malnutrition reduced QOL, compromised recovery, and contributed significantly to the institute's financial burden, which would therefore imply negative implications for both the patients and institution in this study.[188]

4.5 PHYSICAL ASSESSMENT

4.5.1 Muscle Function

Functional capacity is often compromised in the malnourished hospitalised patient and impacts the patient's quality of life as well as daily functioning.[26]On admission and discharge, more than a quarter (28%) of patients had difficulty with daily activities, with more patients reporting regression in functional capacity in the discharge sub-sample.

Fewer patients experienced severe dysfunction in being chair- or bedridden, although there were more patients with severe dysfunction within the discharge sub-sample compared with the admission sample. Similarly, most patients in the discharge sub-sample felt that their functional capacity had further regressed rather than improved.

A more objective measure of decreased muscle function was conducted using handgrip strength and analysed according to gender and age, as these are the strongest influencing factors in healthy people.[197] Nearly a quarter (23,4%) of patients had decreased handgrip strength on admission, and a third of patients on discharge (35%). Loss of functional capacity was similar (36.7%) in a study conducted on nutritional status on hospital admission.[188]

The objective and subjective results obtained differed only slightly. This may be as handgrip strength only assesses upper-limb strength and cannot be used to evaluate activities of daily living, strength or speed of walking nor lower strength of lower extremities.[198]

Early changes in muscle function are frequently related to electrolyte imbalances and nutritional intake.[198] Other factors that may have contributed to decreased muscle function during hospitalisation include disease severity, co-morbidity load, bed rest,[199] infection, electrolyte imbalances, oxidative stress, and inflammation as these are all associated with acute and chronic disease[200] Inflammation adversely affects muscle function as cytokines stimulate muscle degradation, and avert muscle tissue repair, which affects both muscle contractibility and function.[116,198] Additionally the presence of disease is associated with reduced nutritional status, which also has an impact on muscle function.[198]

As most patients had an inflammatory condition on admission, with consequent poor nutritional status, this may have affected muscle function. This also includes the large number of overweight and obese patients included in the study, who besides their disease condition, have chronic low-grade inflammation.[8]

The effect of a poor nutritional status on muscle dysfunction is evident in this study as the impact of nutritional factors doubled when comparing the admission (23.4%) and discharge (47.5%) samples, where the discharge sample had a higher prevalence of malnutrition. This is of concern as reduced muscle function in conjunction with the presence of disease is known to have detrimental effects on functional status, recovery from disease, and clinical outcome.[198]

4.5.2 Clinical Examination

Despite reduced muscle function, the results of the physical assessment indicate that the majority of patients had good muscle stores. This supports the study conducted by

Bisonnette et al., which reported that muscle function does not correlate with muscle weight or size [201] and that early muscle dysfunction is more sensitive to lack of nutrition and restoration rather than muscle mass. [198]

The prevalence of adequate muscle stores may also have been influenced by the number of overweight and obese patients (BMI ≥25kg/m^2; 39.7%) included in the study sample as overweight patients may often appear to have normal muscle mass stores due to the overlying subcutaneous fat layer, masking muscle loss.[116]

Despite good stores, muscle mass was slightly lower within the discharge sample. Areas that were most frequently identified to have the biggest loss include the temple, and clavicle. These areas are in the face or upper body, and have been recognised as areas where muscle loss is best evaluated in the hospital setting, because of less overlying subcutaneous fat and the presence of smaller muscle groups which may be more sensitive to wasting.[116]

Subcutaneous tissue stores were also identified to be adequate, with lower stores observed within the discharge sub-sample. However, despite reported decrease in dietary intake and weight changes, as in this study, it is common for clinicians to observe excess or normal fat stores.[116]

The lowest scores were identified on the orbital areas of patients. This agrees with the literature which states that fat loss is best identified in the orbital area, as the subcutaneous tissue at the triceps and ileac crest are often concealed by a large body physique.[116]

Despite the majority of the patients having both normal muscle and subcutaneous fat stores, there was a wide range of patients, including those with severely depleted stores and patients with good stores.

Both loss of appetite and weight loss are associated with reduced muscle mass. [48] Loss of muscle mass is also associated with increased morbidity and loss of function, even after only one week of illness.[150] Overall, the physical assessment supports the literature in that reduced muscle function is not primarily determined by loss of muscle mass, but rather by nutritional factors, and inflammatory processes.[198]

4.5.3 Prevalence of Risk of Malnutrition

On admission to hospital, patients identified to be at risk of malnutrition ranged from 56.6–62.9%, depending on the screening tool used. This concurs with the estimated worldwide

prevalence of malnutrition (15–76%), although falling within the higher range.[12,33,34,42,42,49,51-60,60-66] Pepersack et al. found that over half of older adults have protein–energy malnutrition on admission to hospital or develop nutritional deficits, which corresponds with the results obtained.[202]

The high prevalence of risk of malnutrition may also be explained by the accompanying disease condition present in most patients, namely cancer and gastrointestinal disorders, since it is known that oncology patients are likely to suffer from cancer cachexia, weight loss and side effects of cancer therapies.[44] Gastrointestinal disorders may present with gastrointestinal side effects, malabsorption or obstruction, limiting dietary intake, and possible nutrient malabsorption, increasing the likelihood of unintentional weight loss.[44]

The results of this study are also similar to a South African study conducted by O'Keefe et al. In this specific study O'Keefe compared the nutritional status of 449 health and 803 hospitalised urbanised black population in Durban, by taking anthropometrical measurements (weight, height, tricep skinfold thickness and MUAC. Similar to the results of this study, a high prevalence of malnutrition was found in urbanised hospitalised patients compared with controls.[33] Although the studies are not comparable owing to different parameters used, both indicate a high prevalence of malnutrition in urbanised South African populations.

Prevalence of malnutrition was determined using the NRS-2002, SGA and AMDT. The NRS-2002 and SGA are both screening tools, whereas the AMDT is a diagnostic tool for malnutrition. It would therefore be expected that the scores of SGA and NRS-2002 would be similar, and also provide a lower prevalence than that of patients diagnosed as malnourished. Although the scores of the SGA (56.6%; *n*=228) and NRS-2002 (59.1%; *n*=237) were relatively similar for identifying patients at risk, they were not higher than the AMDT. Rather, the AMDT had the highest score (62.9%; *n*=252) for diagnosing patients as malnourished. Within the discharge sub-sample, the prevalence of patients identified as at risk for malnutrition ranged between 65.2–79.2% with any of the three tools. Similar to admission data, the AMDT had the highest score (79.2%; *n*=73). The NRS-2002 identified 73.8% (*n*=62) 'at risk', with SGA reporting the lowest number of patients as malnourished (65.2%; *n*=60).

4.5.3.1 Nutritional Risk Screening-2002

On admission, 59.1% of patients were identified to be at nutritional risk by the NRS-2002. The majority (80.3%; *n*=322) of patients had a risk factor for nutritional risk and progressed to the second part of the NRS-2002. Remarkably the entire study sample (100%; *n*=84) on discharge was included in the second part of the NRS-2002, which may indicate the development of nutrition risk factors during hospital stay. The score for disease severity was reasonably low, and although it was stable, it was higher within the discharge sub-sample. This differs from comparable studies, where the mean value for disease severity was lower on discharge.[58,60] This may be due to different interpretations, where in this study a score was allocated according to complications and interventions that occurred during hospitalisation, rather than to patients' disease condition on the day of discharge. Regardless, the median for the total score differed from 2 within the admission sample, compared with 2.5 within the discharge sub-sample. As the disease severity score was not very high (median 1 on admission and discharge), the total score was mostly influenced by the 'nutritional impairment' score of the patient.

On admission, only 7.2% (*n*=29) of the patients included were ≥70 years. This does not compare with other studies, which have a much larger contribution of the elderly. However, within the discharge sub-group, there was a higher percentage of elderly patients (11.9%; *n*=10), which in turn received an age-adjusted score (recognising age as a risk factor for malnutrition).

The lower mean age of patients included in this study and the lower disease scores may have been influenced by the exclusion criteria, as patients with dementia (often the elderly) and those severely ill (admitted to ICU, unconscious, ventilated or on dialysis) were not included. The prevalence of patients at risk of malnutrition may therefore have been underestimated, as these patients are known to be at higher risk of malnutrition.[51,61,181]

When evaluating the NRS-2002 score with the patients where weight loss was experienced, it identified the vast majority (80%) of patients that lost >5%, and all of the patients that lost >10% body mass. This may be due to one of the criteria that the NRS-2002 is based on, as it allocates a score for weight loss. These patients are likely to benefit from nutritional intervention to improve outcomes, which is the purpose of the tool.

The prevalence of nutritional risk on admission that was identified by using the NRS-2002, does not compare with similar studies, as it was much higher.These include the EuroOOPS (32.6%)[53], the PREDyCES study (23.7%)[51], and studies conducted by Liang et al. in Beijing teaching hospitals (27.3%)[58], Raslan et al. (27.9%)[203], and Tangvik et al. (29%),[131] to list a few.

4.5.3.2 American Malnutrition Diagnostic Tool

The AMDT is a new diagnostic tool for malnutrition recommended by ASPEN. For the AMDT to make a diagnosis of malnutrition, the patient must present with two of the following characteristics: involuntary weight loss, decreased dietary intake, decreased functional capacity, muscle wasting, loss of subcutaneous fat, or localised/general fluid accumulation. As it is a new diagnostic tool, there are limited studies available in which it has been used to assess prevalence of hospital malnutrition.[144]

Compared with the other screening tool used in this study, a lower prevalence of malnutrition was expected owing to the nature of its being a diagnostic tool. Nevertheless, the AMDT gave the highest results for prevalence of hospital malnutrition on both admission (62.9%; *n*=252) and discharge (79.2%; *n*=73). Possible reasons for the high prevalence of malnutrition may be because the tool requires the presence of only two of the clinical characteristics mentioned, and the clinical characteristics required are typically present in hospitalised patients. Also patients can be classified as malnourished when using the AMDT, without having any contribution of nutritional factors, that is, the presence of decreased functional capacity (which could possibly be due to age) and the presence of oedema (i.e., liver disease, cardiovascular disease).[16]

The median score on admission (median 2; IQR0-6) was lower compared with the score obtained in the discharge sub-sample (median 3; IQR 2-4). This indicates that the majority of patients are malnourished (presence of two clinical features) and secondly that there were more diagnostic characteristics present within the discharge sub-sample compared with the baseline assessment. This reiterates the importance of routine screening at weekly intervals. Also of interest is the interquartile range which is smaller on discharge and more centred around the presence of two to four characteristics.

The prevalence of malnutrition, as documented by the AMDT, may be regarded as the most representative of the study sample, as the criterion used is not influenced by age or disease severity.

Furthermore, the AMDT identified 90% of patients as malnourished that had lost 5% body mass, and 100% of patients that had lost >10% body mass. These results are the same as for the NRS-2002, and may be because involuntary weight loss is a diagnostic parameter. It could therefore allow for accurate identification of patients that would benefit from nutritional intervention to improve clinical outcome.

4.5.3.3 Subjective Global Assessment

Owing to the lack of a gold standard, the SGA has often been considered the gold standard of nutrition screening.[13,67,118,123,127,204] In this study, compared with the other tools used to identify the prevalence of malnutrition, the SGA identified the lowest number of patients as malnourished (56.6%; *n*=228), although it did show the same trend in the prevalence of malnutrition with a difference between the admission and discharge sample (65.2%; *n*= 60).

The SGA was the only tool included in the study that differentiated between the severity of malnutrition. The majority of patients within the admission sample had mild to moderate malnutrition (87.3%; *n*=199), with severe malnutrition present in 12.7% (*n*=29). The discharge sub-sample had similar results with 85% (*n*=51) having mild to moderate malnutrition and severe malnutrition in 15% (*n*=9) of the sample. The results indicate that there was a higher prevalence of malnutrition within the discharge sub-sample and it included more severe cases of malnutrition compared with the admission sample. Similar results were obtained in the Brazilian National Survey (IBRANUTRI)(*n*=4000), where despite fewer patients diagnosed as malnourished (48%), the prevalence of severe malnutrition was similar (12.6%)[61], as well as in a South African study conducted at Tygerberg Hospital, where 17% of patients were severely malnourished.[71]

The median score was 5.8 (IQR 4.6–6.5) where a score of >6 indicates that the patient is well nourished. Within the discharge sub-sample, the score was 5.2 (IQR 3.9–6.3), indicating a lower score compared with that of the admission sample. Although the SGA score may compare with the mean BMI of the study sample, the two are not comparable parameters,

as a patient with a normal BMI may still have lost considerable weight and can therefore be at nutritional risk.[48]

Possible explanations as to why the SGA indicated the lowest prevalence of malnutrition among the three tools within both the admission and discharge sample, may be due to its subjective nature. It is known that for the physical assessment, the SGA requires training and practice to improve clinical judgement. Additionally, Makhija found that the physical assessment (muscle wasting and loss of subcutaneous tissue) and the weight loss component of the tool, influence the overall rating most significantly.[118,132,133] Although the researchers were health-care professionals with good clinical knowledge and experience of evaluating weight loss and dietary intake, physical assessments are mostly conducted by doctors, and dietitians traditionally have little training in physical assessments. This is turn may have influenced the overall score. To improve accuracy, more training on physical assessment may be advantageous for dietitians.[144]

The SGA assessment also requires a score for disease severity. As for the NRS-2002, this may have limited the true prevalence of malnutrition as those that were severely ill were excluded from the study. The SGA also allocated a score for gastrointestinal side effects. However, a score was only allocated if these were experienced for two weeks or longer, whereas the study sample most frequently reported side effects as 'infrequent' or 'less than one week' and would therefore not have been allocated a score.

Lastly, another possible explanation for the low prevalence may be that the SGA is known to identify and diagnose chronic malnutrition, rather than identify high-risk and acute cases.[205]

When comparing the accuracy of the SGA in identifying those patients with weight loss, the SGA performed the poorest among the three tools. Although it did successfully identify 85% of those that had lost 5% body mass, it only identified 60% of those that had lost >10%. This may be because the SGA focuses on chronic malnutrition and is not sensitive to acute nutritional changes. Hence it may not be an ideal tool for screening in the hospital setting, as it may fail to recognise some cases of malnutrition.[205]

4.6 OUTCOMES OF MALNUTRITION

4.6.1 Discharge Setting

The majority of patients were discharged home (81.5%), with the minority being discharged to other health intuitions, wards not included in the study, or nursing homes.

A small number of patients were excluded from the discharge interview as they had died while in hospital. From the literature, it is evident that an increased mortality rate is associated with malnutrition. The diagnosis of the patients that had died included cancer, nutritional deficiency, and gastrointestinal disease, of which cancer is known to be associated with mortality.[206,207] Of further interest is that a low BMI is an independent risk factor for mortality in the elderly.[208] Although these patients were not elderly per definition, their mean BMI was 20.7kg/m^2 ±5.1SD, and all of them reported significant weight loss prior to admission, which is associated with increased morbidity and mortality.[193,194]

4.6.2 Length of Stay

The mean length of stay for patients was 6.9 days ±5.9SD. The results indicate a weak, yet significant association between length of stay and age (r=0.15; p=0.00; Spearman). This may have been influenced by the inclusion criteria indirectly excluding the elderly.

However patients that were identified to be malnourished, or at nutritional risk by any of the three screening tools, had a significantly (p<0.01) longer length of stay (mean 7.4 ±6.1SD days) than those patients that were not (mean 5.2 days ±4.8 SD). The difference in length of stay was approximately two days, which concurs with the literature that states that LOS is increased by 40–70% in patients that are malnourished. [49] Similar trends have been reported in the literature, with an increase in stay ranging from four up to 43 days.[21,54,56,56,57,180,209-211]

Furthermore there was also a significant difference (p=0.02) between length of stay of patients that had lost weight (mean 10.6 days ±4.8SD) in hospital, compared with those that maintained weight (mean 8.6 days ±3.1SD), with a difference of approximately two days. Likewise, Kondrup et al. reported that LOS was independently related to recent weight loss among malnourished patients.[60] These results thus verify that nutritional status has an impact on LOS, where an increased length of stay is related to increased healthcare cost to

the medical institution.[21,52,61,209,210] Malnutrition is therefore also an economical concern, which can be reduced by proper nutritional care.[49]

Although there was no significant difference found in LOS and disease severity, nor the number of complications on discharge, this may have been due to the exclusion criteria of the study or due to poor documentation of complications in the patients' medical files. However, the results of this study do support the literature that malnourished patients have increased complications, which is often a reason why patients have a longer hospital stay. Other reasons include prolonged treatment duration.[49]

Patients that had longer LOS were diagnosed with TB, nutritional deficiencies, urological disease and those that were admitted for surgery (abdominal, vascular and trauma) also had a longer length of stay.

4.6.3 Complications

In the malnourished, key contributors to morbidity include decreased muscle function, wound healing, impaired immune function and recovery from illness.[49]

In this study, nearly two-thirds of patients on discharge had experienced complications. It is known that malnourished patients are at greater risk of co-morbid complications.[174,175] This was confirmed in this study as there was a significant difference (p=0.048) in nutritional status and the presence of complications, with patients at nutritional risk or malnourished experiencing more complications (mean 1.7 ±1.6SD) than those patients not 'at risk' (mean 0.8± 1.3SD). The AMDT was the only screening tool where there was a significant difference between nutritional status and number of complications (p=0.03). There was no significant difference in the number of complications experienced and the malnutrition score for either the NRS-2002 or SGA. This does not correspond with the literature, where the NRS-2002 was shown to be an independent predictor for poor clinical outcomes,[53] and the SGA an independent predictor for LOS, complications and mortality.[123] However, the SGA did prove to be near significant (p=0.06), and may have been influenced by the results obtained from the physical assessment component, which as previously mentioned, is known to significantly influence the final SGA score.[132]

Also, interestingly, the majority of patients at risk of malnutrition were primarily diagnosed with cancer, gastrointestinal disease, and cardiovascular disease, which are all conditions associated with poorer outcomes in malnutrition.[100,212]

Organ systems most frequently affected by complications in this study, included the gastrointestinal tract, haematological, and cardiovascular system. Chronic inflammation is known to injure the vascular endothelium and may have contributed to the development of cardiovascular disease.[8] As mentioned, gastrointestinal disorders were also one of the main contributors to a primary diagnosis, and therefore may explain the high prevalence of gastrointestinal complications. Furthermore the presence of side effects, including nausea, vomiting, diarrhoea and constipation, may also have contributed.

The severity of complications was determined by ranking them according to the treatment needed to correct them. This is of relevance as a therapy may induce additional stress and morbidity in a patient. When applying the classification system of Dindo et al.,[213] to the patients that were treated for their complications, more than half of patients (51.1%) had Grade 1 complications. Treatment included pharmacological treatment, such as diuretics, anti-emetics, analgesics, and electrolytes, and physiotherapy. However, a large fraction (44%) of patients had Grade 2 complications, requiring pharmacological treatment other than the above, or blood transfusions. Few (4.6%) patients experienced Grade 3 complications requiring surgical, endoscopic, or radiological intervention. The presence of any complication adds to medical treatment costs and nursing care; thus with the high level of both Grade 1 and Grade 2 complications, it can be assumed that medical costs were increased by the high prevalence of patients at risk of malnutrition.[105,172,173]

Both the severity of complications documented, and the lack of screening tools (NRS-2002 and SGA) able to predict complications, may have been limited by the exclusion criteria of this study (excluding the ICU ward and severely ill patients on ventilation or dialysis). This may also explain why there was no significant relationship identified between length of stay and complications.

4.7 NUTRITION SUPPORT

On admission, only 1.3% of patients were identified by health-care staff as patients requiring nutrition support and were referred to the dietetics departments, although at least 56.6% of newly hospitalised patients were identified to be at nutritional risk by one of the screening tools. Although there were more referrals made on discharge (9.8%), the number of patients identified also was higher in the discharge sub-sample. All in all, the results indicate that the study sample has a high prevalence of malnutrition, and that the identification and treatment of the malnourished patient are neglected.

In a Dutch study where 6150 patients were identified as malnourished, only 50% were identified as malnourished by medical staff.[49,214] This confirms the evidence that states that among malnourished patients, at least 50% go unrecognised.[215,216] However, relative to these results, it shows that this percentage is much higher in the South African context.

Referrals for nutrition support were made primarily by nurses and physicians, and the minority were screened by dietitians. In a study conducted by Bavelaar et al., it was found that despite physicians routinely performing physical assessments on patients, nutrition assessments occurred in only 15.3%. Similar results were obtained among nursing staff, who conducted a patient examination in 80% of patients, but only did a nutritional assessment in 29% of cases.[217] Similarly, a study conducted by Kondrup et al. showed that only 20% of doctors and nurses conducted nutritional screening. It may therefore be speculated that owing to the lack of urgency in conducting nutritional screening, patients are not referred for nutrition support.

Kondrup et al. reported that despite doctors and nurses recognising the positive impact of nutritional intervention in the prevention of complications, only 20% of patients were screened. Reasons for poor screening included its being a low priority, lack of knowledge, unclear assignment of responsibility, and the absence of guidelines on screening.[60] Lack of screening by health-care professionals for malnutrition, rather than lack of screening tools, is therefore a worldwide problem.

Of the few patients that were referred, 80% were identified as malnourished by the SGA, NRS-2002, and AMDT. However, when evaluating the referrals to reported dietary intake, a third of these patients had ‘no change’ in dietary intake. Additionally, only 11.1% of patients that reported of an intake of ‘less than a quarter’ of their usual consumption were referred.

Furthermore, half of the patients that were referred had lost weight on discharge, although 44.4% had maintained their weight while in hospital. Only 11.1% of patients that had significant weight loss were referred (<5%) and none of the patients that experienced >10% weight loss were referred. These results clearly lead to the assumption that neither the patients' dietary intake, nor their body mass, is monitored in hospital, because if it were, at least the majority of those patients that were unable to consume anything, and had significant weight loss, would have been referred. Another reason for poor referrals for nutrition support could be lack of awareness of the role of the dietitian, possibly due to poor visibility, as nutritional intervention only occurred in the minority of patients.

Somanchi et al. reported that in developing countries at least one-third of patients are estimated to be malnourished, and that without nutritional intervention approximately two-thirds of these patients will further decline. This statement is to some extent supported by this study and is relevant, as it was conducted in a developing country. Although the prevalence of malnutrition was higher, there is evidence indicating a lack of nutrition support in this setting, with poorer outcomes among the malnourished patients.[68]

Despite poor referrals, the majority of patients that did receive nutrition support received oral nutrition supplements, which are known to be the first line of defence in addressing hospital malnutrition. Numerous studies and systematic reviews have unfailingly demonstrated that ONS have nutritional, clinical, functional and economic benefits for malnourished patients, and thus could play a central, life-changing role in this setting.[148,149,218,219] The problem is therefore not necessarily the lack of intervention, but lack of appropriate referrals for nutritional intervention to occur, which partially depends on the timely and appropriate application of guidelines and protocols from screening and assessment to initiate a nutritional care plan dedicated to the care of the patient.[220-222]

4.8 NUTRITION SCREENING INSTRUMENTS AND PRACTICES

In relation to the above, the poor number and selection of referrals may be partially to blame on the environment of the institution, as none of the wards (surgical, medical or gynaecological) had a nutrition policy in place that could be followed for newly admitted patients. Additionally, none of the wards had a screening tool available. Health-care staff is thus limited in terms of conducting nutrition screening. ESPEN recommends that hospitals and healthcare organisations have a policy and specific protocol for identifying patients 'at

risk' so that these may lead to nutritional care.[13] With the absence of a policy and screening tool at ward level, the likelihood of nutritional care is therefore also scarce. This was evidenced by the number of referrals made for nutrition support in this study, as the number depends somewhat on the timely and appropriate application of policies and protocols.[220-222]

Furthermore, Kondrup et al. conducted a study in which the reasons why patients were not screened or were not classified as 'at risk' patients were documented. The most frequent reported reason for not screening patients was 'there is no instruction to do it'. This again stresses the importance of having a nutrition protocol within each ward. Other reasons for not screening included, lack of knowledge of how to screen and forgetting to screen. Reasons given as to why patients were not classified as 'at risk' included lack of guidelines to define a patient 'at risk', and short length of hospital stay, again highlighting the importance of protocols and guidelines within the wards.[60]

The referral system in this setting was based on telephonic communication, which did not appear to be a limiting factor as the majority of wards did have a telephone in working order. However, owing to the lack of screening tools for the identification of patients 'at risk' and the lack of standardised policies within wards, these may have contributed to the poor number of referrals made for nutrition support.

Most wards (94%) had a scale to measure body weight, although almost a quarter of these were not in working order. Similar observations were made in the IBRANUTRI study where scales were available in 75% of cases.[61] The type of scale varied among wards, which may a cause for confusion amongst inexperienced users and in turn may have limited usage of the available scales. Stadiometers were available in less than half of all the wards. Despite being limited by the availability of stadiometers, a patient's weight could potentially be routinely monitored from admission to discharge.

Nutrition supplements had potential storage space within each ward, as more than three-quarter of the wards had a refrigerator allocated for oral nutrition supplements. However, it was rarely (31.8%) used for its intended purpose. Instead it was often used to store food and drinks of staff members and medication. One could speculate that this may have occurred because of limited use of its original purpose, owing to general lack of nutrition support practised.

Although the reasons for inadequate nutrition screening and intervention are beyond the scope of this study, a survey conducted on nursing staff found that the lack of focus on nutrition was due mainly to a lack of guidelines and instructions pertaining to nutritional screening and intervention; secondly, nurses had an inadequate theoretical and practical knowledge of nutrition.[223] In this specific study, a possible reason could be the heavy burden of patient load on nursing staff. The recommended ratio of enrolled nurses to patients for a tertiary hospital in South Africa, is 1.3:1.[224] This means that for every patient, there should be 1.3 nurses allocated to his or her care. However the ratio of nurses to patients (1:4) was much higher than recommended in this setting in South Africa. Furthermore, the high prevalence of patients at nutritional risk or malnourished admitted to hospital contributes to workload, requiring more nursing care because of higher rates of infection, complications, pressure sores, medications and decreased functional capacity.[21]

4.9 VALIDITY OF SCREENING TOOLS.

Owing to the lack of a universal gold standard for validity testing, the three tools included in the study were compared with one another for concurrent validity without superiority or inferiority of one over the other.[123] However, it should be kept in mind that none of the tools used are completely 'error free', as each tool was designed differently, for a different purpose. Therefore the results can be misleading in terms of validity.[15,16] With regard to the different purposes of the tools, the AMDT is a diagnostic tool, whereas the SGA is an assessment tool [127] and the NRS-2002 is a screening tool.[16] The NRS-2002 was developed to identify 'at risk' patients that could potentially benefit from ONS, and was not designed to assess patients' nutritional status although it is often used for this purpose[16,123] The SGA was designed to be prognostic, a tool able to predict outcomes rather than diagnose malnutrition.[47] Despite their different goals, comparisons are still relevant although true validity of any tool can only be determined when its impact on clinical outcome has been proved.[127]

Validity testing was included in this study to aid in the establishment of an acceptable bedside method for identifying malnourished patients, rather than more expensive or complex methods,[15] and to ensure that referrals for nutrition support are appropriate.[14]

For a screening tool to be useful in identifying malnutrition, ideally it should have both sensitivity and specificity.[15] However a high sensitivity is particularly important in this

situation,[15] so that patients at risk of malnutrition can be identified and nutritional intervention can be implemented. Nutrition support of malnourished patients may results in improved quality of hospital treatment, and is associated with faster recovery and improved muscle function.[225] In this study, sensitivity refers to whether the screening tool is able to correctly identify those patients with malnutrition; specificity refers to whether the tool correctly identifies those patients that are not malnourished. Validity was based on the cut-off points, as stated in the methodology chapter.

4.9.1 Nutrition Risk Screening-2002

When using the NRS-2002 as the reference method, both the AMDT and SGA had poor validity. Both showed good specificity (AMDT 77.3%, SGA 81%), but poor sensitivity (ADMT 38.5%, SGA 41.5%).The tools therefore showed agreement with the NRS-2002 on the patients that were not malnourished, but did not identify malnourished patients correctly. Consequently patients in need of nutritional intervention could be missed on screening. There was also a great amount of variation between both tools, as indicated by the kappa value (AMDT k=0.15, SGA k=0.24).

These results differ from those of a study conducted that applied the SGA to the NRS-2002, which showed fair validity. However, the population study differed, which poses a challenge in validity testing.[226] Furthermore the tools were designed for different purposes as previously discussed, which may have influenced the results.

A systematic review of validity of screening tools also indicated that the NRS-2002 showed inconsistent construct validity to screen for malnutrition among different hospitalised patients and age groups,[123] which may be the reason why it did not perform well as a reference.

4.9.2 Subjective Global Assessment

In the literature, the SGA is most often used as the gold standard in validation studies of nutrition screening tools, as it was designed to predict clinical outcome, which is described by ESPEN to be one of the aims of screening. [13,67,118,123,127,204]

Compared with the SGA as the reference, the NRS-2002 had fair validity, with better sensitivity (73.8%) than specificity (51.8%). These results indicate that the NRS-2002 could positively identify most patients identified as malnourished by the SGA. However inter-rater

agreement was poor (k=0.24). Similar results were obtained by a study by Kyle et al., which showed fair validity of the NRS-2002 compared with the SGA in a group of patients with heterogeneous specialities.[127]

The AMDT had good validity against the SGA, with both a high sensitivity (83.9%) and specificity (80.2%) Amongst all the tools used, it was the only one able to identify malnourished patients accurately. Patients in need of nutrition support are therefore unlikely to be missed during screening with the AMDT, owing to its high sensitivity. Furthermore, because of its high specificity, it should not unnecessarily increase the work load of staff with unnecessary referrals, as it is able to correctly identify well nourished patients. The reason for the high validity may be because both the SGA and AMDT diagnose patients for malnutrition, despite different criteria used.

Furthermore, it had good inter-rater agreement (k=0.62), indicating good homogeneity among fieldworkers. This may be because it is largely based on objective criteria. [226] However, this would need further testing amongst all levels of healthcare staff if considered as a screening tool.

4.9.3 American Malnutrition Diagnostic Tool

When using the AMDT as the reference, the SGA showed good validity. Both sensitivity and specificity were considered good. Specificity was especially high (89.4%), although most importantly the tool had fair sensitivity (71.4%), indicating that the SGA could correctly identify patients that were malnourished, compared with the AMDT.

There was also good inter-rater agreement (k=0.62), which is consistent with the finding of the validation study (k=0.8).[118] A possible explanation for this is that the tool was used by dietitians with a similar level of clinical skills which correspond to the target population for whom it was designed, that is, clinicians.[16,118] However, owing to its subjective nature and skill required, this may not be the case if less skilled workers conduct the screening assessment. For a large-scale institution, implementation of the SGA as a screening tool could be impractical because of the training required,[118] making it both a costly and time-consuming process to ensure that all nurses are adequately trained.

The NRS-2002 had poor validity compared with that of the AMDT. Although specificity (79.6%) was good, the tool lacked sensitivity (35.3%) This means that although well

nourished patients will be correctly identified, patients that are malnourished are not as accurately recognised. Furthermore it had poor precision (k=0.15).

Overall, few tools showed good concurrent validity. However, a systematic review of the validity of screening tools, including the SGA and NRS-2002, found that all tools included had inconsistent results in construct validity, even when applied to populations comparable with those used for the development studies.[123] This may therefore explain why there may have been discrepancies among the validity results compared with those in the literature, possibly influenced by the diverse range of design, purpose and applicability of each tool.[16]

In the context of this study, best results were obtained using the SGA as the reference tool, which is a common practice in validation studies.[13,67,118,123,127,204] Both the NRS-2002 and AMDT had fair/good concurrent validity when compared with the SGA, and could therefore serve as screening tools to be used in this setting. This too concurs with current international recommendations, as the NRS-2002 is recommended by ESPEN for hospital nutrition screening, and the AMDT by ASPEN.[12,13]

When determining the most appropriate screening tool for a given setting, it is important to also consider factors such as applicability, age groups, and disease states that the tool is valid for; type of setting; ease and speed of application; availability of resources; and guidelines for use.[16] However, discussion of which screening tool is most suitable in this setting is beyond the scope of this study, and is also limited, owing to a paucity of studies having used the AMDT to assess hospital malnutrition.

4.10 LIMITATIONS

Although this study gives insight into the prevalence of hospital malnutrition and its contributing factors, the study design as well as methodology did have limitations, which may have influenced the results obtained.

Firstly, the exclusion criteria excluded patients that were demented or confused, which is most often found in the elderly.[44] The prevalence of malnutrition and patients at nutritional risk may therefore in fact have been higher. As these patients were excluded, the scores may have also been affected, as the elderly are more inclined to have a lower functional capacity. Furthermore, the critically ill, unconscious, ventilated or dialysed patients were excluded, which may have been associated with worse clinical outcomes and nutritional status. No significant relationship was found between complications and LOS, which is commonly found in the literature, and this too may have been a product of the inclusion and exclusion criteria.

There were also patients identified to be part of the study that were not in their beds at the time of data collection and consequently excluded. These patients were most likely having a medical or surgical intervention, and consequently may have influenced the results in terms of prevalence of malnutrition, and associated outcomes.

With regard to the methodology, objective anthropometric measurement could not always be obtained as many patients were unwell, in pain or had reduced functional capacity. In these cases the fieldworkers had to make use of estimation, which is a subjective method and depends on the field workers' clinical experience. Although this is common practice in a research study such as this, it has an effect on the accuracy of the data. Fortunately, objective data was obtained in the majority of patients included. Patients were also not knowledgeable about their body mass, and therefore weight loss prior to admission was estimated using subjective methods.

The statistical analyses was unfortunately not matched between the admission and discharge group, which lead to the description of two separate samples (admission and discharge), rather than the patients' health status over time.

In terms of the SGA, a limitation may have been having the physical assessment conducted by dietitians, who traditionally have had little training in physical assessment.[144] Although

dietitians have good clinical knowledge and training in dietary assessment, accuracy may have been improved if the physical assessment had been done in conjunction with a physician with intensive training in conducting physical assessments.

Regarding the nature of the study's being a cohort design, an inherent limitation is lost to follow-up. Unfortunately a large number of patients were lost to follow-up for the discharge assessment, although they did qualify to participate. Patients were often discharged without prior notice; this was determined arbitrarily by the physicians on their ward rounds which were conducted at different times, posing a challenge for the researcher in monitoring patients. Patients were also transferred within wards to different beds, as well as between wards with poor documentation of the patient's whereabouts, which was confirmed in an audit conducted in the hospital, during the time of data collection. All in all, the loss of follow-up may have introduced bias into the study.

Bias may have also have been introduced when assessing whether the regressed functional capacity was influenced by nutritional factors. This was a subjective score allocated by the researcher who was aware of the study outcome and could be considered a limitation, although it was based on scientific knowledge of the disease.

This study also included a heterogeneous group of patients regardless of the screening tool used. This may have its own limitations as the NRS-2002 has been validated for adult patients in the acute setting, and the SGA for a variety of settings and a range of patient populations, namely, geriatric [205,227,228], oncology[229], surgical[118], and renal patients[230], whereas the AMDT has limited data on it, and has not yet been validated for different groups of patients.[144] The tools also do not typically allow for comparison as NRS-2002 identifies those patients at nutritional risk, whereas the SGA and AMDT diagnose patients as malnourished, with the SGA differentiating in the degree of malnutrition. Despite this, they were selected as they are recommended for the hospitalised patient and recommended by reputable international societies.

In terms of validity of the tools, owing to the absence of a true gold standard and universally agreed definition of malnutrition, care should be taken to prevent over-reliance on the validity results of this study. Rather the tools should be tested for their ability to predict the effects of nutritional intervention on outcomes in future studies.[16]

Length of stay was also used as an outcome parameter in this study, which may be criticised as it has many non-nutritional parameters that influence it. However, it was included as it can also be interpreted as an integration of the role of disease and consequences of malnutrition (infection, poor wound healing, impaired functional status).[231]

Lastly, it may be argued that separating TB and HIV/AIDS from the 'infectious' disease category was a limitation as this underestimated the significance it may have had when drawing comparisons. However, this was done as these are highly prevalent communicable diseases in South Africa, and have significant nutritional implications. They were therefore separated so they could be highlighted on their own if there were any related interesting results obtained in the study.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5 CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

From the results it is evident that the prevalence of malnutrition is very high in hospitalised patients in this teaching hospital in South Africa, regardless of the screening tool used to determine this. Despite the burden that malnutrition carries for both the patients and the healthcare facility, it remains overlooked, as evidenced by the few nutrition referrals made. Even with medical and clinical advancements, the correction of a patient's nutritional status does not seem to be a medical priority. More staggering is the probability that the exclusion criteria of this study may have undermined the true prevalence of malnutrition, which currently ranges from 56.6–62.9% on admission, and may therefore be even higher.

Diagnostic categories that made up the majority of malnourished patients both on admission and discharge included those with gastrointestinal disease, cancer, infectious disease (excluding TB and HIV/AIDS) and patients admitted for abdominal surgery. TB and HIV/AIDS were separate categories to enable the researcher to highlight any particular findings related to these highly prevalent diseases in the South African context. The contribution of malnourished patients due to infectious disease is thus even higher. As the trend of the diagnostic categories (that contributed most to malnourished patients) remained reasonably constant between admission and discharge samples, it may be argued that these patients should be identified as high-risk patients and receive nutritional support, irrespective of their nutritional status. It also confirms the increased risk of malnutrition in the presence of inflammatory conditions, as evidenced by the patients' reduced dietary intake, anorexia, gastrointestinal side effects and involuntary weight loss.

Unintentional weight loss was highly prevalent both prior to hospitalisation and during hospitalisation, and is associated with increased morbidity and mortality; it is a strong predictor of negative outcomes regardless of the magnitude and rate of the underlying cause.[48] 'Red flags' for weight loss, including reduced dietary intake, constipation and anorexia[44] were also frequently reported by patients on admission for as long as two weeks, but were not recognised as risk factors by medical staff. More than half of patients included in the discharge sub-sample had lost weight during their hospital stay, which consequently may have contributed to the high prevalence of nutritional risk and

malnutrition on discharge, which ranged between 65.2–79.3%. This indicates a high prevalence of malnutrition irrespective of the screening tool used. In translation this means that within the discharge sample, three to four out of every five patients hospitalised are malnourished. Screening should therefore be conducted on admission and weekly thereafter, as recommended by ESPEN[159], as the results indicate that patients are inclined to become 'at risk' or malnourished when suffering from an inflammatory condition. However, it also raises an important argument relating to screening. While nutrition screening is considered a quick and easy process, not requiring much skill or time, it still adds work load to nurses where hospitals are already understaffed. One could argue whether nutrition screening is deemed necessary with such a high prevalence, and if it should not be compulsory for all patients to be seen by a dietitian instead to promote early nutritional support and prevention.

Furthermore, it can be concluded that patients at risk of malnutrition have worse outcomes than those that are well nourished, as there was a significant difference in the number of complications these patients experienced. Similarly, length of stay was also increased by 40% in patients that were at nutritional risk of becoming malnourished, as well as in those patients that had lost weight during hospitalisation.

Within the institution, there was a definite lack of nutrition awareness, as evidenced by the lack of nutrition policies, guidelines and screening tools available at ward level. Nutrition screening should be a rapid and simple process that can be conducted by staff admitting the patients, which supports the concept that screening tools should be available at ward level.[159] The majority of wards did have a scale to measure body weight, although stadiometers were not readily available. A screening tool that incorporates BMI would thus not be valuable in this setting (NRS-2002). Furthermore the results indicate a lack of nursing staff for a tertiary institution, as the mean ratio of nurses (all types) to patients was 1:4, while the recommendation in SA is 1.3:1 (enrolled nurses only).[224]In context this indicates that nurses are understaffed, and have the additional burden of care from the high prevalence of malnourished patients that require greater attention.[21]

Accordingly, nutrition support was also poor as evidenced by the low number of referrals of malnourished patients on both admission and discharge. Also, referrals were also not always appropriate when related to the patient's dietary intake or amount of weight lost. Of

those patients that had lost a significant amount of weight (>10%), not one was referred for nutrition support, clearly showing that there is a lack of weight monitoring, despite availability of a scale. However, of those that were referred, 88.9% did receive nutritional support, indicating that the problem is lack of screening and referrals, not the absence of nutritional intervention. Although it is well known that nutrition support can reduce length of stay, and thus also treatment costs, only a fraction of hospitalised patients were referred for nutrition support.

Lastly, it can be concluded that in the absence of a true gold standard, the best results in terms of concurrent validity were obtained when using the SGA as the reference, resulting in fair validity of the NRS-2002 and good validity of the AMDT. The AMDT, which indicated the highest prevalence of malnutrition at both admission and discharge, was also the only tool to have both good validity (sensitivity 83.9, specificity 80.2) and inter-rater agreement (k=0.62), and may be considered as a diagnostic tool to screen for malnutrition in this setting.

Based on the results of this study, the null hypotheses are rejected.

5.2 RECOMMENDATIONS

- More studies on the prevalence of adult hospital malnutrition need to be conducted in South Africa, using the same three screening tools to allow for comparisons in terms of prevalence of malnutrition, outcomes and validity, but perhaps with less stringent exclusion criteria to achieve a more accurate reflection of the true prevalence of at-risk and malnourished patients.
- Due to lack of a golden standard for nutrition screening, future studies could include a thorough clinical assessment conducted by a dietitian, to allow for a comparison of the screening tools.
- A qualified nutritional support team should be established in healthcare institutions consisting of representatives of all disciplines, to allow for improved multi-disciplinary interaction, awareness and consultation on matters relating to nutrition. Together, nutrition protocols should be developed and implemented at ward level, for the identification of at-risk or malnourished patients and for the course of action to be followed, thereby improving the quality and quantity of nutritional referrals.
- Routine screening should be implemented in all wards, and the nutritional status of all patients should be evaluated on admission (<48hours), using a quick, simple, valid and reliable screening tool, and repeated at weekly intervals. Research should be conducted for identification of the most appropriate screening tool for the identification of adults at nutritional risk of malnutrition in the South African context as a step towards standard implementation of screening in SA.
- Research on screening tools should specifically investigate the feasibility of using the AMDT in this setting, as it has good concurrent validity and inter-rater agreement. However as it does require additional equipment (handgrip dynamometer), this may be challenging in terms of resources, when applying it to a wider scope of healthcare facilities in South Africa.
- The next step would be to conduct research with nursing staff on nutrition support and intervention to establish why there is no screening, so that the root of the problem may be addressed.
- Future studies could also include a cost effective analysis to provide statistics on the extra health care costs that are associated with the malnourished patient.

- Wards where patients are admitted for cancer, gastrointestinal disease, gastrointestinal surgery or infectious diseases (including TB and HIV/AIDS), and where patients are known to be at an increased risk of malnutrition, should aim to provide high-protein energy-dense snacks to all patients. These patients should be seen by the dietitian. With the increase in workload for dietitians, resources need to be allocated to increase staffing as needed. For this to be practically implemented more staff is needed; however the availability of resources in the South African context might militate against this.
- Steps should be taken to improve the nurse: patient ratio, to ensure nurses are not overworked, and so that patients can receive the quality of care that they are entitled to, as it is the patients' right to not be malnourished.
- All wards should at least be provided with a scale in working condition that is similar to all other scales within the institution, to limit confusion as to instructions of use. Weight should be monitored on a weekly basis, and documented. Documentation of body mass, dietary intake and screening information should be done in a standardised method, and preferably electronically, although such advanced systems are not available in all healthcare settings in South Africa.

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7 ADDENDA

a. Declaration by Language editor
b. Form 3E Information Leaflet and Consent Form
c. Form 4 Admission Data Collection Form
d. Form 5 Discharge Data Collection Form
e. Form 8 Observational Checklist

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ACADEMIC WRITING

Linguistic and technical editing of:

Research proposals
Conference and journal papers
Theses, dissertations, technical reports

Bibliographies
Bibliographic citation
Literature searching

The preliminary pages, and Chapter 1, 3, 4 and 5 of the master's thesis by **Merel-Marlijn Moens** have been edited, and the candidate has been advised to make the recommended changes.

ES van Aswegen
31 October 2015

FORM 3E

INFORMATION LEAFLET AND CONSENT FORM

TITLE OF THE RESEARCH PROJECT:

Prevalence and impact of hospital malnutrition on associated outcomes.

REFERENCE NUMBER: M141041

PRINCIPAL INVESTIGATOR: Merel-Marlijn Moens

ADDRESS:

Wits University, 1 Jan Smuts Avenue, Braamfontein 2000, Johannesburg, South Africa.

RESEARCHER CONTACT NUMBER: 072 3758 414

Dear Patient,

You are being invited to take part in a research project. Please take some time to read the information presented here, which will explain the details of this project. Please ask the study staff any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how you could be involved. Also, your participation is entirely voluntary and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the Wits Human Research Ethics Committee (Medical) and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

What is this research study all about?

It is known that people that are underweight (weighing less than the normal amount for one's age, height, and build) take longer to recover from illness or surgery and are more likely to develop infections. This results in a longer stay in hospital and extra costs.

This study aims to get information on the number of people that are underweight when they are admitted to hospital and when they are discharged.

It will be conducted at Chris Hani Baragwanath Hospital during the period January to April 2015 or until the desired number of study participants have been included.

A total of 400 participants older than 18 years are needed for the study to provide meaningful results.

In order to conduct this study, the researcher will first explain the study and ask your approval to participate.

The information obtained include: asking you questions about your appetite, determining your weight and height, and performing a clinical examination on you to assess for signs of weight loss.

It should not take more than 45 minutes of your time to obtain all the information. This will be repeated again when you are discharged.

Why have you been invited to participate?

You have been asked to participate as you are a patient that has been newly admitted within the last 48 hours and meet our inclusion criteria.

What will your responsibilities be?

To carefully read the information provided by the researcher about the study and to ask questions about any uncertainties you may have. To then provide your written approval to participate if you are comfortable to do so.

To speak to the researcher if you want to stop your participation any time during the study or to contact the researcher or research ethics committee if you have any queries, concerns or complaints.

To provide information that is accurate and honest.

To keep a copy of the consent form for your own record keeping.

Will you benefit from taking part in this research?

You will not benefit directly from the research, but you have the opportunity to help researchers answer the question about the nutritional status and health of South Africans that are admitted to hospital.

Are there any risks or discomforts involved in your taking part in this research?

There are no risks involved by participating in this study.

Depending on your health condition, getting undressed into minimal clothing and walking to the scale and stadiometer may be a discomfort.

If you do not agree to take part, what alternatives do you have?

If you choose not to participate, this will not affect your quality of hospital treatment. You will receive all the medical care that is routinely provided.

Who will have access to your medical records?

Only the research team that is involved in data collection will have access to your medical files. Even though some of the information may be recorded, your identity will be kept anonymous by using coding rather than names on the questionnaires.

The data will be stored according to the HPCSA regulations for a minimum of 2 years after publication or six years if the results are not published, after which the data will be destroyed.

Sponsors of the study, study monitors or research auditors or members of the Health Research Ethics committee may need to inspect the research records.

Will you be paid to take part in this study and are there any costs involved?

You will not be paid to take part in the study.

There are also no costs involved for you, if you do take part.

Is there anything else that you should know or do?

You can contact the researcher at 072 3758 414 if you have any further queries or encounter any problems.

You can contact the Health Research Ethics Committee at 011-274-7123 if you have any concerns or complaints that have not been adequately addressed by the researcher.

You will receive a copy of this information and consent form for your own records.

Declaration by participant

By signing below, I …….. agree to take part in a research study entitled Prevalence and impact of Hospital malnutrition on associated outcomes.

I declare that:

I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.

I have had a chance to ask questions and all my questions have been adequately answered.

I understand that taking part in this study is voluntary and I have not been pressurised to take part.

I may choose to leave the study at any time and will not be penalised or prejudiced in any way.

I may be asked to leave the study before it has finished, if the researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (place) ..... on (date) …….. 2015.

Signature of participant Signature of witnes

Declaration by investigator

I (name) …… declare that:

I explained the information in this document to ……..

I encouraged him/her to ask questions and took adequate time to answer them.

I am satisfied that he/she adequately understands all aspects of the research, as discussed above

I did/did not use an interpreter. (If an interpreter is used then the interpreter must sign the declaration below.)

Signed at (place) ..... on (date) …….. 2015.

Signature of investigator Signature of witness

Declaration by interpreter

I (name) …… declare that:

I assisted the investigator (name) …… to explain the information in this document to (name of participant) …….. using the language medium of Afrikaans/IsiZulu.

We encouraged him/her to ask questions and took adequate time to answer them.

I conveyed a factually correct version of what was related to me.

I am satisfied that the participant fully understands the content of this informed consent document and has had all his/her question satisfactorily answered.

Signed at (place) ..... on (date) ……(2015).

Signature of interpreter Signature of witness

FORM 4

Participant number	

ADMISSION DATA COLLECTION FORM

Date of interview					
2.1	Date of admission to hospital				
2.2	Date of admission to ward				
Hospital code			Hospital name		
3. Ward category and number	Ward category				Ward number
	3.1	Medical			
	3.2	Surgical			
	3.4	Gynaecology			

DEMOGRAPHIC INFORMATION

4. Gender	Male		Female	

5. Date of birth of patient								
	Day		Month		Year			

MEDICAL INFORMATION

6. What is the patient's primary diagnosis on admission (Indicate only one)		
	Present (x)	Provide details of specific medical condition
6.1 General medicine		
Gastroenterology		
Cardiology		

Respiratory		
Nephrology		
Tuberculosis		
Retroviral Disease		
Endocrine / Diabetes		
Weight control		
Allergies		
Neurology		
Urology		
Nutritional Deficiency		
6.2 Surgery		
Abdominal surgery		
Trauma		
Orthopaedic surgery		
Neurosurgery		
Vascular surgery		
Cardiothoracic surgery		
6.3 Oncology		
6.4 Gynaecology		
6.5 Other (please specify)		

7. Indicate the presence of gastrointestinal side effects. Indicate the appropriate options below.

Side-effect		YES	NO	If YES to any, please indicate the frequency		
				Almost daily for 2 weeks	Almost daily for 1 week	Infrequent
7.1	Nausea					

7.2	Vomiting					
7.3	Diarrhoea					
7.4	Anorexia					
7.5	Constipation					

DIETARY INFORMATION

8. Ask the patient to describe any changes in food intake during the past week. Indicate the appropriate option below.		
8.1	No change in usual food intake / consumes all food	
8.2	Decreased intake: consumes only ¾ of usual intake	
8.3	Decreased intake: consumes only ½ of usual intake	
8.4	Decreased intake: consumes only ¼ of usual intake	
8.5	Unable to consume anything	

9. If a decreased food intake occurred (8.2 – 8.5 above), determine the duration.		
9.1	< 1 month	
9.2	> 1 month - < 3 months	
9.3	> 3 months	
9.4	Not applicable	

10. Was the patient referred for specialised nutritional support?		
10.1	Yes	
10.2	No	

11. If YES to question 10, which healthcare professional made the referral?		
11.1	Doctor	
11.2	Dietitian	

11.3	Registered nurse	
11.4	Not applicable	
11.5	Other (specify)	

ANTHROPOMETRY

12.	Assessment / Determination of usual weight measurement.	
12.1	Usual weight (kg)	
12.2	Date of last weight measurement	
12.3	Reading unknown	

13. Determination of weight history

Ask the patient to indicate their weight readings at ANY of the following time periods. If unable to indicate the actual readings, ask them to compare the weight to what it is currently.

Time frame		Actual measurement(kg)	Same as current	More than current			Less than current		
				Little	Med	Lot	Little	Med	Lot
13.1	2 weeks ago								
13.2	1 month ago								
13.3	2 months ago								
13.4	3 months ago								
13.5	6 months ago								

14. Determine whether clothes / jewellery fit more loosely or adjustment of belt setting made

14.1	Yes	
14.2	No	

14.3	N/A	

15.	If YES to question 14 above, determine the duration.	
15.1	< 1 month	
15.2	> 1 month - < 3 months	
15.3	> 3 months	
15.4	Not applicable	

16.	How was the anthropometric measurements taken? Indicate the appropriate options below.		
Measurement		Measured	Estimated
16.1	Weight		
16.2	Height		

17.	Indicate the measurements as determined		
17.1	Weight measurement (kg)		
17.2	Height measurement (cm)	Standing height (cm)	
		Bed length height (cm)	
		Half arm-span reading (cm)	

18.	Were there any factors affecting the weight measurement e.g. casts, external fixing devices etc.		
18.1	Yes		Specify:
18.2	No		

FUNCTIONAL CAPACITY

19.	Indicate the patient's dominant arm	
19.1	Right	

19.2	Left	

20. Measurement of hand-grip strength		
Measurement 1	Measurement 2	Measurement 3

21. Determine general functional capacity. Indicate the appropriate options below.						
Measurement		YES	NO	If YES to any, please indicate change over the past 2 weeks		
				Improved	No change	Regressed
21.1	Experience difficulty with normal activities / ambulation					
21.2	Bed /chair-ridden					

CLINICAL EXAMINATION

22. Test around the following areas for the presence of <u>oedema</u>: ankle, orbital, sacral. Please follow the SOP. (TIP: Sacral - patient must be in a sitting position). Indicate the appropriate option below.

	Clinical finding	Category	Indicate option
22.1	No depression	No oedema	
22.2	2-4mm depression Immediate or few second rebound	Mild	
22.3	6mm deep pit 10-12 second rebound	Moderate	
22.4	8mm very deep pit > 20 second rebound	Severe	

23. Test around the <u>orbital area</u> (under the eyes) for the presence of <u>subcutaneous fat</u>

loss. Please follow the SOP. (TIP: Patient must stand up straight; view patient when standing directly in front of them, touch above the cheekbone) Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].

	Clinical finding	Category	Indicate option (X)		
23.1	Slightly bulged fat pads	Normal / well nourished	6	7	
23.2	Slightly dark circles, somewhat hollow look	Mild-moderate malnutrition	3	4	5
23.3	Hollow look, depressions, dark circles, loose skin	Severe	1	2	

24. Test around the upper arm area (triceps / biceps) for the presence of subcutaneous fat loss. Please follow the SOP. (TIP: patient stand up straight; arm bent, roll skin between fingers, do not include muscle in pinch)Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].

	Clinical finding	Category	Indicate option (X)		
24.1	Ample fat tissue obvious between folds of skin	Normal / well nourished	6	7	
24.2	Fingers almost touch, some depth to pinch	Mild-moderate malnutrition	3	4	5
24.3	Very little space between folds, fingers touch	Severe	1	2	

25. Test around the thoracic/lumbar region (ribs / midaxillary line) for the presence of subcutaneous fat loss. Please follow the SOP. (TIP: Patient must stand up straight, have patient press hands hard against a solid object) Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].

	Clinical finding	Category	Indicate option (X)		
25.1	Chest is full. Ribs do not show. Slight to no protrusion of iliac crest.	Normal / well nourished	6	7	
25.2	Ribs apparent. Iliac crest somewhat prominent.	Mild-moderate malnutrition	3	4	5
25.3	Ribs very apparent. Iliac crest	Severe	1	2	

	very prominent.			

26. Test around the temple region (temporalis muscle) for the presence of muscle wasting. Please follow the SOP. (TIP: patient must stand up straight; view patient when directly standing in front of them, ask patient to turn head side to side)Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].

	Clinical finding	Category	Indicate option (X)		
26.1	Can see/feel well-defined muscle	Normal / well nourished	6	7	
26.2	Slight depression	Mild-moderate malnutrition	3	4	5
26.3	Hollowing, scooping, depression	Severe	1	2	

27. Test around the clavicle bone region for the presence of muscle wasting. Please follow the SOP. (TIP: Patient must stand up straight; look for prominent bone. Make sure patient is not hunched forward) Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].

	Clinical finding	Category	Indicate option (X)		
27.1	Not visible (males), visible but not prominent (females)	Normal / well nourished	6	7	
27.2	Some protrusion	Mild-moderate malnutrition	3	4	5
27.3	Protruding, prominent bone	Severe	1	2	

28. Test around the clavicle and acromion bone region (shoulder) for the presence of muscle wasting. Please follow the SOP. (TIP: Patient must stand up straight; patient arms at side: observe shape)Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].

	Clinical finding	Category	Indicate option (X)	
28.1	Lines of bones prominent, no significant depressions / Rounded, curves at arm, shoulder, neck.	Normal / well nourished	6	7

28.2	Acromion process may protrude slightly	Mild-moderate malnutrition	3	4	5
28.3	Shoulder to arm joint looks square, bones prominent; acromion protrusion very prominent	Severe	1	2	

29. Test around the scapular bone region for the presence of muscle wasting. Please follow the SOP. (TIP: Patient must stand up straight; ask patient to extend hands straight out, push against solid object)Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].

	Clinical finding	Category	Indicate option (X)		
29.1	Lines of bones not prominent, no depressions	Normal / well nourished	6	7	
29.2	Mild depression, or bone may show slightly	Mild-moderate malnutrition	3	4	5
29.3	Prominent, visible bones, depressions between ribs/scapula or shoulder/spine	Severe	1	2	

30. Test around the dorsal hand (Interosseous muscle) for the presence of muscle wasting. Please follow the SOP. (TIP: Patient must stand up straight. Look at thumb side of hand; look at pads of thumb when tip of forefinger touching tip of thumb)Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].

	Clinical finding	Category	Indicate option (X)		
30.1	Muscle bulges, could be flat in well nourished	Normal / well nourished	6	7	
30.2	Slightly depressed or flat	Mild-moderate malnutrition	3	4	5
30.3	Depressed area between thumb – forefinger	Severe	1	2	

31. Test around the patellar region (knee) for the presence of muscle wasting. Please follow the SOP. (TIP: Ask patient to sit with leg propped up, bent at knee). Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].

	Clinical finding	Category	Indicate option (X)

31.1	Muscle protrudes, bones not prominent	Normal / well nourished	6	7	
31.2	Knee cap less prominent, more rounded	Mild-moderate malnutrition	3	4	5
31.3	Bones prominent, little sign of musculature around knee cap	Severe	1	2	

32. Test around the anterior thigh region (quadriceps) for the presence of muscle wasting. Please follow the SOP. (TIP: Ask patient to sit prop leg up on lo furniture; grasp quads to differentiate amount of muscle tissue from fat tissue.) Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].

	Clinical finding	Category	Indicate option (X)		
32.1	Well rounded, developed	Normal / well nourished	6	7	
32.2	Mild depression on inner thigh	Mild-moderate malnutrition	3	4	5
32.3	Depression on inner thigh, obviously thin	Severe	1	2	

33. Test around the posterior calf region for the presence of muscle wasting. Please follow the SOP. (TIP: Patient must stand up straight. Grasp the calf muscle to determine amount of tissue)Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].

	Clinical finding	Category	Indicate option (X)		
33.1	Well-developed bulb of muscle	Normal / well nourished	6	7	
33.2	Not well developed	Mild-moderate malnutrition	3	4	5
33.3	Thin, minimal to no muscle	Severe	1	2	

Please double-check that all sections are fully completed!

Completed by:	
Checked by:	
Date:	

FORM 5

Participant number	

DISCHARGE DATA COLLECTION FORM

Date of interview	
Date of admission	
Hospital	

This form can only be completed if the patient was in hospital for longer than 7 days.

GENERAL INFORMATION

Please indicate the discharge option most relevant		
3.1	Transferred to another hospital	
3.2	Transferred to another ward (that falls outside the inclusion criteria for this study)	
3.3	Discharged to own residential home	
3.4	Discharged to nursing home / hospice	
3.5	Discharged to relatives home	
3.6	Other (specify)	

If the patient is lost to follow-up, please indicate the appropriate option below.

4.1	Deceased in hospital	
4.2	Unexpected discharge	
4.3	Refuse to participate	

4.4	Other (specify)	

If the patient is deceased, indicate the following:			
15.1	Date of death		
15.2	Cause		
15.3	Cause of death unknown		

MEDICAL INFORMATION

Indicate the presence of gastrointestinal side effects. Indicate the appropriate options below.

Side-effect		YES	NO	If YES to any, please indicate the frequency		
				Almost daily for 2 weeks	Between the 2 options	Minor / infrequent
6.1	Nausea					
6.2	Vomiting					
6.3	Diarrhoea					
6.4	Anorexia					
6.5	Constipation					

Indicate if the patient developed any medical complications during hospitalization and indicate the action taken for each complication listed. (This information will be used to determine disease severity)

7.1	Complication 1
Specify complication	
Organ system involved	
Date of diagnosis	

Specify the treatment taken	
Non-invasive treatment	
Pharmacological treatment	
Interventions	
Life-threatening complications	
Death	
7.2	Complication 2
Specify complication	
Organ system involved	
Date of diagnosis	
Specify the treatment taken	
Non-invasive treatment	
Pharmacological treatment	
Interventions	
Life-threatening complications	
Death	
7.3	Complication 3
Specify complication	
Organ system involved	
Date of diagnosis	
Specify the treatment taken	
Non-invasive treatment	
Pharmacological treatment	
Interventions	
Life-threatening complications	
Death	
7.4	Complication 4

Specify complication	
Organ system involved	
Date of diagnosis	
Specify the treatment taken	
Non-invasive treatment	
Pharmacological treatment	
Interventions	
Life-threatening complications	
Death	
7.5	Complication 5
Specify complication	
Organ system involved	
Date of diagnosis	
Specify the treatment taken	
Non-invasive treatment	
Pharmacological treatment	
Interventions	
Life-threatening complications	
Death	

DIETARY INFORMATION

Ask the patient to describe any changes in food intake during the past week in hospital. Indicate the appropriate option below.		
8.1	No change in usual food intake / consumes all food	
8.2	Decreased intake: consumes only ¾ plate / usual intake	
8.3	Decreased intake: consumes only ½ plate / usual intake	
8.4	Decreased intake: consumes only ¼ plate / usual intake	

8.5	Unable to consume anything	

Was the patient referred for specialised nutritional support?		
9.1	Yes	
9.2	No	

Did the patient receive specialised nutritional support?		
10.1	Yes	
10.2	No	

If YES to question 10, what was prescribed? (More than one option can be ticked)				
	Nutrition support option	YES	NO	If YES, indicate duration (in days)
11.1	Enteral nutrition			
11.2	Parenteral nutrition			
11.3	Combination therapy			
11.4	Supplementation drinks			
11.5	Not applicable			
11.6	Other (specify)			

ANTHROPOMETRY

How was the anthropometric measurements taken? Indicate the appropriate options below.			
Measurement		Measured	Estimated
12.1	Weight		
12.2	Height		

Indicate the measurements as determined		
13.1	Weight measurement (kg)	

13.2	Height measurement (cm)	

E. FUNCTIONAL CAPACITY

Indicate the patient's dominant arm		
14.1	Right	
14.2	Left	

Measurement of hand-grip strength		
Measurement 1	Measurement 2	Measurement 3

Determine general functional capacity. Indicate the appropriate options below.						
Measurement		YES	NO	If YES to any, please indicate change over the past 2 weeks		
				Improved	No change	Regressed
16.1	Experience difficulty with normal activities / ambulation					
16.2	Bed /chair-ridden					

CLINICAL EXAMINATION

Test around the following areas for the presence of oedema: orbital, ankle, sacral. Please follow the SOP. (TIP: Sacral - patient must be in a sitting position). Indicate the appropriate option below.			
	Clinical finding	Category	Indicate option
17.1	No depression	No oedema	
17.2	2-4mm depression Immediate or few second rebound	Mild	

17.3	6mm deep pit 10-12 second rebound	Moderate	
21.4	8mm very deep pit > 20 second rebound	Severe	

Test around the orbital area (under the eyes) for the presence of subcutaneous fat loss. . (TIP: Patient must stand up straight; view patient when standing directly in front of them, touch above the cheekbone) Please follow the SOP. Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].

	Clinical finding	Category	Indicate option (X)		
18.1	Slightly bulged fat pads	Normal / well nourished	6	7	
18.2	Slightly dark circles, somewhat hollow look	Mild-moderate malnutrition	3	4	5
18.3	Hollow look, depressions, dark circles, loose skin	Severe	1	2	

Test around the upper arm area (triceps / biceps) for the presence of subcutaneous fat loss. Please follow the SOP. (TIP: patient stand up straight; arm bent, roll skin between fingers, do not include muscle in pinch). Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].

	Clinical finding	Category	Indicate option (X)		
19.1	Ample fat tissue obvious between folds of skin	Normal / well nourished	6	7	
19.2	Fingers almost touch, some depth to pinch	Mild-moderate malnutrition	3	4	5
19.3	Very little space between folds, fingers touch	Severe	1	2	

Test around the thoracic/lumbar region (ribs / midaxillary line) for the presence of subcutaneous fat loss. Please follow the SOP. (TIP: Patient must stand up straight; have patient press hands hard against a solid object). Indicate the appropriate option below, as

well as the relevant scale [1 severe PEM – 7 normal].					
	Clinical finding	Category	Indicate option (X)		
20.1	Chest is full. Ribs do not show. Slight to no protrusion of iliac crest.	Normal / well nourished	6	7	
20.2	Ribs apparent. Iliac crest somewhat prominent.	Mild-moderate malnutrition	3	4	5
20.3	Ribs very apparent. Iliac crest very prominent.	Severe	1	2	

Test around the temple region (temporalis muscle) for the presence of muscle wasting. Please follow the SOP. (TIP: patient must stand up straight; view patient when directly standing in front of them, ask patient to turn head side to side). Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].					
	Clinical finding	Category	Indicate option (X)		
21.1	Can see/feel well-defined muscle	Normal / well nourished	6	7	
21.2	Slight depression	Mild-moderate malnutrition	3	4	5
21.3	Hollowing, scooping, depression	Severe	1	2	

Test around the clavicle bone region for the presence of muscle wasting. Please follow the SOP. (TIP: Patient must stand up straight; look for prominent bone. Make sure patient is not hunched forward) Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].					
	Clinical finding	Category	Indicate option (X)		
22.1	Not visible (males) , visible but not prominent (females)	Normal / well nourished	6	7	
22.2	Some protrusion	Mild-moderate malnutrition	3	4	5
22.3	Protruding, prominent bone	Severe	1	2	

Test around the clavicle and acromion bone region (shoulder) for the presence of muscle wasting. Please follow the SOP. (TIP: Patient must stand up straight; patient arms at side: observe shape) Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].					
	Clinical finding	Category	Indicate option (X)		
23.1	Lines of bones prominent, no significant depressions/ Rounded, curves at arm, shoulder, neck	Normal / well nourished	6	7	
23.2	Acromion process may protrude slightly	Mild-moderate malnutrition	3	4	5
23.3	Shoulder to arm joint looks square, bones prominent, acromion protrusion very prominent	Severe	1	2	

Test around the scapular bone region for the presence of muscle wasting. Please follow the SOP. (TIP: Patient must stand up straight; ask patient to extend hands straight out, push against solid object)Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].					
	Clinical finding	Category	Indicate option (X)		
24.1	Lines of bones not prominent, no depressions	Normal / well nourished	6	7	
24.2	Mild depression, or bone may show slightly	Mild-moderate malnutrition	3	4	5
24.3	Prominent, visible bones, depressions between ribs/scapula or shoulder/spine	Severe	1	2	

Test around the dorsal hand (Interosseous muscle) for the presence of muscle wasting. Please follow the SOP. (TIP: Patient must stand up straight. Look at thumb side of hand; look at pads of thumb when tip of forefinger touching tip of thumb). Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].				
	Clinical finding	Category	Indicate option (X)	
25.1	Muscle bulges, could be flat in	Normal / well	6	7

	well nourished	nourished			
25.2	Slightly depressed or flat	Mild-moderate malnutrition	3	4	5
25.3	Depressed area between thumb – forefinger	Severe	1	2	

Test around the patellar region (knee) for the presence of muscle wasting. Please follow the SOP. (TIP: Ask patient to sit with leg propped up, bent at knee) Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].

	Clinical finding	Category	Indicate option (X)		
26.1	Muscle protrudes, bones not prominent	Normal / well nourished	6	7	
26.2	Knee cap less prominent, more rounded	Mild-moderate malnutrition	3	4	5
26.3	Bones prominent, little sign of musculature around knee cap	Severe	1	2	

Test around the anterior thigh region (quadriceps) for the presence of muscle wasting. Please follow the SOP. (TIP: Ask patient to sit prop leg up on lo furniture; grasp quads to differentiate amount of muscle tissue from fat tissue.) Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].

	Clinical finding	Category	Indicate option (X)		
27.1	Well rounded, developed	Normal / well nourished	6	7	
27.2	Mild depression on inner thigh	Mild-moderate malnutrition	3	4	5
27.3	Depression on inner thigh, obviously thin	Severe	1	2	

Test around the posterior calf region for the presence of muscle wasting. Please follow the SOP. (TIP: Patient must stand up straight. Grasp the calf muscle to determine amount of

tissue) Indicate the appropriate option below, as well as the relevant scale [1 severe PEM – 7 normal].					
	Clinical finding	Category	Indicate option (X)		
28.1	Well-developed bulb of muscle	Normal / well nourished	6	7	
28.2	Not well developed	Mild-moderate malnutrition	3	4	5
28.3	Thin, minimal to no muscle.	Severe	1	2	

Please double-check that all sections are fully completed!

Completed by:	
Checked by:	
Date:	

FORM 8

OBSERVATIONAL CHECKLIST FORM

Date of interview			
Hospital code		Hospital name	
Ward category	3.1 Medical		
	3.2 Surgical		
	3.3.Gynaecology		

NUTRITION DOCUMENTATION

Is there a written nutrition policy or protocol displayed in the ward?		
	Yes	
1.2	No	

Is there a nutrition screening tool available in the ward?		
2.1	Yes	
2.2	No	

COMMUNICATION

Is there a telephone available for staff to make referrals from in the ward?		
3.1	Yes	
3.2	No	

If YES to question 3, is the telephone in working order?		
4.1	Yes	
4.2	No	
4.3	Not applicable	

Is the phone number of the dietetics department displayed in the ward?		
5.1	Yes	
5.2	No	

ANTHROPOMETRIC EQUIPMENT

Is there a scale in the ward?		
6.1	Yes	

6.2	No	

If YES to question 6 above, indicate the type of scale.		
7.1	Beam Scale	
7.2	Analogue	
7.3	Digital	
7.4	Other	
	Specify:	
7.5	Not applicable	

If YES to question 6, is the scale in working condition?		
8.1	Yes	
8.2	No	
8.3	Not applicable	

If YES to question 6, is the scale accessible on ward level?		
9.1	Yes	
9.2	No	
9.3	Not applicable	
Is there a height metre available in the ward?		
10.1	Yes	
10.2	No	

If YES to question 10, is the height metre accessible on ward level?		
11.1	Yes	
11.2	No	
11.3	Not Applicable	

NUTRITION INTERVENTION

Is there a fridge allocated only for the storage of nutritional products?		
12.1	Yes	
12.2	No	

If YES to question 12, is the fridge used for its intended purpose?		
13.1	Yes	
13.2	No	
	Specify	
13.3	Not Applicable	

If YES to question 12, is the fridge in working condition?

14.1	Yes	
14.2	No	
14.3	Not Applicable	

STATISTICS

Indicate the number of nurses that are on duty within each category:		
15.1	Operational Managers	
15.2	Professional Nurses	
15.3	Nursing Assistants	
15.4	Student nurses	
15.5	Other	
	Specify:	

Indicate the number of patients currently admitted to the ward	
16.1	

Please double-check that all sections are fully completed!

Completed by:	
Checked by:	
Date:	