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ADEQUACY OF ORAL INTAKE IN A PRIVATE INTENSIVE CARE UNIT IN GAUTENG PROVINCE

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2013204686

**Dissertation submitted in accordance with
the academic requirements for the degree**

Magister Dietetics

in the

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University of the Free State

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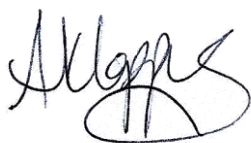
Study Leader: Prof VL van den Berg

DECLARATION

I, Alta Kloppers, declare that the master's research dissertation that I herewith submit to the University of the Free State, is my independent work and that I have not previously submitted it for a qualification at another institution of higher education.

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ALTA KLOPPERS

April 2018

DATE

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LIST OF ABBREVIATIONS

ACBS	Advisory Committee on Borderline Substances
ALLIANCE	Alliance to Advance Patient Nutrition
AM	Australian Modification
AMSN	Academy of Medical-Surgical Nurses
AND	Academy of Nutrition and Dietetics
ARF	acute renal failure
ASPEN	America Society of Parenteral and Enteral Nutrition
BHF	better hospital food
BMI	body mass index
CKD	chronic kidney disease
COPD	chronic obstructive pulmonary disease
CRP	c- reactive protein
CRRT	chronic renal replacement therapy
D	day
DRM	disease related malnutrition
EPaNIC	Early versus Late Parenteral Nutrition in Critically Ill Patients
ESPEN	European Society for Parenteral and Enteral Nutrition
FFA	free fatty acids
FFMI	fat free mass index

G	gram
GFR	glomerular filtration rate
GIT	gastrointestinal tract
HD	haemodialysis
HSREC	Health Services Research Ethics Committee
IBW	ideal body weight
IC	indirect calorimetry
ICD-10	International Statistical Classification of Diseases and Related Health Problems 10 th Revision
ICU	intensive care unit
IL	interleukin
KCAL	kilocalories
KG	kilogram
KH	knee height
LOS	length of stay
M²	metres squared
MIN	minute
ML	millilitre
MM	millimetre
MNA-SF	Mini Nutritional Assessment Short Form

MST	Malnutrition Screening Tool
MUAC	mid-upper arm circumference
MUST	Malnutrition Universal Screening Tool
NHS	National Health Service
NICE	National Institute for Health and Clinical Excellence
NIV	Non invasive ventilation
NPO	<i>Nil per Os</i>
NRS-2002	Nutritional Risk Screening 2002
ONS	oral nutritional supplements
RCT	randomised controlled trial
REE	resting energy expenditure
ROI	return on investment
ROS	reactive oxygen species
SANHANES	South African Health and Nutrition Examination Survey
SCCM	Society of Critical Care Medicine
SHM	Society of Hospital Medicine
SNAQ	Short Nutritional Assessment Questionnaire
SNS	sympathic nervous system
TEE	total energy expenditure
TNF	tumour necrosis factor

UK	United Kingdom
UL	ulna length
UFS	University of the Free State
WHO	World Health Organisation

1 CHAPTER 1: ORIENTATION AND MOTIVATION FOR THE STUDY

1.1 Introduction

In the 19th century, Florence Nightingale noted that injured soldiers seemed to be starving amidst plenty of food. It was not until 1974, however, that Butterworth, in a landmark publication, coined the phrase, “the skeleton in the hospital closet”. This was in reference to the very common phenomenon where critically ill patients, suffering from metabolic stress due to trauma, major surgery, infections, or severe illness, become progressively malnourished in the acute care setting, which in turn leads to serious and often fatal complications, as well as increased expenses of medical care (Souza et al., 2015). Despite many advances in the understanding of this phenomenon as resulting from stress-induced neuroendocrine, inflammatory and acute phase responses, as well as in the management thereof (Preiser et al., 2014), it still remains a largely unappreciated problem in hospitals around the world that continues to impact significantly on cost and clinical outcomes.

1.2 DRM

“Malnutrition is a state of nutrition in which a deficiency, or excess, of energy, protein and other nutrients causes measurable adverse effects on tissue or body form, function and clinical outcome” (Lochs et al., 2006). In the more recently published European Society for Clinical Nutrition and Metabolism (ESPEN) Guidelines on Definitions and Terminology of Clinical Nutrition, the definition of malnutrition is refined as “a state resulting from lack of intake or uptake of nutrition that leads to altered body composition (decreased fat free mass) and body cell mass leading to diminished physical and mental function and impaired clinical outcome from disease” (Cederholm et al., 2016). Malnutrition can result from starvation, disease or advanced ageing (e.g. >80 years), alone or in combination. Disease-related malnutrition (DRM) defines a secondary form of malnutrition in which the presence of disease alters nutrient requirements, as well as substrate metabolism, against the background of inadequate intakes or availability of nutrients (Freijer et al., 2013; Barker et al., 2011).

1.2.1 Prevalence of DRM

More than four decades after Butterworth published “the skeleton in the hospital closet”, malnutrition is still widely under-recognised and under-diagnosed, and remains under-treated. The reported prevalence of malnutrition in acute care facilities is still 20–50%, with the nutritional status deteriorating over the course of admission (Pullen et al., 2017; Wales et al., 2009). The prevalence of malnutrition is especially high in elderly groups and in certain disease states, which include cancer, neurological disease, orthopaedic injury, respiratory disease, gastrointestinal and liver disease, renal disease, HIV and AIDS (Wales et al., 2009). Critically ill patients in an intensive care unit (ICU) are amongst those with the highest prevalence of DRM. A recent systematic review of ICU studies (Lew et al., 2017) found a prevalence of malnutrition amongst ICU patients ranging from 38% to 78%. In this analysis of studies, malnutrition was independently associated with increased length of stay (LOS) in ICU, increased readmission to ICU, increased incidence of infection, and increased risk of hospital mortality. Surprisingly, the prevalence of DRM are remarkably similar amongst hospitals of emerging and industrialised nations (Correia et al., 2014).

1.2.2 Causes of DRM

The aetiology of DRM is multifactorial, ultimately resulting in shortfalls of protein and energy intake relative to needs. Most patients, at the time of admittance to hospital, have already lost weight and present with little to no appetite (Correia et al., 2014). Hiesmayr et al., (2009) showed that more than 40% of patients lost weight in the 3 months before being admitted to hospital, and that 50% reported reduced food intake during the week prior to admission. Globally, up to 50% of patients are already malnourished on admission (Correia et al., 2014), whilst the prevalence of DRM is particularly high amongst ICU patients (Lew et al., 2017).

The pathophysiology of DRM is a complex interplay between reduced intake or availability of nutrients, and an underlying disease-associated inflammatory response that impacts on nutrient requirements and metabolism (Jensen et al., 2010; Jensen et al., 2009), resulting in a catabolic state (McClave et al. 2016). Two distinct types of DRM are currently distinguished (Correia et al., 2014). Chronic DRM refers to nutritional inadequacy associated with chronic conditions that impose sustained moderate inflammation. Acute DRM, also called injury-related malnutrition, refers to undernutrition related to conditions that elicit marked

inflammatory responses. These include, amongst others cancer, cardiac failure, renal disease and rheumatoid arthritis in which inflammation forms a distinct component of the disease itself, thus increasing the risk of malnutrition, even amongst overweight or obese patients. Severe acute health crises, including surgery, trauma, burn injury, severe infection, or sepsis, are also associated with marked inflammation, which contributes to and perpetuates the risk of severe malnutrition. In particular, injury, illness, and inactivity during hospitalisation causes and attenuates loss of muscle mass with low strength or performance, referred to as sarcopenia (Correia et al., 2014).

In addition, hospitalisation itself is a risk factor for declining nutritional status (Correia et al., 2014). Studies show that both the energy and protein intake of hospitalised patients often do not meet nutritional requirements (Pullen et al., 2017; Dupertuis et al., 2003). Identified barriers to adequate oral intake include patient-related factors associated with the disease process, such as poor appetite, nausea and fatigue (Pullen et al., 2017). Several institutional factors have, however, also been identified as significant risk factors for DRM. These include traditional preparation for surgery, *nil per os* (nothing by mouth) orders, interrupted or missed meals due to medical procedures, and unwanted food, that all adds up to nutrient deficits and weight loss (Pullen et al., 2017; Correia et al., 2014).

1.2.3 Impact of DRM

DRM is associated with higher rates of complications, including pressure ulcers, infections, and falls, prolonged recovery and increased mortality (Pullen et al., 2017; Correia et al., 2014). This inevitably also translates to increases in health care costs related to extra care and increased LOS in hospital and ICU (Correia et al., 2014). It is estimated that DRM affects 20 million people per year in the European Union, costing European Governments around €120 billion (Freijer et al., 2013). In England, for example, the National Institute for Health and Clinical Excellence (NICE) recently estimated the annual cost incurred by DRM at £19.6 billion, and identified improved nutritional care as one of the largest potential sources of cost saving to the National Health Service (NHS) (Pullen et al., 2017). Thus, given the magnitude of healthcare cost relating to DRM, even a slight decrease of DRM has the potential to deliver considerable savings (Rice & Normand., 2012).

1.3 Preventing DRM in hospitalised and ICU patients

Several important components of care to prevent and address DRM in hospitalised and particularly in ICU patients, have been identified. These include the following:

1.3.1 Screening for malnutrition

Already in 2002, ESPEN started recommending that all patients should be screened on admission to identify those that are already malnourished, and/or are at further risk for deterioration of their nutritional status during hospitalisation (Kondrup et al., 2003). In 2015, an ESPEN Consensus Statement, defining the basic diagnostic criteria for malnutrition, was published (Cederholm et al., 2015). Similarly, the Academy of Nutrition and Dietetics (AND) and the American Society for Parenteral and Enteral Nutrition (ASPEN) have also published a consensus statement on a standardised set of diagnostic characteristics to identify and document adult malnutrition in routine clinical practice (White et al., 2012).

Screening programs improves the identification of individuals at risk of malnutrition or with existing malnutrition, as well as the timely and appropriate referral for nutrition intervention (Wales et al., 2009). ESPEN criteria recommends that, prior to the diagnosis of malnutrition, the criteria for being “at nutritional risk” according to any validated nutritional risk screening tool must be met (Cederholm et al., 2016). ESPEN defines two alternative sets of diagnostic criteria to confirm the diagnosis of malnutrition based on screening; i.e. either reduced body mass index (BMI) $<18.5 \text{ kg/m}^2$, or combined weight loss and reduced BMI, or reduced gender-dependent fat free mass index (FFMI).

Recommendations are that all patients should be screened for malnutrition within 24 hours of admission to hospital and that screenings are repeated at frequent intervals during hospital stay (Tappenden et al., 2013; Wales et al., 2009). Although there is no existing evidence-based guidelines to determine the required frequency of routine malnutrition screening, weekly screening is recommended in the acute care setting as nutritional status may rapidly decline during admission (Wales et al., 2009).

Simple and easy to use screening tools that are validated in the specific population are recommended. Screening tools that have been validated and are considered appropriate to

use in the acute care setting, includes the Malnutrition Screening Tool (MST), Mini Nutritional Assessment-Short Form (MNA-SF), Malnutrition Universal Screening Tool (MUST), Nutritional Risk Screening 2002 (NRS-2002) and the Short Nutritional Assessment Questionnaire (SNAQ) (Tappenden et al., 2013; Wales et al., 2009). Screening tools that incorporate two or more parameters are recommended, as such screening tools have higher sensitivity and specificity at predicting nutritional status (Wales et al., 2009).

Screening for malnutrition could be performed by nursing staff and doctors, but also by unskilled individuals such as assistants, administrative staff, or patients and carers themselves. The malnutrition screen should be incorporated into standard processes e.g. admission forms and patient information sheets (Wales et al., 2009).

1.3.2 Nutritional assessment

A positive screen for deterioration of nutritional status, and thus for DRM, should prompt immediate nutritional assessment, diagnosis and treatment of malnutrition (Tappenden et al. 2013; Wales et al., 2009). A detailed nutritional assessment entails a systematic approach to collect, record and interpret data pertaining to a patient's medical history (including the use of supplements, herbs and medications), physical and anthropometrical examinations, biochemical analyses, and nutrition, social and psychological history ideally performed and interpreted by a registered dietician (Cederholm et al., 2017).

1.3.3 Nutritional diagnosis and the importance of coding

The nutrition assessment provides the basis for the nutritional diagnosis on which nutrition intervention is subsequently formulated and implemented (Swan et al., 2017). According to the ESPEN Guidelines on Definitions and Terminology of Clinical Nutrition (Cederholm et al., 2017), correct recording of the diagnosis of malnutrition is often neglected. Correct coding is not just necessary to claim from medical aid funders, but is of statistical importance to record the prevalence and incidence of malnutrition amongst patients, and to aid in the development of national policies (Wales et al., 2009).

The most widely used medical coding system, including in South Africa, is the World Health Organisation (WHO) International Statistical Classification of Diseases and Related Health

Problems 10th Revision (ICD-10) system. The ICD-10-Australian Modification (AM), specifies two codes for the diagnosis of malnutrition (Wales et al., 2009).

E43 Unspecified severe protein energy malnutrition:

In adults, BMI < 18.5 kg/m² or unintentional loss of ≥ 10% with evidence of suboptimal intake resulting in severe loss of subcutaneous fat and/or severe muscle wasting.

E44 Protein-energy malnutrition of moderate and mild degree:

In adults, BMI < 18.5 kg/m² or unintentional loss of weight (5–9%) with evidence of suboptimal intake resulting in moderate loss of subcutaneous fat and/or moderate muscle wasting.

1.3.4 Nutrition Care Plan

A detailed nutritional assessment and diagnosis of malnutrition, provides the basis for evidence-based estimation of the patient's nutritional requirements, establishing the most appropriate way of meeting these requirements, as well as suggestions for monitoring the efficacy of the plan and reassessment (Cederholm et al., 2015). Setting of nutritional goals improve patient and cost outcome. Goals should focus on prevention of decline in nutritional status and clinical outcome and optimising nutritional status and health outcomes (Wales et al., 2009).

ESPEN strongly recommends that careful records of nutritional risk screening, diagnosis, assessment of risk factors, nutritional requirements, nutrition therapy, as well as the goals and outcomes for nutrition therapy, should be kept. Outcome goals should include estimated time to reach goals, as well notes on who is responsible for the follow-up. The documentation of nutrition therapy should also provide information on the need for help with serving and eating, and preferred meals (Cederholm et al., 2017).

1.3.5 Meeting nutrition goals

Meeting nutritional requirements as closely as possible, is fundamental to the nutrition care of patients. Early appropriate macro and micronutrient delivery, particularly into the gastrointestinal tract (GIT), improves the clinical course of critical illness, reduces disease severity, diminishes complications, decreases LOS in the ICU, and favourably impacts patient outcomes (McClave et al., 2016). Nutritional intervention following a positive malnutrition

screen includes modification to food provision methods, feeding support, involvement of a nutrition support team, use of oral nutritional supplements (ONS), dietary education in conjunction with ONS if deemed necessary, enteral tube feeding and ONS in conjunction with exercise, parenteral nutrition, and individually prescribed nutrition therapy (Wales et al., 2009).

1.3.5.1 Enteral and parenteral support

In the critically ill, oral feeding is often not feasible or is inadequate to meet the patient's requirements. A rigorous meta-analysis of randomised controlled trials (RCTs) published in 2009, demonstrated that, compared to standard care, the provision of enteral nutrition support to critically ill patients within 24 hours of admission, significantly reduced mortality and pneumonia rates (Doig et al., 2009). Consequently, the introduction of enteral nutrition support within 24 to 48 hours of admission have been incorporated into most best-practice guidelines for ICU patients. As enteral nutrition support may sometimes be complicated by GIT intolerance and underfeeding, the parenteral route, though more invasive may be used to secure delivery of the intended nutrition, alone or in combination with enteral nutrition support. The parenteral route is, however, associated with greater risks and rates of complications (Ridley et al., 2015).

1.3.5.2 Oral feeding

When fed via enteral tube or intravenously, nutrient delivery is controlled externally, and the patients' intake can be more easily controlled than when patients are fed orally (at least theoretically). Controlling oral intakes, although more physiological, is inherently more complicated.

Many patients that are admitted to an ICU do not meet the criteria for enteral or parenteral support and even amongst the critically ill who receives enteral and/or parenteral support, weaning to an oral diet needs to occur at some point (Peterson et al. 2011; Peterson et al. 2010).

Current guidelines support a 'food-first approach' (Donbavand et al., 2017), e.g. that the energy and protein requirements of orally fed patients be provided by meals from the hospital menu, rather than reliance on oral nutrition support (Pullen et al., 2017). Oral nutrition

support is defined as “the modification of food and fluid by fortifying food with protein, carbohydrate and/or fat plus minerals and vitamins; the provision of snacks and/or ONS as extra nutrition to regular meals, changing meal patterns, or the provision of dietary advice to patients on how to increase overall nutrition intake by the above” (Donbavand et al., 2017). The provision of snacks and ONS are reported to impact positively on the nutritional status of patients to prevent DRM. However, hospital snacks tend to be high in energy, yet low in protein content, whilst the reliance on ONS as a substitute for adequate food provision, is very expensive (Pullen et al., 2017).

With optimal food provision considered essential to the prevention of DRM, hospital menus should provide appropriate food choices to meet nutritional requirements through a ‘food first approach’. This is particularly relevant to emerging countries where the health care system is under severe financial pressure. Cederholm et al., (2017) defines hospital catering or care catering, as “the provision of menu services (in-house or outsourced) in health care facilities”, and states that the minimum requirements of hospital catering are to “serve a variety of foods that are suitable and adapted to all types of patients with a variety of energy and nutrient densities”. Yet, hospitalised patients’ oral intakes often do not meet their nutritional requirements, as recently shown in a study in the United Kingdom (UK) in which only 8.3% of patients at risk for DRM, were found to meet their energy requirements, and only 16.7% their protein requirements, by overall oral intakes in hospital. Conversely, through menu choices alone, none of the nutritionally vulnerable patients in this study met their energy requirements, and only 8.3% met their protein requirements (Pullen et al., 2017). Oral intakes were significantly less than energy and protein requirements in another recent study amongst inpatients, 65 years and older, in post-acute geriatric orthopaedic wards in three NHS hospitals in Scotland (Bannerman et al., 2016). In a 2011 UK study amongst patients with fractured neck of femur, 63% of patients received $\leq 50\%$ of their daily energy requirements, and 45% patients received $\leq 50\%$ of their daily protein requirement on the day of the audit (Ord & Steele, 2011). In a study in Queensland, Australia, amongst inpatients specifically receiving therapeutic oral diets (mostly fluid diets), only 37% of patients were provided with, and 18% consumed adequate nutrients to meet their estimated requirements (Rattray et al., 2017).

Providing optimal food service for hospitalised patients is a challenging, complex and difficult task. Hospital food should provide adequate nutrition to promote physical, as well as psychological well-being. Hospitalised patients are deprived of their normal consumer power and are dependent on hospital food to obtain nutrition. Obtaining food from additional sources may not be possible and are less desirable. Therefore, hospital menus should not only be cost-effective, safe and nutritionally adequate, but also appealing and patient-focussed, offering familiar foods to patients to optimise nutritional intake even if feeling unwell (BDA Food Services Specialist Group, 2017).

1.4 Problem statement

Despite evidence of inadequate oral intakes of hospitalised patients in the recent international literature, and recommendations from a recent systematic review that emphasises the importance of auditing the adequacy of food provision to hospitalised patients (Mitchell & Porter, 2016), no published information is currently available pertaining to the nutritional adequacy of orally-fed patients admitted to hospitals in South Africa, leaving an opportunity for research in this field.

This study therefore aimed to assess the nutritional adequacy of oral intakes of patients not receiving enteral nutrition (administered through a tube) and/or parenteral support, in an ICU setting in a private hospital in South Africa. Local data pertaining to the adequacy of oral intakes amongst critically ill patients is important to assist dietitians to optimise nutritional care and identify patient groups at risk of malnutrition and inadequate oral intake. In addition, medical funders in South Africa are often reluctant to pay for ONS in private hospitals, therefore data from this study, could potentially be used to justify the prescription of ONS by dietitians, and to motivate for imbursement of ONS by medical funders.

The researcher observed that over the past decade, catering services have increasingly been outsourced to private catering companies. Unfortunately, these services are typically characterised by the absence of a dedicated on-site food service dietitian to take responsibility and ownership to serve high quality meals that meet the nutritional requirements of patients. This research may therefore also be used to motivate the role of

qualified and registered dietitians in all facets of nutrient delivery, particularly to the critically ill who remain at high risk for DRM.

1.5 Aim of the study

The aim of this study was to assess the adequacy of nutritional intake of exclusively orally fed patients admitted to the ICU in a private South African hospital in Alberton, Gauteng Province.

1.6 Objectives of the study

To achieve the aim, the following were determined for each participant:

- i. Patient profile, including age, gender, hospital admission diagnosis, and LOS in ICU;
- ii. Anthropometry, namely BMI;
- iii. Daily energy and protein requirements;
- iv. Total daily oral energy and protein intakes; and
- v. Adequacy of total daily oral intakes to meet daily energy and protein requirements.

1.7 Layout of the dissertation

This dissertation is structured as follows:

Chapter 1: Background and motivation for the study are discussed, including the background, problem statement, aim, and objectives.

Chapter 2: The literature review includes the definition, aetiology and implications of DRM, the effect of inflammation on nutritional requirements, oral intakes of hospitalised patients, challenges pertaining to provision of oral nutrition to hospitalised patients, nutrition recommendations throughout the continuum of illness, the role of ONS as well as hospital menus to meet nutritional requirements of patients, as well as the role of the food service dietitian to ensure optimal nutrition delivery of hospitalised patients.

Chapter 3: This chapter describes ethical approval and permission, the study design, study population and sampling, measurements, variables and operational definitions, techniques, study procedure, selection and standardisation of techniques to ensure validity and reliability.

Ethical considerations, the pilot study and the statistical analysis are included. The limitations of the study and steps taken to overcome these, are discussed.

Chapter 4: Results of the study are discussed and summarised.

Chapter 5: The results of the study are interpreted and discussed in the context of the relative literature.

Chapter 6: Conclusions are drawn from the results of this study and recommendations based on the findings of the study are made. Limitations of the study are listed and recommendations for future research are made.

2 CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Over the past forty years, numerous publications have investigated and reported on the ongoing dilemma of hospital malnutrition. The prevalence of hospital malnutrition in the acute hospital setting ranges from 20% to 50%, depending on the patient population and definition used to diagnose malnutrition (Lim et al., 2012; van Bokhorst-de van der Schueren et al., 2012; Norman et al., 2008; Kruizenga et al., 2005). A third of patients are malnourished on admission to hospital and two thirds of these patients will develop a further decline in nutritional status while hospitalised. In addition, patients that are admitted to hospital with a normal nutritional status are at high risk to develop malnutrition during hospital stay (Barker et al., 2011).

In this chapter, the definition, aetiology and implications of DRM, the effect of inflammation on nutritional requirements, oral intakes of hospitalised patients, challenges pertaining to provision of oral nutrition to hospitalised patients, nutrition recommendations throughout the continuum of illness, the role of ONS and hospital menus to meet nutritional requirements of patients, as well as the role of the food service dietitian to ensure optimal nutrition delivery of hospitalised patients, are discussed.

2.2 Malnutrition amongst hospitalised patients

Malnutrition among hospitalised patients is a debilitating factor responsible for various serious complications related to impairment on a cellular, physical and psychological level (Tappenden et al., 2013; Cawood et al., 2012; Barker et al., 2011; Peterson et al., 2011; Thibault et al., 2011; Peterson et al., 2010).

As summarised by Tappenden et al., (2013), on a cellular level, malnutrition impairs the immune system, therefore increasing the risk of pressure ulcers and infection, complicating treatment of infection, decreasing nutrient absorption and altering renal function. On a physical level, malnutrition causes loss of lean body mass as well as fat mass. Loss of lean body mass results in decreased respiratory and cardiac function, as well as atrophy of visceral

organs. Unintentional weight loss of 15% is associated with significant loss of muscle strength and respiratory function, whilst loss of 23% body mass is associated with 70% decrease in physical fitness and 30% decrease in muscle strength. In addition, loss of 23% body mass is associated with a 30% rise in the incidence of depression. Thus, a significant number of patients experience depression as malnutrition is associated with fatigue, apathy and anorexia contributing to a delayed recovery (Tappenden et al., 2013). All these complications of malnutrition are associated with increased LOS, increased re-admission rates and delayed recovery time. Malnutrition therefore does not only have negative consequences for patients, but also for health care facilities as it significantly contributes to increased costs (Tappenden et al., 2013; Barker et al., 2011).

Despite the high prevalence and serious implications of hospital malnutrition, as well as the known potential of addressing hospital malnutrition to improve patient outcome and decrease cost, the condition remains widely unrecognised and untreated (Tappenden et al., 2013; Barker et al., 2011).

2.3 Classification of malnutrition amongst hospitalised patients

Although malnutrition broadly describes an imbalance in the intake and assimilation of nutrients that may implicate either over or undernutrition (Freijer et al., 2013; Barker et al., 2011; Stratton et al., 2003), multiple definitions for malnutrition syndromes in the literature may be confusing. In 2010, an International Guideline Committee was established to develop a consensus approach to defining malnutrition syndromes for adults in the clinical setting. Consensus on an aetiology-based system for the definition of malnutrition was achieved through a series of meetings held at ESPEN and ASPEN Congresses (Jensen et al., 2010). The terms “starvation-related malnutrition”, “chronic disease-related malnutrition” and “acute disease-related or injury-related malnutrition” were suggested as nutrition diagnoses in adults in the clinical setting (Jensen et al., 2010; Jensen et al., 2009). Subsequently, these definitions have been further refined and the latest version thereof was published in the 2017 ESPEN Guidelines on Definitions and Terminology in Clinical Nutrition (depicted in Figure 2.1).

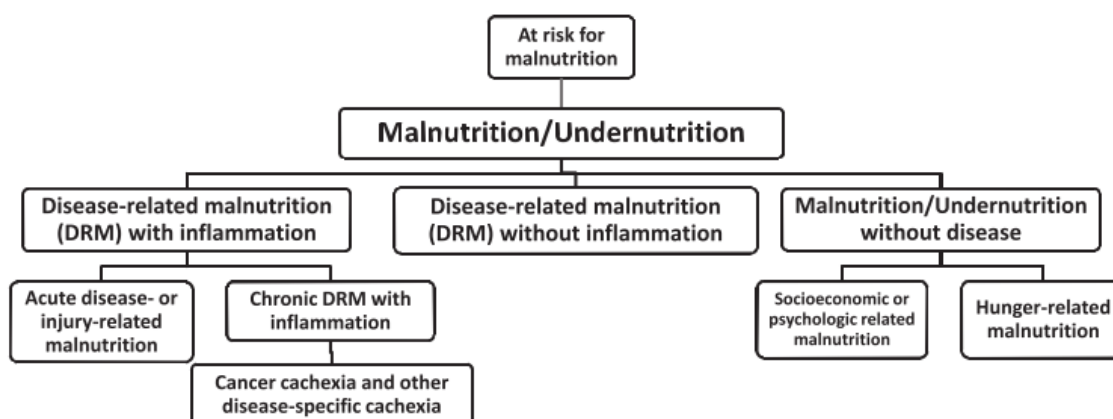


Figure 2.1: Diagnostic tree of malnutrition (Cederholm et al., 2016)

As described in chapter 1, screening tools are recommended to assess which patients, on admission, are at risk for malnutrition. Based on aetiology, three main types of malnutrition are now defined, namely malnutrition without disease, DRM without inflammation, and DRM with inflammation, whilst the latter is further classified into acute DRM (also referred to as injury-related malnutrition) and chronic DRM with inflammation, which may lead to cachexia (Cederholm et al., 2016).

Simple starvation is a physiological state resulting from primary food and nutrient deprivation and is associated with ketones being produced as the primary source of energy. When these physiological reactions cause physiological consequences, it is clinically referred to as malnutrition (Marshal & Agarwal, 2017). This malnutrition syndrome relates to the historic definition of marasmus where both protein and energy intakes are reduced, causing starvation. Extracellular fluid volume is not increased (no oedema develops), and visceral protein is usually maintained until severe starvation is evident. This malnutrition syndrome is the only one that demonstrates obvious similarities in pathophysiology between paediatric and adult patients in both more and less developed countries (Jensen et al., 2009).

The term “starvation-related malnutrition” was originally suggested in the 2010 consensus report to describe chronic starvation without any evidence of inflammation (Jensen et al., 2010). The most recent definition of malnutrition without inflammation, distinguishes between ‘hunger-related malnutrition’, caused by deprivation of food, that can manifest through “famine due to natural disasters like droughts or flooding”, and “socioeconomic- or psychologic-related malnutrition”, that may emerge with “poverty, social inequities, poor

care, mourning, poor dentition, self-neglect, imprisonments or hunger strike". Such conditions have effect not only on the energy intake, but also on the quality of the food intake (Cederholm et al., 2016).

Diagnostic criteria for hunger-related malnutrition are the same as those for malnutrition when hunger or food deprivation in the absence of disease is the clear cause for the condition (Cederholm et al., 2016; Jensen et al. 2010). Hunger-related malnutrition is only diagnosed when protein-energy malnutrition is caused by food and nutrient deprivation over a long period of time in the absence of disease processes and inflammation (Jensen et al., 2010). In hunger-related malnutrition, appropriate and aggressive nutrition treatment without medical intervention is successful and life-saving (Jensen et al., 2009).

2.3.1 Disease-related malnutrition

DRM is a secondary form of malnutrition typically evident in hospitalised and critically ill patients as result of, and in association with, acute or chronic illness. Disease related malnutrition develops as result of inadequate intake or availability of nutrients, in the presence of disease that alters nutrient requirements and substrate metabolism, in the absence or presence of simultaneous inflammation, the inadequacy of nutrients may result from inadequate intakes, in addition to abnormal assimilation of nutrients. Complications of disease, such as malabsorption and/or increased nutrient losses, contribute to a negative nutrient balance, even in the presence of adequate intake. The pathophysiology of DRM is thus a complex interplay between reduced intake or availability of nutrients and underlying disease (Freijer et al., 2013; Barker et al., 2011).

2.3.1.1 Disease-related malnutrition without inflammation

Inflammation does not play a role in the aetiology of this form of malnutrition; rather, malnutrition develops due to factors like dysphagia due to obstruction of the upper digestive system, neurologic disorders such as stroke, Parkinson's disease, dementia, anorexia nervosa or depression, and malabsorption due to intestinal disorders such as short bowel syndrome (Cederholm et al., 2017).

2.3.1.2 Disease-related malnutrition with inflammation

Evidence over the last few decades confirms the vital role of both chronic or acute inflammation in the pathophysiology of DRM (Jensen et al., 2010; Jensen et al., 2009). DRM with inflammation is a catabolic condition, including anorexia and tissue breakdown, altered nutrient requirements and altered substrate metabolism (Cederholm et al., 2016). Inflammation not only promotes catabolism of skeletal muscle, but also alters nutrient requirements and metabolic pathways (Jensen et al., 2010; Jensen et al., 2009). DRM in the presence of inflammation may be associated with a chronic inflammatory condition (referred to as cachexia) or with injury that triggers an acute inflammatory response (Cederholm et al., 2016).

2.3.1.2.1 Chronic disease-related malnutrition (cachexia)

The term “chronic DRM” relates to the historic definition of cachexia, which is a malnutrition syndrome characterised by weight loss, weakness and wasting resulting from loss of body cell mass that occurs during chronic disease conditions (Jensen et al., 2010; Jensen et al., 2009). Thus, the concepts of chronic DRM with inflammation and cachexia are interchangeable, and the perception that cachexia only refers to end-stage malnutrition, is no longer correct (Cederholm et al., 2016).

Cachexia is an intricate metabolic syndrome associated with underlying disease and characterised by loss of muscle mass, with or without loss of fat mass. The most prominent feature of the syndrome is weight loss due to on-going elevated inflammatory activity as proven by biochemical indices. Cachexia occurs frequently in association with end-stage organ diseases that become complicated by catabolic inflammatory responses; these include cancer, inflammatory bowel diseases, congestive heart failure, chronic renal disease, chronic obstructive pulmonary disease and other end-stage organ diseases. The systemic inflammation that drives the catabolism of these disorders is usually mild, a serum concentrations of C-reactive proteins (CRP) seldom rising above 40 mg/L, but flares can occur during disease exacerbations (Cederholm et al., 2016).

In the 2010 proposal for malnutrition definitions (Jensen et al., 2009), sarcopenia, defined as loss of muscle mass, strength, and function occurring with age, was considered as part of the

cachexia continuum, as it is associated with chronic, low grade inflammation, driven by cytokines and oxidative stress. Sarcopenia is associated with loss of alpha-motor neuron input, changes in levels and function of anabolic hormones, decreased physical activity and lower protein intakes (Jensen et al., 2010). The prevalence of sarcopenia ranges from 10% to 50% depending on age group (Jensen et al., 2009). In addition to sarcopenia, a definition of frailty in elderly patients is currently emerging. Conversely, sarcopenic obesity can occur in any age group and refers to obesity in combination with sarcopenia. This occurs in older individuals, in those with type 2 diabetes and chronic obstructive pulmonary disease, in obese patients with malignant disorders, and after organ transplantations (Cederholm et al., 2016). In the current definitions of terminology in critically ill patients, sarcopenia as well as frailty and sarcopenic obesity, are considered as syndromes in their own right (Cederholm et al., 2016), all of which are caused and worsened by injury, illness, and inactivity during hospitalisation, thus complicating and negatively impacting on disease outcome (Correia et al., 2014).

2.3.1.3 Acute disease- or injury-related malnutrition

The term “acute disease-related or injury-related malnutrition” is proposed when acute and severe inflammation accompanies malnutrition as typically occurs in those admitted to the ICU with trauma, burns, closed head injuries, major infection, or after major surgical procedures. As opposed to chronic disease-related malnutrition, the onset of the metabolic response to stress is sudden and severe, associated with an intense inflammatory response, amongst other metabolic reactions, all of which drives muscle catabolism and alters nutrient requirements (Cederholm et al., 2016; Jensen et al., 2010). The metabolic response to stress is an adaptive response to survive the injury or critical illness through substrate mobilisation and altered metabolism of protein, carbohydrates and fat (Winkler & Malone, 2017; Preiser et al., 2014). The specific nutritional challenges associated with this highly pronounced stress metabolism, poses a high risk of consequent malnutrition (Cederholm et al., 2016). The goal of nutrition support during the acute phase is therefore to provide adequate nutrients to support vital organs and maintain appropriate host responses while medical treatment is being provided. Provision of adequate nutrition during the acute phase inflammatory response, however, does not prevent muscle catabolism completely. In addition, sub-optimal

intake of protein and energy during acute inflammation increases muscle catabolism and negatively affects outcomes such as mortality and LOS. Thus, even patients who are not protein and energy undernourished at the time of admission, are at risk to develop malnutrition due to the acute inflammatory response, as well as inadequate food intake (Jensen et al., 2010; Jensen et al., 2009).

2.4 The metabolic response to stress

The metabolic response to stress forms part of an adaptive response to survive critical illness (Preiser et al., 2014). It is complicated and involves three phases which progressively and dynamically combines neuro-endocrine and inflammatory responses to effectively liberate and make available amino acids, glucose and fatty acids from the body tissues as substrates to repair the injury (Stahel et al., 2010).

2.4.1 The phases of the metabolic stress response

In 1942, Cuthbertson first described two distinct characteristic phases following major trauma or injury, namely the ebb phase and the flow phase. A third or chronic phase has also recently been suggested (Preiser et al., 2014; Şimşek et al., 2014; Stahel et al., 2010).

2.4.1.1 Ebb phase

The immediate, post injury or ebb phase, probably aimed at reducing immediate posttraumatic energy expenditure, is associated with hypovolemia, tissue hypoxia and shock accompanied by decreased cardiac output, oxygen consumption and body temperature. The medical management involves hemodynamic stabilisation, as well as treatment of the cause of injury (Winkler & Malone, 2017; Preiser et al., 2014; Stahel et al., 2010). The duration of the ebb phase is relatively short, lasting <12 hours to 24 hours (Şimşek et al., 2014; Stahel et al., 2010).

2.4.1.2 Flow phase

Successful resuscitation and adequate oxygenation during the ebb phase, triggers compensatory reactions which allows transition into the flow phase, which usually lasts from one to three weeks (Stahel et al., 2010). This phase is characterised by hyperinflammation and hypermetabolism as well as associated increases in cardiac output, body temperature,

oxygen consumption and energy expenditure. The aim is to liberate substrates for repair of tissues damaged by the injury, surgery or infectious insult. Endogenous glucose production, proteolysis, as well as lipolysis, are increased. Hormonal responses include increased cortisol, catecholamine and glucagon secretion, as well as increased circulating levels of insulin. Hyperglycaemia is common as result of peripheral insulin resistance and increased endogenous glucose production (Winkler & Malone, 2017; Stahel et al., 2010).

2.4.1.3 Chronic or anabolic phase

Recently the return of oxidative metabolism, tissue repair and recovery, was described as the third, or chronic/anabolic, phase (Preiser et al., 2014; Stahel et al., 2010). During this phase, pituitary factors, as well as peripheral hormones are lowered, but resistance to insulin, cortisol, growth hormone and thyroid hormone continues with ongoing effect on energy, protein and fat metabolism (Preiser et al., 2014). Clinically the onset coincides with the beginning of diuresis and request for oral intake (Şimşek et al., 2014).

During the early phase of the chronic or anabolic phase, there is a transition from catabolism to the anabolism, which depends on the severity of injury. During uncomplicated elective surgery, the transition from catabolism to anabolism happens within three to eight days, while the transition may be delayed for weeks to months after severe trauma or sepsis and factors such as adequate nutrition and protein storage capacity may play a role in the duration of this early phase of anabolism (Şimşek et al., 2014).

The late chronic or anabolic phase coincides with the final phase of recovery when a positive nitrogen balance, as well as protein and fat stores, are restored after the metabolic response to stress has ended. The duration may be several weeks to months after serious trauma (Şimşek et al., 2014).

2.4.2 Pathophysiology of the metabolic response to stress

The metabolic response to stress is mediated through neuroendocrine and inflammatory components. An altered hormonal state triggers substrate mobilisation, and alters metabolism. The inflammatory component is characterised by immunological alterations that are mediated through the release of inflammatory mediators such cytokines after activation of the immune system (Winkler & Malone, 2017; Preiser et al., 2014). In addition, oxidative

stress triggered by injury, needs to be controlled as it can contribute to tissue damage (Preiser et al., 2014).

2.4.2.1 Neuroendocrine component

Once a stressor is signalled to the central nervous system, a classic neuro-hormonal reaction follows. This reaction involves the immediate activation of the sympathetic nervous system (SNS), as well as the hypothalamic-pituitary axis. Activation of the SNS happens within seconds to minutes after the onset of stress (injury), while the activation of the hypothalamic-pituitary axis is slightly more delayed to some hours after the onset of the stress (Preiser et al., 2014).

The activation of the SNS is responsible for the immediate control of organs through adrenergic hormones and receptors, where after, once activated, the hypothalamic-pituitary axis is responsible for stimulating the secretion of pituitary factors that act as precursor factors for peripheral hormone secretion (Preiser et al., 2014). Insulin, cortisol and glucagon levels are increased and enhance muscle catabolism, the hepatic uptake of amino acids for gluconeogenesis, as well as synthesis of acute-phase proteins, whilst cortisol also promotes glycogenolysis (Winkler & Malone, 2017; Preiser et al., 2014).

In addition, hormones secreted by the gastro-intestinal tract, as well as adipose tissue, may also play an important role in the pathophysiology of the metabolic response to stress. The release of adipokines such as leptin, resistin and adiponectin is thought to contribute to metabolic changes. Hormones, such as ghrelin, cholecystokinin and peptide YY, which are secreted by the gut, may further contribute to certain behavioural adaptations that are characteristic to the response to stress. Circulating levels of ghrelin are mostly decreased, whilst the levels of cholecystokinin and peptide YY are increased, and these changes are possibly responsible for the anorexia experienced by patients during the acute phase (Preiser et al., 2014).

2.4.2.2 Inflammatory component

Activation of the inflammatory component, partially regulated by the central nervous system, is more delayed and responsible for inflammatory and immunological changes, after injury or trauma. The immune response includes cellular or humoral responses, and is mediated by the

release of proinflammatory proteins such as antibodies and cytokines. The release of cytokines such as tumour necrosis factor (TNF), interleukin (IL)-1, and IL-6 by phagocytic cells in response to tissue damage, are responsible for clinical signs such as fever and lethargy, weight loss and anorexia. Inflammatory mediators are also responsible for metabolic abnormalities such as enhanced gluconeogenesis, proteolysis and lipolysis (Winkler & Malone, 2017; Preiser et al., 2014).

The acute phase response is a fundamental component of the metabolic response to stress. It is a group of physiological processes that occur soon after injury and inflammation with the aim to destroy inflammation and promote homeostasis as well as healing. The acute phase response is initiated through the release of cytokines among which TNF, IL- 1 and IL-6 play important roles. One of the most important metabolic changes during the acute phase response, is the increased synthesis of positive acute phase proteins such as C-reactive protein and fibrinogen by the liver. The levels of negative acute phase proteins such as albumin and transferrin decrease during inflammation. The reduced production of negative acute phase proteins allows for the increased production of positive acute phase proteins (Winkler & Malone, 2017; Tothova et al., 2014). In addition, besides increased breakdown during inflammation, albumin may also leak through the vascular compartment and albumin levels may drop significantly within 24 hours from an injury or insult (Jensen et al., 2009).

2.4.2.3 The role of uncontrolled oxidative stress associated with the metabolic stress response

Uncontrolled oxidative stress is an imbalance between reactive oxygen species (ROS) generation and antioxidant levels and may also play an important role in the metabolic response to stress. Acute inflammation, ischaemia-reperfusion, hypoxia and hyperoxia may increase the production of ROS and/or consume antioxidant stores, further increasing oxidative stress, increasing inflammation and ROS generation resulting in a vicious cycle that results in severe cellular damage (Preiser et al., 2014).

2.4.3 Metabolic consequences of the metabolic stress response

During the metabolic response to stress, all processes aim to mobilise substrates and reroute delivery to vital organs instead of to normal insulin-dependent organs i.e. fat and muscle. In

healthy subjects the availability of substrates, as determined by meals and timing of meals, determines the utilisation thereof. However, during critical illness, the utilisation of substrates depends on endogenous stores and the mobilisation in metabolic response to stress (Preiser et al., 2014).

The net effect of the metabolic response to stress is uncontrolled catabolism and resistance to anabolic signals. Total energy expenditure and substrate use is increased, whilst muscle and fat mass is progressively decreased until the signals for catabolism dissipate (Winkler & Malone, 2017; Preiser et al., 2014).

2.4.3.1 Energy expenditure

During the early or ebb phase of critical illness, energy expenditure is decreased and lower than before injury. During this phase, temperature as well as energy consumption drops. The drop in metabolic rate is probably aimed at reduced energy depletion (Preiser et al., 2014; Şimşek et al., 2014; Stahel et al., 2010). Later, during the chronic stages of critical illness, energy expenditure significantly increases to values higher than before injury. Energy expenditure is not only influenced by physiological factors such as heart rate, temperature, shivering and agitation, but also therapeutic interventions such as medications i.e. the use of β -blockers and cooling. In the absence of indirect calorimetry, the temporal changes in energy expenditure during critical illness, as well as the influence of the above mentioned factors, complicates the accurate prediction of energy expenditure (Preiser et al., 2014).

While the hormones secreted early during the metabolic response to stress, drive hypermetabolism, later changes such as impaired secretion and peripheral resistance are possibly adaptive and linked to long-term survival and protection of organisms. During the chronic phase of the response to stress, plasma levels of both pituitary factors, as well as peripheral hormones are lowered but peripheral resistance to growth hormone, insulin, thyroid hormones and cortisol persists. The latter may be associated with mitochondrial changes, which can be described as a form of hibernation that results in shutdown of excessive organ function. These changes may be maladaptive when contributing to increased wasting, mortality and multi organ dysfunction. Mitochondrial function may further be impaired as result of oxidative stress as mitochondria handle oxygen (Preiser et al., 2014).

2.4.3.2 Effect on carbohydrate metabolism

Injury and trauma are characterised by increased glucose turnover, insulin resistance and hyperglycaemia, resulting from increased hepatic glucose production (Preiser et al., 2014; Şimşek et al., 2014). Driven by stress hormones and cytokines, gluconeogenesis is the first metabolic change observed after trauma. During normal starvation, gluconeogenesis is downregulated through the exogenous administration of glucose. However, during stress and trauma, gluconeogenesis continues, despite exogenous delivery of glucose and marked presence of hyperglycaemia (Şimşek et al., 2014).

Initially, during the ebb phase, glycogen stores become the primary source of glucose for use as substrate. The metabolic response to stress can generate up to 50 – 75% of glucose requirements during this phase (Preiser et al., 2015). After the first 24 hours, amino acids, lactate, pyruvate and glycerol are used for gluconeogenesis in the liver, kidneys and intestine. Glucose exhibits the ability to yield energy anaerobically during the first stage of glycolysis. Therefore, especially endogenous glucose production is increased early during stress and trauma as it becomes an important substrate in cells and organs where mitochondrial function is impaired or not possible as result of tissue damage and hypoxia. Furthermore, decreased levels of insulin resulting from increased glucagon secretion, in combination with the development of peripheral insulin resistance, is thought to be an adaptive mechanism to facilitate the uptake of glucose by cells and vital organs that are unable to use energy substrates other than glucose during stress conditions. Cells of the central nervous system, erythrocytes and cells that are present in damaged tissue, are all able to utilise glucose as substrate in the absence of insulin (Preiser et al., 2014; Şimşek et al., 2014).

2.4.3.3 Effect on fat metabolism

Tissue hypoxia and mitochondrial dysfunction is common during the early phases of critical illness and the use of lipids as substrate is relatively less increased than that of carbohydrates, because the oxidation of lipids requires sufficient oxygen and functional mitochondria. The latter may explain why an increased lipid supply will not result in increased lipid oxidation (Preiser et al., 2014). However, during the early phase, lipolysis and the release of free fatty acids (FFA) are increased under the influence of hormonal factors such as adrenocorticotrophic hormone, cortisol, growth hormone, insulin, as well as glucagon, and exogenous provision of

lipids does not inhibit lipolysis. Therefore, during the early phase the metabolism of lipids are increased, but complete oxidation is limited in the presence of poor oxidation and mitochondrial function. The initial limited ability to oxidise free fatty acids during the early phase of critical illness, over increased lipolysis, contributes to the formation of lipid peroxides and consequent organ damage. However, the ability of peripheral tissue to oxidise FFA improves later and, in the liver, FFA are converted to ketones or re-esterified to triglycerides which are released into the bloodstream as very-low-density-lipoprotein. Glycerol structures are used for gluconeogenesis in the liver. The increased rate of lipid oxidation, together with muscle cell loss, results in wasting (Winkler & Malone, 2017; Preiser et al. 2014; Şimşek et al. 2014).

2.4.3.4 Effect on protein metabolism

Protein catabolism is part of the metabolic response to stress and results in a reduced lean mass, as well as reduced total body nitrogen content (Hurt et al., 2017). During stress, the increased rate of protein degradation over that of protein synthesis, with a consequent negative nitrogen balance, is driven by hormones and inflammatory mediators (Di Girolamo et al., 2016; Preiser et al., 2014). Immobility is another important factor that alters protein metabolism by negatively influencing all the steps of protein synthesis. Therefore neuroendocrine adaptations, inflammation and immobility are three factors identified to be detrimental to protein metabolism (Di Girolamo et al., 2016).

Increased cortisol drives catabolism of mainly skeletal muscle and the promotion of hepatic uptake of amino acids. The process of muscle catabolism is an adaptive response to injury and stress. Amino acids are used for gluconeogenesis, as well as for the synthesis of acute-phase proteins that are necessary for tissue repair. If this adaptive response persists, it causes significant loss of lean body mass at a rate of 1.5% – 5% per day. It is documented that these losses can be as much as 1 kg per day with most of the losses occurring during the first 7-10 days (Wischmeyer, 2016). In addition, peripheral resistance to anabolic stimuli from growth hormone and insulin negatively affects protein metabolism. Similarly, adipokines such as leptin, resistin and adiponectin also possibly induce higher resistance to anabolic signals. Cytokines, such as TNF, IL-1, and IL-6 as already discussed in paragraph 2.3.2.2, also negatively affects protein metabolism. These cytokines, particularly TNF, are thought to affect protein

metabolism by reducing transcription and translation of myofibrillar proteins. Lastly, immobilisation negatively affects all steps of protein synthesis i.e. transcription, translation and post-translation and plays an important role in muscle mass loss during immobilisation. Prolonged immobilisation is also thought to stimulate catabolism of muscle protein through different proteolytic pathways (Di Girolamo et al., 2016).

Continuous losses of lean body mass eventually contribute to the development of ICU-acquired weakness due to skeletal muscle mass that rapidly becomes depleted (Di Girolamo et al., 2016; Preiser et al., 2014). ICU-acquired weakness is a condition characterised by considerable weakness in patients after a prolonged stay in ICU. The condition is associated with increased morbidity and mortality. Patients mainly complain of proximal weakness, loss of muscle function and muscle mass, as well as fatigue. Continued, persistent muscle wasting and weakness may still be prominent five years after discharge from ICU (Preiser et al., 2014).

2.4.3.5 The contribution of chronic inflammation to cachexia during metabolic stress

Chronic inflammation is characterised by low grade, ongoing cytokine-mediated inflammation, which is associated with insulin resistance, and plays a key role in the pathophysiology of chronic diseases of lifestyle. During critical illness, the presence of this type of chronic low-grade inflammation may increase lipolysis, proteolysis, and oxidation, as well as protein turnover, contributing to the pathophysiology of cachexia. In conditions such as rheumatoid arthritis, which is characterised by chronic low grade inflammation, there may even be an increase in fat mass, masking body cell loss and change in body composition, until advanced cachexia develops (Jensen et al., 2009).

2.5 Oral intake of hospitalised patients

Poor oral intake of hospitalised patients is well documented and contributes to the development of DRM or worsening of existing malnutrition during hospital stay (Tappenden et al., 2013; Thibault et al., 2011) and therefore food provision is essential to prevent DRM (Pullen et al., 2017; Tappenden et al., 2013). It is widely reported that approximately 70% - 75% of patients in acute care settings typically do not meet nutritional requirements (Reeves et al., 2013; Thibault et al., 2011). In a prospective observational study of 36 patients requiring non-invasive ventilation (NIV), it was found that the nutritional intake of three quarters of

these patients, failed to meet 80% of their minimum protein and energy requirements (Reeves et al., 2013).

However, data describing the oral intakes of patients admitted specifically to ICU is limited, but Peterson et al., (2011) found that the average oral intakes of a group of 50 medical and surgical ICU patients in the first seven days following extubation, did not meet more than 50% of energy and protein requirements.

Inadequate food intake of hospitalised patients is affected by patient related and institutional factors (Tappenden et al., 2013).

2.5.1 Patient-related factors affecting oral intake of hospitalised patients

There is a direct correlation between appetite and health status, as healthier patients have a better appetite and food intake than sicker patients do. Besides general anorexia, other patient-related factors that may impair oral intake of hospitalised patients, include age, nausea, vomiting, psychological conditions (such as low mood, apathy and depression), neurological conditions that affect chewing or swallowing ability, dementia, food availability, limited mobility and weakness, sensory losses (such as loss of taste and smell), treatments such as ventilation, frequent *NPO* periods required for diagnostic and therapeutic procedures, surgery, drains and tubes, as well as medicine that alter taste and appetite (Tappenden et al., 2013; van Bokhorst-de van der Schueren et al., 2012; Barker et al., 2011).

Patient awareness of the importance of nutrition care while hospitalised, may also affect patients' oral intake, as patients that are aware of the importance of nutrition care are more likely to have a better appetite and oral intake. Therefore, nutrition education to patients and family members remains important (Tappenden et al., 2013; van Bokhorst-de van der Schueren et al., 2012; Barker et al., 2011). During the systemic inflammatory response, altered hormone levels such as ghrelin, cholecystokinin, peptide YY and leptin, as previously described, are thought to be the cause of poor appetite experienced by the critically ill patient, as they act on the central nervous system and down-regulate hunger (Peterson et al., 2011). Residual pain causing odynophagia after extubation, as well as breathlessness and fatigue experienced by patients receiving NIV are reported as important contributing factors

to inadequate oral intake of patients after extubation, as well as for patients on NIV (Reeves et al., 2013; Peterson et al., 2011).

2.5.2 Institutional factors affecting oral intake of hospitalised patients

Besides patient-related factors, institutional factors also play a role in the oral intake of hospitalised patients. Overall lack of organisational awareness and recognition of the importance of quality nutrition care, allows for poor organisation of nutrition services that do not prioritise the nutritional care of patients, as well as poor catering services. In addition, this lack of awareness results in health care workers are not adequately trained to recognise the importance of nutritional care (Tappenden et al., 2013; Barker et al., 2011). Lack of appropriate nutritional training of important role players such as nursing staff and specialists leads to their inability to deal with nutrition-related problems and to recognise the importance of nutrition as an essential component of the overall treatment of patients (Tappenden et al., 2013; Barker et al., 2011). In addition, lack of institutional awareness may allow nursing functions and ward rounds to be performed during meals, and visitors to distract patients during meal times (Tappenden et al., 2013; van Bokhorst-de van der Schueren et al., 2012; Barker et al., 2011).

Oral intake is also significantly influenced by catering services i.e. food quality and meal planning which relates to the quality of food provided by the catering department, as well as the process of ordering and serving of meals to patients. Inappropriate prescription of therapeutic diets and menus that are not suitable for patients, does not acknowledge patients food preferences, or lack of variety, as well as inappropriate preparation of meals, are identified as additional barriers for optimal oral intakes (van Bokhorst-de van der Schueren et al., 2012; Peterson et al., 2011).

2.5.3 Addressing organisational factors to optimise nutrition care of hospitalised patients

Changing health care policies and increased focus on affordable, high quality and transparent care worldwide, allows the ideal opportunity to re-address the topic of hospital malnutrition and the importance of the delivery of optimal nutrition as an essential component of patient recovery. Addressing DRM allows opportunity to reduce overall healthcare costs, and improve patient recovery (Tappenden et al., 2013).

To address DRM effectively, requires multi-disciplinary collaboration between physicians, nursing staff, dietitians, and pharmacists, other para-medical professionals, catering services, administrators and policy makers. The key stakeholders are identified as the dietitian, nurse, physician and hospital administrators. In 2013, the Alliance to Advance Patient Nutrition (Alliance), consisting of members of the Academy of Medical-Surgical Nurses (AMSN), AND, ASPEN, the Society of Hospital Medicine (SHM) and Abbott Nutrition, formally identified and published a report on the barriers that negatively affect institutional nutrition delivery. The identified factors included failure to identify malnourished or patients at risk of malnutrition on admission, lack of dietetic staff, delayed implementation of nutrition care, nursing staff not being actively involved in nutrition care, non-implementation of dietician's orders, and patients not being adequately assisted to consume meals. To address these barriers, the Alliance developed six key principles to improve the nutrition care of hospitalised patients (Tappenden et al., 2013).

2.5.3.1 First key principle: Creating an institutional culture

The first key principle, identified by the Alliance, is to create an institutional culture where all stakeholders recognise the importance of nutrition care. These stakeholders include clinicians and administrators. To increase awareness of the financial and clinical implications of malnutrition amongst stakeholders, the Alliance recommended, firstly, that clinicians are trained to identify and treat malnutrition according to evidence-based guidelines. Discussion of nutrition care plans should become mandatory components of team discussions and ward rounds. Secondly, malnutrition needs to be included as part of the patient's diagnosis and treatment thereof should be viewed as core component of overall patient treatment. Thirdly, hospital administrators need to be made aware of the financial benefit of optimal nutrition care and be motivated to financially allow for optimal nutrition care as proposed by the clinical team. Lastly it is recommended that professional associations for various clinical disciplines are made aware of the importance of optimal nutrition care, facilitating further education, development of toolkits and guidelines for optimal nutritional care of hospitalised patients (Tappenden et al., 2013).

2.5.3.2 Second key principle: Redefining the clinician's role to include nutrition care

The second key principle is to redefine the clinician's role to include nutrition care. Effective nutrition care involves interdisciplinary involvement of all parties and should no longer be the responsibility of only the dietitian. It is recommended that a nutrition champion is identified in all disciplines involved to ensure that optimal nutrition care of patients becomes a priority. All parties involved need to be empowered pertaining to nutrition care. Multidisciplinary, nutrition focussed groups should identify institutional barriers to optimal nutrition care and develop policies and drive the implementation thereof. Nurses should be empowered to recognise nutrition risk factors, as well as to implement some preliminary nutrition orders. Dietitians should be granted privileges for ordering therapeutic diets, oral nutritional supplements, vitamins and minerals to prevent delayed implementation of nutrition orders while waiting for physicians to sign off for orders (Tappenden et al., 2013).

2.5.3.3 Third key principle: Recognise and diagnose all malnourished patients

The third key principle is to recognise and diagnose all malnourished patients, as well as those at risk. Each hospitalised patient should be screened within 24 hours from admission. Screening tools should be scientifically validated, practical and simple to apply as clinicians may have limited time and nutrition knowledge to perform in-depth nutrition screening. Current available tools, already listed in chapter 1, include the MST, MNA-SF, MUST, NRS-2002 and the SNAQ. Screening results should be documented and in the case of a positive screen, prompt nutritional intervention should be actioned. Patients with an adequate nutritional status on admission should be rescreened regularly during hospital stay as many patients become malnourished during hospital stay (Tappenden et al., 2013).

In the case of a positive screen, prompt assessment, as well as nutrition intervention should be actioned. This entails that a dietitian should perform a nutritional assessment within 48 hours from admission. During the assessment, the dietitian should obtain anthropometrical, biochemical, clinical, as well as dietary information. These are interpreted and the significance thereof in relation to nutrition deficits are determined. After comprehensive assessment, a nutrition diagnosis should be made (Tappenden et al., 2013). As already described above, aetiology-based definitions of malnutrition have been developed. Following the first consensus proposal of aetiology-based definitions for malnutrition that acknowledge the

importance of disease in the development of malnutrition, in 2010 (Jensen et al., 2010), the AND and ASPEN developed a set of diagnostic criteria to diagnose adult malnutrition. Six characteristics were identified, namely insufficient energy intake, weight loss, loss of subcutaneous fat, loss of muscle mass, localised or generalised fluid accumulation that masks weight loss, and lastly, diminished functional status. It is proposed that malnutrition is diagnosed when at least two of these characteristics are identified (Tappenden et al., 2013).

The recently published ESPEN guidelines on definitions and terminology, use slightly different criteria to accommodate the latest definitions, and these have been mentioned before (Cederholm et al., 2016). Diagnostic criteria for DRM without inflammation are the same as those for malnutrition, combined with an underlying disease, but with no biochemical evidence that indicate present or recurrent inflammation (Cederholm et al., 2016).

In addition to information pertaining to weight changes and usual food intake, functional changes such as mental status, ambulation, as well as the ability to obtain, prepare and consume food needs to be assessed and monitored. These factors should not only be identified but addressed to improve food intake and nutritional status. Furthermore, assessment of the patient's clinical background and medical history is necessary to identify the presence of acute or chronic inflammation and the potential thereof to contribute to an aetiology-based diagnosis of malnutrition. The use of inflammatory bio-markers such as albumin and pre-albumin are no longer used to diagnose malnutrition, as it is now well recognised that the serum levels of these biomarkers are not only affected by nutritional status, but also factors such as inflammation and fluid status. However, the use of bio-markers such as albumin, C-reactive protein, white blood cell count and glucose levels are useful to recognise underlying inflammation and the importance thereof in the aetiology of malnutrition (Tappenden et al., 2013).

Once the diagnosis of malnutrition is made, it is suggested that the condition should be accurately coded and added as complicating factor of the primary diagnosis. Doing so ensures adequate documentation and allows the obtaining of statistics to quantify the burden and cost of malnutrition (Tappenden et al., 2013).

2.5.3.4 Fourth key principle: Implementation and monitoring of nutrition intervention

The fourth principle involves rapid implementation and monitoring of nutrition intervention. Prompt implementation of nutrition is, however, often compromised. Factors such as *NPO* orders, lack of nursing protocols recognising the importance of nutrition, insufficient dietetic staffing delaying nutrition assessment and diagnosis, disregard of dietitians' recommendation by physicians focusing on other medical problems, and inadequate oral intakes due to patient-related, as well as institutional factors already discussed above, are barriers that often prevent immediate nutrition intervention. These barriers can be addressed through strict protocols and nutrition instructions, prioritising nutrition delivery to malnourished and at-risk patients. The Alliance suggested that, unless contraindicated, all malnourished patients are fed within 24 hours from admission, while awaiting a nutrition consult. Immediate nutrition intervention, even before a nutrition consult, may include modification of hospital diet, assistance with ordering and eating of meals and ordering of ONS. Nursing staff should closely record and monitor patient intake and notify other role players, such as the physician and dietitian, in case of incomplete consumption. Frequent patient discussion to emphasise the importance of nutrition care is important. Multi-disciplinary intervention to adjust nutrition goals is only possible if the nutrition plan is closely monitored and recorded (Tappenden et al., 2013).

2.5.3.5 Fifth key principle: Effectively communicate the nutrition care plan

The fifth principle pertains to effective communication of the nutrition care plan. Careful and accurate documentation of the nutrition care plan is essential for effective communication amongst health care providers. Data pertaining to screening results, nutrition assessment data, nutrition diagnosis, nutrient-medication interactions and altered nutrient requirements, nutrition intervention, treatment goals, detailed dietary intake, as well as progress of implementation of nutrition goals, should be documented and enforced through standard operating procedures and nutrition protocols. Documentation should be updated regularly, and therefore, patient progress should also be documented. Documented information should be communicated to health care providers to allow informed engagement by all providers. By including accurate and comprehensive documentation of the nutrition care plan in discharge summaries, continuity of care will be ensured when patients are transferred to other post-

acute facilities. Documented data pertaining to the progress of the patient will ensure accurate updating of nutrition diagnosis and coding, as the condition changes (Tappenden et al., 2013).

2.5.3.6 Sixth key principle: Develop a comprehensive discharge nutrition care and education plan

Finally, the sixth principle involves the development of a comprehensive discharge nutrition care and education plan provided to patients, family members and caregivers. Failing to emphasise the importance of adequate nutrition care after discharge may result in suboptimal nutrition care during one of the most vulnerable stages of patient recovery. Post-discharge nutrition care should be emphasised as part of post-discharge guidelines to ensure continuity of care and to prevent the loss of nutrition goals achieved in the in-patient setting after discharge. The Alliance recommended that clinicians discuss nutrition with family members and patients, not only at the time of discharge, but also throughout hospital stay. Clear, written instruction with nutrition care after discharge, and instruction for follow-up appointments, should be provided at the time of discharge. Post-hospitalisation phone calls should include questions about dietary intake, weight changes, and concerns should be brought to the attention of the dietitian. Appropriate management of malnutrition after discharge is essential to prevent hospital re-admission (Tappenden et al., 2013).

2.6 Nutrition support of hospitalised patients

The success of nutrition intervention requires successful medical treatment of the underlying condition, as the prognosis of patients with chronic DRM mainly depends on the underlying condition (Jensen et al., 2010; Jensen et al., 2009). Despite nutritional intervention not altering the course of the underlying condition itself, nutrition remains an important supportive measure that facilitates optimal and effective medical treatment of these patients. Conversely, the existence of malnutrition may negatively affect the medical treatment and prognosis of these patients (Jensen et al., 2010). Once patients are screened and identified as malnourished or at risk of malnutrition, dietetic involvement to plan, implement and monitor medical nutrition therapy is activated. Patients that are not at risk for malnutrition on admission need frequent rescreening, whilst optimal nutrition support is provided

throughout the continuum of illness. Malnutrition, starvation, sarcopenia, and cachexia result in the catabolism and subsequent dysfunction of multiple organ systems and skeletal muscle, leading to poor patient outcomes such as physical dysfunction, hospitalisations, poor quality of life, and increased risk of death.

The main goal of nutrition support of critically ill patients is therefore to reduce the deterioration of nutritional status (Peterson et al., 2011; Peterson et al., 2010) and to prevent further catabolism of lean body mass (Peterson et al., 2011). The NICE clinical guideline CG32 defines nutrition support as methods to improve or maintain nutritional intake and include oral nutrition support, enteral tube feeding and parenteral nutrition. Oral nutrition support includes provision of ONS, dietary modification of menus, as well as nutritional counselling. Enteral tube feeding is the delivery of nutritionally complete feeds directly into the gut with a feeding tube while parenteral nutrition delivers nutrition intravenously (National Institute for Health and Care Excellence (NICE), 2017).

Current treatment of the metabolic response to stress suggests a combination of nutritional therapy, pharmaceutical interventions as well as early mobilisation (Di Girolamo et al., 2016). Nutrition therapy for the critically ill is a complex and controversial subject, as determining ideal nutrient requirements and nutrition therapy strategies against the background of increasing knowledge and understanding of the metabolic response to stress, is complicated (Preiser et al., 2015).

Once haemodynamically stable, nutrition therapy commences. Feeding strategies such as early enteral nutrition, optimal provision of macro and micronutrients, and good glycaemic control are associated with better outcomes after critical illness (Winkler & Malone, 2017; McClave et al., 2016). Current goals of nutrition support include prevention of starvation, correction or prevention of nutrient deficiencies and maintenance of adequate fluid and electrolyte balance. The current focus is on providing nutrition support without worsening metabolic complications that are associated with the metabolic response to stress. Strategies include optimal provision of energy and protein in an attempt to attenuate the metabolic response to stress, reduce oxidative cellular damage and modulate the immune response, whilst maintaining tight glucose control (Winkler & Malone, 2017). The optimal intake of macronutrients remains largely undefined, as research has been yielding controversial

results. Future research should investigate the effects of protein separate from that of energy, as well as the effect of the source of energy provided as fat or carbohydrates (Preiser et al., 2015).

2.6.1.1 Energy requirements

Evidence suggests that restricted energy delivery and energy debt after trauma and major injury, are associated with increased catabolism and poor outcome, especially in immobile patients. However, determining energy expenditure in the critically ill patient remains difficult and challenging. In the absence of indirect calorimetry, predictive equations fail to estimate energy expenditure accurately and easily results in either over- or underfeeding. An added complicating factor is the fact that energy expenditure is not stagnant and varies over time (Preiser et al., 2015).

Moreover, even if the exact energy expenditure can be measured, the answer to the question of whether energy delivery should match the energy expenditure, remains uncertain. Arguments against matching energy expenditure and energy delivery during the early phase of critical illness is supported by physiological evidence that endogenous energy production from glucose during the first few days after injury, match 50% to 75% of energy expenditure. A further argument against early matching of energy intake and energy expenditure is that of the possible suppression of autophagy by the early provision of exogenous nutrients (Preiser et al., 2015). Therefore, the early phases of critical illness are not hypermetabolic states, with total energy expenditure (TEE) matching resting energy expenditure (REE). Therefore, it has recently been suggested that energy delivery during these early phases should not exceed 15 kcal/kg/day. Such low energy delivery may not, however, be applicable to the malnourished critically ill patient with diminished stores to metabolise (Wischmeyer, 2016). Currently ASPEN recommends a simplistic weight-based formula (25 – 30 kcal/kg/day) to estimate energy requirements of the critically ill patient (McClave et al., 2016), while ESPEN recommends using 20 – 25 kcal/kg/d during the initial phase of critical illness but 25 – 30 kcal/kg per day for patients that are undernourished (Kreymann et al., 2006).

Adequate oral intake is often taken for granted and it is assumed that patients can and will eat adequately, especially after discharge from ICU (Peterson et al., 2011). However, during

the later phases of critical illness, TEE may be 1.7 times that of REE while endogenous energy production has decreased. Current evidence suggest that energy intake should match energy expenditure after the early phase of critical illness (Wischmeyer 2016; Preiser et al., 2015). Currently ESPEN recommends 25 – 30 kcal/kg/d during the later recovery or anabolic phase (Kreymann et al., 2006) while energy requirements as much as 40 kcal/kg/d during the recovery phase have recently been suggested (Wischmeyer, 2016).

Current evidence supports hypocaloric energy delivery of 65 – 70% of target energy requirements if measured with indirect calorimetry (IC) in the critically ill obese patient. In the absence of IC, ASPEN recommends 11 – 14 kcal/kg actual body weight for patients with a (body mass index) BMI in the range of 30 – 50 kg/m² and 22 – 25 kcal/kg ideal body weight (IBW) with a BMI > 50 kg/m² (McClave et al., 2016).

Critically ill patients with pre-existing chronic kidney disease (CKD) receiving haemodialysis (HD) are treated similar to patients with acute renal failure (ARF). ESPEN recommends 20 – 30 kcal/kg/d for non-protein energy to be adapted to individual needs if patients are either overweight or underweight (Cano et al., 2006), while ASPEN recommends 25 – 30 kcal/kg/d (McClave et al., 2016).

2.6.1.2 Protein requirements

During normal physiological conditions, the body's amino acid pool is fuelled by the degradation of tissue, *de novo* amino acid synthesis, as well as nutritional provision of protein. Amino acids from the amino acid pool are either incorporated into proteins that regulate specific pathways or are oxidised for energy and waste products such as urea are excreted. The optimal amount of protein required by critically ill patients cannot be derived from healthy subjects as protein catabolism of lean body mass is significantly increased during critical illness. In addition, various pathways that are regulated by proteins become activated. Evidence also suggests increased protein synthesis in patients with multiple organ failure with simultaneous compromised clearance of metabolites of amino acids (Preiser et al., 2015).

Current recommendation for the optimal delivery of protein during critical illness is 1.2-2.0 g/kg/day, as early as possible (Hurt et al., 2017; McClave et al., 2016; Singer et al., 2009).

Protein recommendations for obese, critically ill patients are 2.0-2.5 g/kg IBW (Hurt et al. 2017; McClave et al. 2016). For patients with a BMI in the range of 30 – 40 kg/m² protein delivery of 2 g/kg IBW is suggested while 2.0 – 2.5 g/kg IBW is suggested for patients with a BMI ≥ 40 kg/m² (McClave et al., 2016).

For critically ill patients receiving HD, ESPEN recommends protein delivery of 1.0 – 1.5 g/kg/d and up to a maximum of 1.7 g/kg/d for patients receiving chronic renal replacement therapy (CRRT) (Cano et al., 2006), while ASPEN recommends 1.5 g/kg/d and 2.5g/kg/d for patients on CRRT (McClave et al., 2016).

Protein loss during critical illness is associated with increased mortality and morbidity. Although studies have shown that high dose protein delivery in the ICU does not blunt catabolism of lean body mass, it is believed to stimulate protein synthesis and therefore maintain muscle mass. Current evidence suggests that achieving protein goals within the first week after ICU admission reduces mortality and that enteral protein intake should exceed >1.2 g/kg/d by the fourth day following ICU admission. In addition, it has been demonstrated that meeting >80% of protein requirements in ICU, significantly reduces mortality independent of energy delivery (Preiser & Wernerman, 2017).

Until recently, the prevailing concept with regard to protein delivery to critically ill patients, was that “more is better” (Preiser & Wernerman, 2017). A study investigating the effect of protein delivery above or below 1.2 g/kg/day on day four from ICU admission, demonstrated that patient mortality varied depending on the clinical condition, i.e. presence or absence of sepsis, as well as level of energy production i.e. over- or underfeeding. Non-septic and non-energy-overfed patients demonstrated a decreased mortality with increased protein delivery when providing at least 1.2 g/kg/day, whilst increased protein delivery did not show any effect on mortality in septic patients or patients that were energy-overfed. The latter suggests that the effect of protein delivery on mortality and outcome depends on various factors such as severity of illness, presence or absence of sepsis, the level of energy provision, timing and dose (Weijs et al., 2014). Evidence into the early provision of parenteral nutrients, specifically protein, in comparison to other nutrients, for example, suggested that protein, rather than energy delivery may contribute to worse outcomes of the early parenteral group (Preiser et al., 2015; Casaer et al., 2011).. The Early Parenteral Nutrition Completing Enteral Nutrition in

Adult Critically Ill Patients study (EPaNIC study) showed increased mortality in an early parenterally fed group of patients, suggesting that the smallest amount of nutrients was associated with the fastest recovery (Preiser et al., 2015; Casaer et al., 2011). Similar studies on the effect of early parenteral nutrition in patients that are unable to tolerate enteral feeds, demonstrated either an increased morbidity or no benefit during the first three days of ICU admission (Preiser et al., 2015). Preiser et al., (2015) noted that these studies were all related to parenteral provision of nutrients and suggested that the early optimising of nutrient delivery via the enteral route should not be discouraged, especially in patients that are at high nutritional risk.

The worsened outcome described in these studies, may be explained at the hand of suppression of autophagy, as there is evidence that nutrient delivery above recommendations, may inhibit autophagy. During autophagy, toxic and harmful cells and organelles are isolated and transported into lysosomes where degradation takes place. This process is thought to be of specific interest during sepsis as it may help with the degradation of harmful substances. Autophagy is, thus, an important process during critical illness and suppression of autophagy is associated with increased muscle weakness and decreased muscle recovery (Di Girolamo et al., 2016).

These findings prompted the convening of the International Protein Summit in 2016, which brought together experts in clinical nutrition and protein metabolism from around the world. The summit aimed to assess the impact of high-dose protein administration on clinical outcomes and to address barriers to protein delivery in the critically ill patient. The summit surmised that, whilst protein doses in the range of 1.2 – 2.0 g/kg are incapable of blunting the catabolic response, it may be needed to best stimulate new protein synthesis and preserve muscle mass. Quality of protein, which is determined by source, amino acid content and ratio, and digestibility, affects nutrient sensing pathways. The consensus was that achieving protein goals within the first week following admission to the ICU should take precedence over meeting energy goals. In addition, the summit conceded that high-protein hypocaloric (providing 80%–90% of energy requirements) feeding may prove to be the best strategy during the initial phase of critical illness to avoid overfeeding, improve insulin sensitivity, and

maintain body protein homeostasis, especially in those patients at high nutrition risk (Hurt et al., 2017).

2.7 Oral nutrition support

A 'food first' approach is widely recommended to meet nutritional requirements; in other words, the provision of normal food to improve nutritional status should be the first step in providing nutrition support to prevent malnutrition in care settings (BDA Food Services Specialist Group, 2017; Pullen et al., 2017). More than half of patients admitted to ICU have fully functional gastro-intestinal tracts and do not require enteral or parenteral nutrition support but can be fed orally. In addition, patients receiving artificial nutrition support will eventually require oral nutrition support when they are weaned onto oral diets (Peterson et al., 2011). In most cases, adequate nutritional intake is possible via 'good food' as long as any additional support needed is provided (National Institute for Health and Care Excellence (NICE), 2017). Many patients who are able to eat food, however, have their appetite curbed by illness. In such cases, experts recommend foods with energy-rich, smaller but more frequent meals, and/or high-energy snacks between meals, or using ONS (Hamilton & Boyce., 2013). In addition to the use of fortified food, and provision of additional snacks and/or sip feeds, nutrition education to improve meal patterns and nutritional intakes of patients (National Institute for Health and Care Excellence (NICE), 2017; Lochs et al., 2006), as well as assistance to eat, also form part of oral nutrition support. A recent systematic review of studies (Elia et al., 2016) has confirmed that food fortification, and the provision of ONS and/or hospital snacks have the potential to improve nutritional intakes of patients and, therefore, their nutritional status (National Institute for Health and Care Excellence (NICE), 2017; Pullen et al., 2017).

Kondrup et al., (2002) demonstrated that hospitalised patients can gain weight through consuming a general ward diet, addition of ONS as well as intense monitoring at each meal. It was suggested that the same measures can be taken in ICU to improve oral intake. Measures that can be implemented in ICU include liberalised medical nutrition therapy, considering patient's food preferences to be incorporated into meals and planning of snacks as well as education to healthcare staff and family pertaining to the importance of adequate nutritional intake. It was emphasised that individualised medical nutrition therapy and

ongoing monitoring are key elements to optimised oral intake of patients (Kondrup et al., 2002).

2.7.1 Fortified foods, therapeutic diets and hospital snacks

Additional nutrition may be provided via food fortification by enhancing the energy and protein intake of food without increasing the volume using foods such as milk powder, butter and cream. Both meals and snacks can be fortified in this way (National Institute for Health and Care Excellence (NICE), 2017).

Although as much as 85% of patients can safely consume normal food, it is essential that standard diets be adjusted to accommodate the requirements of all patients. It may be necessary to modify standard diets to accommodate requirements for specific religious, personal and cultural reasons (such as vegan diets), modified texture, specific dietary requirements for tests or investigations, special therapeutic requirements and finally, to meet the requirements of special patient groups where standard diets do not meet requirements (National Institute for Health and Care Excellence (NICE), 2017). It is reported that the prescription of therapeutic diets may hamper adequate nutritional intake and therefore contributes to compromised nutritional status (Peterson et al., 2011).

Food choices from standard diets should accommodate patients that require healthier eating such as patients with cardiovascular disease, hypertension, diabetes and obesity. Healthier eating is particularly important to maintain good general nutrition and meet nutritional requirements while being hospitalised. In addition, healthier choices on the standard menu are also important as they serve as educational tools for health promotion. Standard diets should also accommodate patients with higher energy requirements such as patients at nutritional risk and with poor appetite. Modifications of standard diets to the types and textures of foods that is needed by individuals with oro-pharyngeal dysphagia to accommodate safe swallowing, as well as patients requiring modification of texture and softer alternatives in the case of chewing difficulties and mouth sores, may be necessary (BDA Food Services Specialist Group, 2017).

Standard diets may also be modified to therapeutic diets where diet is prescribed as part of the treatment of medical conditions such as renal diets, diets for liver disease, food allergy and gluten intolerance (BDA Food Services Specialist Group, 2017).

Test or investigation diets are temporary diets that are prescribed in preparation for specific tests such as providing food and fluid items for swallowing assessments and laxative diets in preparation of surgery. These diets may not necessarily be nutritionally adequate (BDA Food Services Specialist Group, 2017).

Standard diets may not meet the nutritional requirements of specific patient groups and additional consideration may be necessary to provide additional or alternative options to accommodate the special nutritional requirements of these groups of patients. Patient groups with special dietary requirements include children, the elderly, maternity patients, long stay patients, patients with mental health conditions and patients at high nutritional risk. Oncology and haematology patients are particularly important as patients with cancer, besides being at nutritional risk due to the disease process, often have special dietary requirements in terms of neutropenic diets. After bone marrow transplant or frequent high dose chemotherapy, patients experience neutropenia which requires neutropenic (or low microbial) diets (BDA Food Services Specialist Group, 2017).

The provision of hospital snacks may potentially be an important component to provide optimal nutrition, especially for patients that prefer small frequent meals (National Institute for Health and Care Excellence (NICE), 2017; Pullen et al., 2017). Pullen et al., (2017) reported the offering of hospital snacks to patients being inconsistent which is thought to inhibit optimal nutrition. Therefore, it is recommended that snacks should be offered to patients twice daily instead of relying on patient's requests (BDA Food Services Specialist Group, 2017). Pullen et al (2017), however, found that the nutritional content of hospital snacks, in terms of energy and protein, is inferior to that of ONS. Although these snacks have the potential to improve nutrition intake of hospitalised patients, it was suggested that these shortcomings should be considered when determining nutritional goals of snack provision, as well as when attempts are made to improve the nutritional value of these snacks.

2.7.2 Oral nutritional supplements

Oral nutritional supplementation refers to the supplementary oral intake of dietary food for special medical purposes in addition to normal food. These supplements are available as sip feeds, in powdered form, dessert-style products or bars (Lochs et al., 2006). The aim with the intake of ONS is to improve overall nutritional intake and therefore clinical outcomes of patients (Parkes, 2016).

Several systematic reviews and meta-analysis have shown that the use of ONS is an effective means of preventing and treating malnutrition (Elia et al., 2016; Philipson et al., 2013; Cawood et al., 2012, Hubbard et al., 2012; Stratton & Elia, 2007). Existing evidence suggest that ONS is more effective than dietary counselling to improve short-term outcomes of malnourished patients (Baldwin & Parsons, 2004), although more research is needed to investigate the role of ONS in association with other methods of dietary treatment (Stratton & Elia 2007; Baldwin & Parsons, 2004). In addition, no negative effects of ONS on the voluntary food intake of patients (Hubbard et al., 2012; Cawood et al., 2012; Stratton & Elia, 2007), and no adverse reactions, have been recorded. The evidence of beneficial use of ONS to incur notable reduction in complications and mortality is strongest in malnourished patients, the elderly and the acutely ill (Stratton & Elia, 2007).

2.7.2.1 Indications and general recommendations for the use of ONS

A range of evidence-based recommendations regarding the use of ONS, intended to assist appropriate clinical use of ONS together with clinical judgement and professional expertise, are available (Stratton & Elia, 2007).

To ensure cost and clinical effectiveness of ONS, it is recommended that ONS is prescribed in specific conditions, according to specific guidelines. ONS should be considered an medical intervention and should only be supplied to patients with a positive nutrition screen with a validated screening tool, and if nutritional goals cannot be met through meals and snacks, and the therapeutic adaptation and fortification thereof (BDA Food Services Specialist Group, 2017; Parkes, 2016). Although a 'food first' approach is recommended, the British Association for Parenteral and Enteral Nutrition states that, in some patients, treatment may begin with both food and supplements (Stratten et al. 2010). Similarly, the NHS Vale of York Clinical

Commissioning Group recommends that ONS is only prescribed according to the Advisory Committee on Borderline Substances (ACBS) indications which are disease-related malnutrition, short bowel syndrome, intractable malabsorption, proven inflammatory bowel, post total gastrectomy, dysphagia, bowel fistulas, haemodialysis, pre-operative preparation of patients who are undernourished and continuous ambulatory peritoneal dialysis (Parkes, 2016). However, the prescription of ONS in the case of patients with pressure ulcers, chronic obstructive pulmonary disease, stroke, older people with hip fractures, pancreatic disease, HIV and chronic infectious diseases as well as chronic heart failure, has also been reported in the literature (Stratton & Elia, 2010). Although evidence-based guidelines are available for general use of ONS, more research is required regarding the clinical outcomes and the use of ONS in specific patient groups (Stratton & Elia, 2007).

With regard to treating malnutrition in institutional and community-dwelling patients, the NHS Vale of York Clinical Commissioning Group recommends that ONS is prescribed according to specific guidelines, outlined as a series of six steps. The first step in the process is to identify malnourished patients or patients at risk of malnutrition. Once patients are identified as malnourished or at risk of malnutrition using a validated screening tool, the underlying cause of malnutrition should be identified. Underlying causes of malnutrition which may be social and/or disease related, should be addressed and treated. The next step is to set realistic goals. Goals may be set in terms of target weight or BMI. In cases where weight gain is unrealistic or not desirable, weight maintenance should be set as target. Clinical outcomes such as wound healing may also be set as a goal. The end of treatment should be identified, and goals should be reviewed on a regular basis, for example, once per month. Once goals are set, a 'food first' approach should be used as first line of treatment. Only once a food first approach does not yield positive outcomes after four to six weeks, the prescription of ONS should be considered in addition to the 'food first' approach in conditions where at least one of the ACBS indications are met. After the prescription of ONS, it is necessary to set clear goals and discuss dosage, timing and expected length of treatment with the patient. A trial prescription of a daily supplement should initially be prescribed for one week and should be reviewed thereafter. If the patient tolerated the trial, it is recommended that a clinically beneficial dose around 600 kcal/d is prescribed. It is recommended that ONS are prescribed on acute prescription as repeat prescriptions increase the risk of waste. Patients should be advised to

take ONS between meals and not as a meal replacement to maximise the effectiveness and to avoid spoiling patients' appetite for food. Finally, frequent monitoring is recommended and the use of ONS should be discontinued if goals are met. However, the patient should be assessed one month after discontinuation to ensure that nutritional goals are maintained (Parkes, 2016).

2.7.2.2 Standard versus high protein ONS

A systematic review by Cawood et al., (2012) examining the effect of high protein ONS on clinical, functional and nutritional outcomes, demonstrated benefits when compared to control groups. A major finding of the systematic review was a significant overall reduction of 19% in a range of complications. However, these outcomes are consistent with systematic reviews that include all types of ONS. The systematic review found that there is currently not enough evidence to make recommendations for the use of high protein ONS versus the use of standard ONS. The use of high protein ONS may, however, be beneficial in certain groups of patients such those with catabolic stress, increased protein losses, or low protein intake, as well as patients where an additional supply of amino acids may aid wound healing (Cawood et al., 2012).

2.7.2.3 Compliance

The efficacy of ONS to prevent and address malnutrition, depends, amongst other factors, on whether or not patients consume the prescribed amounts (den Uijl et al., 2015). In addition, compliance to ONS must be considered to minimise wastage and optimise clinical benefit (Hubbard et al., 2012). In a systematic review, Hubbard et al., (2012) found an overall compliance of 78% to ONS. Critically and acutely ill, older patients have a slightly decreased compliance due to a loss of appetite and compromised physical abilities. In the same review it was found that ONS with a calorie density of ≥ 2 kcal/millilitre (ml) was associated with a significantly increased compliance, possibly due to the smaller volume that needs to be consumed by patients (Hubbard et al., 2012).

A recent study regarding compliance to ONS amongst frail elderly patients in various settings, found that most took ONS on prescription by a doctor or dietician, because they trusted him

or her. Interestingly, about two thirds of participants considered ONS to be a food rather than a medicine (den Uijl et al., 2015).

2.7.2.4 Monitoring

Recommendations are that the prescription of ONS should be monitored and adapted regularly according to patient tolerance and nutritional requirements to minimise wastage and optimise clinical benefit (Hubbard et al., 2012).

2.7.2.5 Cost benefits

The cost benefit associated to the use of ONS relates to reduced LOS in hospital and reduced 30-day readmission rates (Cawood et al., 2012). In a systematic review and meta-analysis by Philipson et al., (2013), the use of ONS was associated with reductions in LOS of 2.3%, and a reduction in the probability of readmission of 6.9%. Episode cost was decreased by \$4734. The use of ONS cost on average \$88,26 per episode, but generated a saving of \$4734 per episode, which translates into a return on investment (ROI) of \$52.63 for every dollar spent on ONS. It was also found that the largest financial benefit of ONS was for the sickest group of patients (Philipson et al., 2013).

2.8 Summary

Malnutrition in acute care facilities is well documented in the international literature as a serious debilitating factor, yet remains unappreciated (Van Bokhorst-de van der Schueren & Roosemalen, 2012; Barker et al., 2011; Peterson et al., 2011; Peterson et al., 2010). DRM results in major complications which burdens health care cost (Freijer et al., 2013; Barker et al., 2011; Peterson et al., 2011). In addition, it is widely reported that oral intakes of hospitalised patients do not meet nutritional requirements (Reeves et al., 2013; Thibault et al., 2011; Dupertuis et al., 2003; Kondrup et al., 2002), which further contributes to a worsening of nutritional status of patients during hospitalisation (Peterson et al., 2011; Peterson et al., 2010; Amaral et al., 2007; Pirlich et al., 2006). Early detection and appropriate treatment of malnutrition is essential. Various methods of dietary treatment for malnutrition are available, of which the use of ONS currently proves to be the most effective (Stratton & Elia, 2007).

3 CHAPTER 3: METHODOLOGY

3.1 Introduction

This study assessed the adequacy of nutritional intake of exclusively orally fed patients admitted to the ICU in a private South African hospital. In this chapter the approval of the study, study design, study population, sampling methods, variables and operational definitions, as well as the methodology and techniques used for the execution of the study, are described. The study procedures, validity and reliability issues, methods used in statistical analysis of the results, and ethical considerations are included. Challenges experienced during the study that may result in limitations, are also discussed.

3.2 Approval and permission to conduct the study

Ethical approval was obtained from the Health Sciences Research Ethics Committee of the University of the Free State (HSREC 40/2016). Permission to perform the study was obtained from the Netcare Research Operations Committee (Appendix A). An application to conduct the study was sent to Netcare as per standard protocol to apply to do non-trial research in a Netcare facility. In addition, a letter requesting permission to perform the study and a detailed document explaining the purpose of the study, as well as procedures that would be followed during the study, was sent to the hospital manager (Appendix B).

3.3 Study design

An observational cross-sectional study was conducted. Figure 3.1 outlines the conceptual framework of the study.

3.4 Study population

The study was performed in a 222-bed private hospital in Alberton, Gauteng. The hospital is a level one trauma facility and hosts a 30-bed mixed trauma, surgical and medical ICU.

The study population consisted of all adult patients older than 18 years admitted to the ICU who complied with the inclusion criteria. Although the study was conducted over a period of 14 days, participants were only included in the study if they fulfilled the inclusion criteria

which was not necessarily for the duration of the study. Usual ICU admission statistics for January 2016 indicated an average number of 10.4 patients per day in the unit, who complied with the inclusion criteria. From the study population, a convenience sample of all patients present in the ICU over a period of 14 consecutive days, commencing on a Monday and including weekends and public holidays, was drawn. It was estimated that over a 14-day period around 146 (10.4 x 14) data collection points would be included in the study.

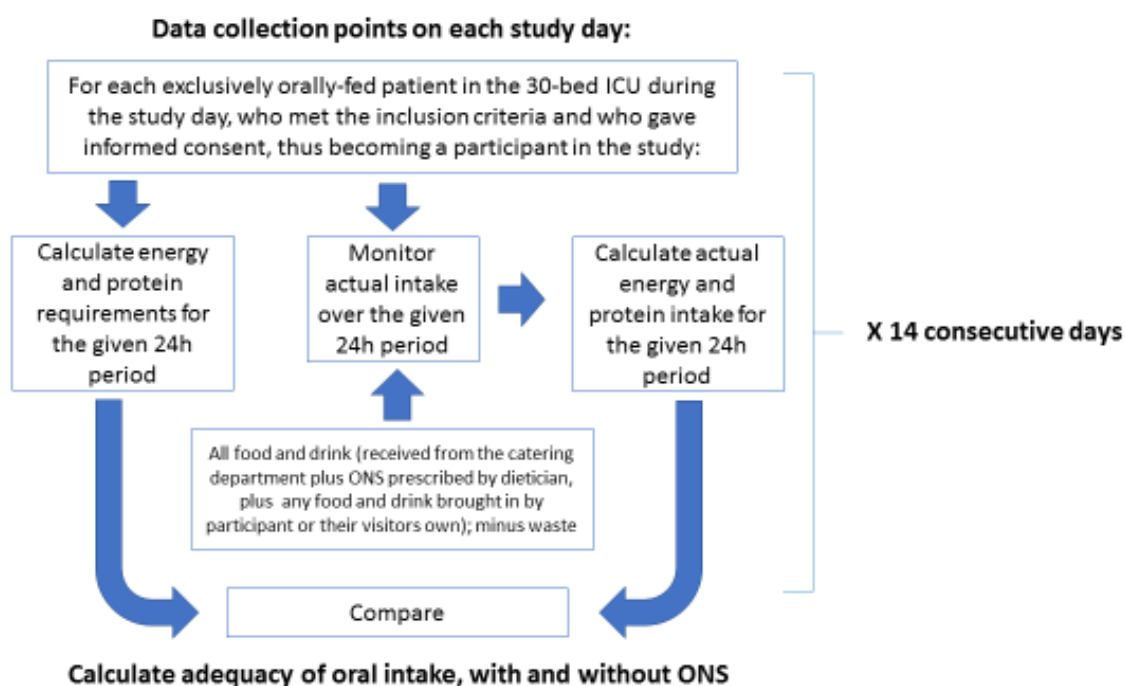


Figure 3.1: Conceptual framework of the study

3.4.1 Sampling

The following procedures were followed to select the participants for the study.

3.4.1.1 Sample size

The study was performed over a period of 14 consecutive days during February 2017, starting on a Monday and including two weekends, but no public holidays. During this time 29 patients that met the inclusion criteria, went through the ICU, some staying longer than others. On every one of the 14 study days, data was collected on each of the patients that were present in the ICU. Thus, 94 data collection points on 29 participants were included in the study, realising 65% of the sample size originally predicted.

3.4.1.2 Inclusion and exclusion criteria

All admitted adult patients (≥ 18 years) in the ICU on the study days were included in the study if they were not receiving artificial nutrition support (enteral nutrition administered through a tube or parenteral nutrition), irrespective of the number of meals missed because of being *NPO*, or due to tests or procedures. The population, thus, included patients who were admitted to ICU with fully functional gastro-intestinal tracts and for whom oral nutrition, with or without ONS, were indicated. In addition, post-acute patients who initially required artificial nutrition support as enteral nutrition via a tube and/or parenteral nutrition, but who recovered to such an extent that they advanced to an oral diet, with or without ONS, were also included.

Patients who were not admitted to ICU for the 24-hour duration of a relevant study day, and patients for whom it was not possible to determine height and weight by either direct or indirect measurements i.e. knee height (KH) and mid-upper arm circumference (MUAC), due to injury, were excluded from the study.

3.5 Variables and operational definitions

The variables measured in this study include patient profile, anthropometry, energy and protein requirements, total oral energy and protein intake and the adequacy of total oral intake to meet energy and protein requirements over the relevant 24-hour period.

3.5.1 Patient profile

Patient profile referred to age, gender, diagnosis on hospital admission and LOS in ICU.

Patients were grouped based on primary diagnosis on admission to the ICU into the following subgroups to enable comparison of oral dietary adequacy between the different groups:

- Trauma;
- Medical;
- Surgical; and
- All other.

Length of stay in ICU referred to the time from admission to ICU, until the day that the participant became part of the study. For patients that spent more than a day in the study,

the LOS was recorded as the number of days in ICU before the study as well as the number of days from the first study day.

3.5.2 Anthropometry

Anthropometry, for the purposes of this study, referred to BMI, which was determined using weight in kilograms (kg) divided by height in metres squared (m^2). However, the majority of patients were non-ambulatory, which necessitated calculating BMI based on indirect measurements, i.e. KH and MUAC, to estimate weight and height.

3.5.2.1 BMI

BMI remains the best generally accepted measure of weight for height, which, in the clinical setting, is considered one of the four components of nutritional screening of hospitalised patients to evaluate the current nutritional status of patients (Kondrup et al., 2002).

BMI was interpreted as follows according to the European Society for Parenteral and Enteral Nutrition (ESPEN) guidelines (Kondrup et al., 2002).

- underweight: $<18.5 \text{ kg/m}^2$;
- borderline underweight: $18.5 - 19.9 \text{ kg/m}^2$;
- within normal range: $20 - 24.9 \text{ kg/m}^2$;
- overweight: $25 - 29.9 \text{ kg/m}^2$;
- obesity: $>30 \text{ kg/m}^2$

3.5.3 Energy and protein requirements

Energy and protein requirements, for purpose of this study, referred to each participant's estimated energy and protein requirements intended to cover increased needs due to disease i.e. stress, fever, digestive or renal losses, for the relevant 24h of data collection.

These energy and protein requirements were calculated requirements using the currently used standard protocol guidelines to calculate requirements in the unit.

3.5.3.1 Energy requirements

Energy requirements need to be determined to establish the goals of nutrition therapy and may be calculated using simplistic weight-based formulas, published predictive equations, or

IC. In the absence of IC, energy requirements are calculated using predictive equations. More than 200 predictive equations have been published in the literature, with accuracy rates ranging from 40%–75% when compared with IC. The applicability of IC is limited due to availability and cost. The accuracy of IC may also be influenced by variables such as the presence of air leaks or chest tubes, supplemental oxygen, ventilator settings, continuous renal replacement, anesthesia, physical therapy, and excessive movement (McClave et al., 2016).

As per the American guidelines (McClave et al., 2016), kilocalorie (kcal) is the unit used to measure energy required or consumed by patients. Therefore, although South Africa uses the metric system for weight and measurement, for this study, the term kcal, instead of kilojoules, was used.

Predictive equations express energy requirements as a range. ASPEN recommends estimating total daily energy requirements as 25-30 kcal/kg actual body weight for patients with a BMI <30 kg/m²; 11-14 kcal/kg actual body weight for patients with a BMI 30-50 kg/m²; and 22-25 kcal/kg ideal body weight, for patients with a BMI >50 kg/m² (McClave et al., 2016).

For the purposes of this study, energy requirements were estimated as 25 kcal/kg actual body weight for patients with a BMI <30 kg/m²; 11 kcal/kg actual body weight for patients with a BMI 30-50 kg/m²; and 22 kcal/kg ideal body weight for patients with a BMI >50 kg/m² (McClave et al., 2016).

From a metabolic point of view, patients with CKD receiving chronic HD, who develop a superimposed acute illness are considered similar to patients with ARF and requirements should be determined as such (Cano et al., 2006). All patients with a glomerular filtration rate (GFR) of ≤ 60 ml/minute (min)/1.73m² were considered to have renal failure (National Kidney Foundation, 2006). Daily total energy requirements should be estimated using 25 – 30 kcal/kg of actual body weight (McClave et al., 2016). For purposes of this study, 25 kcal/kg of actual body weight was used to estimate energy requirements.

3.5.3.2 Protein requirements

ASPEN recommends estimating total daily protein requirements using 1.2 - 2.0 g/kg for patients with a BMI < 30 kg/m², 2.0 g/kg ideal body weight for patients with a BMI 30 – 40

kg/m² and 2.0 - 2.5 g/kg ideal body weight for patients with a BMI \geq 40 kg/m². Using ideal body weight, as opposed to adjusted body weight, for the calculation of protein requirements for the obese population, is recommended and therefore IBW was used for the study (McClave et al., 2016).

For the purposes of this study, protein requirements were estimated using 1.5 g/kg for patients with a BMI < 30 kg/m², 2.0 g/kg ideal body weight for patients with a BMI 30 – 40 kg/m² and 2.5 g/kg ideal body weight for patients with a BMI \geq 40 kg/m².

IBW was calculated using the as suggested by ASPEN (McClave et al., 2016)

Hamwi equation (Winkler, M.F. & Malone, 2017).

Males: 48 kg for the first 152.4 cm + 1.1 kg for each additional cm in height

Females: 45 kg for the first 152.4 cm + 0.9 kg for each additional cm in height

ASPEN recommends using 1.2 – 2.0 g/kg for patients with ARF and 2.5 g/kg for patient on chronic renal replacement therapy (CRRT). For of this study, protein requirements for participants with ARF was estimated using 1.5 g/kg and 2.5 g/kg for patient on CRRT (McClave et al., 2016).

3.5.4 Total oral energy and protein intake over a 24h period

Oral intake referred to the nutritional content of all meals, snacks and beverages received from the catering department of the hospital, all ONS, as well as all personal snacks and beverages consumed by patients during the 24-hour period that commenced at 6h00 on the relevant study day. The nutritional value of consumed food, snacks and beverages was calculated using the *FoodFinder 3* software package, which is based on the South African Medical Research Council Food Composition Tables. The nutritional value of ONS was assessed using nutritional information from manufacturing companies. The nutritional values of food, snacks and beverages were expressed in terms of the energy value (kcal) and protein (g) content.

3.5.5 Adequacy of total oral intake to meet energy and protein requirements

Adequacy of oral intake was determined by expressing each participant's energy and protein intake as a percentage of the calculated requirements for the relevant 24h period.

3.6 Measuring techniques

The researcher, assisted by a trained fieldworker, as well as nursing staff, collected and recorded data on separate data forms (Appendix C, D, E and F) for each participant for each study day. Both the researcher as well as the fieldworker were dietitians. The fieldworker was trained by the researcher prior to the study.

3.6.1 Patient profile

The fieldworker obtained age, gender, hospital admission diagnosis and length of stay in ICU from patient records. The researcher trained the fieldworker to obtain the data from patient records and to stratify hospital admission diagnosis into trauma, medical, surgical or other.

3.6.2 Anthropometry

Direct measurement of height and weight according to standardised techniques were only possible in fully ambulatory patients who were able to stand up straight and unassisted. For patients on whom height and weight measurements according to the standardised techniques are not possible, these parameters have been estimated using indirect measurements.

For quality control purposes, direct and indirect measurements were recorded and compared for the fully ambulatory participants, to assess the reliability of these estimates in the study population.

For participants on whom data points were measured on more than one consecutive day, direct as well as indirect measurements were only taken on the first day of inclusion in the study.

3.6.2.1 Fully ambulatory participants

For fully ambulatory participants, weight and height were measured by the researcher or the fieldworker (both trained dietitians), according to the standardised techniques discussed

below. A physiotherapist assisted the researcher to mobilise participants safely to and from the scale and stadiometer where necessary.

3.6.2.1.1 Weight

Weight was determined with a mobile, floor type, *Scales 2000* digital scale with power supply. The scale was placed on a hard, flat surface and adjusted for zero balance before each measurement. The participants wore minimal clothing (hospital gown or pyjamas without shoes) and stood unassisted without touching anything, in the middle of the platform with weight equally distributed between both feet, looking straight ahead. Weight was recorded to the nearest 100g. To ensure reliability, the scale was calibrated with a known weight (two kilograms bag of sugar) at the beginning of every study day and whenever the scale was moved from one location to another (Lee & Nieman, 2007).

3.6.2.1.2 Height

Height was measured with a mobile *Seca 213* stadiometer. The participants wore minimal clothing (hospital gown or pyjamas without shoes). Participants were instructed to stand straight in a fully erect position, feet together, and knees straight. Participants' heads were positioned in the Frankfort plane implicating that the angle of the eye and the opening of the external auditory meatus were on a horizontal line. Arms hung loosely at the sides with palms facing the thighs. The head was not necessarily in contact with the vertical surface however the heels, buttocks and shoulder blades were in contact with the vertical surface of the stadiometer where possible. Participants were asked to take a deep breath and stand tall with relaxed shoulders. The moveable headboard was lowered until it touched the crown of the head. Height was measured with the researcher's eyes being level with the headboard to avoid parallax errors. Height was recorded to the nearest millimetre (1 mm) (Lee & Nieman, 2007).

3.6.2.2 Non-fully ambulatory participants

For participants on whom measurements of height and weight could not be performed according to standardised techniques, estimations based on indirect measurements of long bones were used in standardised estimation formulas. Estimation formulas based on lower limb measurements, such as KH, as well as upper limb measurements, such as ulna length are

available. As a recently published study indicated that ulna length might over-estimate height in the South African population, KH was used as it is highly correlated with stature (Van den Berg et al., 2016).

For non-fully ambulatory participants, indirect measurements (i.e. KH and MUAC) were taken by the researcher or the fieldworker, according to the standardised techniques discussed below. Calculations to determine indirect measurements were done by the researcher and fieldworker.

3.6.2.2.1 Knee height (KH)

Knee height was measured with a *Scales 2000* knee to ground length measuring rod consisting of an adjustable measuring stick with a blade attached to each end at a 90° angle. Knee height was measured on the left leg. While lying supine the leg was bent at the knee with the ankle at a 90° angle. One of the blades was positioned under the heel of the foot and the other was placed over the anterior surface of the thigh. The shaft of the caliper was held parallel to the tibia and pressure was applied to compress the tissue. Two successive measurements were taken. If the two readings agreed within 5 mm, the mean was calculated; otherwise, a third measurement was taken. In cases where the left leg was unavailable as result of injury, the right leg was used. Standing height was estimated using KH as indicated in Table 3-3.1 (Lee and Nieman, 2007).

Table 3-3.1: Estimating stature from knee height for various groups (Lee & Nieman, 2007)

Age [‡]	Equation [†]	Error ^{††}
Black females		
>60	$S = 58.72 + (1.96 \text{ KH})$	8.26cm
19-60	$S = 68.10 + (1.86 \text{ KH}) - (0.06 \text{ A})$	7.60cm
6-18	$S = 46.59 + (2.02 \text{ KH})$	8.78cm
White females		
>60	$S = 75.00 + (1.91 \text{ KH}) - (0.17\text{A})$	8.82cm
19-60	$S = 70.25 + (1.87 \text{ KH}) - (0.06 \text{ A})$	7.20cm
6-18	$S = 43.21 + (2.14 \text{ KH})$	7.80cm
Black males		
>60	$S = 95.79 + (1.37 \text{ KH})$	8.44cm
19-60	$S = 73.42 + (1.79 \text{ KH})$	7.20cm
6-18	$S = 39.60 + (2.18 \text{ KH})$	9.16cm
White males		
>60	$S = 59.01 + (2.08 \text{ KH})$	7.84cm
19-60	$S = 71.85 + (1.88 \text{ KH})$	7.94cm
6-18	$S = 40.54 + (2.22 \text{ KH})$	8.42cm

‡ Age in years rounded to the nearest year; † S = stature; A = age; KH = knee height

†† Estimated stature will be within this value for 95% of persons within each age, sex and race group.

3.6.2.2.2 Mid-upper arm circumference

MUAC was measured using a flexible, non-stretchable tape, in the recumbent position. Garments were removed, and sleeves were rolled up. A sandbag was placed under the elbow to raise the arm slightly off the surface of the bed. The measurement was taken at the midpoint of the left upper arm, between the acromion process and the tip of the olecranon. After locating the midpoint, the tape was wrapped gently but firmly around the arm at the midpoint. Measurements were taken to the nearest millimeter (1 mm) (Katzenellenbogen & Joubert, 2014). In cases where the left arm was unavailable as result of injury, the right arm was used.

Weight was estimated based on KH and MUAC as indicated in Table 3-3.12 (Lee & Nieman, 2007). Weight for Indian and coloured participants was estimated using the formula for white participants as there are no race-specific equations for these population groups.

Table 3.2: Conversion of KH (cm) and MUAC (cm) to body weight (kg) (Lee & Nieman, 2007:233)

FEMALES			
Age [‡]	Race	Equation ^b	Accuracy ^c
6-18	Black	Weight = (KH X 0.71) + (MUAC X 2.59) - 50.43	±7.65kg
6-18	White	Weight = (KH X 0.77) + (MUAC X 2.47) - 50.16	±7.20kg
19-59	Black	Weight = (KH X 1.24) + (MUAC X 2.97) - 82.48	±11.98kg
19-59	White	Weight = (KH X 1.01) + (MUAC X 2.81) - 66.04	±10.60kg
60-80	Black	Weight = (KH X 1.50) + (MUAC X 2.58) - 84.22	±14.52kg
60-80	White	Weight = (KH X 1.09) + (MUAC X 2.68) - 65.51	±11.42kg
MALES			
Age ^a	Race	Equation ^b	Accuracy ^c
6-18	Black	Weight = (KH X 0.59) + (MUAC X 2.73) - 48.32	±7.50kg
6-18	White	Weight = (KH X 0.68) + (MUAC X 2.64) - 50.08	±7.82kg
19-59	Black	Weight = (KH X 1.09) + (MUAC X 3.14) - 83.72	±11.30kg
19-59	White	Weight = (KH X 1.19) + (MUAC X 3.21) - 86.92	±11.42kg
60-80	Black	Weight = (KH X 0.44) + (MUAC X 2.86) - 39.21	±7.04kg
60-80	White	Weight = (KH X 1.10) + (MUAC X 3.07) - 75.81	±11.46kg
[‡] Age (in years) rounded to the nearest year ^b Weight in kg; Knee height in cm ^c For persons within each group estimated weight should be within the stated value for 95% of the subject			

3.6.3 Energy and protein requirements

The researcher and fieldworker calculated and recorded each participant's energy and protein requirements (Appendix F and G).

3.6.4 Adequacy of total oral intake to meet energy and protein requirements

Plate waste, using the weighed method, as described below, was used to determine the actual consumption of food, snacks and beverages during the relevant 24h period. Adequacy of oral intakes of each participant on every study day was expressed as a percentage of nutritional requirements.

The researcher and fieldworker performed meticulous plate waste studies and the researcher calculated the energy and protein contribution of all actual oral intakes.

3.6.4.1 Determining consumption of food items received from catering department

All food items, as well as wastage, were weighed with a *Seca 856* digital scale as described below. To ensure reliability, the batteries for the scale were changed after every day of use and the scale was calibrated with a known weight (500g margarine) at the beginning of each day and after every 20 readings, as well as whenever the scale was moved from one location to another.

A record form was developed to document the actual consumption of food items received from the catering department. The initial weight of menu items, as well as that of plate waste of each menu item after the meal, were recorded to the nearest 0.5 g. Determining of food consumption was done by subtracting the weight of plate waste per menu item from the initial weights of all menu items served to patients. The nutritional value of consumed food items was determined using the *FoodFinder* software and the energy (kcal) and protein (g) content recorded (Appendix E).

3.6.4.1.1 Determining food portion sizes served to patients

The catering department gave their cooperation in reorganising their menu to ensure that no combined dishes such as macaroni and cheese or stew were served for the duration of the study, as weighing separate components of a dish may contribute to error when calculating actual wastage or intake of individual food components. To obtain an accurate weight for food items served to participants, all individual food items were weighed and recorded by the researcher or trained fieldworker before each meal.

Food portions of some menu items served at breakfast and snacks were estimated by using standard portions for bread and pre-packed products i.e. yoghurt, beverages, biscuits, rusks and condiments such as margarine, sugar and jam.

3.6.4.1.2 Meal orders

The hospital in which the study was conducted offers patients the opportunity to order from a set *a la carte* menu. Meal orders for each participant in the study were, as usual, taken by the ward host or hostess one day prior to the relevant study day. The trays of patients that were participating in the study were clearly marked with a yellow sticker before it was sent to the ward. The patient's name and bed number were indicated on the sticker.

3.6.4.1.3 Determining of plate waste

To determine the plate waste of food received from the catering department of the hospital, the researcher or trained fieldworker, collected, measured and recorded plate waste after each meal (Appendix E).

Plate waste in hospitals refers to the amount of served food that remains uneaten by patients. There are two main methods to measure plate waste, i.e. weighing or visual estimation. For this study, all plate waste was weighed as it is considered the most accurate method, although it requires significant resources and time to complete and can therefore be difficult to implement without disrupting or delaying normal foodservice operations. However, if well planned, it has been used successfully in many studies (Williams & Karen, 2011).

3.6.4.2 Determining oral intakes from consumption of personal snacks, beverages and ONS

Among the quantitative methods to estimate daily consumption of individuals, a food record is considered the most accurate method, as it does not depend on memory and recall. An estimated food record requires the respondent to record all food and beverages, including snacks eaten, in household measures for a specified period. Food portions may be estimated by the respondent in various ways, such as using household measures i.e. household measuring cups and spoons; measuring food items with a ruler; and counting items such as eggs and slices of bread. Errors may however arise if portion sizes are not quantified correctly, as well as during conversion of volumes of food to weights (Gibson, 2005).

For the study, a diet record form was developed to record the intake of personal snacks, beverages and ONS (Appendix D). On the relevant study day, the record form was left at each participant's bedside and completed by either the researcher, fieldworker or nursing staff (trained as such by the researcher) whenever any personal snacks, beverages or ONS were consumed. Portions were estimated using household measures such as teaspoons, tablespoons and cups, as well as by recording weights and volumes indicated on packages. The form was developed to prompt users to provide as much detail as possible including brand names of food items consumed. All record forms were collected by the researcher or the fieldworker at 6h00 on the day following the relevant study day.

All personal snacks and beverages consumed were coded by the researcher or the trained fieldworker, and analysed after completion of the study, using the *FoodFinder 3* software. The energy and protein content of consumed ONS were calculated manually and added to the energy and protein content of personal snacks and beverages. The result of the analysis, expressed as energy (kcal) and protein (g) were recorded (Appendix D).

3.6.4.3 Determining total oral intake

The energy and protein content of meals, snacks and beverages received from the catering department of the hospital, from personal snacks and beverages, as well as from ONS consumed during the study day, were added up to determine each participant's total oral intake expressed in terms of energy (kcal) and protein (g). The total oral intake for each participant per study day was recorded (Appendix F).

3.7 Study procedure

The study was conducted according to the following steps:

Step 1:

- i) Approval to conduct the study (HSREC 40/2016) was obtained from the HSREC of the University of the Free State (UFS).
- ii) Approval to conduct the study was obtained from the Netcare Research Operations Committee and from the hospital manager.

Step 2:

- i) The researcher met with the catering and nursing staff to explain the study and ask their assistance. The catering staff were asked to assist with measuring of menu items in the kitchen and nursing staff were asked to assist with recording of personal snacks, beverages and ONS during the study.
- ii) The researcher met with the physiotherapists to explain the study and to ask for their assistance when participants needed to be moved to the scale and stadiometer.

Step 3:

- i) The pilot study was conducted on five randomly selected patients admitted to ICU who met the inclusion criteria for the study and their results were included in the main study.

The main study commenced and continued for 14 consecutive days. For the duration of the study step 4 was performed daily.

Step 4:

- i) All participants that met the inclusion criteria were identified and informed consent was obtained from each participant one day prior to their first study day.
- ii) Patient profile and anthropometrical data were obtained on each participant's first study day.
- iii) The record form for recording personal snacks, beverages and ONS was placed at the bedside of each participant by the researcher / trained fieldworker at 6h00 on the day of the study and all completed record forms from the previous day were collected from participants the day after.
- iv) Weight of individual menu items were obtained prior to each meal being served. Food waste was measured after each meal.

After completion of the data collection as per step 4, steps 5 and 6 were performed.

Step 5:

- i) Indirect anthropometrical measures of non-ambulatory participants were calculated.
- ii) Nutritional requirements of each participant were calculated.
- iii) All menu items as well as additional snacks and beverages consumed by the participants were coded and the nutritional value thereof determined.
- iv) The adequacy of oral intake of each participant were calculated.

Step 6:

Data was captured on the *Office Excel* software package and electronically forwarded to the Department of Biostatistics at UFS.

3.8 Reliability and validity

Validity refers to the adequacy with which any measurement, index or indicator reflects what it is intended to measure. Reliability or precision refers to the degree of similarity of the results obtained when the measurement is repeated on the same subject (Katzenellenbogen & Joubert, 2014).

To increase validity, the most appropriate measurement instruments and techniques were selected based on recent literature and evidence-based recommendations (anthropometry, energy and protein requirements, ideal body weight, and oral intake).

To limit possible bias by overestimating height, KH was chosen as it is the preferred indirect method of estimating height from measurements of long bones (even if the right instead of the left leg, on which the equations were standardised needs to be use). Ulna length as an indirect measurement to determine height may overestimate the height of stunted participants, which is a common phenomenon in South African community (van den Berg et al., 2016).

To prevent over- or underreporting of intake and to obtain an objective result of intake, the record form developed to record the intake of personal snacks, beverages and ONS, was completed by trained nursing staff, assisted by the researcher and fieldworker, and not by participants themselves. Participants were also specifically asked not to adjust behaviour or the intake of food or supplements as result of being included in the study as this may result in bias and influence the validity of results.

As these record forms, developed to record the intake of personal snacks, beverages and ONS, were to be completed by different members of the nursing staff, the researcher and the fieldworker, the record form was worded in direct and simple language and quantities was given as simple household measures or volumes and portion sizes indicated on packaging. Training was done prior to the study to educate nursing staff with regards to the accurate completion of the record form to limit possible bias and/or measurement error as a result of incorrect reporting of intake. Dupertuis et al., (2003), however, found that the intake of patients from personal snacks and beverages accounts for less than 0.5% of total nutritional intake and may not significantly influence the results of the study.

The researcher and the trained fieldworker captured the data independently of each other, on two different Excel spread sheet, which were then verified by the biostatistician, to ensure data integrity.

The fieldworker was trained by the researcher prior to the study day to ensure that the correct and required data were obtained from patient records and accurately recorded on the data forms.

Reliability of measurements were improved by measures explained previously. Scales were calibrated regularly with a known weight, batteries were replaced on a regular basis and correct techniques as described in the literature, were meticulously followed to take measurements.

All measuring and weighing was done by the researcher or the fieldworker to ensure that consistent readings were measured in the same, consistent manner to minimise individual variation. Prior to the study, the researcher and the fieldworker performed three measurements each of height, KH and MUAC to ensure that error of measurement was within 5 mm for KH and 1 mm for height and MUAC respectively.

For quality control purposes, indirect measurements were also recorded for the fully-ambulatory participants. In the fully-ambulatory subgroup, direct and estimated weights and heights were compared to assess the reliability of these estimates in the current study population.

Using the weighed method to determine plate waste as previously discussed, contributed to reliability of measurements as it is considered the most accurate method to determine plate waste. No combined dishes such as macaroni and cheese and stew were served for the duration of the study as determining quantities of wastage and actual food intake of individual component may be inaccurate. Individual food components can be measured more accurately, ensuring better reliability of the results.

The record form, for purpose of recording the intake of personal snacks, beverages as well as ONS, were tested in a pilot study to ensure that it was easily understood and completed by nursing staff and the trained fieldworker. The researcher trained nursing staff prior to the study to ensure accurate capturing of data. The researcher and trained fieldworker were

available during the study days to explain the record form to nursing staff or to assist with the accurate completion of the form.

3.9 Pilot study

A pilot study is a mini-study that tests the study design and methods, obtain data to assist in determining the sample size, as well as tests the adequacy of field training (Katzenellenbogen & Joubert, 2014)

A pilot study was conducted to ensure that the planned methods were feasible, the record form for recording the intake of personal snack, beverages as well as supplements was easily understood, as well as to check that the data obtained was in line with what the researcher was planning to assess. The pilot study further contributed to ensure that the fieldworker was adequately trained to perform the data collection and capturing. It further helped to determine how long it would take to weigh and measure the participants, as well as to weigh the food before and after meals.

The pilot study was done on five randomly selected patients admitted to ICU that fitted the inclusion criteria for the study. All participants in the ICU on the day of the pilot study, that met the inclusion criteria were allocated a number. The first five numbers drawn from a bag was included in the pilot study. Data obtained from the pilot study were included in the final analysis of the study, as no changes were made to the study design and record forms.

3.10 Data analysis

The statistical analysis was performed by the Department of Biostatistics at the UFS. The data were described as medians and percentiles for continuous data, and frequencies and percentages for categorical data. The Wilcoxon signed-rank test for non-parametric data was used to compare data between subgroups to assess whether their population mean ranks differ. A p-value ≤ 0.05 was considered statistically significant.

3.11 Ethical aspects

Written consent was obtained from all participants. Each potential participant was handed a detailed information document (Appendix H, I and J) accompanying the consent form

(Appendix K, L and M) on the day before their first full 24h (from 06h00 to 06h00) in the ICU. The information document explained the purpose of the study and the procedures that were to be followed during the study. The form explained that participation in the study was voluntary, that refusal to participate would not involve any penalty or loss, that all information gathered would only be used for purpose of the particular study and would be kept strictly anonymous by de-identifying data. The form also explained that participation would assist dieticians to improve the delivery of optimal nutritional care to hospitalised patients, that there was no compensation, nor incentives, for participating in the study, that participants had the right to withdraw their participation at any point during the study, and that the study may be published, but without identifying the participants. It was also explained that if any dietary related problem, not being treated adequately by standard protocol, were identified during the study, the participant will be referred to the attending doctor for appropriate treatment and/or further dietary intervention. Once participants gave consent, they commenced with the study at 06h00 on the following day. Consent was obtained once only, but it was explained to participants that they would be included in the study daily for the duration of their stay in ICU.

The information document and consent forms were available in Afrikaans, English and Northern-Sotho. However, all patients understood Afrikaans and English and no Northern-Sotho consent forms were used. No patients were excluded from the study as result of not understanding any of the above languages.

The study was observational and, although the risk for any adverse effect or injury as result of the research was considered minimal, there was some risk for participants to be injured during the process of weighing and measuring. To minimise this risk of injury, a physiotherapist assisted the researcher when required, to mobilise participants to and from the scale and stadiometer, as well as to advise the researcher in cases where participants could not be mobilised safely. In cases where participants were not able to be mobilised safely, alternative methods to establish height and weight, as described previously, were performed. The researcher also acquired insurance to pay compensation in the case of any adverse effect or injury as result of the research, as well as against prosecution for possible malpractices.

It was explained to participants that the study is observational and that all participants will receive the same dietary intervention irrespective if they are included or excluded from the study. The study did not interfere with any other treatment of participants.

To ensure the application of effective measures to prevent and control transmission of microorganisms and prevent the spread of infection, the researcher and fieldworker were compliant to all infection control measures. Standard precautions for hand hygiene and routine cleaning of measuring equipment were ensured as per usual protocol in the unit. Hand hygiene was performed with alcohol-based hand rubs before and after contact with each individual participant. All measuring equipment such as the surface of the scale, stadiometer, calliper and measuring tapes were sprayed with alcohol solution and wiped down with alcohol swabs between participants' measurements. The researcher, as well as the fieldworker, did not wear any jewellery such as watches, bangles and rings other than a wedding ring and no sleeves below elbows.

3.12 Challenges experienced during the study and possible limitations

The researcher estimated to include an average 146 data collection points in the study. The estimation was based on usual ICU admission statistics of 10.4 participants meeting the inclusion criteria per day over a period of 14 days. However, the overall ICU occupancy was exceptionally low during the period of the study. In addition, several patients declined to participate in the study and the researcher managed to recruit only 29 participants who yielded 98 data points for comparison.

4.2 Patient profiles

The patient profile included age, gender, diagnosis for hospital admission, as well as LOS in the ICU, as summarised in Table 3-3.1 & Table 4.2.

The sample comprised of 15 male and 11 female participants. Most of the participants (65.4%) were between 20 and 40 years of age, and the remaining 34.6% were between 40 and 60 years of age.

Most participants (84.6%) were admitted with trauma. Only three participants had a surgical diagnosis. There were no participants with a medical diagnosis and one participant was stratified with a diagnosis other/ than trauma, medical or surgical.

Table 4.2: Patient profile for the participants (n=26)

VARIABLES	FREQUENCY / PERCENTAGES	
	n	%
Age		
20 – 30 years	9	34.6
31 – 40 years	8	30.8
41 – 50 years	5	19.2
51 – 60 years	4	15.4
Gender		
Male	15	57.7
Female	11	42.3
Admission diagnosis		
Trauma	22	84.6
Surgical	3	11.5
Medical	0	0
Other	1	3.8
LOS		
1 -10 days	18	69.2
11 -20 days	5	19.2
21 -30 days	2	7.7
31 -40 days	0	0
41- 50 days	0	0
51- 60 days	0	0
61- 70 days	1	3.8

Most participants (69.2%) had spent less than 10 days in the ICU, whilst 19.2% spent between 10 and 20 days. Two participants spent between 20 and 30 days and one spent more than 60 days in ICU. Length of stay in ICU ranged from 2 to 68 days with a median of 8 days (25th percentile: 4 days; 75th percentile: 13 days).

4.3 Anthropometry

Most of the participants (69.2%) were non-ambulatory as presented in Table 4.3.

Table 4.3: Mobility of participants (n=26)

VARIABLES	FREQUENCY / PERCENTAGES	
	N	%
Mobility		
Ambulatory	8	30.8
Non-ambulatory	18	69.2

Anthropometry in this study, referred to BMI. In the non-ambulatory sub-group, KH and MUAC were used to estimate indirect weight and height to determine BMI. In the ambulatory sub-group BMI was calculated from both direct and indirect measurements for weight and height, as a means of quality control. The frequencies and percentages of BMI of participants, calculated from direct measurements for the fully ambulatory participants, and from indirect measurements of KH and MUAC for the non-ambulatory patients, are presented in Table 4.4. The BMI of the entire sample (N=26) ranged from 14.8 to 39.1 kg/m² with a median of 24.5 kg/m² (25th percentile: 21.5 kg/m²; 75th percentile: 30.1 kg/m²).

Table 4.4: BMI of participants (n=26)

VARIABLES	FREQUENCY / PERCENTAGES	
	n	%
BMI		
Underweight: <18.5 kg/m ²	1	3.8
Borderline underweight: 18.5 – 20 kg/m ²	2	7.7
Within normal range: 20 – 24.9 kg/m ²	13	50
Obesity class I: 25 - 29.9 kg/m ²	3	11.5
Obesity class II: 30 - 39.9 kg/m ²	7	26.9
Obesity class III: ≥40 kg/m ²	0	0

To assess the reliability of indirect weight and height estimation in the study population, BMI based on direct and indirect weight and height measurements were compared in the fully ambulatory subgroup (n=8). The differences in directly and indirectly assessed BMI in this group is summarised in Table 4.5, and were not statistically significant (p=0.8), confirming the reliability of the indirect measurements in this sample.

Table 4.5: Difference between the median BMI calculated from direct and indirect measurements of height and weight for the fully ambulatory group (n=8)

VARIABLE BMI (kg/m ²)	MINIMUM	25 TH PERCENTILE	MEDIAN [‡]	75 TH PERCENTILE	MAXIMUM
Calculated from direct measurements	-2.6	-1.6	0.5	1.5	5.2

[‡]p=0.84 by Wilcoxon test

4.4 Energy and protein requirements

Energy and protein requirements were calculated for each participant. The energy requirements ranged from 870 to 2103 kcal/day with a median of 1608 kcal/day. The protein requirements ranged from 67.6 to 162.4 g/day, with a median of 106.8 g/day (Table 4.6).

Table 4.6: Energy and protein requirements (n=26)

VARIABLE	MINIMUM	25 TH PERCENTILE	MEDIAN	75 TH PERCENTILE	MAXIMUM
Energy (kcal/day)	870	1130	1608	1820	2103
Protein (g/day)	67.8	96.9	106.8	114.0	162.4

4.5 Food, snacks and ONS received

Table 4.7 is a summary of the intakes in terms of food and products that each participant received.

Table 4.7: Intakes per patient

Participant number	Study days													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	SD FPE Powerade													
2	FWD Supportan Powerade													
3	MFD	SD	FWD	FWD	FWD Coke									
4	FWD Supportan													
5	FWD													
6	FWD	FWD	FWD	FWD	FWD	FWD	FWD	FWD	FWD	FWD	FWD	FWD	FWD	FWD
7	FWD	FWD	FWD	FWD										
8	FWD	FWD	FWD	FWD	FWD	FWD								
9	MFD	MFD	FWD FPE	FWD FPE	FWD FPE	FWD FPE								
10	FWD	FWD	FWD	FWD	FWD	FWD	FWD	FWD	FWD	FWD	FWD	FWD	FWD	FWD
11	FWD FPE	FWD FPE												
12	FWD FPE	FWD FPE	FWD FPE	FWD FPE										
13	SD													
14	FWD	FWD												
15	FWD	FWD	FWD											
16	FWD	FWD	FWD	FWD	FWD	FWD	FWD							

17	FWD Supportan	FWD Supportan	FWD Supportan Burger											
18	FWD													
19	FWD	FWD												
20	FWD	FWD	FWD	FWD										
21	FWD	FWD	FWD	FWD										
22	FWD FPE													
23	MFD FPE	MFD FPE	MFD FPE	MFD FPE										
24	FWD													
25	SD Supportan													
26	FWD Supportan													

Abbreviations: Soft diet (SD); Mixed fluid diet (MFD); Full ward diet (FWD); Fresubin Protein Energy (FPE)

4.5.1 Food received from catering department

Diets that were ordered from the catering department for this study included the full ward diet (regular menu), soft menu and mixed fluid menu. All diets were presented as *a la carte* menus from which participants were requested to select menu items. During this study, most participants were served full ward diets while soft diets were served to four and mixed fluid diets to three participants. As per agreement with the catering department, no combined dishes were served for the duration of the study.

4.5.2 Personal snacks and beverages

Personal snacks and beverages that were consumed included beverages such as *Coca Cola* and *Powerade*. Only one patient consumed a burger that he received from his wife after he returned from theatre.

4.5.3 Oral nutritional supplements

In this study, 11 participants received ONS while 15 participants did not receive any supplements.

As per protocol agreed on with the attending doctors, all patients that are admitted to the unit, were screened by the dietitian. If not contra-indicated, all hemodynamically stable patients that were intubated and ventilated were commenced on enteral nutrition within 24-48 hours. In cases where enteral nutrition was contra-indicated or inadequate to meet nutritional requirements, according to the protocol set in the unit, parenteral nutrition was commenced. Once oral intake is considered safe, ONS are automatically commenced while patients are weaned off artificial nutrition support. Patients that are not commenced on artificial nutrition support on admission, are screened by the dietician within 24 h from admission, using the NRS 2002 to identify patients at nutritional risk. A positive screen prompts dietetic intervention and prescription of appropriate supplementation to meet nutritional requirements. For patients that had a negative screen, screens are repeated weekly.

Participants receiving any form of artificial nutrition support were excluded from the study. Therefore, the eleven participants that received ONS were either weaned off artificial

nutrition support using ONS which is automatically continued after artificial nutrition support is stopped or never received artificial nutrition support on admission to ICU but were considered at nutritional risk after screening using the NRS 2002.

Thirteen of the 15 participants that did not receive ONS were not considered at nutritional risk. However, two of the 15 participants that did not receive supplements were at nutritional risk but refused to take ONS as they did not like the taste thereof.

Oral nutritional supplements that were provided were the sip feeds *Supportan* and *Fresubin Protein Energy* from *Fresenius Kabi*.

Table 4.8 is a summary of the trade names, daily prescription as well as calorie and protein contribution of ONS to each participant's intake.

Table 4.8: Trade name, daily prescription, calorie and protein contribution of ONS to each participant's intake

Participant number	Trade name	Daily Units	Daily calorie contribution (kcal)	Daily protein contribution (g)
1	Fresubin Protein Energy	1	300	20
2	Supportan	1	300	20
4	Supportan	2	600	40
9	Fresubin Protein Energy	2	600	40
11	Fresubin Protein Energy	3	900	60
12	Fresubin Protein Energy	1	300	20
17	Supportan	1	300	20
22	Fresubin Protein Energy	1	300	20
23	Fresubin Protein Energy	2	600	40
25	Supportan	2	600	40
26	Supportan	1	300	20

4.5.4 Plate waste

The study was not designed to quantify plate waste, however Table 4.9 and Table 4.10 briefly summarises plate waste for each full day (data collection point) that each participant was included in the study. In cases where participants consumed 100% of all three meals on a given day (collection point), 0% plate waste was indicated. 'Some plate waste' was used to indicate any food left uneaten at one or more meals on a particular day. 'No' breakfast, lunch and/or dinner was indicated when a participant skipped an entire meal due to *NPO* instructions and/or being absent from in the unit during meal times, for example, due to tests or theatre procedures being performed on them.

The menu items that were most often not consumed, were toast and condiments served with breakfast, vegetables served with lunch and/or supper, and in some cases custard served with jelly as dessert. Noteworthy is that the protein component of the menu was mostly consumed.

21	Some PW	0% PW	Some PW	0% PW										
24	Some PW													

Abbreviations: PW = Plate Waste; B = Breakfast; L = Lunch; S = Supper.

Abbreviations: PW = Plate Waste; B = Breakfast; L = Lunch; S = Supper.

As summarised in Table 4.9 and Table 4.10, participants, collectively, had 0% plate waste (in other words, consumed all the food provided to them at each meal of that day) at 38 (40%) data collection points (representing one full day of ICU stay). Similarly, 'some plate waste' was recorded at 38 (40%) data collection points. A 100% plate waste at one or more meals (thus, none of the food that was provided was consumed) was recorded at seven (7.4%) data collection points, whilst 100% waste at all three meals of a given day, was recorded at two collection points, 100% plate waste at two meals at one collection point, and 100% plate waste at one meal, at four collection points. No incidences of 100% plate waste occurred in the group that did not receive supplements.

Overall, participants missed one or more meals due to NPO instructions for theatre and/or not being present in the ward at meal time at eleven (11.7%) collection points. One meal of the day was missed for these reasons at five collection points, whilst two meals was missed for these reasons at six collection points.

4.6 Total energy and protein intakes

Actual intakes of all catered food, snacks and ONS were carefully monitored and waste subtracted. Energy and protein intakes for each participant were determined without and with ONS where applicable. For participants that were included in the study for more than one day, the average energy and protein intakes were determined for the duration of days included in the study and are summarised in Table 4.11.

Overall, 11 participants received ONS. Without ONS, this subgroup consumed medians of 853 kcal/day of energy and 52.0 g/day of protein. The ONS consumed by these 11 participants during the study, contributed a median of a 600 kcal energy and a median of 40.0 g protein per day. These products increased the median oral energy intakes by 504 kcal/day (59.1%) to 1357 kcal/day, and the median oral protein intakes by 28.0 g/day (53.8 %), to 80.0 g/day (Table 4.11). This increase was statistically significant (Table 4.12).

Table 4.11: Distribution of the average energy and protein intakes over duration of ICU stay during 14-day study

VARIABLE	MINIMUM	25 TH PERCENTILE	MEDIAN	75 TH PERCENTILE	MAXIMUM
For subgroup that received ONS (n = 11)					
Without ONS					
Energy (kcal/day)	110	583	853	1124	1219.0
Protein (g/day)	0.2	27.5	52.0	65.2	78.5
With ONS					
Energy (kcal/day)	710	1185	1357	1424	7410.0
Protein (g/day)	40.2	72.5	80.0	87.3	449.4
For subgroup that did not received ONS (n = 15)					
Energy (kcal/day)	1140	1308	1394	1490	1573
Protein (g/day)	63.1	68.6	77.5	85.3	109
Pooled for total sample (n=26)					
Without ONS					
Energy (kcal/day)	110	1070	1231	1443	1573
Protein (g/day)	0.2	55.5	68.6	79.3	109.0
With ONS					
Energy (kcal/day)	710	1257	1377	1479	1573
Protein (g/day)	40.2	69.4	78.6	88.3	109.0

Table 4.12: Comparison of the median energy and protein intakes without and with ONS

VARIABLES	WITHOUT ONS	WITH ONS	p-value for the difference in means
For subgroup that received ONS (n = 11)			
Energy intake (kcal/day)	853.0	1356.8	0.001*
Protein intake (g/day)	52.0	80.0	0.001*
Pooled for total sample (n=26)			
Energy intake (kcal/day)	1231.0	1376.8	0.004*
Protein intake (g/day)	68.6	78.6	0.001*

*Wilcoxon test; p<0.05 deemed statistically significant

The 15 participants that did not receive ONS had median oral intakes of 1394 kcal/day of energy and 77.5 g/day of protein. Even when the data of the whole sample were pooled, the addition of ONS raised energy and protein intakes statistically significantly (Table 4.112).

4.7 Adequacy of total oral intakes

Subsequently, the oral energy and protein intakes of each participant were expressed as percentages of their individual requirements. These are summarised in Table 4.13.

Table 4.13: Adequacy of average energy and protein intakes, expressed as percentage of requirements

VARIABLE	MINIMUM	25 TH PERCENTILE	MEDIAN	75 TH PERCENTILE	MAXIMUM
For subgroup that received ONS (n = 11)					
Without ONS					
Energy	6.7%	30.0%	57.2%	64.7%	107.0%
Protein	0.2%	24.5%	53.7%	59.5%	76.9%
With ONS					
Energy	43.3%	67.7%	76.4%	82.3%	135.2%
Protein	40.9%	68.8%	74.3%	80.3%	98.8%
For subgroup that did not receive ONS (n = 15)					
Energy	70.9%	80.4%	98.0%	128.3%	165.1%
Protein	53.1%	61.9%	68.3%	81.6%	131.7%
Pooled for total sample (N=26)					
Without ONS					
Energy	6.7%	61.1%	79.9%	106.8%	165.1%
Protein	0.2%	54.5%	61.0%	73.9%	131.7%
With ONS					
Energy	43.3%	75.0%	82.6%	119.0%	165.1%
Protein	40.9%	63.0%	70.9%	81.0%	131.7%

In the pooled sample (n=26), the median energy intake without ONS was elevated from 79.9% to 82.6% of requirements with ONS. For the pooled sample (n=26), median protein intake was elevated from 61% to 70.9% of requirements. Although the increases were statistically significant, energy and protein intakes were still inadequate (Table 4.13).

In the subgroup not receiving ONS (n=15), the median energy intake was 98% of requirements, but protein intake was only 68.3% of requirements (Table 4.13).

In the subgroup that received ONS, median energy intakes were elevated from 57.2% of requirements without the ONS, to 76.4% of requirements with the addition of the ONS. Similarly, protein intakes were elevated from 53.7% adequacy without ONS, to 74.3%

adequacy with the addition of ONS (Table 4.13). These increases were statistically significant for both energy and protein adequacy (Table 4.14).

Figure 4.1 plots the adequacy of the average energy (a) and protein (b) intakes per individual participant in the subgroup that received ONS (n=11). These plots clearly illustrate that without ONS, the oral intakes of all but one participant fell short of energy requirements and that the oral intakes of all participants fell short of protein requirements. For most participants, even the addition of ONS, failed to increase oral intakes to 100% of requirements.

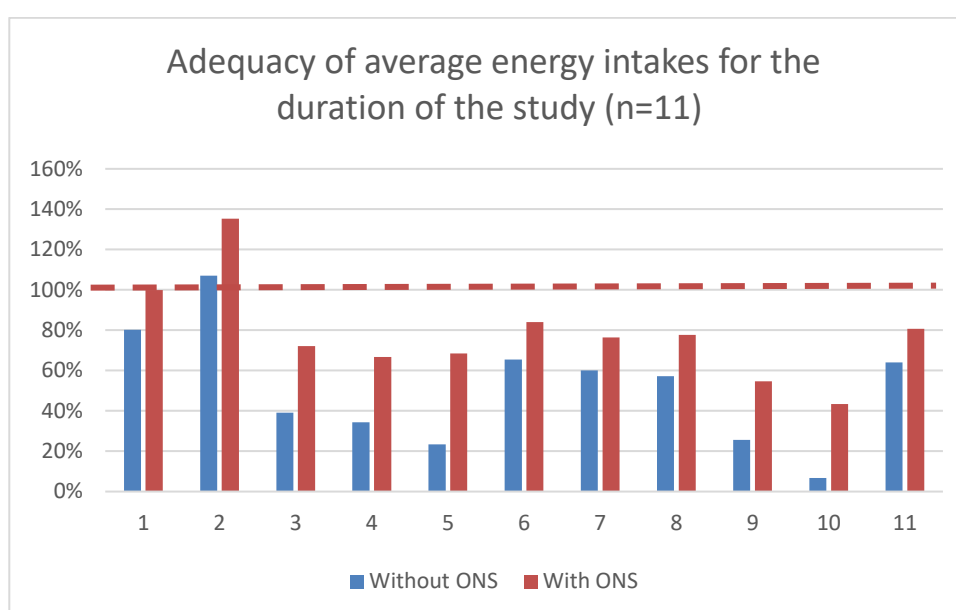


Figure 4.1 (a): Adequacy of oral energy intakes per individual participant, with and without ONS in the subgroup that received ONS (n=11).

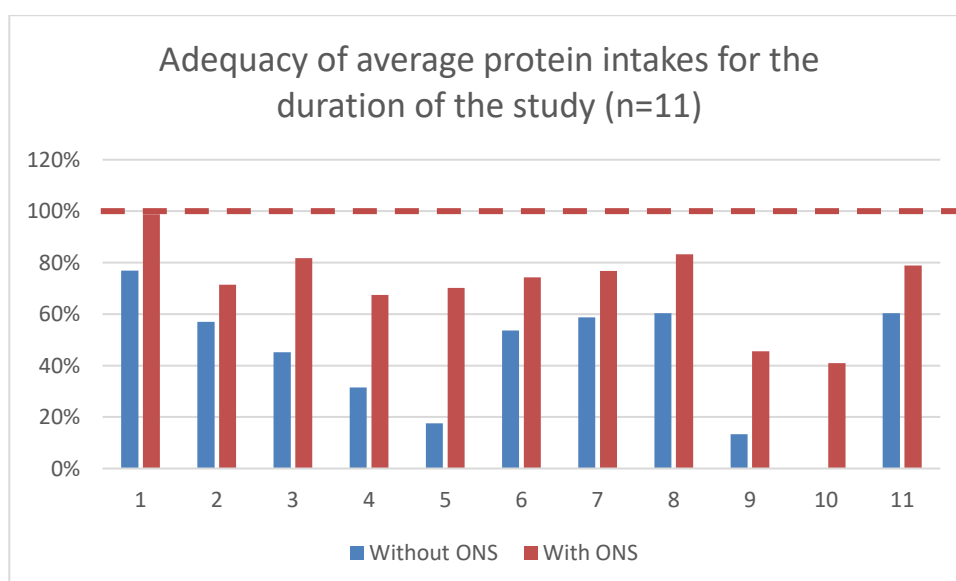


Figure 4.1 (b): Adequacy of oral protein intakes per individual participant, with and without ONS in the subgroup that received ONS (n=11).

Figure 4.2 plots the adequacy of the average energy and protein intakes per individual participant in the subgroup that did not receive ONS (n=15). This plot illustrates that without ONS, the oral intakes of all but two participants fell short of 100% of protein requirements. However, seven participants exceeded 100% of energy requirements.

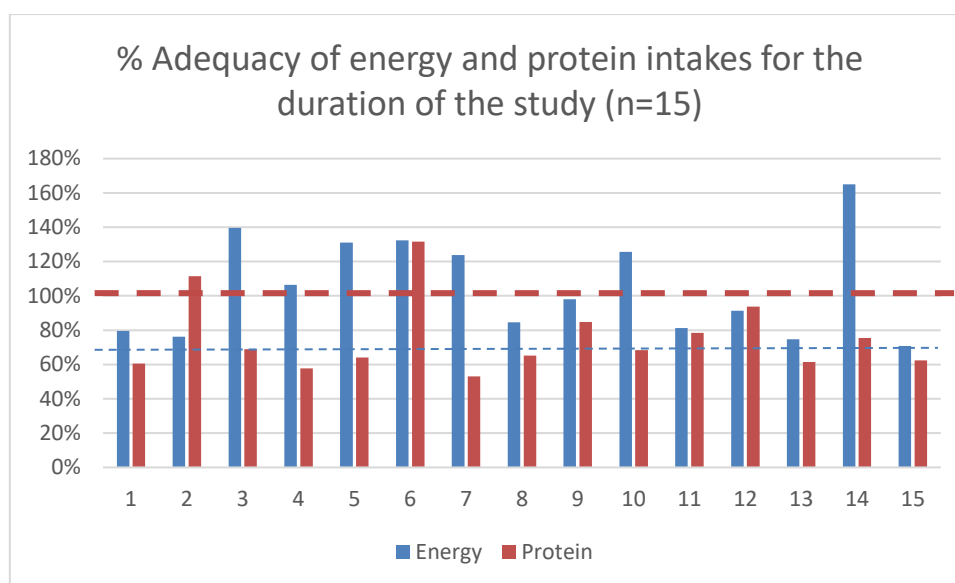


Figure 4.2: Adequacy of oral intakes per individual participant in the subgroup that did not receive ONS (n=15)

These trends persisted even after pooling the results for the total sample. The median adequacy of total oral intake for energy without ONS was 79.9% for energy and 61.0% for protein, while the medians for the adequacy of total oral intake for energy with ONS were 82.6% and 70.8% for energy and protein, respectively (Table 4.14). When ONS were included, these increases were statistically significant for both energy and protein adequacy, although not enough to elevate energy and protein intake to adequacy (Table 4.14).

Table 4.14: Comparison of median adequacy of energy and protein intakes without and with ONS, expressed as percentage of requirements

VARIABLES	WITHOUT ONS	WITH ONS	p-value for the difference in means
For subgroup that received ONS (n = 11)			
Energy intake (kcal/day)	57%	76%	0.001*
Protein intake (g/day)	54%	74%	0.001*
Pooled for total sample (n=26)			
Energy intake (kcal/day)	79.9%	82.6%	0.004*
Protein intake (g/day)	61.0%	70.9%	0.001*

*Wilcoxon test; $p < 0.05$ deemed statistically significant

4.7.1 Adequacy of total oral intake per BMI subgroups

The sample was further divided according to BMI (Table 4.15). Overall, 7 participants (26.9%) had a BMI ≥ 30 kg/m², ranging from 30.1 to 39.1 kg/m² with a median of 32.4 kg/m². Nineteen participants (73.1%) had a BMI < 30 kg/m², ranging from 14.8 to 27.9 kg/m².

Table 4.15: Classification per BMI subgroups (n =26)

VARIABLES	FREQUENCY / PERCENTAGES	
	N	%
BMI SUBGROUPS		
Non-obese (BMI < 30 kg/m ²)	19	73.1
Obese (BMI ≥ 30 kg/m ²)	7	26.9

The pooled oral intakes for the subgroup with BMI < 30 kg/m² and the subgroup with BMI ≥ 30 kg/m² are summarised in Table 4.16.

In the subgroup with BMI < 30 kg/m² ONS elevated the median energy and protein intakes from 1194 kcal to 2125 kcal and 65.3 g to 109.0 g. For the subgroup with BMI ≥ 30 kg/m² ONS elevated the median energy and protein intakes from 1386 kcal to 1394 kcal and 79.6 g to 79.9 g. Only one participant in this subgroup received ONS.

Table 4.16: Median energy and protein intakes according to BMI subgroups

VARIABLE	MINIMUM	25 TH PERCENTILE	MEDIAN	75 TH PERCENTILE	MAXIMUM
For subgroup with BMI < 30 kg/m² (n=19)					
Without ONS					
Energy (kcal/day)	110	774	1194	1388	1573
Protein (g/day)	0.2	50.7	65.3	72.7	109.0
With ONS (10 in this subgroup received ONS, 9 did not)					
Energy (kcal/day)	710	1239	2125	1471	1573
Protein (g/day)	40.2	68.6	109.0	87.3	109.0
For subgroup with BMI ≥ 30 kg/m² (n=7)					
Without ONS					
Energy (kcal/day)	1136	1236	1386	1439	1525
Protein (g/day)	65.8	77.8	79.6	80.6	93.9
With ONS (only 1 participant in this group received ONS, 6 did not)					
Energy (kcal/day)	1140	1359	1394	1460	1525
Protein (g/day)	65.8	78.4	79.9	87.6	98.5

The adequacy of intakes per BMI subgroups are summarised in Table 4.17. In the subgroup with BMI < 30 kg/m² ONS elevated the median adequacy of intakes from 70.9% to 77.7% for energy and 60.6% to 76.7% for protein. For the subgroup with BMI ≥ 30 kg/m² ONS elevated the median adequacy of intakes from 125.6% to 131.1% for energy and 64.1% to 68.3% for protein.

As only one participant with BMI ≥ 30 kg/m² received ONS, the contribution of ONS in this subgroup is difficult to interpret and the comparison between energy and protein intakes with and without ONS is not meaningful. Noteworthy, however, is the fact that, even without ONS, oral intakes in the heavier subgroup exceeded energy requirements (125.6%), whilst the protein intakes fell short of requirements without ONS (64.1%) as well as with ONS (68.3%).

Table 4.17: Median adequacy of energy and protein intakes without and with ONS, expressed as percentage of requirements, according to BMI subgroups

VARIABLE	MINIMUM	25 TH PERCENTILE	MEDIAN	75 TH PERCENTILE	MAXIMUM
For subgroup with BMI < 30 kg/m² (n=19)					
Without ONS					
Energy	6.7%	48.2%	70.9%	49.4%	132.3%
Protein	2%	49.4%	60.6%	77.7%	131.7%
With ONS					
Energy	43.3%	71.5%	77.7%	84.3%	132.3%
Protein	40.9%	63.8%	76.7%	84.0%	131.7%
For subgroup with BMI ≥ 30 kg/m² (n=7)					
Without ONS					
Energy	106.0%	115.0%	125.6%	135.0%	165.0%
Protein	53.0%	57.0%	64.1%	69.0%	76.1%
With ONS (only 1 participant in this group received ONS, 6 did not)					
Energy	106.0%	123.0%	131.1%	137.0%	165.0%
Protein	53.0%	61.1%	68.3%	70.0%	76.0%

Figure 4.3 depicts the adequacy of oral energy intakes per individual participant in the subgroups with BMI <30 kg/m² (a) and BMI ≥30 kg/m² (b). Figure 4.4 depicts the adequacy of oral protein intakes per individual participant in the subgroups with BMI <30 kg/m² (a) and BMI ≥30 kg/m² (b). The oversupply of energy, accompanied by deficient protein intakes in the heavier group is clear.

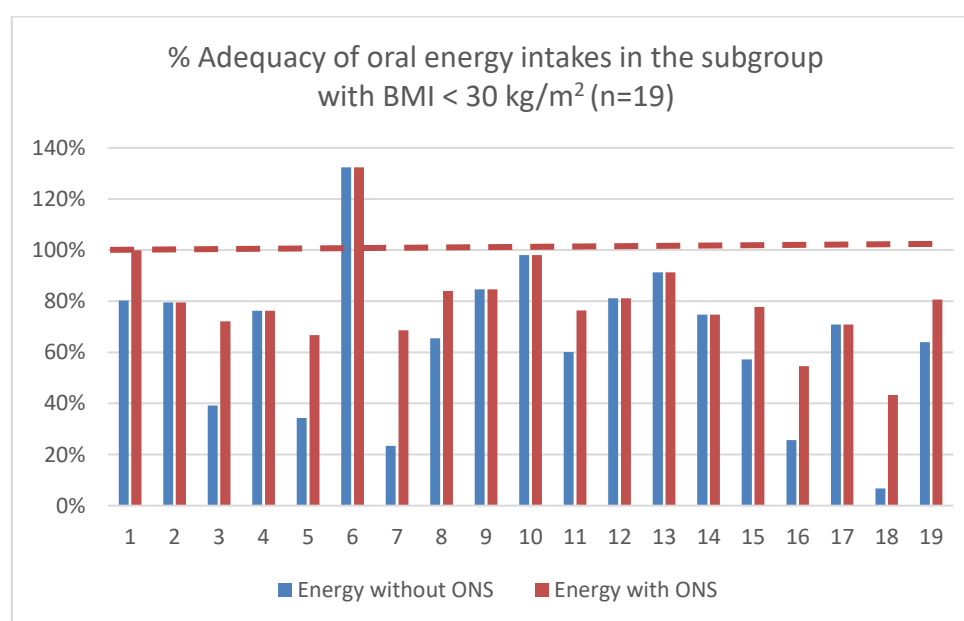


Figure 4.3 (a): Adequacy of oral energy intakes per individual participant in the lighter subgroup.

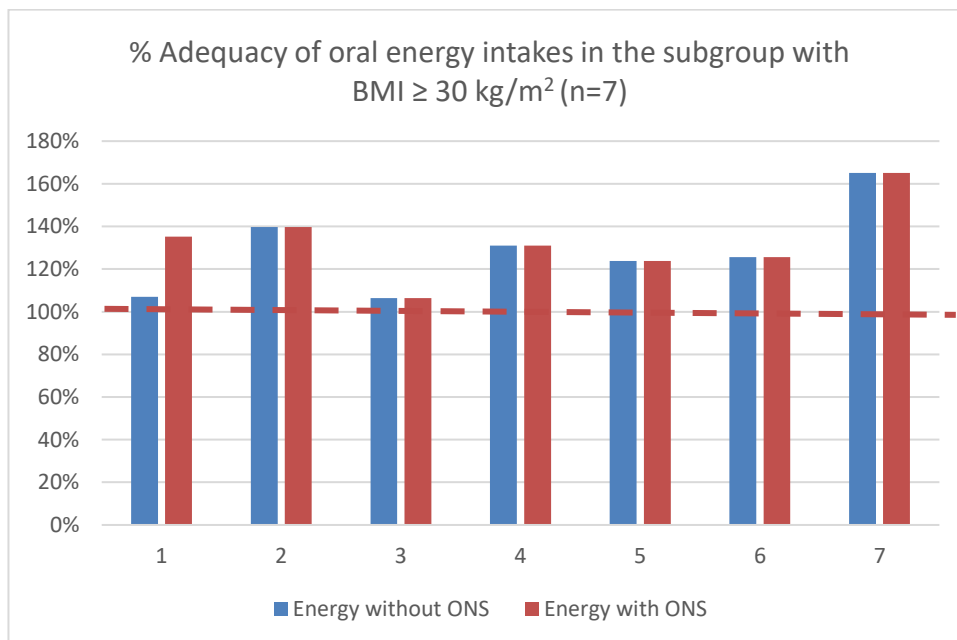


Figure 4.3 (b): Adequacy of oral energy intakes per individual participant in the heavier subgroup.

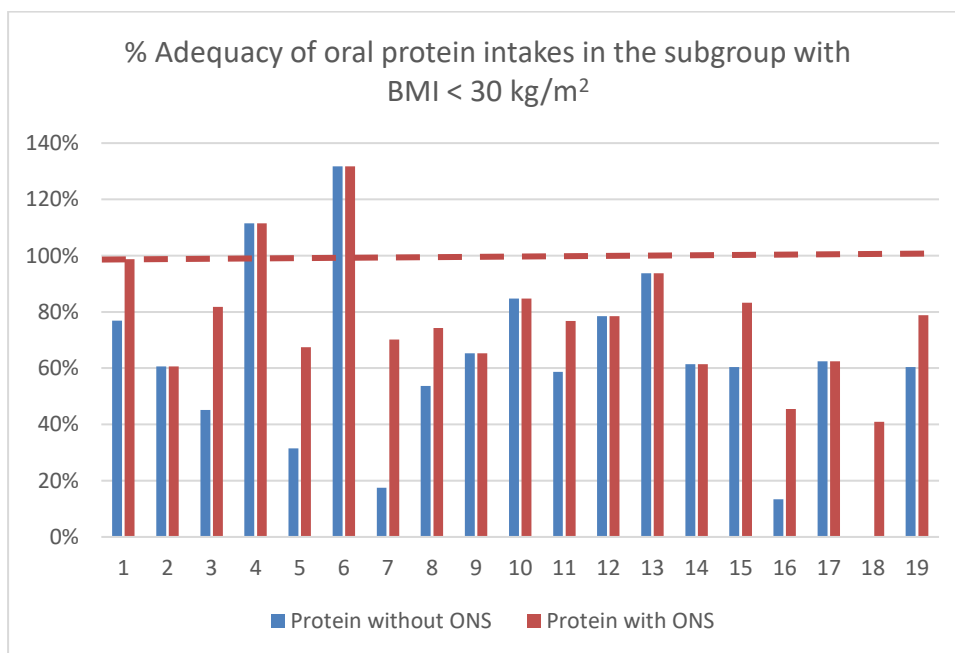


Figure 4.4 (a): Adequacy of oral protein intakes per individual participant in the lighter subgroup.

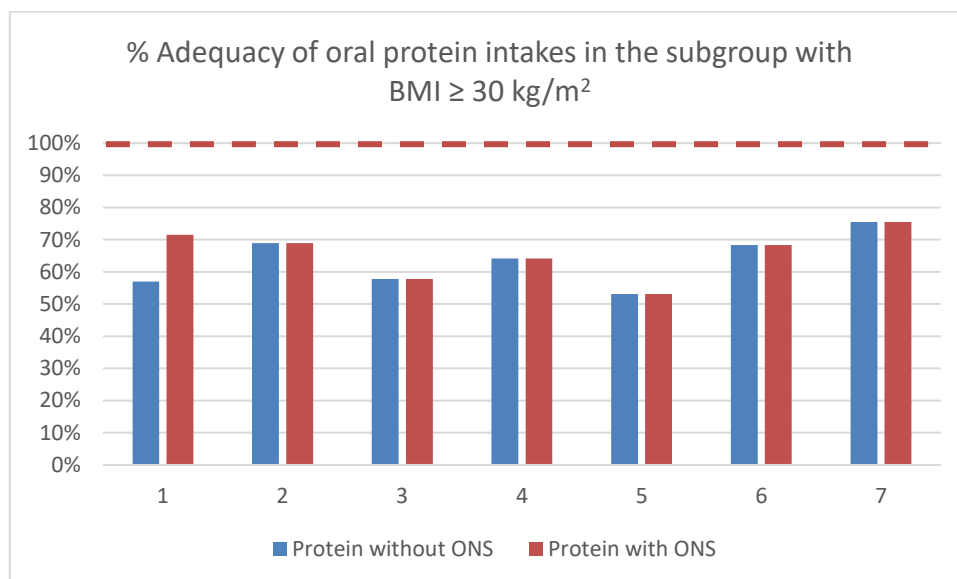


Figure 4.4 (b): Adequacy of oral protein intakes per individual participant in the heavier subgroup.

4.8 Summary

For the total sample (n=26) as well as the subgroup that received ONS (n=11), the median energy and protein intakes were inadequate, with and without ONS. The energy intake for the subgroup that did not receive ONS (n=15) was almost adequate at 98%, whilst protein intake was inadequate.

Although the addition of ONS did not elevate energy and protein intake to adequacy in these two groups, the increase in energy and protein intakes were statistically significant for the total sample (n=26), as well as for the sub-group (n=11) that received ONS.

When the sample was divided per BMI group, for the subgroup BMI < 30 kg/m² (n=19) the median energy intake for energy and protein was inadequate with and without ONS.

For the heavier subgroup (n=7), energy requirements were exceeded both without and with ONS while protein intake remained inadequate even with ONS.

Therefore, it may be summarised that the intake of energy was inadequate for all the subgroups, with and without ONS, except for the heavier subgroup where energy intake exceeded requirements, with and without ONS. Protein intake was inadequate for all the subgroups despite the addition of ONS.

5 CHAPTER 5: DISCUSSION OF RESULTS

5.1 Introduction

During the 14-day study period, 26 participants that met the inclusion criteria were included in the study. Data on total oral intakes were collected for each participant on each full day that they were admitted to the ICU during the 14-day study period, yielding 94 data points for comparison with their requirements.

In this chapter, the results of the study regarding patient profile, anthropometry, energy and protein requirements, energy and protein intake, as well as adequacy of oral intake, are discussed and interpreted in context of the current literature. Limitations of the study and the potential influence thereof on the findings are also discussed.

5.2 Patient profiles

Evidence suggests that an aging population increases ICU admissions and the demand on critical care resources (Angus et al., 2011). In this study, the majority of participants were between 20 and 40 years old, which could be attributed to the fact that the unit is essentially a trauma unit that admits injury on duty cases, thus representing a younger population of patients. There were also more male than female participants in the study, of which the majority were admitted for trauma-related diagnoses. This is in line with the results of an international literature review that indicated that young males are the highest risk group to be injured in the workplace (Salminen, 2004). In the current study, 10 participants (just less than 40%) had a LOS between one and five days, whilst the remaining participants (around 62%) had a LOS of longer than 5 days up to as long as 68 days in one case.

5.3 Anthropometry

Screening tools such as MUST, NRS 2002 and MNA require BMI to determine nutritional risk whilst dietary requirements are calculated in relation to the patient's weight. To calculate BMI, it is necessary to obtain height and weight, but these are often difficult to measure in the critically ill population because the standardised reference techniques require that the subject is able to stand up straight and unassisted. Besides the nature of injuries and pain,

these patients are often unconscious, sedated and/or confused, necessitating the use of indirect measurements of height and weight to determine BMI (Van Den Berg et al., 2016). Studies have shown that recumbent length (Barbosa et al., 2012), eyeballing techniques (Maskin et al., 2010), and self-reporting (Griebeler et al., 2011) do not produce accurate and reproducible results. A scientific approach to estimating height and weight involve mathematical equations based on indirect measurement of body parts.

The developers of the MUST, for example, recommend equations based on ulna length. The ulna is easy to access and easy to measure accurately in most critically ill patients, whilst being highly predictive of height in the European population (Malnutrition Advisory Group (MAG), 2011). In a South African hospitalised population, Van den Berg, et al., (2016), however, found that the MUST equations significantly over-estimated height for both male and female patients. The question was raised whether the overestimation of height based on UL could be associated with the high prevalence of stunting in the South African population, as forensic evidence suggest that stunting affects the length of the lower limbs, rather than that of the upper (Bogin & Varela-Silva, 2010). If this is true, equations based on lower limb lengths may be reflect actual height better in the South African population limbs (Van den Berg et al., 2016).

In this study, most participants were non-ambulatory as result of injuries, which necessitated obtaining indirect measures of height and weight to determine BMI. Based on the recommendations of Van den Berg et al., (2016), equations to estimate height and weight, based on KH was elected for this study. The accuracy of the indirect methods in this the study population, was confirmed by obtaining direct and indirect measurements of height and weight for the ambulatory group of participants. No statistically significant difference was found between BMI calculated from direct and indirect measurements in the ambulatory group, which indicates that proxy measurement using KH to obtain height and weight indirectly, was reliable to estimate weight and height in the non-ambulant patients from the current study population.

Half of the participants had a normal BMI and only one participant were underweight (BMI < 18.5 kg/m²), whilst seven participants (more than 25%) were obese (BMI ≥ 30 kg/m²). A pooled analysis of trends in adult BMI in 200 countries from 1975 to 2014, showed that the

number of obese adults in the world had risen from 105 million in 1974 to 640 million by 2014, which constitutes an increase of more than 600% (Chan, 2017). In Sub-Saharan Africa, the prevalence of obesity was mostly higher than the global average (NCD Risk Factor Collaboration (NCD-RisC) – Africa Working Group, 2017). Currently, around one third of United States adults have a BMI ≥ 30 kg/m² and is considered obese (Smith & Smith, 2016). However, between 1980 and 2004, the prevalence of obesity more than doubled, from 15% to 33%, in adults and it is predicted that, if the trend continues, more than half (51%) of adults in the United States are likely to be obese by 2030 (Smith & Smith, 2016). Closer to home, figures from the Human Sciences Research Council's first South African Health and Nutrition Examination Survey (SANHANES), showed that, in Gauteng, 21% of men and 28.1% of women are overweight, while 12.9% of men and 39.9% of women are obese (Shisana et al., 2013).

Prevalence data for obesity amongst critically ill patients depends on the cohort examined. Recent data suggests a prevalence of obesity among ICU patients varying between 25% and 50% (Dennis and Travenen, 2016; Arabi et al., 2015; Secombe et al., 2015). This figure coincides to the obesity prevalence of 26.9% amongst participants in the current study, although the sample was small. The prevalence of obese patients in ICU reflects that of the general population (Secombe et al., 2015). In addition, obese adults are at increased risk for many chronic medical conditions that increase the likelihood of ICU admissions by changing the way many organ systems function. This affects and complicates the management of the critically ill obese patient (Marik, 2015). Thus, it is inevitable that intensivists will, in the future, be caring for an increasing obese population (Secombe et al., 2015).

5.4 Energy and protein requirements

The median for energy and protein requirements were 1607.5 kcal and 106.8g, reflecting the enhanced needs of the critically ill, as discussed in chapter 2.

5.5 Oral energy and protein intakes

Oral intake of hospitalised patients consists of food, snacks and beverages that are served by the catering department, personal snacks and beverages, as well as ONS (Pullen et al., 2017), which was also the case in the current study.

5.5.1 Meals, snacks and beverages received from the catering department

At the time of this study, the catering function at the hospital was outsourced to an external catering company. According to the contract, the catering department provided patients with three meals plus two snacks per day.

5.5.1.1 Food service schedule

Breakfast, lunch and supper were served at 8h15, 12h30 and 17h15, respectively. Tea and coffee were served four times per day at 05h00, 10h00, 15h00 and 19h00. A small snack in the form of a rusk was served at 05h00, and another, consisting of half sandwich (one slice of bread) with a protein filling, at 19h00. Water was available throughout the day. This is in line with international standards. For example, in the United Kingdom, the NHS Plan, “Better Hospital Food (BHF) Programme (2001)” stipulates that patients must be served breakfast, lunch and an evening meal, snacks at least twice a day, at least seven beverages a day and access to chilled water 24 hours a day. In addition, the food service should have the flexibility to accommodate small and frequent meal patterns as are required by many patients (Dashti & Morgensen, 2017). These guidelines are to ensure that adequate amounts of food and fluids are available to all patients regardless of their individual needs (BDA Food Services Specialist Group, 2017).

It remains up to the health care team, however, to prescribe and order (from what is made available by the food service) the most appropriate food delivery for each patient, in terms of frequency, and consistency. The role of the dietician, with expert knowledge and insight into the nutritional therapeutic needs of the patient, is vital as part of the multi-disciplinary team. The Alliance recommends that therapeutic dietitians should be granted privileges to not only assess and diagnose the nutritional status of patients, and advise physicians on the appropriate meal order to best meet the needs of the patient, but to order meals for patients themselves (Tappenden et al., 2013).

5.5.1.2 Menu type

At the time of the study, the catering service offered all meals from an *a la carte* menu, presented to patients by ward host/hostesses one day prior to serving the menu. The two types of menus that are commonly used in healthcare settings are *a la carte* menus and cyclic

menus. *A la carte* menus involve choosing individual dishes from a menu, as opposed to a set menu, and should include enough choice to provide for the client group. A cyclic menu is a set menu that differs each day and repeats itself after a few days or weeks. (National Food Management Institute, n.d.). *A la carte* menus offer daily choice of dishes and increases the probability of patients receiving a dish they like, which contributes to improved patient satisfaction (BDA Food Services Specialist Group, 2017; Whitehouse, 2016; National Food Management Institute, n.d.) and works well for short-stay patients. Cyclic menus are set, differ every day and repeats after a set cycle of days to weeks. Cyclic menus give the perception of greater choice and is therefore a better alternative for long-stay patients (BDA Food Services Specialist Group, 2017; National Food Management Institute, n.d.).

Dietary needs of patient groups are important when menus are planned and must be assessed and incorporated in menus. Factors to take into consideration are age, gender, specific nutritional requirements including the need for special therapeutic diets, food preferences and length of stay. Length of stay is generally accepted to be short stay in acute facilities (BDA Food Services Specialist Group, 2017; National Institute for Health and Care Excellence (NICE), 2017).

5.5.1.3 Types of diets ordered

In the current study, meals were ordered from the full ward diet (regular) menu, soft menu, and mixed fluid menu (all offered as *a la carte* menus). Most participants were served full ward diets, while soft diets were served to four and mixed fluid diets to three participants.

5.5.1.3.1 Ward diet

A la carte menus were available for the full ward diet as well as for therapeutic diets. Portion sizes were standard irrespective of nutritional status, nutritional requirements and sex, however, a 'standard' or 'large portion' option was available for the full ward diet. A large portion implicates a double starch portion.

The breakfast menu for the full ward diet consisted of a choice of a breakfast cereal or hot porridge. Hot breakfast options were a choice of egg that could be fried, scrambled or poached, served with bacon, a fishcake or a sweetcorn fritter. Alternatively, a sliced fruit platter served with yoghurt was available. Breakfast was served with a fruit juice and choice

of whole wheat or white toast. Lunch and dinner had hot and cold options available. The hot options for lunch, as well as dinner, included a choice of a soup, beef casserole, roasted chicken, spaghetti bolognese, or fish served with a choice of starches. Cold options included a chicken salad or a roll with salad, ham and/or cheese. Dessert was only served at dinner and included a choice of jelly and custard, fresh fruit, fruit salad or yoghurt. A chef's special for both main meals and dessert were available every day.

5.5.1.3.2 Therapeutic diets

ICU patients frequently develop dysphagia (swallowing disorders), after extubation. The complications can include aspiration, reintubation, pneumonia, and a prolonged hospital LOS. The availability of appropriately modified texture diets are therefore vital (Macht et al., 2013).

Therapeutic diets that were served during the study included soft diets and mixed fluid diets. The soft diet consisted of the same menu items than the full ward diet, however, all meat and chicken were chopped, and only soft fruits or canned alternatives were served. The mixed fluid diet consisted of a choice of fruit juice, sugar-free cordial, smooth yoghurt, *Inkomazi*, *Mageu*, liquidised soup of the day, or a commercial meal supplement. In addition, the breakfast menu also included maize meal or *Future Life* porridge, and the lunch and dinner menu included jelly and custard, as well as ice cream. Participants could choose three of these menu items.

5.5.1.4 Role of the food service dietician

As the only professionals that are equipped with knowledge of food and how food service impacts on nutritional care and clinical outcomes, food service dietitians are ideally placed to be involved at every level of the food chain, thus forming a vital link between patients, clinical and catering staff (BDA Food Services Specialist Group, 2017; Pullen et al., 2017). At the time of the study, however, the catering function at the hospital was outsourced to an external catering company and the contract did not include the service of an onsite foodservice dietitian.

Food service dietitians are equipped to manage all important areas of the food chain, i.e. service planning, support and provision, managing of therapeutic diets as well as monitoring and auditing of food service (BDA Food Services Specialist Group, 2017). They collaborate with

catering managers to ensure that evidence-based nutrition standards are incorporated in menu planning to meet nutritional requirements of patients. They provide nutritional analysis of menus and have extensive knowledge of therapeutic diets and the skills to incorporate evidence-based principles into menu planning. In addition, the food service dietitian has knowledge of large scale catering, and plan, implement and evaluate extensive training programs for clinical and catering staff that are involved in the food chain. Furthermore, food service dietitians collaborate with patients, clinical and catering staff to implement protected mealtimes and to ensure that such mealtime policies are adhered to. They also equip patients to make the best possible food choices to accommodate special dietary requirements, whilst meeting nutritional requirements. Finally, the food service dietitian plays a role in monitoring and auditing the foodservice (BDA Food Services Specialist Group, 2017).

In the United Kingdom, it is recommended that a food service dietitian is appointed in all NHS departments to act as the main interface between catering and clinical services. It is recommended that the dietitian is appointed in a senior capacity to allow sufficient authority to lead development, conduct training and manage processes as the food service dietitian's role extends to all areas i.e. catering, clinical as well as governance and policy making (BDA Food Services Specialist Group, 2017). During the current study it was observed that the ward host/hostess, in the absence of an onsite food service dietitian, was mainly responsible for communication between the patients and the catering department.

5.5.2 Personal snacks and beverages

Similar to the study of Dupertuis et al., (2003), in this study, few participants consumed additional personal snacks and beverages. A possible explanation is that most of the participants were admitted for injuries obtained while on duty and were admitted to the unit from distant locations. These participants did not receive any visitors, as friends and family reside elsewhere. In addition, these participants were non-ambulatory and it was not possible for them to visit the hospital tuck shop to buy snacks and beverages. During the study, only one participant, who had not been admitted for an injury on duty, consumed an additional hamburger that was brought by a visitor. In addition, some patients consumed sweetened fizzy drinks i.e. *Coca Cola* and energy drinks i.e. *Powerade*, brought by visitors.

Dupertuis et al., (2003) found that the contribution of personal snacks and beverages accounted for less than 0.5% of the protein intake of hospitalised patients (Dupertuis et al., 2003). However, it has been reported that as much as 63% of hospitalised patients consume nonhospital food that may potentially have a significant impact on oral intake and nutritional status. Therefore, Pullen et al., (2017) investigated the nutritional contribution of nonhospital foods to the overall intake of hospitalised patients and demonstrated a significant difference in the energy intake between patients that received and did not receive nonhospital food and beverages. However, the overall contribution of these foods and beverages were not found to result in a significant number of participants meeting energy requirements. No significant difference in protein intake between the groups were found (Pullen et al., 2017).

Similarly, in this study, personal snacks and beverages contributed to negligible protein while the consumption of sweetened beverages contributed to the overall energy intake through 'empty energy' sources. Noteworthy is that the participants that consumed the sweetened beverages in the current study were all overweight and/or obese and that the consumption of sweetened beverages contributed to their intakes exceeding energy requirements.

Pullen et al., (2017) also recognised that inequalities between patients who have money and resources to obtain food from outside the hospital versus patients that do not have the money and resources, is an ethical concern. It was therefore recommended that the nutritional requirements of all patients should be provided by the catering department and that nonhospital food and drink should not be relied on to help meet nutritional requirements (Pullen et al., 2017).

5.5.3 Oral nutritional supplements

The term enteral nutrition comprises all forms of nutrition support that imply the use of dietary food for special medical purposes administered into the gastro-intestinal tract, independent of the route of application and includes ONS (Lochs et al., 2006).

The use of ONS, as already extensively discussed in Chapter 2, has been proven as an effective means of treating malnutrition, providing many benefits including improved patient mortality and morbidity. In addition, the correct use of ONS has major cost saving effects (Philipson et al., 2013; Cawood et al., 2012; Hubbard et al., 2012; Stratton & Elia 2007). In this study, the

addition of ONS, increased both energy and protein intakes statistically significantly, despite the small sample size.

In the current study, ONS were provided in the form of commercially available enteral formulae, which are classified according to the energy and protein content, as well as special properties. Commercial ONS products are available with low, normal or high energy content. So-called normal energy formulae provide 0.9 – 1.2 kcal/ml, low energy formulae provide 0.9 kcal/ml while high energy formulae provide more than 1.2 kcal/ml. In addition, these ONS are available as so-called high protein formulae with a protein content of 20% or more of total energy. Protein in formulae may be intact protein, peptide-based or free amino acids. In addition, some formulae contain immune modulating substances intended to enhance immune function (Lochs et al., 2006). The energy density and protein content of sip feeds that were available in the hospital in the current study, are listed in Table 5.1: **Energy density and protein content of sip feeds that were available in the hospital in the current study**

Table 5.1: Energy density and protein content of sip feeds that were available in the hospital in the current study

PRODUCT	kcal/ml	protein/100ml
Fortisip Compact Protein	2.4	14.4
Fresubin 2kcal	2.0	10.0
Supportan	1.5	10.0
Fresubin Protein Energy	1.5	10.0
Forticare	1.6	8.8
Fresubin Energy	1.5	5.5
Fresubin Original	1.0	4.0

Similar to recommendations by Parkes, (2016), general practice for the prescription of ONS in the unit is that it is considered medical intervention and is only prescribed after a positive nutrition screen using the NRS 2002. However, it is standard protocol in the unit to also prescribe ONS when patients are weaned off artificial nutrition support. The use of ONS is then also continued for the remainder of ICU admission. To minimise wastage and optimise clinical benefit, it is recommended that the prescription of ONS is monitored regularly according to patient tolerance and nutritional requirements (Hubbard et al., 2012). Therefore, it is also standard practice in the unit, to monitor the prescription of ONS regularly at the hand

of the suggested criteria. Although a 'food first' approach is recommended as first line of treatment for patients with a positive nutrition screen (Parkes, 2016), poor oral intake amongst patients that are admitted to ICU, are well recorded (Peterson et al., 2011; Peterson et al., 2010). Thus, in line with recommendations of the British Association for Parenteral and Enteral Nutrition, treatment in the unit begins with food and supplements simultaneously (Stratton & Elia, 2010).

Based on evidence that support the importance of early and adequate protein delivery in ICU (Wischmeyer, 2016), general practice in the unit is that ONS with the highest protein content is prescribed to best meet protein requirements. In the unit, ONS are consumed between meals in accordance with recommendations that sip feeds should be taken between meals and not as meal replacement to maximise effectiveness and to avoid spoiling the patient's appetites (Parkes, 2016).

The sip feeds that participants in this study received, were *Fresubin Protein Energy* and *Supportan*. Both these sip feeds have an energy density of 1.5 kcal/ml and protein density of 10g/100ml, and are available as 200ml ready-to-drink sip feeds. In comparison to *Fresubin Protein Energy*, *Supportan* is also enriched with omega-3 fatty acids and anti-oxidants, contains fibre, and 24% of the fat content is provided as medium chain triglycerides. The rationale for choosing these products, were prescribing supplements with the highest protein content and considering patient preference . Six participants (54%) consumed *Fresubin Protein Energy* while the remaining five participants (45.5%) consumed *Supportan*. *Supportan* was primarily prescribed based on patient preferences and not for the additional immune modulating benefits, except in the case of one participant. *Fresubin Protein Energy* which does not provide any fibre, were also chosen above similar fibre containing products, because the latter are generally perceived by the patients as too sweet and rich.

A clinically beneficial dose is reported to be around 600 kcal/d (Parkes, 2016). As listed in Table 5.2, in this study, one participant was prescribed three units of ONS (900 kcal/d), four participants were prescribed two units (600 kcal/d) and six participants were prescribed only one unit (300 kcal/d). Three of the participants who received only one unit, did not tolerate more. The six participants receiving only one unit per day, who represented more than half the sample that received ONS, all had a relatively longer ICU stays of ≥ 10 days. Although their

ONS intake fell short of the recommended dose (Parkes, 2016), ONS still statistically significantly elevated energy and protein intakes in the sample, and may still have been of therapeutic value to the patients.

Table 5.2: Summary of sip feeds received by participants

Participant number	Product	Number of units
1	Fresubin Protein Energy	1
2	Supportan	1
4	Supportan	2
9	Fresubin Protein Energy	2
11	Fresubin Protein Energy	3
12	Fresubin Protein Energy	1
17	Supportan	1
22	Fresubin Protein Energy	1
23	Fresubin Protein Energy	2
25	Supportan	2
26	Supportan	1

5.6 Adequacy of oral energy and protein intake

The aim of this study was to assess the adequacy of intakes of energy and protein intakes amongst exclusively orally fed ICU patients.

5.6.1 Adequacy of energy intakes

Accumulative energy deficits in the ICU is associated with worse clinical outcomes (Peterson et al., 2011). Energy expenditure and requirements are not stagnant and varies over time. Uncertainty prevails pertaining to the amount of energy to be delivered during the early phase with evidence that early energy delivery should be limited to accommodate endogenous energy production from glucose, as well as possibly to prevent the inhibition of autophagy (Preiser et al., 2014). However, energy requirements increase as patients proceed over the continuum of critical illness. Wischmeyer (2016) defines the acute phase as the first five days after ICU admission and the chronic phase as the phase that develops thereafter for the duration of ICU stay. The acute and chronic phases are followed by the recovery phase, usually after discharge from ICU. Energy delivery of around 25 – 30 kcal/kg is suggested during the chronic phase, but it is proposed that these requirements becomes much higher during the recovery phase, thus, once discharged from ICU, energy provision of 30–40 kcal/kg is

suggested (Wischmeyer, 2016). Dupertuis et al., (2003) reported that 55% of participants in acute care facilities did not meet energy requirements (Dupertuis et al., 2003). In the current study 65.4% of participants did not meet energy requirements.

A study by Kondrup et al., (2002) that investigated the incidence of nutritional risk and causes of inadequate nutritional care in hospital, reported that consuming less than 75% of energy requirements was associated with worse outcomes while consuming more than 75% of daily energy requirements was associated with improved clinical outcomes (Kondrup et al., 2002). In this study, for the pooled sample (n=26), the adequacy for energy intakes were above 75% in the subgroups that received ONS, as well as in those who did not. In the subgroup receiving ONS (n=11), the adequacy of energy was elevated to more than 75% of energy requirements by the addition of ONS. However, even if 75% of requirements are met, there is still a shortfall of 25%. Difficulties and challenges that prevent 100% nutrition delivery need to be considered and addressed to optimise energy delivery in ICU. An additional concern is that an adequate energy supply is a prerequisite to prevent protein being used as metabolic fuel.

5.6.2 Adequacy of protein intakes

In terms of protein delivery, recent evidence suggests that, during the first couple of days of ICU admission, protein delivery should be restricted to around 0.8 g/kg to prevent inhibition of autophagy. However, protein requirements increase significantly to as much as 2.0 g/kg during the late acute phase, as well as during the chronic and recovery phases (Wischmeyer, 2016). Adequate and timely delivery of protein is essential to promote a positive nitrogen balance which facilitates protein synthesis and tissue repair (Pullen et al., 2017; Wischmeyer, 2016).

In the current study, however, none of the participants was consuming adequate amounts of protein. The delivery of protein did not meet 80% of requirements with or without the provision of ONS, emphasising the challenge raised in the international literature to achieve adequate protein delivery in ICU (Heyland et al., 2017; Dupertuis et al., 2003). Dupertuis et al., (2003) reported a protein intake of 50 ± 10 g/d, which was below requirements. In a more recent study, Pullen et al., 2017 reported that the protein intake for a nutritionally vulnerable group was 45 g/d which was significantly less than set requirements of 65.3 g/d (Pullen et al.,

2017). In the current study, the mean protein intake for the pooled sample (n= 26) was 68.6 g/d without ONS and 78.6 g/d with ONS compared to the mean protein requirement of 106.8 g/d for this group.

A systematic review, published in 2012, found that most critically ill adults receive less than 50% of the recommendation, which was then 1.5 g protein/kg/day for the first week or longer of their stay in an intensive care unit (Hoffer & Bistran, 2012). Despite the importance of adequate food provision, inadequate energy and protein intake to meet nutritional requirements of hospitalised patients, remains common and widely documented (Pullen et al., 2017) while achieving optimal oral intake in the ICU population may be even more challenging (Peterson et al., 2011; Peterson et al., 2010).

Better outcomes with optimal nutrition delivery, relates to normal inflammatory and immune functions that depend on an adequate supply of amino acids. In addition, protein availability affects wound healing by facilitating the formation and deposition of the protein, collagen. The function of fibroblasts, which produces collagen, are also dependent on the availability of amino acids. The availability of protein also plays an important role in the function of hepatic cells which produce acute phase proteins (Cawood et al., 2012). In addition, in the absence of adequate non-protein energy, the body uses protein as alternative metabolic fuel to the detriment of protein anabolism and recovery. Muscle and tissue are broken down affecting vital organ systems, causing poor wound healing and prolonged rehabilitation (Pullen et al., 2017; Wischmeyer, 2016).

Even if an energy intake of more than 75% of requirements found in the current study was to be considered adequate, the inadequate intake of protein demonstrated in this study, and the effect thereof on protein catabolism and associated poorer clinical outcomes, may be aggravated in the presence of an energy intake of less than 100% of requirements. Nicole et al., (2015) demonstrated that protein delivery of 80% and above of what was prescribed, improved 60-day survival and a shorter time to being discharge alive (Nicolo et al., 2015).

Considering adequate non-protein energy delivery as a prerequisite to prevent catabolism of protein to meet energy requirements, (Pullen et al., 2017; Wischmeyer, 2016; Nicolo et al.,

2015) the suboptimal delivery of both energy and protein, despite supplementation, in this study, is concerning.

5.6.3 Possible causes of inadequate oral intakes

Similar to results reported in the literature, the current study indicated that, although, there was a statistically significant increase in energy and protein intake with the addition of ONS, both energy and protein intakes were still inadequate even after the addition of ONS. Similar to Dupertuis et al., (2003), more participants were underfed in terms of protein than energy.

As discussed previously, the causes of an inadequate food intake amongst hospitalised patients are multifactorial and are classified into patient-related, as well as institutional factors (Correia et al., 2014). Patient-related factors include fatigue, poor appetite, nausea and vomiting. Leptin, an appetite regulating protein that is secreted during the acute inflammatory response syndrome, possibly has a unique role to play in the diminished appetite of the critically ill patient (Peterson et al., 2011). Institutional factors that contribute to poor oral intake include traditional preparation for surgery, *NPO* orders and interrupted or missed meals due to medical procedures (Pullen et al., 2017; Correia et al., 2014). This study was not designed to determine reasons for non-consumption of meals and poor oral intake. However, during the study the researcher became aware of various factors that may have affected the oral intake of participants during this study.

It was observed that patients did not complete meals as result of complaints of anorexia, nausea, a lack of interest in food, as well as being too weak to eat. In addition, participants missed meals as result of *NPO* instructions for theatre or being out of the unit during meal times as result of tests and medical procedures. The frequency of missing two meals per day was reported more frequently than missing only one meal on a specific study day. Of even more concern is that the same participants, who were regularly scheduled for theatre, repeatedly missed two meals on a given study day.

Dupertuis et al., (2003) reported that at least 59% of participants did not meet their nutritional requirements because of reasons other than their underlying disease condition. These factors relate to institutional factors such as unsuitable meal times, quality, and quantity of food served. Importantly, Dupertuis et al., (2003) also noted that LOS played a

role in meeting set nutritional requirements. Participants evaluated after a shorter LOS were less likely to cover requirements than those with a LOS of more than one week. Similarly, in the current study, when assessing adequacy of energy intake at the hand of LOS of more than seven days, 69% of participants met energy requirements, compared to only 35% of participants that met energy requirements for the pooled sample (n = 26). The latter is suggestive of LOS as an important determinant of adequacy of oral intake. More recent evidence suggest that another possible cause is loss of appetite during the earlier phases of acute metabolic stress. Speculation is that loss of appetite in the acute phase of illness is an adaptive, protective response aimed at improving autophagy and detoxification (Schütz et al., 2014).

Dupertuis et al., (2003) suggested another possible explanation, namely that over time patients become more accustomed to the hospital meal service than they were during their early stay. Inadequate food provision is considered a fundamental factor in the development of DRM (Pullen et al., 2017; Dupertuis et al., 2003). Pullen et al., (2017) investigated the potential of hospital menus to meet nutritional requirements of hospitalised patients and reported that the intakes of participants, as recorded from the intake of hospital food alone, were significantly lower than recommendations. Therefore, it is recommended that hospital menus should accommodate appropriate food choices to meet the nutritional requirements of all patients. It is also suggested that energy and protein requirements of patients are met through hospital food alone to prevent reliance on ONS as substitute for adequate food provision (Pullen et al., 2017).

5.6.3.1.1 Adequacy of intakes from hospital food alone

Participants in the current study that did not receive ONS (n=15), were not at nutritional risk and reported good appetite. The median energy intake for this subgroup was almost adequate at 98%. This suggests that in patients with good appetite, it is possible to meet nutritional requirements for energy when consuming hospital food alone. Noteworthy is that for this subgroup, although participants reported a good appetite and had less plate waste than for the group receiving ONS, the intake of protein was still only 68.3% of requirements and thus, inadequate. This suggest that careful consideration is necessary to supplement protein and/or adjust menu choices to meet protein requirements without exceeding the

requirement for non-protein energy. This highlights the importance of the therapeutic dietician to assess the patients' ever-changing nutritional needs and direct meal and supplement orders. In addition, it highlights the need for an on-site food service dietician, as suggested by the BDA Food Services Specialist Group (2017) that should liaise with the therapeutic dietician to ensure that each patient's needs can be met orally through the provision of appropriate menu choices.

Interestingly, two participants in the subgroup not receiving ONS (n=15), who were at nutritional risk with BMI of $\leq 18.5 \text{ kg/m}^2$, refused to take ONS. Both these participants had good appetites and ordered double portions from the menu. They received double portions of starch and presented little plate waste. One of the participants exceeded both protein and energy requirements, while the other met energy requirements and 85% of protein requirements. As weight is factored into equations to calculate energy and protein requirements, it may be suggested that nutritional requirements of lighter patients may be met more easily through hospital food only, than that of their heavier counterparts. This supports the potential of hospital food to meet the nutritional requirements of specific patient groups who are not at nutritional risk and who have good appetite. Thus, the hospital menu seems to have the potential to meet the nutritional requirements of specific patient groups, therefore appropriate assistance with menu choices may enhance the optimising of oral intake in hospitalised patients.

The results of the current study suggest that optimal nutritional intake in terms of energy, from hospital food only, may be possible for patients who are not at nutritional risk, such as the subgroup in this study who did not receive ONS. However, careful attention to menu choices accommodating individual patient requirements and that of different patient groups, as well as supplementation with ONS are necessary to meet protein requirements for all patients and energy requirements for patients at nutritional risk such as the subgroup that received ONS in this study. The results of the current study indicated that nutritional requirements of especially lighter patients might be easier to meet, as weight is factorised into equations to calculate nutritional requirements. The researcher speculates that serving individualised portion sizes instead of generic portion sizes from hospital menus may facilitate

better outcomes in terms of meeting nutritional requirements with hospital menus. Once again, the input from a dietitian would be indispensable.

5.6.3.1.2 Adequacy of oral intakes with the addition of ONS

Evidence suggests that the addition of ONS does not interfere with appetite (Cawood et al., 2012) and that ONS should be taken between meals to prevent spoiling of appetite (Parkes, 2016). In this study, all the episodes where 100% plate waste was recorded, occurred in the subgroup that received ONS (n=11). For participants in the subgroup that did not receive ONS, 0% plate waste was recorded on 44.9% of the study days and 'some plate waste' on 46.4% of the study days. Two meals were missed on two (2.9%) of the study days and one meal was missed on four (5.8%) of the study days. Meals that were missed were as result of *NPO* instructions for theatre or not being in the unit as result of tests when meals were served. For the subgroup who received ONS, 0% plate waste was recorded for 28% of the study days and 'some plate waste' for 24% of the study days. Hundred percent plate waste was recorded for 28% of the study days. Missing two meals were recorded for 16% of the study days while missing one meal was recorded for 4% of the study days. A trend is therefore observed for more food wastage in the group receiving ONS. The group receiving ONS also more often missed two meals per day than the group not receiving ONS. The question arises whether the group that were receiving ONS, was not sicker and therefore consumed less hospital food than the subgroup not receiving ONS. These participants also missed more meals than the subgroup not receiving any ONS, implying that they were scheduled for theatre more often than the subgroup not receiving ONS. Considering the results of this study, indicating that the addition of ONS increased the intake of energy and protein significantly, one may contemplate what the intake of this group would have been without the addition of ONS. Indeed, literature reports that the largest benefit of ONS is found amongst the sickest patients (Philipson et al., 2013).

Pullen et al., (2017) reported that ONS contributed to 38% of energy and 27% of protein intake in a nutritionally vulnerable group (Pullen et al., 2017). In the current study, the median energy contribution of ONS for the subgroup receiving ONS, and therefore also nutritionally vulnerable, was 26.9% of requirements and the protein contribution, 28.5% of requirements.

5.6.4 In obese versus non-obese participants

At this point in time, ASPEN is the only professional organisation to formulate specific recommendations for the critically ill obese patient. These recommendations are based on hypocaloric, but high protein delivery (Secombe et al., 2015). ASPEN recommends that, for all classes of obesity, the goal of the feeding regimen should not exceed 65%–70% of target energy requirements as measured by indirect calorimetry (IC). In the absence of IC, a weight-based equation using 11–14 kcal/kg actual body weight per day for patients with BMI in the range 30–50 kg/m² and 22–25 kcal/kg ideal body weight for patients with BMI >50 kg/m², is suggested. Protein delivery of 2.0 g/kg ideal body weight for patients with a BMI of 30–40 kg/m² and up to 2.5 g/kg ideal body weight per day for patients with a BMI ≥ 40 kg/m², is recommended (McClave et al., 2016).

The rationale for the suggested recommendations is that it will provide steady weight loss while facilitating sufficient protein to facilitate a neutral or even slightly positive nitrogen balance to promote wound healing and prevent catabolism. Yet, despite these recommendations being based on robust physiological principles, the optimal level of energy and macro-nutrient delivery for the critically obese patient remains unclear and the level of evidence to support these recommendations are ambiguous. Further research is necessary to define nutritional strategies to reduce mortality and morbidity for the critically ill obese patient (Secombe et al., 2015).

Considering these unique energy and protein requirements of obese patients, i.e. significantly lower energy requirements, but increased protein requirements, the current sample was further subdivided into subgroups for non-obese (BMI < 30 kg/m²) and obese (BMI ≥ 30 kg/m²) participants. The findings illustrated that energy intake exceeded requirements for the subgroup with BMI ≥ 30 kg/m² (n = 7), without and with inclusion of ONS, while being inadequate for the subgroup with BMI < 30 kg/m² (n = 19), irrespective of ONS. However, protein intake remained inadequate for both the subgroups with a BMI ≥ 30 kg/m² and those with BMI < 30 kg/m² even after adding ONS.

In the current study, the menu that ward host/hostesses would present to patients to order from, was prescribed (ordered) by the attending doctor. A full ward diet was ordered for most

of the participants in this study, although a life style menu was available from the catering department. The life style menu is indicated for patients with diabetes (none of the participants in this study suffered from diabetes), hypercholesterolaemia and in need of weight reduction, but although seven of the participants were obese, the life style diet was not ordered for any one of them. Compared to the full ward diet, the life style menu did not offer the option of large portions and in fact states that no extra starch portions are offered. The menu was similar to the full ward diet but offered higher fibre and low GI starch and fruit options. All condiments, yoghurt and beverages were also sugar free.

As already discussed elsewhere, general practice in the unit at the time of the study was to prescribe ONS with high protein content. However, these supplements have a high energy density of ≥ 1.5 kcal/ml and, thus, contribute not only additional protein, but also energy. In the case of the heavier subgroup, these supplements therefore contributed to further exceeding energy requirements without increasing protein requirements to adequacy. Noteworthy is that a high protein menu was available in the unit at the time of the study. The high protein diet was similar to the full ward diet but offered three high protein snacks between meals. These snacks were also available to all patients that requested it and had the potential to increase protein intake with as much as 21 g/d without the addition of the exceptionally high energy content of the ONS. As reported by Pullen et al., (2017), patients are often not offered all the available menu options and snacks (Pullen et al., 2017). During this study, none of the high protein snacks were ordered by any of the participant. Although the appetite of critically ill patients may be compromised, it is also advised that a 'food first approach' is followed before the prescription of ONS (Parkes, 2016). As previously mentioned, in the unit where the study was conducted, a 'food first approach' was not necessarily practiced. However, it may be valuable to offer patients high protein snacks from the catering service to test tolerance thereof and increase protein intake without the addition of high energy ONS. Adding a powdered protein supplement (modular protein feed, for example *Protifar*) to food items such as custard and yoghurt, may also facilitate delivery of additional protein without the addition of non-protein energy.

During this study, it was observed that menus were mainly ordered by attending doctors, hence a full ward diet was ordered for most participants that tolerate an oral diet. The ward

host/hostess was the main person responsible for communicating menu options to participants. In the absence of a food service dietitian, no dietitian-led training happened in the unit and the main communication between patients and the catering department remains the ward host/ hostess. In the current study, a full ward diet was ordered by attending doctors, even for obese patients. Doctors therefore seemed to be unaware of all the available options. In addition, upon ordering of menu items, large portion were granted by ward host/hostesses irrespective of patients' BMI and medical condition. Dietitian-led training to all health care providers, including doctors, as well as to catering staff, may improve the appropriateness of diets ordered by doctors, as well as guidance of the patient by ward hosts/hostesses towards better menu options. In addition, informing patients of all available menus and choices of snacks, may also improve patient awareness and facilitate better menu choices. In the Nutrition and Hydration Digest, the British Dietetic Association (BDA) suggests that patients should be well informed pertaining to the food service and available options to enable them to make informed choices (BDA Food Services Specialist Group, 2017). Pullen et al., (2017) suggested that patients benefit from support in making the most appropriate food choices and that patients are possibly not always offered all the available choices. It was further reported that 30% of patients found it difficult to make appropriate food choices due to lack of information. Not only the catering staff, but also all health care staff, should be empowered to assist patients to make the best possible food choices. This empowerment should happen through dietitian-led training that is facilitated by the foodservice dietitian (Pullen et al., 2017). Similarly, Van Bokhorst-de van der Schueren et al., (2012), found that patients were largely uninformed about available meals and snacks and expressed a need for a reference person to whom food questions can be directed.

A robust food chain is necessary to provide a food service of excellence. The food chain describes all the processes involved in delivering food to patients. It involves patients making food choices, catering staff producing or assembling meals, ward hosts/hostesses serving meals, nursing staff assisting patients to eat and monitoring consumption as well as dietitians who provide the expertise in food, nutrition and health. Optimal communication between the various role players are important for the food chain to be effective. The food chain is supported by management, contracts and service agreements, negotiated service specifications between food service stakeholders, adequate funding, menu planning,

information relayed to patients and staff pertaining to making the best possible menu choices, management of food preparation and ward environment, training, daily supervision and, finally, monitoring, audit and adjusting of services as required (BDA Food Services Specialist Group, 2017).

Food service dietitians are ideally placed to be involved at every level of the food chain and to form a vital link between patients, clinical and catering staff, as they are the only professionals that are equipped with knowledge of food and how food service impacts on nutritional care and clinical outcome (BDA Food Services Specialist Group, 2017).

5.7 Summary

Interestingly, although the sample was small, the study demonstrated that KH seemed to be an accurate proxy measure for height in this study population. Furthermore, the study confirmed that, in general, the oral intake of patients admitted to ICU, do not meet nutritional requirements, despite the addition of ONS, but that the addition of ONS increased the intake of both energy and protein significantly. An overall inadequate intake of protein in all the subgroups was identified. The study also demonstrated the potential of the hospital menu to meet and/or exceed energy requirements of some subgroups such as the non-nutritionally vulnerable and patients with a BMI ≥ 30 kg/m². The role of the food service dietitian to ensure communication between the catering department, clinical staff as well as the patient has been identified as crucial factor to help meet nutritional requirements through a 'food first approach'.

6 CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

In this final chapter, the conclusions and recommendations, as well as limitations of the study, are discussed.

6.1 Introduction

Malnutrition among hospitalised patients is a common phenomenon responsible for many complications which increases not only mortality and morbidity of patients, but also the cost of treatment (Tappenden et al., 2013; Cawood et al., 2012; Barker et al., 2011; Peterson et al., 2011; Thibault et al., 2011; Peterson et al., 2010).

The aim of the current study was to assess the adequacy of nutritional intake of exclusively orally fed patients admitted to the ICU in a private South African hospital in Alberton, Gauteng Province. In order to achieve this aim, the objectives were to determine the following for each participant:

- Patient profile, including age, gender, hospital admission diagnosis, and LOS in ICU;
- Anthropometry, namely BMI;
- Daily energy and protein requirements;
- Total daily oral energy and protein intakes; and
- Adequacy of total daily oral intakes to meet daily energy and protein requirements.

6.2 Summary

In summary, the following results were obtained:

6.2.1 Patient profile, including age, gender, hospital admission diagnosis, and LOS in ICU

- i. 65.4% of participants were between 20 and 40 years of age and the remaining 34.6% were between 40 and 60 years of age;
- ii. 57.7% of participants were male and 42.3% were female;

- iii. 84.6% of participants were admitted for trauma, 11.5% for surgical and 3.8% for reasons other than trauma, surgical or medical; and
- iv. 69.2% of participants spent less than 10 days, 19.2% between 10 and 20 days, 7.7% between 20 and 30 days and 3.8% more than 60 days in ICU.

6.2.2 Anthropometry

- i. 3.8% of participants had a BMI < 18.5 kg/m², 7.7% had a BMI between 18.5 – 19.9 kg/m², 50% had a BMI between 20 – 24.9 kg/m², 11.5% had a BMI between 25 – 29.9 kg/m² and 26.9% had a BMI between 30 – 39.9 kg/m²;
- ii. 69.2% of participants were non-ambulatory and indirect measures were taken to determine BMI; and
- iii. The difference between directly and indirectly obtained BMI was not statistically significant ($p = 0.8$) in the same group.

6.2.3 Energy and protein requirements

- i. The median energy requirement of participants was 1608 kcal/kg and the median protein requirement was 106.8 g/d.

6.2.4 Total daily oral energy and protein intakes

- i. A full ward diet was served at 84 of the 94 data collection points, a soft diet was served at three of the 94 data collection points and a mixed fluid diet was served at seven of the 94 data collection points;
- ii. Only four participants consumed personal snacks and beverages;
- iii. Eleven participants received ONS;
- iv. For the pooled sample ($N = 26$) the median energy intake was 1231 kcal/d without ONS and 1377 kcal/d with ONS, whilst the median protein intake was 68.6 g/d without ONS and 78.6 g/d with ONS;

- v. For the subgroup that received ONS (n = 11) the median energy intake was 853 kcal/d without ONS and 1357 kcal/d with ONS, whilst the median protein intake was 52.0 g/d without ONS and 80.0 g/d with ONS;
- vi. For the subgroup that did not receive ONS (n = 15) the median energy intake was 1394 kcal/d while the median protein intake was 77.5 g/d;
- vii. The addition of ONS increased the intake of both energy and protein statistically significantly for the pooled sample (N = 26) as well as the subgroup that received ONS (n = 11);
- viii. The median energy intake for the subgroup with a BMI ≥ 30 kg/m² was 1386 kcal/d and was increased to 1394 kcal/d after the addition of ONS; and
- ix. The median protein intake for the subgroup with a BMI ≥ 30 kg/m² was 79.6g/d before the addition of ONS and 79.9 g/d after the addition of ONS.

6.2.5 Adequacy of total daily oral intakes to meet daily energy and protein requirements

- i. Oral intake of energy was inadequate (79.9% of requirements, elevated to 82.6% of requirements with ONS) for the pooled sample (N = 26), as well as for the subgroup receiving ONS (n = 11) (57.2% of requirements elevated to 76.4% of requirements with ONS);
- ii. Oral intake of energy was 98% of requirements for the subgroup (n = 15) that did not receive ONS;
- iii. Oral intake of energy through the hospital menu, personal snacks and beverages, without the addition of ONS, exceeded requirements (125%) for the subgroup with a BMI ≥ 30 kg/m². The addition of ONS further increased requirements to 131.1% of requirements;
- iv. Oral intake of protein was inadequate (61.0% of requirements elevated to 70.9% of requirements with ONS) for the pooled sample (N = 26), as well as for the subgroup receiving ONS (n = 11) (53.7% of requirements elevated to 74.3% of requirements with ONS);

- v. Oral intake of protein was inadequate (68.3% of requirements) for the subgroup (n = 15) that did not receive ONS; and
- vi. Oral intake of protein was inadequate (64.1% of requirements elevated to 68.3% of requirements with ONS) for the subgroup with a BMI ≥ 30 kg/m² even after the addition of ONS.

6.3 Conclusions and Recommendations

Conclusion and recommendations based on this study are:

- i. Although the sample was small, KH seemed to be an accurate proxy measure for height in this study population. A recent study in a South African population of hospitalised patients indicated that UL as a proxy measurement significantly overestimated height (van den Berg et al., 2016). Some evidence exists to suggest that stunting, which is very common in the South African population, affects lower limb length more than upper limb length (Bogin & Varela-Silva, 2010).

Recommendation: KH should be used, where possible, to determine the indirect height and weight of non-ambulatory critically ill patients, at least in the South African setting.

- ii. In the absence of a food service dietitian, the only communication between the catering department and patients was facilitated via the ward host/hostess. In addition to a therapeutic dietician assessing each patient's ever-changing nutritional needs, the presence of an on-site food service dietitian, as suggested by the BDA Food Services Specialist Group (2017), is essential to liaise with clinical staff and the catering department to optimise nutritional intake through the provision of appropriate menu choices. This highlights the distinct roles of the therapeutic and the food service dietitian in the hospital setting.

Recommendation: As the only professional equipped to facilitate communication between the catering department, clinical staff as well as patients, the presence of a dedicated food service dietitian will ensure a robust food chain, which is essential to

provide a food service of excellence and optimise nutrition delivery through a 'food first approach'.

The food service dietitian should be allocated ordering rights for special diets as attending doctors do not have appropriate knowledge of available menus and indications thereof.

- iii. During the study, most of the participants received a full ward diet irrespective of nutritional status and requirements while a life style diet for weight reduction as well as high protein snacks were available. During the study, none of the participants received high protein snacks. Pullen et al., (2017) suggested that patients should be assisted to make appropriate and informed food choices and that the food service dietitian is the only health care professional that is equipped to do so. In a study by Van Bokhorst-de van der Schueren et al., (2012) it was reported that most patients stated that they were relatively uninformed on the meal services and the possibilities for extra food between meals. In addition, they also requested a reference person to ask questions on food.

Recommendation: A food service dietitian should educate and counsel patients pertaining all the available menu options, including availability of all menus and availability of high protein snacks to empower patients to make the best possible choice to facilitate optimal nutrient delivery.

- iv. Kondrup et al., (2002) stated the importance of nutrition education to family members and patients to emphasise the importance of nutritional intake and the role thereof in recovery. Personal snacks and beverages that were consumed by participants were mainly energy drinks. Noteworthy is that the participants that consumed these energy drinks were all overweight. No nutrition education of family and visitors to enhance the nutritional quality of snacks brought into the hospital, was provided.

Recommendation: Nutrition education of family members and visitors should take place to improve the nutritional quality and appropriateness of snacks and beverages brought by family members and visitors.

- v. The addition of ONS increased the intake of energy and protein significantly.

Recommendation: The addition of ONS is essential to optimise the nutrient delivery of orally fed patients in ICU.

- vi. Excess energy delivery to the obese population is a concern and needs consideration. Energy intake of participants with a BMI $\geq 30\text{kg/m}^2$ were exceeded with hospital food alone. Although only one participant in this subgroup received ONS, the addition of ONS contributed to further exceeding energy requirements. Despite exceeding energy requirements, protein requirements were inadequate. None of the obese participants ordered high protein snacks from the catering department.

Recommendations: Careful consideration is necessary to increase the protein intake of obese patients without increasing non-protein energy intake. To achieve this aim, protein powders (modular protein supplements) may be mixed into menu items such as porridge, milk and yoghurt to enhance the protein content. Ordering of high protein snacks from the catering department has the potential to increase protein intake by 21 g/d and should be considered to optimise protein intake through a 'food first approach'. For this patient population, the high energy content of currently available high-protein ONS should be taken into consideration. Considering the increasing obese population that becomes reflected in the ICU population, there is a need for high-protein, but low-energy ONS which is currently not available in South Africa.

- vii. Energy requirements during the recovery phase may be as high as 40 kcal/kg (Wischmeyer, 2016), whilst adequate oral intake after discharge from ICU is often taken for granted (Peterson et al., 2010). During this study, participants were only followed up for the duration of ICU stay. However, it was observed that adequate oral intake after discharge from ICU was taken for granted. Education of patients, family members and care givers upon discharge pertaining to specific nutrition instructions and the importance of adequate nutrition, is essential (Tappenden et al., 2013).

Recommendation: Follow up and monitoring of nutritional intake after discharge from ICU, and from hospital, is essential to ensure ongoing optimal nutritional intake during the recovery period. All patients, family members and caregivers should receive

nutrition education upon discharge. Progress should be monitored through outpatient clinics.

6.4 Limitations of the study

The overall ICU occupancy was exceptionally low during the period of the study. In addition, several patients declined to participate in the study and the researcher managed to recruit only 29 participants that yielded only 94 data collection points over the 14-day study period. Although a larger sample, may have been more representative of the study population, even with these small numbers, statistically significant results were obtained.

6.5 Recommendations for future research

Recommendations for further research include the following:

- i. Development and testing of South African guidelines to improve interdisciplinary collaboration between doctors, nursing staff, food service dietitian, therapeutic dietitian and the catering department aimed at directing and monitoring adequate oral intakes of ICU patients.
- ii. Development of high protein low energy ONS appropriate to optimise and meet the specific nutritional requirements of the critically ill obese patient.
- iii. Investigating nutritional requirements of patients during the recovery phase and the contribution of optimal nutrition to rehabilitate patients successfully into the workplace after injury.
- iv. Developing a position statement outlying the specific role and responsibilities of the therapeutic dietitian versus the food service dietitian to guide funders pertaining to appropriate reimbursement of dietetic services.

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8 Appendix A: Ethical approval from Netcare



Netcare Hospitals (Pty) Ltd

Tel: + 27 (0)11 301 0000
 Fax: Corporate +27 (0)11 301 0499
 76 Maude Street, Corner West Street, Sandton, South Africa
 Private Bag X34, Benmore, 2010, South Africa
www.netcare.co.za

RESEARCH OPERATIONS COMMITTEE FINAL APPROVAL OF RESEARCH

Approval number: UNIV-2016-0035

Mrs Alta Kloppers

E mail: alta@dieticianonline.co.za

Dear Mrs Kloppers

RE: ADEQUACY OF ORAL INTAKE IN A PRIVATE INTENSIVE CARE UNIT IN GAUTENG PROVINCE

The above-mentioned research was reviewed by the Research Operations Committee's delegated members and it is with pleasure that we inform you that your application to conduct this research at Netcare Union Hospital, has been approved, subject to the following:

- i) Research may now commence with this FINAL APPROVAL from the Netcare Research Operations Committee.
- ii) All information regarding Netcare will be treated as legally privileged and confidential.
- iii) Netcare's name will not be mentioned without written consent from the Netcare Research Operations Committee.
- iv) All legal requirements regarding patient / participant's rights and confidentiality will be complied with.
- v) The research will be conducted in compliance with the GUIDELINES FOR GOOD PRACTICE IN THE CONDUCT OF CLINICAL TRIALS IN HUMAN PARTICIPANTS IN SOUTH AFRICA (2006)
- vi) Netcare must be furnished with a STATUS REPORT on the progress of the study at least annually on 30th September irrespective of the date of approval from the Netcare Research Operations Committee as well as a FINAL REPORT with reference to intention to publish and probable journals for publication, on completion of the study.

Directors: J du Plessis, S Chetty, R H Friedland, K N Gibson

Company Secretary: L. Bogwandeen

Reg. No. 1996/006591/07

- vii) A copy of the research report will be provided to the Netcare Research Operations Committee once it is finally approved by the relevant primary party or tertiary institution, or once complete or if discontinued for any reason whatsoever prior to the expected completion date.
- viii) Netcare has the right to implement any recommendations from the research.
- ix) Netcare reserves the right to withdraw the approval for research at any time during the process, should the research prove to be detrimental to the subjects/Netcare or should the researcher not comply with the conditions of approval.
- x) APPROVAL IS VALID FOR A PERIOD OF 36 MONTHS FROM DATE OF THIS LETTER OR COMPLETION OR DISCONTINUATION OF THE TRIAL, WHICHEVER IS THE FIRST.

We wish you success in your research.

Yours faithfully

 30/6/2016
 Prof Dion du Plessis
 Full member, Netcare Research Operations Committee & Medical Practitioner evaluating research applications as per Management and Governance Policy


 Shannon Nell
 Chairperson: Netcare Research Operations Committee
 Netcare Hospitals (Pty) Ltd
 Date: 15/7/2016

Directors: J du Plessis, S Chetty, R H Friedland, K N Gibson

Company Secretary: L Bagwandeen

Reg. No. 1998/00666/1/07

9 Appendix B: Letter and information document to hospital manager

Faculty Health Sciences
Department of Nutrition
and Dietetics
PO Box 339
Bloemfontein
9300
Tel: (051) 401 2894

The Hospital Manager
Netcare Union Hospital
47 Clinton Road
New Redruth
Alberton

Dear Mrs Abrahams

Re: Proposed research project:**Adequacy of oral intake in a private intensive care unit in Gauteng Province**

My name is Alta Kloppers. I am a postgraduate student at the University of the Free State. As part of a Masters of Science degree in Dietetics I wish to conduct research that involves assessing the “adequacy of nutritional intake of orally fed patients admitted to ICU in a private hospital setting”. This project will be conducted under the supervision of Dr Louise van den Berg (Department of Nutrition and Dietetics, UFS). I hereby seek your consent to perform the proposed study in the Netcare Union Hospital during 2016.

Despite the well documented incidence of malnutrition and inadequate oral intake of hospitalised patients in the international literature, no formal information is currently

available pertaining to the nutritional adequacy of orally fed patients in South Africa. Data pertaining to the adequacy of oral intake among hospitalised patients in South Africa is important to assist dietitians to optimise nutritional care of patients, identify patient groups at risk of malnutrition and inadequate oral intake, justify the use of oral nutritional supplements (ONS) and motivate for imbursement of ONS by medical funders.

The proposed study will be an observational cross-sectional study and will aim to assess the nutritional adequacy of orally fed patients admitted to the general ICU of the Union Hospital. The study population will consist of a convenience sample of adult patients admitted to general ICU, not receiving any artificial nutrition support on the relevant study day. The study will be performed by myself and a trained fieldworker over a period of 14 consecutive days starting on a Monday and including weekends and Public Holidays. Participation is voluntary and written consent will be obtained from all participants.

Participants will be weighed and measured on the day of the study. Food intake will be assessed through plate waste studies measuring food before meals as well as uneaten food after meals. Weighing of participants as well as of food will be done by the researcher and the fieldworker. The researcher and fieldworker will be assisted by a physiotherapist to safely measure and weigh patients when required. Interruption of normal routine and patient care will be minimal as the majority of tasks will be performed by the researcher and fieldworker. Nursing staff will be requested to assist with the completion of a food record form for the 24-hour duration of the study to assess the intake of all personal snacks, beverages and supplements. The researcher and/or fieldworker will however be available from 6h00 – 19h30 on the study day to assist with the completion of the record forms.

Please find attached a copy of the protocol.

Ethical approval will be obtained from the Health Sciences Research Ethics Committee of the University of the Free State. The study is observational and the risk for any adverse effect or injury as result of the research is minimal. The researcher is however insured to pay compensation in the case of any adverse effect or injury as a result of the research as well as against prosecution for possible malpractices.

The Department of Nutrition and Dietetics appeals for your approval to perform this study in 2016. Your co-operation will be appreciated, please feel free to contact Dr Van den Berg at 051 401 2894 or myself at 083 229 5023 for any further information.

Thank you for your time and consideration in this matter.

Yours sincerely

Researcher:

Alta Kloppers

Dr Louise van den Berg (Supervisor)

Department of Nutrition and Dietetics

Adequacy of oral intake in a private intensive care unit in Gauteng Province

Dear Mrs Abrahams

My name is Alta Kloppers and I am registered as a postgraduate student at the University of the Free State, Department of Nutrition and Dietetics, for a Masters of Science degree in Dietetics. The purpose of my study is to assess the adequacy of nutritional intake of orally fed patients admitted to ICU.

Despite the well documented incidence of malnutrition and inadequate oral intake of hospitalised patients in the international literature, no formal information is currently available pertaining to the nutritional adequacy of orally fed patients in South Africa. Data pertaining to the adequacy of oral intake among hospitalised patients in South Africa is important to assist dietitians to optimise nutritional care of patients, identify patient groups at risk of malnutrition and inadequate oral intake, justify the use of oral nutritional supplements (ONS) and motivate for imbursement of ONS by medical funders.

The proposed study will be an observational cross sectional study and will aim to assess the nutritional adequacy of orally fed patients admitted to general ICU in the Netcare Union hospital. The study population will consist of a convenience sample of adult patients admitted to general ICU and are anticipated to not receive any artificial nutrition support on the relevant study day. The study will be performed by myself and a trained fieldworker for a period of 14 consecutive days commencing on a Monday and will include weekends and Public Holidays. Participation is voluntary and participants will not be remunerated. Written consent will be obtained from all participants.

Participants will be involved in the study for a minimum of 24-hours (one study day), commencing at 6h00 on the day of the study until 6h00 the following morning. Participants may however be included in the study more than once. Participation will involve participants being weighed and measured. Food intake will be assessed through plate waste studies measuring food before meals as well as uneaten food after meals. Weighing and measuring of participants as well as of food will be done by the researcher and the fieldworker.

All scales, length meters, measuring tapes and callipers will be provided by the researcher. Interruption of normal routine and patient care will be minimal as the majority of tasks will be performed by the researcher assisted by the fieldworker. Nursing staff will be requested to assist with the completion of a food record form for the 24 hour duration of the study to assess the intake of all personal snacks, beverages and supplements. The researcher and/or fieldworker will however be available from 6h00 – 19h30 on the study day to assist with the completion of the record forms.

The procedure will include the following:

An information session will be conducted with all potential co-workers such as catering and nursing staff prior to the study;

Written consent will be obtained from all potential participants one day prior to the study;

The researcher, assisted by the fieldworker and physiotherapist when required, will weigh and measure participants. Measurements will include height, knee height as well as mid-upper arm circumference;

Nursing staff will be requested to assist with the completion of a food record form, recording the intake of all personal snacks, beverages as well as supplements;

The researcher will weigh all menu items that will be served to participants by the catering department before meals on the study day;

All uneaten food will be weighed after meals on the study day.

Body measurements will take approximately 15 – 20 minutes per participant. Completion of the record form for the purpose of recording personal snacks, beverages and supplements will be for the 24 hour duration of the study.

Ethical approval will be obtained from the Health Sciences Research Ethics Committee of the University of the Free State and can be contacted at telephone number (051) 4052812.

As the study is observational, the risk for any adverse effect or injury as a result of the the research is minimal. A physiotherapist will assist with the safe mobilisation of

participants, when required, to minimise the risk of injury. The researcher is however insured to pay compensation in the case of any adverse effect or injury as a result of the research as well as against prosecution for possible malpractices.

Interruption of normal routine will be minimal as the majority of tasks will be performed by the researcher and fieldworker. The study will not interfere with any treatment of participants. Nursing staff will be requested to assist with the completion of a food record form for the 24-hour duration of the study to assess the intake of all personal snacks, beverages and supplements.

Once the study is completed the results may be published and/or presented but the participants will remain anonymous.

The Department of Nutrition and Dietetics appeals for your approval to perform this study in 2016. Your co-operation will be appreciated, please feel free to contact Dr Van den Berg at 051 401 2894 or myself at 083 229 5023 for any further information.

10 Appendix C: Data form for recording once-off patient data

Participant number

			1-3
--	--	--	-----

1 Date (dd/mm/yy) /..... /.....

						4-9
d	d	m	m	y	y	

2 Age:.....years

		10-11
--	--	-------

3 Gender

Male(1)	Female(2)
---------	-----------

	12
--	----

Stratification according to hospital admission

4 diagnosis

Trauma(1)	Surgical(2)
Medical(3)	Cardiac (4)
Other (5)	

	13
--	----

5 Ambulatory

Yes(1)	No(2)
--------	-------

	14
--	----

6 Weight(direct)

,		kg
---	--	----

			15-17
--	--	--	-------

7 Height (direct)

	cm
--	----

			18-20
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12 Appendix E: Form for recording plate waste

Participant number: _____

Study date: _____

Meal: _____

Menu item	Code	Weight before meal (g)	Plate waste (g)	Weight consumed (g)	Energy consumed (kcal)	Protein consumed (g)
TOTAL						

**13 Addendum F: Data form for recording requirements, daily intake and adequacy
of intake**

Participant number

1 Date (dd/mm/yy)/...../.....

2. Length of stay in ICU:.....days

3. Daily energy requirements

kcal

4. Daily protein requirements

g

5. Daily total energy intake

kcal

6. Daily total protein intake

g

7. % Adequacy of energy intake

%

8. % Adequacy of protein intake

1-3

4-9

10 -12

13-16

17-19

20-23

24-26

27-28

%

| 29-30

14 Addendum G: Calculations

Participant number:

Study date:

dd/mm/yy

Number of days included in study:

1) WEIGHT (INDIRECT) estimated using KH & MUAC:

2) HEIGHT (INDIRECT) estimated using KH:

3) BMI = $\frac{\text{kg}}{\text{m}^2}$ = _____ kg/m²

Use direct measurements for weight and height for ambulatory patients and indirect measurements for non-ambulatory participants)

4) ENERGY AND PROTEIN REQUIREMENTS:

Ideal body weight (BMI ≥ 30): *(Use Hamwi Equation)*

Energy requirements (kcal)

Protein requirements (g)

5) AVERAGE TOTAL DAILY ORAL INTAKE (EXCLUDING ONS):

	Energy intake (kcal)	Protein intake (g)
Catering department		
Personal snacks and beverages		
TOTAL		
AVERAGE		

6) ADEQUACY OF AVERAGE DAILY ORAL INTAKE AS % OF REQUIREMENTS (EXCLUDING ONS)

Energy requirements	Protein requirements

7) AVERAGE TOTAL DAILY ORAL INTAKE (INCLUDING ONS):

	Energy intake (kcal)	Protein intake (g)
Catering department		
Personal snacks and beverages		
ONS		
TOTAL		
AVERAGE		

8) ADEQUACY OF AVERAGE DAILY ORAL INTAKE AS % OF REQUIREMENTS (INCLUDING ONS)

Energy requirements	Protein requirements

9) AVERAGE TOTAL DAILY ORAL INTAKE (INCLUDING SUPPLEMENTS):

	Energy intake (kcal)	Protein intake (g)
Catering department		
Personal snacks and beverages		
ONS		
TOTAL		
AVERAGE		

10) AVERAGE % CONTRIBUTION OF ONS TO AVERAGE TOTAL DAILY ENERGY AND PROTEIN INTAKE (EXCLUDING ONS)

	% contribution to energy intake	% contribution to protein intake

15 Appendix H: Participant information document

Adequacy of oral intake in a private intensive care unit in Gauteng Province

Dear participant,

My name is Alta Kloppers and I am registered as a postgraduate student at the University of the Free State, Department of Nutrition and Dietetics. As part of a Masters of Science degree in Dietetics on the title stated above. The purpose of the study is to assess the adequacy of nutritional intake of orally fed hospitalised patients.

Research is the process to learn the answer to a question. In this study I want to learn about the dietary intake of patients while they are in the hospital. This is an observational study which means that your food intake as it would normally would have happened while in hospital, will merely be observed. The study will therefore not involve any dietary or medical treatment other than what you would have received if you were not included in the study. Your involvement in the study will be for a minimum of one study day (24hour period) but you may be included in the study more than once. You are also requested to not consciously alter your behaviour or the intake of food or supplements as a result of inclusion in the study as this may influence the results of the study.

For the purpose of the study you will be weighed and measured. Your knee height and mid-upper arm circumference will also be measured. If you are unable to get out of bed only your knee height and mid-upper arm circumference will be measured to help estimate your weight and height. The intake of food received from the catering department will be determined by weighing your food before it is served to you and again by weighing all the food that you did not eat. The intake of all your personal snacks, beverages and supplements will be recorded by nursing staff, the researcher and a fieldworker throughout the duration of the study day.

You are kindly invited to participate in the study.

The procedure will include the following:

Consent that you will participate in the study;

The researcher and fieldworker will measure and record your height, weight, knee height and mid-upper arm circumference;

In cases where height and weight cannot safely be measured, only knee height and mid-upper arm circumference will be measured;

The researcher and fieldworker will weigh food that you receive from the catering department before meals as well as uneaten food after meals.

The intake of all your personal snacks, beverages and supplements will be recorded by nursing staff, the researcher and a fieldworker throughout the duration of the study day.

Body measurements will take approximately 15 - 20minutes. The completion of the record for personal snacks, beverages and supplements is for the 24hour duration of the study.

The foreseeable risks or harm to participants as a result of the study procedure is minimal, however, the researcher is insured to pay compensation in the case of any adverse effect or injury as a result of the research.

Written consent for participating in the study will be obtained once but you may be included in more than one study day. Your participation in the study is voluntary, and refusal to participate will involve no penalty or loss of benefits. Participants have the right to withdraw from the study at any time without penalty. There is no compensation for participating in the study, however, should any dietary related problem be identified, your doctor will be notified and you may be referred for further dietary intervention. The findings of the study will provide data that could assist dieticians and doctors to improve nutritional care of patients while in hospital.

Permission and consent for access to patient files will be obtained from the hospital manager and patients. All efforts will be made to keep personal information confidential. Absolute confidentiality cannot be guaranteed. Personal information may be disclosed if required by law. Once the study is completed the results may be published but the participants will remain anonymous.

Questions regarding the study may be directed to the researcher, Alta Kloppers at 083 229 5023 or e-mailed to alta@dieticianonline.co.za at all times. Any problems or complaints may be reported to the Secretariat and Chair: Health Sciences Research Ethics Committee of the University of the Free State. Telephone number (051) 4052812.

16 Appendix I: Dipelaelo Tshedimošo

Tekano ya bolwetši bja molomo ja ka ya lekala la phraebete ka profenseng ya Gauteng

Dipelaelo, ka tshwanelo

Leina la ka ke Alta Kloppers, ke moithuti ka Yunibesithing ya Freistata, lekaleng la tša phepo le dietetics. Bjalo ka ke le moithuti, ke dira Masters Degree ya ka lekaleng la Dietetics. Iebaka le phagameng la go dira dipatlišišo tša ka ke go lekola tekanelo dijo tšeo di fiwang balwetši ba leng boekelong kapa sepetlele. Dinyakišišo ke tshepedišo ya go ithuta karabo ya potšišo. ke nyaka go ithuta ka ga mohuta wa dijo tše di jewago ke balwetši mola ba le sepetlele. E ke thuto ya kgo nyaka go lemoga dijo tša gago bjalo ka ge o ne o le ka boekelong. Dinyakišišo tše di ka se akaretša kalafo efe goba efe ya mohuta wa dijo goba ga se o tla o amogela ka ge e le gore o be o sa go ithuta.

Thuto e tla ba ka tlase ga letšatši le lengwe (ura tše 24), eupša o ka kgopelwa go akaretšwa ka go ithuta go feta gatee. O kgopelwa go fetša maitshwaro a gago goba go ja dijo goba ditlaleletšo goba šeo se ka ama dinyakišišo le dipheho tša thuto ee. O tla elwa. Gago ka mangwele botelele le bonala e kgahlišago sedika le yona e tla elwa. Ge o sa kgone go fologa mpetong, botelele bja mangwele le bonala e kgahlišago sedika e tla elwa go thuša go akanya boima bja gago le bogodimo. Go ja dijo tšeo di amogetšwego go tšwa go Kgoro di tla bekgwa sekaleng sa dijo pele o di ja, le gore o ka go kala ka moka tša dijo gore ga se wa go ja. Go ja ka moka tša gago le ditlaleletšo snacks, dino di tla ngwalwa ke bašomi ba kalafo, monyakišiši le fieldworker ka moka ya go ithuta ka letšatši.

O mengwa go tla go tšea karolo mo dinyakišišong.

Tshepedišo ye e tla akaretša tše di latelago:

- Tumelo ya gore o tla tšea karolo ka go ithuta
- Monyakišiši le fieldworker ba tla ela bogolo bja gago, le go ngwala, matolo botelele le bonala e kgahlišago sedika
- Ge botelele le boima bo ka se kgone go elwa, matolo botelele le bonala e kgahlišago sedika e tla elwa

- Monyakišiši le fieldworker ba tla kala dijo go tšwa go Kgoro ya pele ga go apea dijo gammogo le dijo ka morago ga go ja.
- Go ja dijo ka moka tša gago le ditlaleletšo snacks, dino di tla ngwalwa ke bašomi ba kalafo, monyakišiši le fieldworker ka moka ya go ithuta ka letšatši
- tla tšea magato e ka bago tše 15 20minutes. Go ya ka dipego go snacks, dino le ditlaleletšo ke go diiri tše 24 24.03.06 ya thuto.

Ponelopele ya dikgonagalokotsi goba kgobalo go bakgathatema ka baka la tshepedišo ya go ithuta ke monyakišiši akaretšwago ke go lefa pušetšo ge khuetšo ye mpe goba kgobalo ka baka la dinyakišišo. Tumelelo yeo e ngwetšwego go kgatha tema go ithuta di tla hwetšwa ka morago ga ge o ka no ba gona magata a fetang le tee. Go kenela tema ke ka boithaopo, mokgatatema a ka gana go kgatha tema ga a nyaka ntle le kotlo goba tahlego ya dikholego. Bakgathatema ba na le tokelo ya go tšwa ka dithutong ka nako efe goba efe ka ntle le kotlo. Ga go na le tefo ya go kgatha tema go ithuta, le ge go le bjalo, ge eba goba le ntho efe ya mohuta wa dijo tšeo di amanago le bothata, Ngaka ba gago ba tla tsebišwa gomme o ka romelwa go hwetša mohuta wa dijo.

Diphihlelelo tša thuto e tla go fa tshedimošo yeo e ka go thuša bašomi le dingaka tša phepo go kaonafatša tlhokomelo ya balwetši ka ge ka sepetlele. Maitapišo a tla dirwa go dira gore tshedimošo ya sephiri. Go ka se kgone go tiišetšwa.

Tshedimošo ya sephiri o tla tsebagatšwa ge e nyakwa ke Molao. Ge dipoelo tša thuto e phethwa ka phatlalatšwa fela batšeakarolo ba tla se bolele leina la gago.

Dipotšišo mabapi le dinyakišišo di ka lebišwa go banyakišiši, Alta Kloppers ka lebaka leo o ka 083 229 5023 goba emailed go alta@dieticianonline.co.za dinako ka moka. Mathata a itšego goba dipelaelo ka begwa go Bongwaledi le Modulasetulo: Disaense tša maphelo tša maitshwaro a Komiti ya Yunibesithi ya Freistata. Nomoro ya mogala (051) 4052812.

17 Appendix J: Deelnemer inligtingsdokument

Toereikendheid van orale inname in 'n privaat intensiewesorg eenheid in Gauteng Provinsie.

Geagte Deelnemer,

My naam is Alta Kloppers en ek is geregistreer as 'n nagraadse student aan die Universiteit van die Vrystaat, Departement van Menslike Voeding en Dieetkunde as deel van 'n Meestersgraad in dieetkunde. Die doel van hierdie navorsingsprojek is om die toereikendheid van orale voeding in hospitaal pasiënte te bepaal.

Navorsing is die proses wat soek na 'n antwoord op 'n vraag. In hierdie studie wil ek meer leer oor die orale inname van pasiënte gedurende verblyf in die hospitaal. Die studie is obeserverend van aard en daar word beplan om slegs u voedselinname, net soos wat u normaalweg in die hospitaal sou eet, waar te neem. Die studie gaan geen dieet- of mediese behandeling, anders as wat u normaalweg gedurende u verblyf in die hospitaal sou ontvang het, insluit nie. U deelname aan die studie gaan vir 'n minimum van een dag duur (24 uur periode). Dit kan egter gebeur dat u vir meer as een dag in die studie ingesluit kan word. U word versoek om nie doelbewus eetgewoontes, inname van kos of neem van suplemente wat aan u voorgeskryf is, te verander nie aangesien dit die resultate van die studie negatief kan beïnvloed.

U sal vir die doeleindes van die studie geweeg en gemeet word. Kniehoogte sowel as die omtrek van u bo-arm sal ook gemeet word. Indien u nie uit u bed kan opstaan nie sal slegs u kniehoogte en omtrek van u bo-arm gemeet word. Deur van formules gebruik te maak kan u lengte en gewig uit hierdie metings bepaal word. Die voedselinname wat u vanaf die kombuis ontvang sal bepaal word deur alle voedsel voor ete te weeg. Die voedsel wat u nie geëet het nie sal na ete weer geweeg word om vas te stel presies hoeveel van die voedsel wat aan u bedien is, wel ingeneem is. Die inname van alle persoonlike versnaperinge, drankies sowel as suplemente sal deur die verpleegpersoneel gedokumenteer word.

U word hiermee uitgenooi om deel te neem aan die studie.

Die studieprosedure sal die volgende behels:

Toestemming vir deelname aan die studie;

Die navorser en assistent sal u gewig, lengte, kniehoogte en bo-armomtrek bepaal

Indien u nie uit die bed kan opstaan sal slegs u kniehoogte en bo-armomtrek gemeet word;

Die navorser en assistent sal u voedsel voor ete sowel as voedsel wat nie geëet is nie, na ete weeg;

Die inname van al u persoonlike versnaperinge, drankies en suplemente sal deur verpleegpersoneel gedokumenteer word;

Die neem van metings sal ongeveer 15 - 20minutes neem. Die voltooiing van inname van u persoonlike versnaperinge, drankies en suplemente is vir die duur van die studie (24 uur).

Die risiko vir enige besering of skade as gevolg van die studie is minimaal. Die navorser is egter verseker en sal die kostes van enige vergoeding, in die geval van besering of skade kan dra.

Skriftelike toestemming vir deelname word vereis. Let asseblief daarop dat u slegs eenkeer sal toestemming gee om deel te neem maar u deelname aan die studie kan meer as een dag behels. U deelname in die studie is vrywillig. Neem kennis dat u onder geen omstandighede gepenaliseer of benadeel sal word, indien u van die studie sou onttrek nie. Alle deelnemers het die reg om enige tyd, vrywillig van die studie te onttrek. Daar is geen vergoeding vir deelname aan die studie. Indien enige dieetverwante probleme tydens die studie geïdentifiseer word, sal u egter na u geneesheer verwys word vir verdere behandeling. Daar word verwag dat die resultate van die studie, dokters en dieetkundiges in die toekoms kan help om die dieetbehandeling van pasiënte in die hospitaal, te verbeter.

Alle persoonlike inligting sal so vertroulik en konfidensieel as moontlik gehou word maar totale konfidensialiteit kan nie gewaarborg word nie. Persoonlike inligting mag egter openbaar gemaak word indien dit geregtelik versoek word, Na afloop van die studie kan resultate gepubliseer. Deelnemers sal egter anoniem bly.

Enige navrae in verband met die studie kan gerig word aan die navorser, Alta Kloppers by 083 229 5023 of per e-pos aan alta@dieticianonline.co.za . Verdere probleme of klagtes kan aan die Voorsitter van die Etiekkomitee van Gesondheidswetenskappe en Navorsing van die Universiteit van die Vrystaat by (051) 4052812

18 Appendix K: Consent to participate in research

Adequacy of oral intake in a private intensive care unit in Gauteng Province

You have been asked to participate in a research study and you have been informed about the study by the researcher, Alta Kloppers. You have been informed about any available compensation if injury occurs as a result of study-related procedures.

You may contact Alta Kloppers at 083 229 5023 if you have questions about the research or if you are injured as a result of the research. You may contact the Secretariat of the Health Sciences Research Ethics Committee of the University of the Free State at telephone number (051) 4052812 if you have questions about your rights as a research participant.

Please tick if you agree

I confirm that I have read and understand the information sheet and have had the opportunity to ask questions.

I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason.

I agree to take part in the above study.

If you agree to participate, you will be given a signed copy of this document as well as the participant information sheet, which is a written summary of the research.

The research study, including the above information has been verbally described to me. I understand what my involvement in the study means and I voluntarily agree to participate.

Signature of Participant

Date

Signature of Witness

Date

Signature of Translator

Date

19 Appendix L: Go fa tumelelo ya go kgatha tema ka dinyakišišo

Tekano ya bolwetši bja molomo ja ka ya lekala la phoraebete ka profenseng ya Gauteng

O kgopetšwe go kgatha tema ka dinyakišišo tše gomme o tsebišitšwe ka thuto e ke banyakišiši, Alta Kloppers. O tsebišitšwe ka ga ge eba gona le kgobalo eo e seng ya maikemešetšo, tefelo e maleba e gona ka baka leo.

O ka ikgokaganya le Alta Kloppers ka nomoro ya mogala go 083 229 5023 ge e le gore o na le dipotšišo ka dinyakišišo goba ge e le gore o gobetše ka baka la dinyakišišo.

O ka ikopanya le Bongwaledi bja disaense tša maphelo tša maitshwaro a Komiti ya Yunibesithi ya Freistata ka nomoro ya mogala (051) 4052812 ge e le gore o na le dipotšišo ka ga ditokelo tša gago bjalo ka mokgathatema.

Ka kgopelo tshwaya
ge e le gore o dumela

1. .Ke tiišetša gore ke na le tshedimošo ya go bala le go kwešiša le go bile le sebaka sa go botšiša dipotšišo
2. Ke kwešiša gore go ya ka ke ya boithaopo le gore ke go lokologa go ntšha ka nako efe goba efe, ka ntle le go fa lebaka la
3. Ke a dumela go tšea karolo.

Ge e le gore o dumela go kgatha tema, o tla fiwa khopi ya tokumente ye gammogo le tshedimošo ya motho, yeo e ngwadilwego kakaretšo ya dinyakišišo.

Dinyakišišo tša go ithuta, go akaretša tshedimošo ya ka godimo e hlalošitše ka molomo go nna. Ke kwešiša seo ka go ithuta ka go dumelelana le ke go tšea karolo.

Signature Ya mogatatema

Letšatši

Signature Ya hlatse

Letšatši

Signature Ya toloki

Letšatši

20 Appendix M: Toestemming om aan navorsing deel te neem

Toereikendheid van orale inname in 'n privaat intensiewesorg eenheid in Gauteng Provinsie

U is gevra om deel te neem aan n navorsingstudie en u is ingelig aangaande die studie deur die navorsers, Alta Kloppers. U is verder ingelig met betrekking tot enige moontlike besering of skade wat kan ontstaan as gevolg van die studie

U kan Alta Kloppers by 083 229 5023 skakel indien u enige navrae met betrekking tot die studie het of in die geval van enige besering of skade as gevolg van die studie.

U kan ook klagtes en enige navrae met betrekking tot u regte as deelnemer aan die studie aan die Voorsitter van die Etekkomitee van Gesondheidswetenskappe en Navorsing van die Universiteit van die Vrystaat by (051) 4052812 rig.

Merk asb as u instem

1. Ek bevestig dat ek die inligtingstuk gelees het en verstaan en dat ek die geleentheid gehad het op vrae te vra.
2. Ek verstaan dat my deelname vrywillig is en dat ek myself enige tyd van die studie kan onttrek.
3. Ek gee toestemming om aan die studie deel te neem.

Indien u instem om aan die studie deel te neem sal u n getekende afskrif van hierdie dokument sowel as die inligtingsdokument ontvang.

Die navorsingstudie sowel as bogenoemde inligting is aan my verduidelik. Ek verstaan wat my deelname aan die studie behels en ek gee vrywillig toestemming om aan die studie deel te neem.

Handtekening van deelnemer

Datum

Handtekening van getuie

Datum

Handtekening van vertaler

Datum

21 SUMMARY

The prevalence of DRM in acute care facilities is a common phenomenon that negatively impacts on patient mortality, morbidity and cost of treatment. However, it remains a widely under-recognised and under-treated problem. The aim of this study was to assess the adequacy of nutritional intake of exclusively orally fed patients admitted to the ICU in a private South African hospital in Alberton, Gauteng Province.

An observational cross-sectional study was conducted over a period of 14 consecutive days. A total of 26 participants were recruited and included in the study and their oral intakes were followed up daily throughout their stay in the ICU to deliver a total number of 94 data collection points for comparison. The sample comprised of 15 male and 11 female participants. Majority of the participants were admitted to ICU as result of trauma, were between the ages of 20 and 40 years and spent less than 10 days in ICU. Fifty percent of the participants had a normal BMI between 20 – 24.9 kg/m².

Energy and protein requirements as well as total oral intakes in terms of energy and protein content, were calculated for each participant. For participants that were included in the study for more than one day, the average daily oral intake was calculated. Total oral intake included food received from the catering department, personal snacks and beverages as well as ONS. To assess the adequacy of nutritional intake, the nutritional content of consumed food and beverages was compared to requirements at the hand of energy and protein content.

For the total sample (n=26) as well as the subgroup that received ONS (n=11), the median energy and protein intakes were inadequate, with and without ONS. The energy intake for the subgroup that did not receive ONS (n=15) was almost adequate at 98%, whilst protein intake was inadequate. Although the addition of ONS did not elevate energy and protein intake to adequacy in these two groups, the increase in energy and protein intakes were statistically significant for the total sample (n=26), as well as for the sub-group (n=11) that received ONS. When the sample was divided per BMI group, for the subgroup BMI < 30 kg/m² (n=19) the median energy intake for energy and protein was inadequate with and without ONS. For the heavier subgroup (n=7), energy requirements were exceeded both without and with ONS while protein intake remained inadequate even with the addition of ONS.

Therefore, the intake of energy was inadequate for all the subgroups, with and without ONS, except for the heavier subgroup where energy intake exceeded requirements, with and without ONS. Protein intake was inadequate for all the subgroups despite the addition of ONS.

This study confirmed that, in general, the oral intakes of patients admitted to ICU is inadequate. It was confirmed that the prescription of ONS to optimise the oral intakes, is essential. However, specific consideration to optimise protein delivery without exceeding energy requirements in the critically ill obese patient, is necessary. Furthermore, the study highlighted the important role of a dedicated food service dietitian in the hospital setting.

Recommendations for future research include the development of South African guidelines aimed at directing and monitoring adequate oral intakes of ICU patients, development of ONS to meet the specific nutritional requirements of the critically ill obese patient and suggestions to investigate the nutritional requirements and importance of optimal nutrition during the recovery phase. Finally, the researcher considers it necessary to develop a position statement outlining the specific role and responsibilities of the therapeutic dietitian versus the food service dietitian, highlighting the importance of a dedicated food service dietitian.

22 OPSOMMING

Die voorkoms van wanvoeding in akute sorg-hospitale is 'n algemene verskynsel wat die mortaliteit en morbiditeit van pasiënte, sowel as koste verbode aan behandeling, negatief beïnvloed. Tog is dit 'n verskynsel wat swak geïdentifiseer word en daarom ook nie na wense behandel word nie. Die doel van hierdie studie was om die toereikendheid van die voedingsinname van pasiënte met uitsluitlik orale inname in 'n intensiewe sorg eenheid in 'n Suid-Afrikaanse privaat hospitaal in Alberton, Gauteng Provinsie, te bepaal.

'n Obserwerende dwarsnitstudie is oor 'n periode van 14 opeenvolgende dae uitgevoer. 'n Totaal van 26 deelnemers is gewerf waarvan die orale innames daaglik, vir die duur van verblyf in die intensiewe sorg eenheid, opgevolg is, wat 'n totale aantal van 94 data-insamelingspunte opgelewer het. Die steekproef het uit 15 manlike en 11 vroulike deelnemers bestaan. Die meerderheid van die deelnemers is in die intensiewe sorg eenheid opgeneem as gevolg van trauma. Die meeste van die deelnemers se ouderdomme was tussen 20 en 40 jaar en het minder as 10 dae in die intensiewe sorg eenheid deurgebring. Vyftig persent van die deelnemers het 'n normale liggaamsmassa-indeks tussen 20 – 24.9 kg/m² gehad.

Energie- en proteïenbehoefte sowel as die totale orale inname in terme van energie- en proteïene, is vir elke deelnemer bepaal. Vir deelnemers wat meer as een dag in die studie ingesluit was, is die gemiddelde orale inname bereken. Die totale orale inname het voedsel van die spysenieringsafdeling, persoonlike versnaperings en drank sowel as orale supplemente ingesluit. Ten einde die toereikendheid van die voedingsinname te bepaal, is die voedingswaarde van alle voedsel en drank wat ingeneem is, aan die hand van die energie- en proteïeninhoud, vergelyk met die voedingsbehoefte van elke deelnemer.

Vir die totale steekproef (n=26), sowel as die subgroup wat orale supplemente ontvang het (n=11), was die mediaan vir energie- en proteïeninname ontoereikend, met sowel as sonder orale supplemente. Die energie-inname van die subgroup wat nie orale supplemente ontvang het nie (n=15) was 98% en dus bykans toereikend, maar proteïeninname ontoereikend. Alhoewel die inname van orale supplemente nie energie- en proteïeninname na toereikende vlakke verhoog het nie, het dit beide energie- sowel as proteïeninname statisties beduidend

verhoog vir die totale steekproef (n=26) sowel as die subgroep wat orale supplemente ontvang het (n=11). Die steekproef is verder verdeel volgens liggaamsmassa-indeks. Vir die subgroep met n liggaams massa indeks < 30 kg/m² (n=19) was die mediaan vir energie- en proteïnnname ontoereikend met en sonder oral supplemente. Vir die swaarder subgroep (n=7) is energiebehoefte, met en sonder orale supplemente, oorskrei terwyl proteïnnname ontoereikend was selfs wanneer orale supplemente ingeneem is. Dus, behalwe vir die swaarder subgroep waar energiebehoefte oorskrei is, was die energie-inname van al die ander groepe ontoereikend. Die proteïnnname van al die subgroepe was ontoereikend, ten spyte van die inname van orale supplemente.

Die studie het bevestig dat die orale inname van pasiënte wat in die intensiewe sorg eenheid opgeneem is, oor die algemeen ontoereikend is. Aangesien die inname van orale supplemente van kardinale belang is om die voedingsinname te optimaliseer, is spesifieke oorweging egter nodig om optimale proteïnnname vir kritieke siek, obese pasiënte te verseker sonder om energiebehoefte te oorskrei. Die studie het verder die belangrike rol van 'n toegewyde voedseldiensdieetkundige in die hospitaal beklemtoon.

Aanbevelings vir verdere navorsing sluit in die ontwikkeling van Suid-Afrikaanse riglyne om toereikende orale inname van pasiënte in die intensiewe sorg eenheid, te verseker. Verdere navorsing word ook voorgestel vir die ontwikkeling van orale supplemente om aan die unieke voedingsbehoefte van die kritieke siek obese pasiënt te voldoen sowel as om die rol van toereikende voeding tydens die rehabilitasiefase, te verseker. Laastens stel die navorser voor dat 'n posiestelling wat die rol en verantwoordelikhede van die terapeutiese dieetkundige versus die voedseldiensdieetkundige uiteensit, asook die belang van 'n toegewyde voedseldiensdieetkundige beklemtoon, gepubliseer word.