Malnutrition: Significance, Prevalence and Management of the Hospitalised Surgery Patient

by

Lisa Amy Barker
BAppSc(HealthSc), MNutrDiet.

Submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

Deakin University
September 2014
I am the author of the thesis entitled *Malnutrition: Significance, Prevalence and Management of the Hospitalised Surgical Patient*

submitted for the degree of **Doctor of Philosophy**

This thesis may be made available for consultation, loan and limited copying in accordance with the Copyright Act 1968.

*I certify that I am the student named below and that the information provided in the form is correct*

**Full Name:** ............Lisa Amy Barker........................................................................................................

**Signed:** ........................................................................................................................................

**Date:** ............8 September 2014........................................................................................................
DEAKIN UNIVERSITY
CANDIDATE DECLARATION

I certify the following about the thesis entitled:

Malnutrition: Significance, Prevalence and Management of the Hospitalised Surgery Patient

submitted for the degree of Doctor of Philosophy

a. I am the creator of all or part of the whole work(s) (including content and layout) and that where reference is made to the work of others, due acknowledgment is given.

b. The work(s) are not in any way a violation or infringement of any copyright, trademark, patent, or other rights whatsoever of any person.

c. That if the work(s) have been commissioned, sponsored or supported by any organisation, I have fulfilled all of the obligations required by such contract or agreement.

I also certify that any material in the thesis which has been accepted for a degree or diploma by any university or institution is identified in the text.

'I certify that I am the student named below and that the information provided in the form is correct'

Full Name: Lisa Amy Barker
(Please Print)

Signed: ..........................................................

Date: 8 September 2014
# Table of Contents

**ABSTRACT**  7

**ACKNOWLEDGEMENTS**  11

**PUBLICATIONS AND PRESENTATIONS**  13

**LIST OF TABLES**  16

**LIST OF FIGURES**  17

**CHAPTER ONE - REVIEW OF THE LITERATURE**  18

1.1  What is Malnutrition?  18

1.2  Malnutrition Screening and Assessment  21

1.3  Nutrition Screening and Assessment Tools  23

1.4  Malnutrition Prevalence and Dietetic Intervention in the Acute Setting  27

1.5  Malnutrition and its Associated Consequences  30

1.5.1  Consequences for the Patient  30

1.5.2  Consequences for the Health Care Facility  32

1.6  Malnutrition Identification and Treatment  35

1.7  Malnutrition and Surgery  38

1.7.1  Pre-operative Nutrition  40

1.7.2  Peri-operative Nutrition  42

1.7.3  Post-operative Nutrition  45

1.8  Immunonutrition  48

1.8.1  Nucleotides  49

1.8.2  Arginine  50

1.8.3  Omega-3 Polyunsaturated Fatty Acids  51

1.9  Evidence Surrounding the use of Immunonutrition in Surgical Patients  53

1.10  Conclusions and Recommendations  57

**CHAPTER TWO - RESEARCH OBJECTIVES**  59

2.1  Aims  59

2.2  Rationale  61

2.3  Hypothesis  62
CHAPTER THREE – MALNUTRITION IDENTIFICATION, DIAGNOSIS AND DIETETIC REFERRALS: ARE WE DOING A GOOD ENOUGH JOB? 63

3.1 Introduction 63

3.2 Method 66
  3.2.1 Study Design 66
  3.2.2 Exclusion Criteria 67
  3.2.3 Retrospective Medical Audit 68
  3.2.4 Implementation of Education, Training and New Documentation 68
  3.2.5 Re-audit and Evaluation 69
  3.2.6 Ethical Approval 70
  3.2.7 Statistical Analysis 70

3.3 Results 71
  3.3.1 Initial Audit – Part One 71
  3.3.2 Follow-up Audit – Part Two 74

3.4 Discussion 77

3.5 Conclusions 82

CHAPTER FOUR – PREOPERATIVE IMMUNONUTRITION AND ITS EFFECT ON POSTOPERATIVE OUTCOMES IN WELL-NOURISHED AND MALNOURISHED GASTROINTESTINAL SURGERY PATIENTS: A RANDOMISED CONTROLLED TRIAL 83

4.1 Introduction 83

4.2 Methods 86
  4.2.1 Study Design 86
  4.2.2 Outcome Measures 88
  4.2.3 Ethical Approval 90
  4.2.4 Statistical Analysis 89

4.3 Results 91

4.4 Discussion 100

4.5 Conclusions 107

CHAPTER FIVE – NUTRITIONAL MANAGEMENT OF GASTROINTESTINAL SURGICAL PATIENTS IN VICTORIA’S PUBLIC HOSPITALS 108

5.1 Introduction 108

5.2 Methods 111
  5.2.1 Survey Development 111
  5.2.2 Survey Pilot 114
  5.2.3 Hospital and Participant Identification 115
  5.2.4 Survey Undertaking 115
  5.2.5 Statistical Analysis 116

5.3 Results 117
  5.3.1 Demographics 117
  5.3.2 Pre-Admission Clinic 120
  5.3.3 In-Patient Stay 121
5.3.4 Influence of Dietitian Experience, Workload and Department Size 123
5.3.5 Facilitation of Change 124

5.4 Discussion 126

5.5 Conclusions 131

CHAPTER SIX – CONCLUSIONS AND FUTURE DIRECTIONS 132

6.1 Summary of Major Findings 132

6.2 Future Directions and Considerations 135
   6.2.1 Effectiveness of Nutrition Screening in Identification of Malnourished Hospitalised Patients 135
   6.2.2 Implementation of the ERAS Program in Colorectal Surgery Patients: Significance in the Malnourished Patient Population 137
   6.2.3 Implementation of a Protocol for the Nutritional Management of Surgical Patients in a Large Tertiary Teaching Hospital 138

6.3 Conclusions 140

REFERENCES 141
Abstract

Malnutrition is a serious and debilitating condition that is highly prevalent in hospitalised patients. Malnutrition is the result of the complex interplay between underlying disease, disease-related metabolic alterations and the reduced availability and absorption of nutrients. Malnutrition has been shown to adversely affect patients by increasing the risk of infections and pressure ulcers, delaying wound healing, decreasing nutrient absorption, accelerating the loss of muscle mass, lengthening of hospital stay and increasing mortality. With the consequences of malnutrition in mind, several tools have been developed to screen for and assess malnutrition, however their use in the clinical environment is inconsistent. As a consequence of this inconsistency in application, this in turn reduces the number of patients who are identified as malnourished or at nutrition risk, and concomitantly reduces the number of patients receiving dietetic intervention and nutritional support.

The adverse effects of malnutrition on patients have also been linked to increased hospital costs. For this reason, the presence of malnutrition attracts additional funding for hospital admissions under current health system funding arrangements. Therefore, in addition to patients not receiving nutrition support, the absence of malnutrition diagnosis and documentation leads to health care facilities also forgoing entitled funding.

With these factors in mind, it is interesting to consider patient population subgroups that are more at risk of malnutrition, with gastrointestinal surgery
patients falling within this category. This patient group has worse outcomes after surgery than their well-nourished counterparts, and appropriate management of nutritional intake can lead to improved outcomes for both the patient and the health care facility. Because of the benefit nutrition support plays in the surgical patient group, research has led to the development of Enhanced Recovery After Surgery (ERAS) guidelines, containing a list of multimodal recommendations to improve postoperative outcomes for gastrointestinal surgical patients. One of these strategies includes the consumption of immunoenhancing supplements pre-operatively, which has been shown internationally to reduce length of stay and infection rates after surgery. However the adoption of many of these recommendations including immunonutrition use in Australia has been poor.

With an understanding of the issues relating to malnutrition and the effectiveness of its management and treatment, especially in surgical patients, it was hypothesised that an analysis of local malnutrition prevalence, documentation and funding was required to first raise awareness of the magnitude of the issue. Therefore, a study was developed to assess the prevalence of malnutrition at a large Melbourne tertiary teaching hospital. In addition, the study aimed to establish the consistency of documentation of malnutrition by dietitians, and to consider any reimbursement forgone by the hospital due to absence of documentation.

The findings from this first study showed that malnutrition rates at the hospital were similar to those reported in the literature, and that documentation of
malnutrition was often absent, resulting in a significant loss of entitled funding to the hospital. Following the reporting of these findings, education of dietitians and persons responsible for identifying malnourished patients from medical histories for financial reasons was performed to highlight the scale of the issue, and strategies put in place to ensure adequate diagnosis, documentation and recording of malnutrition. A follow up audit was then conducted to measure the success of the intervention, resulting in a significant increase in dietetic documentation of malnutrition, and recognition of this by funding personnel. However the lack of identification by way of nutrition screening by nursing staff and therefore dietetic referrals for treatment of malnutrition remained an issue.

A second study was developed to look more specifically at an identified at-risk group of patients: those having gastrointestinal surgery. A randomised control trial was conducted where patients undergoing elective gastrointestinal surgery were provided with a pre-operative immunonutrition supplement or no supplementation, and post-operative outcome measures such as infections and length of hospital stay were recorded. Results of this study showed a trend towards a reduction in infection rates and length of hospital stay within the supplemented group, with a larger magnitude of effect seen in malnourished patients, however these benefits failed to reach statistical significance.

A final study was then developed to capture the current status of best practice nutritional management in gastrointestinal surgery patients in Victorian public hospitals by way of a telephone survey. The survey also intended to explore barriers and enablers to the implementation of best practice guidelines to
encourage their uptake as standard practice. Results showed wide variability in nutritional management of gastrointestinal surgery patients, much of which was outside documented best practice guidelines. However it was hypothesised that dietetic experience and department or hospital size would have a positive effect on surgical nutrition intervention, however this was not the case, showing that the presence of a pathway for nutritional management was an important factor in the successful role out of best practice nutritional management.

The results of this thesis provide local evidence of an international problem, and confirm the need for dietitians and health care facilities to better manage malnourished patients. It also provides an insight into simple and achievable strategies that can be put in place to allow for adoption of best practice guidelines around malnutrition identification, documentation and treatment, especially in vulnerable patient groups.
Acknowledgements

I firstly want to express my sincere and deep gratitude to my primary supervisor, Associate Professor Tim Crowe. I feel in many ways, thanks are not enough to acknowledge the time, effort and reassurance Tim has given me. Throughout the planning, study design and write up phases of my work, Tim has always been interested in what I have been doing, and has always made the time to discuss and review what I have done. He has kept me on track, even during busy times in my life, and without him, it would have been possible for me to get this far. Thank you.

I would also like to thank Ms. Susan Shedda and Dr. Sharleen O’Rieley for their additional supervision and support.

Thank you to Catrina Gray and Belinda Gout, honours students who worked with me on parts of the projects in Chapters Three and Four. Your contribution to data collection was invaluable, and I sincerely thank you both for your hard work and dedication.

Additional thanks goes out to the surgical team at the Royal Melbourne Hospital for your support during the project in Chapter Four, especially Lisa Wilson and Mr. Benjamin Thomson. Lisa was an integral part of patient recruitment during the study, and I could not have done it without her. Benjamin was a key advocate for me, and provided the guidance I needed in study design from a surgeon's point of view.
And lastly, and perhaps most importantly, I would like to thank my family for their unconditional support during the last six years. To my parents, and my parents-in-law, thank you for your continual support and the many babysitting hours. To my husband Jarrod, thank you for not complaining about the endless nights in front of the computer, and for supporting me throughout all aspects of this work. And to my children Will, Ella and Ned, my pregnancies with you, and your early years spanned the life of these studies. I dedicate this thesis to you, and hope it provides you with inspiration as you embark on your careers later in your lives.
Publications and Presentations

Publications


Conference Presentations


- Barker L, Crowe T. Pre-operative oral immunonutrition on postoperative outcomes in gastrointestinal surgery patients. Higher Degree by Research Symposium, Deakin University, Melbourne, 2008

• Gout B, Barker L, Crowe T. Malnutrition identification, diagnosis and dietetic referrals: are we doing a good enough job? AuSPEN, Sydney 2008
List of Tables

Table 1.1 Factors contributing to malnutrition in acute care patients 20
Table 3.1 Characteristics of patients according to nutritional status 72
Table 3.2 Medical history audit of patients assessed as malnourished 73
Table 3.3 AN-DRG payment variations with the inclusion of malnutrition codes 74
Table 3.4 Characteristics of patients according to nutritional status at the time of re-audit 75
Table 3.5 Medical history audit of patients assessed as malnourished at re-audit 76
Table 4.1 Nutritional composition of Impact® Advanced Recovery 87
Table 4.2 Diagnostic criteria used to define infectious and non-infectious complications 89
Table 4.3 Patient demographics at baseline 93
Table 4.4 Intention to treat results for full study cohort 94
Table 4.5 Intention to treat results for patients categorised by nutritional status 95
Table 4.6 Gastrointestinal and nutritional markers of post-operative recovery 97
Table 4.7 Average cost per patient of total admission and components of admission for study participants 99
Table 5.1 Survey questions as asked to participants 112
Table 5.2 Demographics of surveyed hospitals 119
Table 5.3 Nutrition department demographics 120
Table 5.4 Inpatient stay characteristics of upper and lower gastrointestinal surgery patients 123
Table 5.5 Relationship between differing factors on the prevalence of return to diet and dietitian satisfaction with nutritional management 124
List of Figures

Figure 4.3  Consort Diagram showing participant flow through the study. 92

Figure 5.3  Flow chart diagram showing hospital recruitment and dietitian participation 118
Chapter One - Review of the Literature

1.1 What is Malnutrition?

Malnutrition is a broad term that can be used to describe any imbalance in nutrition; from over-nutrition often seen in the developed world, to under-nutrition seen in many developing countries, but also in hospitals and residential care facilities in developed nations. Malnutrition can develop as a consequence of deficiency in dietary intake, increased requirements associated with a disease state, from complications of an underlying illness such as poor absorption and excessive nutrient losses, or from a combination of these aforementioned factors (1, 2). Malnutrition is associated with negative outcomes for patients, including higher infection and complication rates (3-6), increased muscle loss (6-8), impaired wound healing (4, 9), longer lengths of hospital stay (10-12) and increased morbidity and mortality (13-17).

Recently, the definition of malnutrition has been clarified by the European Society of Parenteral and Enteral Nutrition (ESPEN) to highlight the differences between cachexia, sarcopenia (loss of muscle mass and function) and malnutrition (18). Cachexia can be defined as a "multifactorial syndrome characterized by severe body weight, fat and muscle loss and increased protein catabolism due to underlying disease(s)" (18). Therefore, malnutrition seen in hospitalised patients is often a combination of cachexia (disease-related) and malnutrition (inadequate consumption of nutrients) as opposed to malnutrition alone. Within the context of this review, the definition of malnutrition adopted
refers to the complex interplay between underlying disease, disease-related metabolic alterations and the reduced availability of nutrients (because of reduced intake, impaired absorption and/or increased losses or a combination of these) which is a combination of cachexia and malnutrition (18).

In 1859, Florence Nightingale wrote about hospitalised soldiers during the Crimea war, starving amongst plenty of food (19). Over 100 years later, beginning from the 1970s, numerous authors have reported malnutrition rates in hospital patients to be approximately 35%, with an additional 30 to 55% of patients entering acute hospitals being at risk of malnutrition (20-24). Studies have also reported on factors that contribute to malnutrition (see Table 1.1), consequences of malnutrition and the benefit nutrition support can offer malnourished patients (15, 25-27).
Table 1.1 Factors contributing to malnutrition in acute care patients (15).

<table>
<thead>
<tr>
<th>Personal</th>
<th>Organisational</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Failure to recognise malnutrition</td>
</tr>
<tr>
<td>Apathy / depression</td>
<td>Lack of nutritional screening or assessment</td>
</tr>
<tr>
<td>Disease (e.g., cancer, diabetes, cardiac, gastrointestinal)</td>
<td>Lack of nutritional training</td>
</tr>
<tr>
<td>Inability to buy, cook or consume food</td>
<td>Confusion regarding nutritional responsibility</td>
</tr>
<tr>
<td>Inability to chew or swallow</td>
<td>Failure to record height and weight</td>
</tr>
<tr>
<td>Limited mobility</td>
<td>Failure to record patient intake</td>
</tr>
<tr>
<td>Sensory loss (taste, smell)</td>
<td>Lack of adequate intake</td>
</tr>
<tr>
<td>Treatment (ventilation, surgery, drain tubes)</td>
<td>Lack of staff to assist with feeding</td>
</tr>
<tr>
<td>Drug therapy</td>
<td>Importance of nutrition unrecognised</td>
</tr>
</tbody>
</table>

Over the last 30 years, advances in medical, surgical, nursing and nutrition support have been made; however, numerous publications continue to report the high prevalence and lack of awareness of malnutrition (11, 17, 28). To improve detection rate, many studies have investigated various tools for screening and assessing malnutrition, and shown many of these tools to be simple, fast, accurate and of utility in the clinical setting (29-33). Despite the availability of such tools, malnutrition prevalence rates still remain high and detection and appropriate treatment is not always being provided to overcome this ongoing problem.
1.2 Malnutrition Screening and Assessment

Identifying malnutrition or malnutrition risk is fundamental to its treatment. Many validated tools for nutrition risk screening and nutrition assessment exist for the clinician to use in assisting with accurate identification, referral and treatment of patients who are malnourished or at risk of malnutrition.

The American Dietetic Association defines nutrition risk screening as “the process of identifying patients with characteristics commonly associated with nutritional problems who may require comprehensive nutrition assessment” (34). In straightforward terms, nutrition risk screening refers to a rapid and simple set of usually two or three questions that have been validated to predict malnutrition risk. Patients identified through screening as ‘at risk’ are subsequently referred for further nutritional assessment, usually performed by a dietitian. Nutrition screening can be performed by any trained health professional, but is usually completed by nursing or nutrition assistant staff.

In contrast to nutrition risk screening, the American Dietetic Association defines nutrition assessment as “a comprehensive approach to defining nutritional status using medical, nutritional, and medication histories; physical examination, anthropometric measurements and laboratory data” (34). Essentially, nutrition assessment is a diagnostic tool to determine if a patient is currently malnourished, though does require greater skill and time to perform than nutrition risk screening.
Patients are generally referred to a dietitian by medical and nursing staff to provide nutritional care, and little time often exists for these staff to screen additional patients (35). It is therefore of concern that many malnourished patients in acute settings are not identified as such, and thereby not referred for further nutrition assessment and treatment. In some countries, namely the United Kingdom, United States, the Netherlands and some parts of Denmark, nutrition screening on patient admission is mandatory, with satisfactory hospital accreditation dependent on this being carried out (30). In Australia however, this is currently not the case. A seminal study in 1998 looking at screening practices of dietitians in Australian hospitals surveyed dietitians on their usual practice and perceived barriers to nutrition risk screening. Of alarm, only 5% of 124 hospitals whose dietitians participated in the survey carried out routine nutrition risk screening, as required by hospital policy (35). Although a 2008 follow up to this study showed an improvement of nutrition screening rates (36), it is still true that nutrition screening requires an all-of-hospital approach to prevent movement down the list of patient management priorities.

In 2013, the Australian Council on Healthcare Standards introduced a new set of five standards, some of which are mandatory for hospitals to follow, and others which were considered ‘developmental’ (or non-mandatory) (37). Standard 12.5 discusses nutritional needs of hospitalised patients, specifying that nutrition screening should be routinely performed, and systems for dietetic referral and/or treatment as required put in place, however this standard remains non-mandatory.
1.3 Nutrition Screening and Assessment Tools

Numerous nutrition screening and assessment tools exist to identify risk of, and diagnose, malnutrition. Recent evidence-based practice guidelines published by the Dietitians Association of Australia considered levels of evidence for use of validated screening and assessment tools in the acute setting as well as other areas (38). They reported on five screening and three assessment tools validated for use in the acute setting. These guidelines provided a Grade B (Good) National Health and Medical Research Council (NHMRC) grade of recommendation that routine nutrition risk screening should occur within the acute setting, but only a Grade D (Poor) recommendation for the adoption of routine screening in the sub-acute, residential aged care and community setting. A detailed description highlighting the developmental background and validation process for each of the discussed tools which formed part of the Guideline development is beyond the scope of this review; however, a brief description of the main tools outlining their strengths and weaknesses is included following.

The Malnutrition Screening tool (MST) is a simple, three-question tool assessing recent weight and appetite loss and is validated for use in general medical, surgical and oncology patients (39, 40). It was designed for use by non-nutrition-trained staff and utilises a scoring system to identify patients at high nutrition risk, which can then provide a basis for dietetic referrals and intervention (39, 41). Related to the MST, the Malnutrition Universal Screening Tool (MUST) was developed to detect both under-nutrition and obesity in adults,
and was designed for use in multiple settings including hospitals and nursing homes. Considerations of Body Mass Index (BMI), unplanned weight loss and the presence or absence of serious disease allow a score to be derived to indicate whether nutrition intervention is necessary. The MUST has been determined to consistently give reliable results; however, is limited by the fact it has not been validated in children or renal patients (42-45), and requires accurate measures of height and weight for completion.

The Mini Nutrition Assessment (MNA) was developed specifically for use among elderly patients (≥65 years) in hospitals, nursing homes and the community and is thus limited to this demographic (39, 46). The original form considers anthropometrical, medical, lifestyle, dietary and psychosocial factors in an 18 item assessment, using a points-based scoring system to determine if a patient is at risk of, or suffering from, malnutrition (46, 47). The short-form MNA (MNA-SF), which is an abridged version of the MNA, provides a simple nutrition screen with the full MNA completed only for those patients deemed at nutritional risk by the short form (48-50).

Nutritional Risk Screening (NRS-2002) uses recent weight loss, BMI and dietary intake, combined with a subjective assessment of disease severity (based on increased nutrition requirements and/or metabolic stress), to generate a nutrition risk score (39). Such subjective grading of illness severity may not accurately reflect current nutritional status and the tool does not allow for definitive diagnosis of malnutrition. The NRS tool has, however, been
recommended for use in hospitalised patients by ESPEN and may be useful for prompting the initiation of nutrition support (43, 51).

The four item Short Nutrition Assessment Questionnaire (SNAQ) was developed to diagnose malnutrition in hospitalised patients and provides an indication for dietetic referrals as well as outlining a nutrition treatment plan (39, 52). It has been validated for hospital inpatient and outpatient use, as well as residential patients and does not require calculation of BMI (53, 54).

Subjective Global Assessment (SGA) is one of the most commonly used nutrition assessment tools, and assesses nutrition status via completion of a questionnaire which includes data on weight change, dietary intake change, gastrointestinal symptoms, changes in functional capacity in relation to malnutrition as well as assessment of fat and muscle stores and the presence of oedema and ascites (55). This tool allows for malnutrition diagnosis, and classifies patients as either: A—well-nourished; B—mildly/moderately malnourished; or C—severely malnourished. SGA has been found to be an appealing method of assessing nutritional status, as its subjective nature allows clinicians to capture subtle patterns of change in clinical variables (e.g., weight loss patterns rather than absolute weight loss). A high degree of inter-rater reproducibility has been shown for SGA, with 91% of surgical patients classified by SGA having two clinicians agreeing on SGA classification (55).

It is, however, important to note that the previously mentioned screening tools do not allow a specific diagnosis of malnutrition versus cachexia, and that in fact,
many patients diagnosed as at risk of, or actually malnourished, may be better classified by the definition of malnutrition used in this review (incorporating cachexia). As it stands, there are no specific screening tools to identify cachexia versus malnutrition, however some questionnaires exist to diagnose anorexia and cachexia in cancer patients, which is outside the scope of this review, and is discussed elsewhere (18).
1.4 Malnutrition Prevalence and Dietetic Intervention in the Acute Setting

Malnutrition prevalence in the acute hospital setting has been widely documented in the literature to be between 20 and 50%, depending on the patient population and definition and criteria used for diagnosis (1, 56, 57). Rather than only reporting on malnutrition rates, many of these aforementioned malnutrition prevalence studies have also considered other aspects of patient care affected by malnutrition, namely length of stay (LOS), medication use, infection rates, dietetic referrals, documentation of malnutrition and mortality.

Australian studies show malnutrition rates of hospitalised patients to be similar to those reported in other developed countries. In 2007, SGA was used to assess the nutritional status of patients in a private hospital and reported a malnutrition rate of 42%, with only 15% of these patients referred to a dietitian (58). In the setting of a public teaching hospital, malnutrition rates and awareness of malnutrition and its risk factors by medical and nursing professionals in elderly patients was assessed (59). The study reported a prevalence rate for malnutrition of 30% using MNA. Documentation by medical and nursing staff of weight and appetite loss was found to be poor at just 19% and 53% respectively, with dietetic referrals being made for only 7% and 9% of these patients respectively.

In 2002 and 2003, 20 Queensland public acute-care facilities conducted a single-day audit of nutritional status using SGA and found malnutrition rates to be 35%
and 31\% respectively (57). Also documented as part of the two audits were variables found to be significantly associated with an increased risk of malnutrition, namely older age, metropolitan location of facility and medical specialty.

A further Australian study used the SGA tool to assess malnutrition rates in a metropolitan teaching hospital setting and found a malnutrition rate of 36\% in the two hospitals studied (17). Twelve-month follow-up of patients assessed as malnourished found a longer LOS (17 days versus 11 days for well-nourished patients) and higher mortality rates of 30\% compared to 10\% for well-nourished patients.

European, American and South American data in comparable settings reflect similar malnutrition rates to Australia. A German study published in 2006 reported a 27\% rate of malnutrition (using SGA), with malnourished patients having a LOS 43\% longer than well-nourished patients (56). A Danish group used NRS to determine nutrition risk and found 40\% of patients to be at risk of malnutrition, with only 8\% documented as malnourished (60). Two English studies in 2000 and 2003 reported malnutrition rates of 20\% and 19\% respectively, with the former study reporting malnourished patients having a longer LOS by 3 days and higher rates of medical prescriptions and infections compared to well-nourished patients (28, 61). Two further studies using SGA reported prevalence rates of malnutrition of 48\% and 45\% with again poor medical documentation and longer LOS in malnourished patients (1, 62).
It is clear from the number of published studies; malnutrition is a worldwide problem with poor diagnosis and documentation rates and higher LOS and infection rates commonly reported.
1.5 Malnutrition and its Associated Consequences

Malnutrition has often been referred to as the “skeleton in the hospital closet”, as it is often overlooked, undiagnosed and untreated (63, 64). Despite this, the negative consequences of malnutrition have been widely reported in the literature, and can be separated into two main categories: consequences for the patient and consequences for the health care facility.

1.5.1 Consequences for the Patient

Malnutrition has been shown to cause impairment at a cellular, physical and psychological level (14-16). This impairment is dependent on many factors, including the patient’s age, gender, type and duration of illness, and current nutritional intake. On a cellular level, malnutrition impairs the body’s ability to mount an effective immune response in the face of infection, often making infection harder to detect and treat (65). Malnutrition also increases the risk of pressure ulcers, delays wound healing, increases infection risk, decreases nutrient intestinal absorption, alters thermoregulation and compromises renal function (1, 14-16).

On a physical level, malnutrition can cause a loss of muscle and fat mass, reduced respiratory muscle and cardiac function, and atrophy of visceral organs (6, 14, 15). Malnutrition has been shown that an unintentional 15% loss of body weight causes steep reductions in muscle strength and respiratory function, while a
23% loss of body weight is associated with a 70% decrease in physical fitness, 30% decrease in muscle strength and a 30% rise in depression (16). At a psychological level, malnutrition is associated with fatigue and apathy, which in turn delays recovery, exacerbates anorexia and increases convalescence time (15).

It is widely reported in the literature that malnutrition is associated with an increased length in hospital stay (10, 66, 67). One study conducted in the United States looked at adult patients hospitalised for more than 7 days and examined the impact nutritional decline had on outcomes, including LOS (10). The results showed that patients who were admitted with some degree of malnutrition, and those patients who experienced a decline in nutritional status during their admission, had significantly longer hospital stays (by an average of 4 days) than patients considered well-nourished at both admission and on discharge.
Similarly, a study conducted in Australia found a significantly greater difference of 5 days between the LOS of malnourished and well-nourished patients (17).

In addition to a longer LOS, malnourished patients are more prone to experiencing complications during their period of hospitalisation than patients who are in a well-nourished state (10). Complications can occur when an unexpected incident or disease adds to a pre-existing illness without being specifically related to the illness (1). For example, one study that assessed the nutritional status of patients preoperatively found that malnourished patients had significantly higher rates of both infectious and non-infectious complications (68). Following on from a higher complication risk, as mentioned prior
malnutrition has also been shown to be associated with an increase in mortality rates (16, 17, 69).

Despite the multitude of evidence indicating that patients who are nutritionally compromised suffer worse outcomes, it is difficult to control for disease severity in the clinical setting and thus definitively conclude that malnutrition alone is a cause of these outcomes. The fact that numerous studies internationally, in a wide variety of clinical settings and patient groups, all report similar findings lends strength to the premise that malnutrition is detrimental in terms of clinical outcome. The high prevalence rate of malnutrition in the hospital setting indicates that negative outcomes such as longer hospital stays, higher complication and infection rates, and greater mortality would be highly prevalent also. It is therefore not surprising that malnutrition has significant secondary effects to health care facilities.

1.5.2 Consequences for the Health Care Facility

Malnutrition places additional stress on acute health care facilities. As previously stated, malnourished patients often have higher rates of infections and pressure ulcers (and consequently require greater nursing care), require more medications, are less independent due to muscle loss and consequently have longer lengths of hospital stay (17, 56, 62, 70). All these issues combined indirectly increase hospital costs associated with treating the patient, secondary to the management of their primary medical reason for admission.
Malnutrition also has an indirect effect on health care costs by way of the casemix funding system, as exists in much of Australia and other countries around the world. Under casemix-based funding, once a patient is discharged, their medical notes are audited by medical coders and their major diagnosis, surgeries, co-morbidities, complications and other interventions are recorded and a Diagnosis Related Group (DRG) is assigned. In Australia at least, hospitals are subsequently reimbursed for the patient admission based on the DRG. Malnutrition, when documented as a co-morbidity or complication, has the ability to influence a DRG, often resulting in a ‘higher’ classification which has the potential to attract greater hospital reimbursement (71).

An Australian study reported estimates of unclaimed reimbursements from patient admissions where malnutrition was not recorded as a co-morbidity as part of the DRG. In Brisbane in 1997, a study used SGA to determine nutrition status in a hospital population and estimated an annualised financial loss to the hospital of AUD1,677,235 due to undiagnosed and undocumented malnutrition (72).

Two international studies, one in Germany and one in the United States, both reported financial losses to the hospital due to unrecognised malnutrition based on a DRG funding system. In the German study, SGA was used to define malnutrition and reported a 19% rate of malnutrition in the patient population, an increased LOS of 4 days in the malnourished patient group, and an annual financial shortfall of €35,280 due to unrecognised malnutrition (73). Similarly,
the American study reported a loss of greater than USD86,000 after conducting a retrospective audit of patient medical charts (70).

Other studies have also shown increased financial costs to health care facilities due to untreated malnutrition based simply on the increased LOS associated with malnutrition. To illustrate, one study found that patients at risk of malnutrition had a 6-day longer LOS than those not at nutritional risk, resulting in treatment costs for malnourished patients increasing by USD1,633 per patient per hospital stay (74). Taking the opposite approach, a similar study looked at the cost-benefit associated with nutritional intervention in patients at risk of malnutrition and found that early intervention using specialised nutritional products and frequent reviews was more cost-effective than either early intervention or frequent review alone, with an estimated saving to the health care facility of USD1,064 per patient (75).

It seems evident by the number of researchers who have examined the relationship between malnutrition and its effect on both patients and treatment costs, that benefits to both individuals and hospitals exist if malnutrition is correctly identified and treated.
1.6 Malnutrition Identification and Treatment

In order to prevent or reverse the associated negative clinical outcomes for malnourished patients, it is imperative that these patients are promptly identified. Routine nutrition screening using one of the previously described validated nutrition screening tools can provide a basis for dietetic referrals for prescription of appropriate nutrition support.

A Cochrane review published in 2008 examined evidence surrounding dietary advice and the nutritional intake of adults with illness-related malnutrition (76). The review comprised 36 studies with 2,714 participants and compared a combination of dietary advice, dietary supplements or no advice with outcome measures including mortality, morbidity, weight, nutrient intake and measures of clinical function. The authors concluded that dietary advice plus nutritional supplements may be more effective than advice alone or no advice on the measure of short-term weight gain, but highlighted the lack of evidence in the management of illness-related malnutrition. The lack of an unequivocal finding of the benefit of nutritional intervention in malnourished patients is likely related to the difficulties in performing high-quality randomised-controlled trials owing to the ethical concerns of withholding nutrition support to patients identified as malnourished.

Some smaller studies have reported positive results with nutritional intervention in malnutrition including a survey of 19 United States hospitals which demonstrated that hospital LOS was influenced by the degree of
nutritional care received by patients at risk of malnutrition (75). Patients who received high quality nutritional care (defined as early intervention plus frequent use of nutrition services) averaged a 2.2-day shorter period of hospitalisation than those who received medium quality nutritional care (defined as early intervention or frequent use of nutrition services). Those who received low quality nutritional care (defined as late or no intervention and/or infrequent or no use of nutrition services) had the longest average period of hospitalisation; however, the notion of low quality care does raise ethical concerns.

An Australian study conducted in 2005 investigated the impact of early and intensive nutrition intervention among outpatients receiving radiotherapy to the gastrointestinal or head and neck area (77). Those patients who received individualised nutrition intervention were significantly more weight stable and experienced significantly less deterioration in nutritional status than patients who received usual nutrition care. Several other randomised controlled trials looking at nutrition advice and supplementation, as opposed to supplementation alone, on outcomes such as body weight, quality of life, muscle function and hospital readmission show favourable results for a combination of dietary counselling and supplementation (78-81).

With the substantial body of evidence highlighting the clinical risks that malnutrition poses to patients and the benefits that nutrition advice and supplementation can have, it is clear that nutrition screening allows for early identification and treatment of malnutrition, thus optimising the patient's
chances of attenuating some or all of the adverse outcomes associated with malnutrition.
1.7 Malnutrition and Surgery

Malnutrition rates in surgical patients have been documented to range from 30-50% (24, 68, 82). Along with malnutrition, metabolic stress and starvation associated with major gastrointestinal surgery, confounded often with cancer and pre-operative chemo-radiotherapy can cause a number of changes in metabolism including negative nitrogen balance, an increase in energy expenditure and a hyperinflammatory response (33, 83-88). Preoperative nutritional status is a highly significant factor in determining postoperative complications, due to its strong influence on postoperative nutritional status, immunity and the inflammatory response (89-91). Surgical procedures can also lead to postoperative malnutrition and immune-suppression together with a range of other metabolic and physiological symptoms, which represent the chief causes of postoperative complications (92).

In addition to the consequences of malnutrition discussed earlier, surgical procedures themselves induce an inflammatory response that may become excessive and harmful in some patients (93, 94). Following surgery, a hyperinflammatory state can deplete the body's antioxidant defence mechanisms and lead to a suppression of lymphocyte function, a situation termed immunosuppression (95). A 2007 study showed the main risk factors for the onset of postoperative complications in patients undergoing major abdominal surgery for cancer were advanced age of the patient, type of surgery (with pancreatic surgery the greatest risk), low serum albumin, weight loss, and the type of nutritional support given (85). The findings of this aforementioned study
emphasised the results of other studies which suggest that malnutrition appears to be an independent predictive factor for postoperative morbidity, with the risk of complications positively correlated with weight losses in excess of 10% of body weight (85, 89, 96).

Gastrointestinal surgery can have even more deleterious effects on patients’ nutritional status, as often lengthy periods of fasting are required before and after surgery. Also, as gastrointestinal surgical procedures may be undertaken for the treatment of a wide range of disorders of the gastrointestinal tract including cancers, chronic malabsorptive disorders or obstructions causing symptoms including early satiety, fatigue, weight loss and dysphagia, which all potentially play a significant part in the development of malnutrition in suffering patients (97, 98).

Several studies have looked specifically at the surgical population to compare complication rates of malnourished and well-nourished patients post-operatively (68, 99, 100). Complication rates significantly higher in malnourished patients were seen, with 40% of malnourished patients suffering complications compared to 15% of well nourished patients (p<0.001) (33). Furthermore, the latter study confirmed the more severe the malnutrition, the more severe the complication suffered. Further studies confirmed morbidity rates, especially severe infections, were higher in malnourished patients with odds ratios being between 3.09 and 8.80 (68, 99, 100).
As surgery (especially gastrointestinal surgery) can further compromise the nutritional state of the patient, nutritional reinforcement is now beginning to be recognised as a vital component of medical care (101, 102). Evidence-based guidelines also exist advising on nutritional management of surgical patients (103-105). They generally discuss this nutritional management in three distinct phases: pre-operative, peri-operative and post-operative. The following sections will discuss each phase and its recommended nutritional management in more detail.

1.7.1 Pre-operative Nutrition

The pre-operative nutrition phase considers the period of time leading up to surgery. It generally commences approximately four weeks prior to surgery, and lasts up until the 24-hour period prior to surgery commencing. Nutrition assessment of all patients undergoing elective surgery should be carried out during this time to establish if malnutrition or malnutrition risk is present (106, 107). Guidelines state that preoperative oral dietary supplementation and dietary advice should be commenced 10 to 14 days before surgery in patients who are malnourished (108).

Numerous randomised control trials and practice guidelines (103, 106, 109-111) support the fact that malnourished surgical patients benefit from preoperative nutrition supplementation. For example, a study prospectively randomised 488 moderately to severely malnourished patients undergoing elective gastrointestinal surgery into two groups (111). The treatment group received
parenteral or enteral nutrition for 7 days pre and postoperatively versus a control group receiving postoperative nutrition only. Complications rates were lower in the pre-operative treatment group (18% versus 33%, p=0.012) as were mortality rates (5 versus 14, p=0.003). The total length of hospitalisation (29 versus 22 days, control versus treatment groups respectively, p=0.014) and postoperative stay of control patients was significantly longer (23 versus 12 days, p<0.001).

In a more straightforward study, the effect of standard pre-operative supplements as well as diet education was compared to diet education alone (112). One hundred and twenty five patients were randomised to receive either supplementation with a standard high-energy high-protein drink (400ml, treatment group) or no supplement (control group). Post-operative outcomes such as complications, antibiotic use and length of stay were measured. This study reported no significant differences between groups, however a significant reduction in weight losing patients with wound infections in the treatment group was seen (5 versus 10 in the control group, p=0.034).

Findings of these studies can also be supported by a Cochrane review on pre-operative nutrition support in patients undergoing gastrointestinal surgery (113). Studies included in the review considered the use of immunonutrition (which is discussed in more detail later in this review), parenteral nutrition and oral/enteral nutrition. The main findings of the review indicate that immunonutrition when given in the pre-operative phase achieves the most successful reduction in post-operative complications (RR 0.67, CI 0.53 to 0.84).
A further study looking not only at timing of supplementation, but type of nutrient quality of the supplement by randomising 150 malnourished patients undergoing major elective gastrointestinal surgery into three groups has also been done (109). One group received standard postoperative enteral feeding (control group), the second a liquid diet enriched with immunonutrition for seven days preoperatively and standard enteral feeding postoperatively (preoperative group), while the third group received the immunonutrition for 7 days preoperatively and the same immunonutrition feed postoperatively (perioperative group). Complications rates were highest in the control group (24 versus 14 versus 9 respectively, p=0.02, control group versus pre-operative versus perioperative group respectively). Postoperative LOS was significantly shorter in the preoperative (13.2 days) and perioperative (12.0 days) groups than in the control group (15.3 days) (p=0.01 and p=0.001, respectively).

Overall, the data concerning preoperative nutrition support favours the use of early identification of at-risk or malnourished patients, and nutrition supplementation prior to surgery for those identified as such. Specialised immunonutrition supplementation over any other type of nutrition support in this period has shown the most beneficial results and this area will be discussed in more detail later in the review.

1.7.2 Peri-operative Nutrition

The perioperative nutrition phase can be defined as the 24 hours leading up to surgery, and the duration of the surgery itself. This phase has been studied more
intently over the last 10 years, with a focus on many aspects to improve patient outcomes, some of which are centered on nutrition. Strategies proposed to assist recovery and reduce complications include avoidance of bowel preparation and prolonged fasting prior to surgery, preoperative carbohydrate loading, avoidance of nasogastric intubation and drains postoperatively, alternate anesthesia (epidural and short acting), smaller surgical incisions, controlled intravenous intraoperative fluid provision and intraoperative warming. As a group (including some post-operative strategies that will be discussed following), these multimodal strategies have become collectively known as Enhanced Recovery After Surgery (ERAS) (114).

Strong evidence supports the individual components of ERAS. Pre-operative bowel preparation has been shown to cause unnecessary stress and dehydration to patients (115), and a Cochrane review including 5805 patients showed there were no benefits of bowel preparation versus no bowel preparation in colonic surgery (116). Additionally, reducing the need for bowel preparation allows for consumption of other drinks, allowing for carbohydrate fluid consumption, or carbohydrate loading, peri-operatively. Historically, peri-operative fasting from midnight was standard practice to avoid aspiration during surgery. However recent published anesthesiology guidelines no longer support this practice (117). Numerous randomised controlled trials, meta-analyses and reviews have concluded that consumption of clear fluids up until 2 hours pre-operatively does not increase gastric residual volume, stomach pH, risk of aspiration or related morbidity and mortality (107, 118-120). ERAS consensus guidelines
recommend intake of clear fluids up until 2 hours prior to surgery, and solid foods up until 6 hours prior to surgery (121).

In addition, the consumption of a clear carbohydrate beverage before midnight and again approximately two hours prior to surgery has shown many post-operative benefits. Twenty-one randomised studies were analysed where one group of patients was assigned a clear fluid drink containing greater than 50g of carbohydrate in the peri-operative period (treatment group) and the other (control group) provided with a placebo (clear non-carbohydrate fluid) or fasted until surgery (119). The treatment group demonstrated a mean reduction in length of stay of 1.08 days (p=0.007), and reduced post-operative insulin resistance, however this was not linked to a significant reduction in post-operative complications (risk ratio 0.88 (0.50-1.53), p=0.640). Current recommendations call for a loading dose of 400ml of 12.5% clear carbohydrate fluid in the 2-3 hours prior to surgery (121). The practice of reduced fasting and carbohydrate loading allows patients to enter surgery in a metabolically fed state, therefore reducing thirst, hunger and anxiety (120, 122), increasing insulin sensitivity (123) reducing postoperative nitrogen and protein losses and supporting maintenance of muscle mass (124, 125).

Other components of ERAS that are not focused around nutrition provision are beyond the scope of this literature review, and are discussed in detail including evidence levels for their use in practice guidelines (121).
1.7.3 Post-operative Nutrition

The post-operative nutrition phase begins immediately after surgery, and can last for varying amounts of time, depending on the complexity of the surgery. Generally, the post-operative period refers until the time point at which a patient is discharged from hospital, but can also cover the six week period after the operation was performed while patients are convalescing, usually at home.

ERAS guidelines contain recommendations for the management of gastrointestinal surgery patients in the post-operative period. These recommendations include guidelines around pain management, early mobilisation and nutrition provision.

It has been common for gastrointestinal surgery patients to be ‘nil by mouth’ for long periods of time after surgery. Now however, it is well documented that this practice is not beneficial over the early introduction of foods and fluids after surgery (126, 127). Keeping patients nil by mouth and the use of nasogastric decompression was traditionally practiced to avoid post-operative nausea and vomiting, prevent damage to the new anastomosis and achieve an earlier return of bowel function. However a Cochrane review of 37 studies encompassing 5711 patients having either routine nasogastric tube use (control group) or selective or no tube use (experimental group) reported that those patients in the experimental group had an earlier return of bowel function (p<0.00001), no significant difference in anastomotic leak rates (p=0.70) and results that seemed to favour the experimental group with less incidences of nausea and vomiting.
(p=0.011) and shorter but non-significant lengths of hospital stay (p=0.26) (128). Additionally a further review (129) reported early feeding practices in gastrointestinal surgery strengthened the anastomosis site, prevented an increase in gut mucosal permeability, promoted positive nitrogen balance, improved caloric intake, reduced infectious complications and resulted in a lower length of stay.

ERAS guidelines for colonic surgery recommend oral diet re-commencement four hours after surgery, with energy dense nutritional supplements prescribed at approximately 200 mL, 2-3 times daily from the day of surgery until a normal amount of food intake is achieved (121). Furthermore, in malnourished patients, oral nutritional supplements should continue for eight weeks post surgery to improve nutritional status and protein balance (130).

Evidence for early feeding in upper gastrointestinal surgery is not as prolific in the literature. A randomised multicentered trial involving 453 patients across five centres assigned patients to receive either enteral feeding via a jejunostomy or normal food by mouth from the first postoperative day (131). Complication rates were higher in the enterally fed group (33% compared to 28%), however this failed to reach significance (p=0.26). There were also no significant differences seen between reoperation rates and mortality between the groups, however the oral feeding group had a quicker return of bowel motility, as measured by time until first flatus (2.6 days compared to 3.0 days, p=0.001).
In addition to this study, a further 121 patients with upper gastrointestinal cancers were randomised into an early enteral nutrition group or a nil by mouth group (132). Findings in favour of early enteral nutrition in respect to infections (p=0.017) and anastomotic leaks (p=0.055) were observed, and the median length of hospital stay was shorter in the fed group (16 days compared to 19 days, p=0.023).

ESPEN guidelines on nutrition in surgery also state that feeding on post-operative day one after upper gastrointestinal surgery is safe (103). Early enteral feeding after upper gastrointestinal surgery has been shown to decrease gut permeability and reduce inflammatory responses, whole body catabolism and minimise weight loss, as well as improving immune function (129).

Strong evidence supports early feeding after gastrointestinal surgery, and also highlights the advantages to both patients and health care systems by way of reduced complications, potentially improved nutritional intake and shorter lengths of hospital stay.
1.8 Immunonutrition

All forms of nutrition can be considered to be fortifying the activities and function of the immune system at some level; however, a range of nutrients have a more powerful ability to modulate inflammation and the resultant oxidative stress, and these include specific amino acids, long-chain omega-3 fatty acids and nucleotides. Considerable published literature has examined the role that specialist nutrition therapy, namely immunonutrition, plays in enhancing postoperative outcomes. It is thought that preoperative administration of immunonutrients allows the obtainment of sufficient concentrations of these nutrients at the time of surgical stress, when the patient’s need for the maximal stimulation of the immune system is at its greatest (133).

An area of rapidly emerging interest in the field of nutrition and surgical recovery is the role of immune-enhancing specialist nutrition in altering and improving postoperative outcomes. Immunonutrition is defined as the ability of nutrients to influence the activities of cells of the immune system (134). Immunonutrition involves the administration of supranormal amounts of specific nutrients or combinations of nutrients via the enteral or parenteral route, to produce a pharmacological effect on one or more components of the physiologic and biochemical response to surgery, trauma or infection (95, 135). There is a consensus in the literature that immunomodulation has the ability to minimise the early inflammatory response to trauma or surgery and the associated tissue injury, to assist in the restoration of optimal immune and
inflammatory responses, to prevent infections and morbidity, and to ultimately enhance survival (102, 136).

The nutrients typically considered for inclusion in immune-modulating supplements are generally those which have been demonstrated to be safe and efficacious in clinical trials, and which can alter eicosanoid synthesis, cytokine production and immune function and decrease immune impairment after surgery (137-141). Such products include a range of macro- and micro-nutrients including carbohydrates, proteins and lipids as well as a variety of ingredients with immune-modulating capability such as trace elements, antioxidant vitamins, long-chain omega-3 fatty acids, nucleotides/RNA and the amino acids arginine, taurine and glutamine (142). Some of these nutrients are discussed in greater depth following.

1.8.1 Nucleotides

Nucleotides are important during immunological challenge and aid the development and activation of specialised immune cells (134). Purines and pyrimidines are semi-essential nutrients for rapidly turning-over cells including those of the gastrointestinal tract, and although the evidence is somewhat unpersuasive, nucleotide supplementation has been shown to improve some aspects of tissue recovery from reperfusion injury and radical resection (143). The administration of such nucleotides has resulted in improved immune competence, enhanced patient responses to infections and abridged length of stay (144). Enteral nucleotide supplementation has only limited success however, because following luminal brush border hydrolysis to
nucleosides, the intestinal mucosa and liver act as minor barriers against the transfer of dietary nucleotides to peripheral tissues (143). Much of the human clinical trial research involving nucleotides has administered these in combination with a range of other immunonutrients, hence it is difficult to delineate the benefit of nucleotides in isolation.

1.8.2 Arginine

Arginine, a conditionally essential amino acid, decreases dramatically in plasma concentrations in individuals with protein malnutrition, sepsis, injury or inflammation, which are all conditions observed in gastrointestinal surgery patients (145). Arginine has varied biological actions including the stimulation of growth hormone, prolactin and insulin-like growth factor (146), and is required for enhancement of cell-mediated immunity by the stimulation of T lymphocyte function (102).

Arginine is the precursor of the important endothelial vasodilator, nitric oxide and is an amino acid which becomes conditionally essential during catabolic states as endogenous synthesis may be limiting, which renders arginine a key component of most immunonutrition formulas (147). Following surgery, arginine restores macrophage function and lymphocyte responsiveness to improve wound healing and protect against infection and ischaemia reperfusion tissue injury (144) as well as producing antibacterial effects, improved gut function and antioxidant functions (148).
A systematic review found that studies in critically ill patients which utilised immunonutritional formulas with high arginine content were linked with a major reduction in infectious complications and a tendency toward lower mortality rates in comparison with other formulas, suggesting that the supplementation of enteral nutrition with moderate doses may be of benefit to patients (149).

1.8.3 Omega-3 Polyunsaturated Fatty Acids

Fatty acids are the precursors of immunoregulatory eicosanoids, and the omega-3 fatty acids generate a less inflammatory eicosanoids series than do omega-6 fatty acids, making these molecules potentially useful in a range of inflammatory processes (150). Omega-3 fatty acids such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are readily transferred from the diet into inflammatory cell membranes to replace omega-6 fatty acids to affect the binding of ligands and signalling molecules as well as inhibit the conversion of omega-6 fatty acids to eicosanoids (147, 151).

Supplementation with omega-3 fatty acids has been investigated in various combinations with other immunonutrients in a large number of clinical trials (152). In a randomised double-blind trial involving 256 patients, it was found that supplementation involving omega-3 fatty acids had no influence on postoperative mortality, morbidity or intensive care unit length of stay following major abdominal surgery; however, a significantly reduced length of hospital admission and a higher level of serum anti-inflammatory mediators such as LTB5 (leukotriene B5) was observed (153). Another study which investigated
the five-day preoperative immunonutritional supplementation of patients undergoing major surgical procedures for cancer found that postoperative levels of EPA and DHA in supplemented patients had increased and levels of inflammatory markers were significantly lower in supplemented patients even on the day of surgical procedures in comparison with control patients and with baseline pre-supplementation levels (154).

In summary, immune-enhancing nutrients function in differing manners to impart a variety of effects on the immune system and the inflammatory response to increase antioxidant defences, or to boost intestinal barrier function. While in isolation the influence of the supplementation of these nutrients on the incidence of postoperative complications remains somewhat unknown, the benefits observed from immunonutrition on immune function and postoperative complications in surgical patients are thought to be a consequence of the combination of these beneficial nutrients, and the grouping of their individual effects.
1.9 Evidence Surrounding the use of Immunonutrition in Surgical Patients

Over the past 10 years, a moderate amount of research has been published looking at the role of immunonutrition in surgical patients, including two meta-analyses, however its use has not yet become common practice.

An early study in 1999 administered an immunonutrition formula versus a standard formula pre-operatively, and continued the same formula in the post-operative period. It found significantly reduced infection rates and length of stay in patients treated with the immunonutrition formulation compared to patients treated with an isocaloric, isonitrogenous placebo (155). With evidence that both pre- and post-operative immunonutrition could positively affect immune function in the post-operative period, the same research group followed up their original study this time looking at the effect of immunonutrition on well-nourished patients, compared to conventional treatment (87). The conclusion was that pre-operative supplementation with immunonutrition equally helped improve post-surgical outcomes in well-nourished patients, compared to a standard isonitrogenous, isocaloric control.

Other studies have examined the role of various peri-operative administrations of immunonutrition on a variety of subgroups, which again have showed a beneficial effect on postoperative complications and length of stay (156-158). A meta analysis has also been published focusing on the role of immunonutrition, examining the relationship between pre-, peri- and post-operative nutrition support and postoperative morbidity which concluded that a significant
reduction (39-61%) in postoperative infectious complications and significant
two day length of stay reduction exists with immunonutrition use (142). This
meta-analysis also reinforced that patients on isocaloric, isonitrogenous control
standard nutrition support did not show positive changes in outcome measures
compared to patients receiving immunonutrition supplementation. A second
meta-analysis also reported similar results (159).

A further meta-analyses investigated the impact of immunonutrition on
gastrointestinal patients in relation to postoperative complications, LOS and
mortality (160). Twenty-one RCTs (conducted between January 1985 and
September 2009) totaling 2730 patients were included in the analysis. Results
indicated immunonutrition significantly reduced overall complications when
administered preoperatively (OR 0.48, 95, CI 0.34 to 0.69), peri-operatively (OR
0.39, CI 0.28 to 0.54) or postoperatively (OR 0.46, CI 0.25 to 0.84). Postoperative
infections were also reduced with immunonutrition (OR 0.36, CI 0.24 to 0.56),
OR 0.41, CI 0.28 to 0.58, and OR 0.53, CI 0.40 to 0.71) for the three time periods
respectively. Immunonutrition use also decreased length of hospital stay by 2.12
days (CI 1.26-2.97, p<0.001); however LOS was also considered to be influenced
by additional factors including hospital protocols and reimbursement systems.
In addition, positive effects of immunonutrition were strengthened when low-
quality trials were excluded. Overall the authors encouraged cautious
interpretation of the results due to various methodological issues, however the
use of perioperative immunonutrition for gastrointestinal surgery patients was
recommended.
Although immunonutrition has the scope to provide a significant benefit to gastrointestinal surgery patients, developing a consensus for standard post-operative care is difficult due to different post-operative surgical management protocols and preferences by different surgical consultants and institutions. However, implementing a pre-operative strategy (as opposed to a post-operative strategy) for the provision of immunonutrition that is standardised and easy to implement is more feasible, as pre-operative procedures are similar at most institutions.

To date, no studies have looked only at pre-operative immunonutrition regardless of patient’s nutritional status, compared to current standard practice (no supplementation). As numerous other published studies have compared immunonutrition against a standard control supplement and found a superior benefit for immunonutrition over standard nutritional supplementation (indicating the therapeutic role for the immuno-enhancing agents in these supplements), there is scope for a study to compare immunonutrition against ‘standard’ practice of no nutritional supplementation pre-operatively.

Despite an array of published evidence of the benefits of pre-operative immunonutrition, its use is not yet routine. As the majority of studies have used immunonutrition therapy alongside post-operative management not considered routine, perhaps clinicians have failed to construct clear evidence based guidelines due to difficulties in implementation. Further to this, minimal research exists on the role of immunonutrition in patients who are malnourished. While the contribution that malnutrition makes to impairment of
immune function has been known for decades, a thorough understanding of this relationship is a challenge that remains incomplete.
1.10 Conclusions and Recommendations

Malnutrition is prevalent around the world and is a burden on patients and health care facilities. Despite numerous advances in medicine and clinical care, the correction of a patient’s nutritional status appears to be overlooked or not considered as a sufficient medical priority.

The treatment of malnutrition first requires a malnourished patient to be identified via either screening or assessment. This needs to be done on admission, and preferably made mandatory by health care accrediting bodies. In order to achieve this, dietitians need to have the confidence and knowledge to detect malnutrition, which ideally will be done using a validated assessment tool such as SGA for example. In order for patient outcomes and financial benefits to be monitored, adequate documentation of malnutrition is essential.

Screening alone is, however, only one part of the solution. A clear nutrition care pathway should indicate the action required based on the screening result. As screening will inevitably create an increased number of dietetic referrals to assess these potentially malnourished patients, additional funding would allow for extra staff to deal with the increased dietetic workload.

In patient sub-groups who have been shown to be more at risk of malnutrition, for example surgical patients, specialised nutritional therapy with immuno-enhancing supplementation may be of benefit, especially for patients who present malnourished prior to their surgery. Specific guidelines and protocols
should be developed and adopted by institutions to ensure all patients receive optimal nutrition care.
Chapter Two - Research Objectives

2.1 Aims

The overall aim of this thesis was to explore in detail the local magnitude of malnutrition in hospitalised patients, with a specific focus on gastrointestinal surgery patients, and to look at ways identification and treatment of malnourished patients can be improved to provide better health outcomes for patients and hospitals. Three studies were designed and conducted to meet the following specific aims:

1. a) To assess malnutrition prevalence in a large tertiary referral teaching hospital via nutrition screening, and to determine the rates of dietetic referral for malnourished patients, to assess the correct diagnosis and documentation of malnutrition, and to consider the financial implications of failed malnutrition identification in medical coding.
   
   b) To implement a series of strategies to improve malnutrition identification by dietitians and medical coders, and then re-audit malnutrition rates, referrals, documentation and coding in the same hospital.

2. To examine the efficacy of pre-operative immunonutrition supplementation, in the setting of routine post-operative management, on length of hospital stay, complication rates and hospital costs in well-nourished and malnourished patients.
3. To investigate the current routine pre-, peri- and post-operative nutritional management practices of gastrointestinal surgery patients state-wide and to compare current nutritional management to best practice guidelines, and identify barriers in implementation of best practice.
2.2 Rationale

Although there is a large amount of published evidence to support the use of nutrition screening to identify malnutrition, and pathways established to treat patients found to be at risk of malnutrition, many hospitals in Australia, including Victoria, do not routinely adopt such procedures. This may be due to a lack of awareness, lack of resources, lack of financial support or a combination of all three. The published literature also supports the treatment of malnourished patients, especially malnourished patients undergoing surgery, and has shown improvement in clinical outcomes associated with improved pre-operative treatment of malnutrition. However, this has not become standard practice in many hospitals. Although awareness of the issue has increased in recent times, practice has not always followed suit.

The rationale for completing this research is to provide local data on malnutrition rates, malnutrition assessment and documentation, and also malnutrition treatment practices in pre-operative patients and surgical nutrition management in general. Having informed local data will send a stronger message to hospitals that more work needs to be done regarding malnutrition identification, assessment and routine treatment.
2.3 Hypothesis

The following hypothesis have been made in relation to the thesis aims:

1. a) In a representative metropolitan tertiary referral hospital, rates of malnutrition assessment, referral, documentation and medical coding of malnutrition are low.

b) That awareness raising, education and formal documentation procedures will improve malnutrition identification, documentation and medical coding of malnutrition.

2. That the use of a pre-operative immunonutrition supplement for patients undergoing gastrointestinal surgery will reduce complication rates and length of stay, with malnourished patients experiencing a greater benefit.

3. That surgical nutrition management of patients in Victorian public hospitals differ widely, and that management based on best practice is more likely to be achieved in a department where the dietitian is more experienced and knowledgeable in the field of gastrointestinal surgical nutrition.
Chapter Three – Malnutrition identification, diagnosis and
dietetic referrals: are we doing a good enough job?

3.1 Introduction

Malnutrition is a serious and debilitating condition that is highly prevalent in the
hospital setting with rates from between 20 to 50% reported in the literature
(161-165). Malnutrition is a state in which insufficient nutrients are available to
maintain normal bodily functions and optimal health (14). There are numerous
symptoms that a malnourished patient may present with, including muscle
wastage, cognitive impairment, pallor of the skin, poor appetite and weight loss
(162). The condition can develop as a result of a deficiency in dietary intake,
increased requirements associated with a disease state, from complications of an
underlying disease or illness, such as poor absorption or excessive nutrient
losses, or a combination of these factors (165). Negative outcomes of
malnutrition that have been shown to significantly impact on the patient include
higher rates of medical complications, infections and mortality as well as an
increased length of hospital stay (reported as up to a 5 day longer stay for
malnourished compared with well-nourished patients)(14, 62, 161).

Despite the severity of both the prevalence of malnutrition and also the negative
outcomes associated with the condition, many patients remain undiagnosed and
thus untreated. Several Australian and international studies have reported low
dietetic referral rates for malnourished patients. The results from these studies
show that of those patients identified as malnourished (by means of various screening and assessment tools), only 5 to 34% were correctly identified and subsequently referred for dietetic treatment (24, 161, 163).

In order to address the issue of malnutrition in the hospital setting, various nutrition screening and assessment tools have been developed to allow early and easy detection of malnutrition (166-168). Unfortunately insufficient time, monetary resources and lack of support from other staff members have been identified as perceived barriers to the implementation of routine screening (169). One Australian study has assessed national screening practices and found that only 25% of institutions are currently performing any form of nutrition risk screening, with this figure likely to be an overestimate of the true practice rate (161). In contrast, some countries such as the United States and Scotland require that nutrition screening is performed as a standard aspect of care for all newly admitted patients (161, 170). Aside from patient benefits, routine screening also has the opportunity to provide a substantial source of reimbursement for hospitals with several Australian and international studies showing substantially increased financial reimbursement under a casemix-based funding system (73, 162, 171, 172).

Although numerous studies worldwide have identified high rates of malnutrition, few studies have looked at the adequacy of identification and referrals, and the impact this can have on hospital reimbursements. This study aimed to assess the prevalence of malnutrition among patients in a tertiary teaching hospital to determine whether patients were being correctly identified
and referred for dietetic intervention and to assess the financial implications to
the hospital for not correctly identifying and coding patients as malnourished.
The second part of this study aimed to assess how malnutrition identification,
documentation, and coding rates could be improved after an intervention to
train dietitians and medical coders in these areas was put into place.
3.2 Method

3.2.1 Study Design

The study was conducted at a large public tertiary teaching hospital in Melbourne, Australia, over a period of 3 months (May to July 2008). A random selection of eligible patients were assessed for malnutrition over a 5-week period using the Subjective Global Assessment (SGA) tool (166, 173). The SGA has been previously validated against objective measures of malnutrition in a variety of patient groups, including renal, liver and HIV patients (162). SGA assesses nutrition status via completion of a questionnaire which includes data on weight change, dietary intake change, gastrointestinal symptoms, changes in functional capacity in relation to nutrition as well as an assessment of fat and muscle stores and the presence of oedema and ascites (29). The tool classifies patients as either: A – well-nourished; B – mild/moderately malnourished; or C – severely malnourished. One researcher, previously trained in using the SGA, performed all of the assessments.

Over a 5-week period, each ward of the hospital was assessed twice to ensure an accurate representation of patients with varying medical conditions. At the beginning of each day, patient lists for the wards to be assessed were printed and a random number assigned to each bed number for the ward. Numbered pieces of paper were drawn from an envelope by a person with no involvement in the study, and the patient in that bed subsequently considered against inclusion and exclusion criteria for malnutrition assessment. Informed consent was not
required as per the ethical approval of the study; however, participation was voluntary. A total of 275 patients were assessed for malnutrition. Patients’ albumin levels on the first or second day of admission were recorded where available. Length of hospital stay data was obtained for all assessed patients on discharge to allow an analysis between malnutrition status and length of stay to be performed.

3.2.2 Exclusion Criteria

Patients who were non-English speaking where an interpreter was not available, absent from their bed at the time of assessment, and those patients who were deemed too unwell by ward staff at the time of assessment were not included in the study.

Patients with an admission already longer than two weeks at the time of assessment and patients in rehabilitation and day-stay wards were also excluded. These exclusions existed as the aim of the study was to assess malnutrition in the acute setting only and to determine the prevalence of malnutrition among newly admitted patients. Because of the critical medical issues, patients in intensive care unit (ICU) were also excluded.
3.2.3 Retrospective Medical Audit

A retrospective audit was performed on the medical histories of patients that were determined to be malnourished to assess if, during the patients’ stay, malnutrition had been accurately diagnosed and documented in the medical history, whether the patient had been referred to and seen by a dietitian and whether malnutrition had been included in the patient’s Australian National Diagnosis Related Group (AN-DRG). Malnutrition is considered a co-morbidity or complication under the AN-DRG classification system for casemix-based funding (174). Using a similar approach as described prior (162), for admissions where malnutrition was present but not coded, the admission was subsequently recoded and regrouped, to determine the financial implications for the hospital. The prevalence of malnutrition determined in the sample group and the proportion of patients whose Diagnosis Related Group (DRG) and allocated financial reimbursement changed as a result of including the malnutrition code was extrapolated to the total number of hospital admissions from July 2007 to June 2008 to allow an annual estimate of the potential financial shortfalls to the hospital.

3.2.4 Implementation of Education, Training and New Documentation

In the 12-month period following the results analysis of the first part of this study (sections 3.2.1 – 3.2.3), a series of training sessions were conducted for the dietitians at the same hospital. These sessions covered the importance of adequate malnutrition assessment and documentation, and included training on
the use of SGA. These face-to-face sessions were conducted by a dietitian experienced with the use of SGA, and involved a theory component, a video component (Subjective Global Assessment, Baxter Health Care, Illinois, USA), and a practical component involving assessment of two hospital patients who had previously been assessed by the experienced dietitian for results comparison.

A series of meetings were also held with senior members of the Medical Coding team where current procedures for malnutrition coding were discussed, along with the importance of malnutrition identification and coding in respect to hospital reimbursement. A new Initial Nutrition Assessment Form was developed for use containing a clear tick box section for the assessing dietitian to specify nutritional status (well nourished, at risk of malnutrition or malnourished).

### 3.2.5 Re-audit and Evaluation

Six hospital dietitians along with six student dietitians were recruited to carry out the re-audit of malnutrition rates and documentation at the same hospital. Training was provided to all participants prior to the study commencing. On a selected single day, all patients, except those who met the exclusion criteria (as stated in 3.2.2 prior), were assessed by either a dietitian or student using the SGA to establish their nutritional status. All patients identified as being malnourished had their medical histories retrospectively audited after discharge using the same procedure as described in 3.2.3.
3.2.6 Ethical Approval

Both projects were approved by the Human Research Ethics Committees of both Royal Melbourne Hospital and Deakin University as a quality assurance activity.

3.2.7 Statistical Analysis

Comparison between nutritional status by SGA classification and length of hospital stay or serum albumin on admission were performed by ANOVA with Tukey's HSD post-hoc testing. For binomial comparisons, the chi-square test was used to determine differences between gender distribution or proportion of patients with albumin levels below 35 g/L according to SGA category. Pearson's product moment correlation was used to determine associations between serum albumin levels and length of stay. All data analysis was performed using SPSS (Version 17). A p value of less than 0.05 was used to determine statistical significance.
3.3 Results

3.3.1 Initial Audit – Part One

During the assessment period a total of 275 eligible patients were assessed for malnutrition using the SGA. Malnutrition prevalence was 23%, with 16% of patients mildly or moderately malnourished (SGA category B) and 7% severely malnourished (SGA category C, see Table 3.1). There were no observable trends for differences in age or gender distribution across the categories of the SGA. Patients considered well nourished had significantly shorter lengths of hospital stay by 4.5 days compared to malnourished patients (SGA category B and C combined; p < 0.001). Mean serum albumin levels were similar between SGA category groups with a trend for lower levels in malnourished patients. There was a higher proportion of malnourished than well-nourished patients with a serum albumin below 35 g/L (39% vs 22% respectively; p = 0.02). There was no association between serum albumin and length of hospital stay (r = -0.069; p = 0.35).
### Table 3.1 Characteristics of patients according to nutritional status

<table>
<thead>
<tr>
<th></th>
<th>Total sample</th>
<th>SGA (A) (mean ± SD)</th>
<th>SGA (B) (mean ± SD)</th>
<th>SGA (C) (mean ± SD)</th>
<th>SGA (B+C) (mean ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>275</td>
<td>213</td>
<td>44</td>
<td>18</td>
<td>62</td>
</tr>
<tr>
<td>Age (y)</td>
<td>59.5 ± 19.9</td>
<td>58.5 ± 19.5</td>
<td>64.8 ± 18.1</td>
<td>57.5 ± 26.8</td>
<td>62.7 ± 21.0</td>
</tr>
<tr>
<td>No. (%) ≥ 65 yrs</td>
<td>128 (47%)</td>
<td>95 (45%)</td>
<td>24 (55%)</td>
<td>9 (50%)</td>
<td>33 (53%)</td>
</tr>
<tr>
<td>Male/Female</td>
<td>144/131</td>
<td>116/97</td>
<td>22/22</td>
<td>6/12</td>
<td>28/34</td>
</tr>
<tr>
<td>LOS (d)</td>
<td>9.8 ± 9.4</td>
<td>8.8 ± 8.8</td>
<td>13.7 ± 10.4*</td>
<td>12.5 ± 11.1</td>
<td>13.3 ± 10.5*</td>
</tr>
<tr>
<td>Albumin (g/L), n = 184</td>
<td>36.7 ± 5.4</td>
<td>37.4 ± 5.3</td>
<td>35.5 ± 6.0</td>
<td>34.2 ± 4.9</td>
<td>35.1 ± 5.7</td>
</tr>
<tr>
<td>No./Total Sample (%) albumin &lt; 35g/L</td>
<td>50/184 (27%)</td>
<td>29/130 (22%)</td>
<td>13/39 (33%)</td>
<td>8/15* (53%)</td>
<td>21/54* (39%)</td>
</tr>
</tbody>
</table>

LOS = length of stay; SGA = Subjective Global Assessment; SGA (A) = well nourished; SGA (B) = mild/moderately malnourished; SGA (C) = severely malnourished. Percent figures shown in brackets relate to the number of patients in the malnutrition risk category; *p < 0.05 compared SGA (A) category.

Of patients assessed as malnourished by SGA and whose medical histories were available at the time of audit, only 15% were correctly identified and documented as such in the medical histories. A dietitian was involved in 45% of malnutrition cases; however, only 29% of those cases were correctly documented as malnourished in the medical history by dietetic staff (Table 3.2).
Table 3.2  Medical history audit of patients assessed as malnourished

<table>
<thead>
<tr>
<th>Description</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of histories audited</td>
<td>53</td>
</tr>
<tr>
<td>No. correctly documented as malnourished</td>
<td>8</td>
</tr>
<tr>
<td>No. referred to a dietitian for malnutrition assessment and/or intervention?</td>
<td>19</td>
</tr>
<tr>
<td>No. seen by a dietitian for any condition (regardless of whether they were referred or not)</td>
<td>24</td>
</tr>
<tr>
<td>No. correctly identified as malnourished by a dietitian</td>
<td>7</td>
</tr>
<tr>
<td>No. correctly coded as malnourished</td>
<td>5</td>
</tr>
<tr>
<td>No. of histories requiring recoding (by adding malnutrition to the DRG)</td>
<td>48</td>
</tr>
</tbody>
</table>

DRG = Diagnosis Related Group

Forty-eight out of 53 patients were categorised as malnourished by the SGA, but not correctly documented or coded as malnourished. In a hypothetical recode, the inclusion of the appropriate malnutrition code resulted in a change of DRG and subsequent financial reallocation for 10 out of 48 patients. For these 10 patients alone, the hospital forewent AUD 27,617 in reimbursements. When extrapolating this figure based on the proportion of patients identified as miscoded from the sample population to the 18,394 patients admitted to hospital acute-care beds in the previous financial year (excluding emergency, intensive care and critical care units), a substantial shortfall of AUD 1,850,540 in entitled financial reimbursements were missed by the hospital.
Table 3.3  AN-DRG payment variations with the inclusion of malnutrition codes

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Original payment</th>
<th>Revised payment</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>$1486</td>
<td>$3330</td>
<td>$1862</td>
</tr>
<tr>
<td>63</td>
<td>$3066</td>
<td>$2519</td>
<td>-$547</td>
</tr>
<tr>
<td>162</td>
<td>$7724</td>
<td>$15940</td>
<td>$8216</td>
</tr>
<tr>
<td>174</td>
<td>$1335</td>
<td>$2207</td>
<td>$872</td>
</tr>
<tr>
<td>186</td>
<td>$1960</td>
<td>$4188</td>
<td>$2228</td>
</tr>
<tr>
<td>190</td>
<td>$3804</td>
<td>$7052</td>
<td>$3248</td>
</tr>
<tr>
<td>254</td>
<td>$2693</td>
<td>$7601</td>
<td>$4908</td>
</tr>
<tr>
<td>258</td>
<td>$1486</td>
<td>$3330</td>
<td>$1844</td>
</tr>
<tr>
<td>270</td>
<td>$6650</td>
<td>$7442</td>
<td>$792</td>
</tr>
<tr>
<td>273</td>
<td>$3513</td>
<td>$7707</td>
<td>$4194</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$33717</td>
<td>$61316</td>
<td>$27617</td>
</tr>
</tbody>
</table>

$=Australian dollars

3.3.2 Follow-up Audit – Part Two

One year after the initial audit, 237 patients were assessed for malnutrition using SGA over a single day (Table 3.4). Malnutrition prevalence was 43% (compared to 23% in the first audit, p=0.001), with the highest rates of malnutrition in gastroenterology, haematology and general medicine patients (67%, 60% and 58% of patients malnourished from each unit respectively). There were no significant differences in age and gender distribution between SGA groups (p=0.105 and p=0.372 respectively). Similar to the baseline audit, well-nourished patients had a shorter length of hospital stay by 6.2 days compared to malnourished patients (SGA groups B and C combined, p=0.002). There was a positive correlation between albumin levels and length of hospital stay (r=0.230, p<0.001).
Table 3.4 Characteristics of patients according to nutritional status at the time of re-audit

<table>
<thead>
<tr>
<th></th>
<th>Total sample</th>
<th>SGA (A) (mean ± SD)</th>
<th>SGA (B) (mean ± SD)</th>
<th>SGA (C) (mean ± SD)</th>
<th>SGA (B+C) (mean ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. patients</td>
<td>237</td>
<td>136 (57%)</td>
<td>83 (35%)</td>
<td>18 (8%)</td>
<td>101 (43%)</td>
</tr>
<tr>
<td>Age (y)</td>
<td>63.5 ± 17.6</td>
<td>60.8 ± 16.9</td>
<td>66.8 ± 18.2</td>
<td>68.8 ± 17.2</td>
<td>67.2 ± 18.0</td>
</tr>
<tr>
<td>Male/Female</td>
<td>133/104</td>
<td>81/55</td>
<td>44/39</td>
<td>8/10</td>
<td>54/49</td>
</tr>
<tr>
<td>LOS (d)</td>
<td>16.3 ± 15.4</td>
<td>13.7 ± 12.1</td>
<td>18.5 ± 18.1</td>
<td>26.0 ± 19.5</td>
<td>19.8 ± 8.5*</td>
</tr>
<tr>
<td>Albumin (g/L), n = 188</td>
<td>30.4 ± 5.6</td>
<td>31.9 ± 4.7</td>
<td>28.9 ± 5.6</td>
<td>28.1 ± 4.2</td>
<td>28.7 ± 5.3</td>
</tr>
</tbody>
</table>

LOS = length of stay; SGA = Subjective Global Assessment; SGA (A) = well nourished; SGA (B) = mild/moderately malnourished; SGA (C) = severely malnourished. Percent figures shown in brackets relate to the number of patients in the malnutrition risk category; *P < 0.05 compared SGA (A) category

Ninety-six percent (n=97) of medical histories of patients identified as malnourished were available for a post discharge audit. Of these, 30 (31%) histories correctly identified and documented malnutrition (a doubling in the identification rate from the 15% reported in the initial study, p=0.048). A dietitian was involved in approximately half of the malnutrition cases, and less than one quarter of malnourished patients were correctly coded as such (Table 3.5), with these findings similar to the first audit. However, every patient identified as malnourished by the dietitian in the medical history was coded as malnourished by the medical coders in the re-audit, a significant improvement compared to only 71% in the initial study (p=0.048).
<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of histories audited</td>
<td>97</td>
</tr>
<tr>
<td>No. correctly documented as malnourished</td>
<td>30</td>
</tr>
<tr>
<td>No. seen by a dietitian for any condition (regardless of whether they were referred or not)</td>
<td>50</td>
</tr>
<tr>
<td>No. correctly identified as malnourished by a dietitian</td>
<td>23</td>
</tr>
<tr>
<td>No. correctly coded as malnourished</td>
<td>23</td>
</tr>
<tr>
<td>No. of histories requiring recoding (by adding malnutrition to the DRG)</td>
<td>74</td>
</tr>
</tbody>
</table>

DRG = Diagnosis Related Group

Seventy-four patients with malnutrition identified by way of SGA but whose malnutrition was not documented in the medical history and recorded in the DRG classification required recoding. The hypothetical recode resulted in a change of DRG and subsequent financial reallocation for 14 out of 74 patients, resulting in a shortfall of AUD 69,079 in reimbursements. When extrapolating this figure using the same model used in the initial audit, AUD 6,004,938 of financial reimbursements were missed by the hospital.
3.4 Discussion

This study assessed a total of 512 patients at two different time intervals in an acute metropolitan hospital and demonstrated a high prevalence rate of malnutrition. An Australian study published approximately 12 years earlier reported a similar prevalence rate, indicating that despite the evidence being available, few inroads into this serious problem have been achieved (172). This study also provides unique insight into the adequacy of dietetic referrals for treatment of malnutrition, the frequency of dietetic staff to accurately document malnourished patients and the financial implications of current practice.

No significant differences or obvious trends were found in terms of age and gender distribution across the three SGA categories, although relationships between these parameters have been observed in previous Australian and international studies (31, 56, 62, 161, 175). Malnutrition rates were higher in the second audit than the first (43% versus 23% respectively), and although both of these numbers are within the normal range for malnutrition in the published literature, some of this variance may be attributed to a difference in methodology, with one researcher conducting all SGAs in the first audit, and numerous researchers conducting SGAs in the second audit.

In the initial malnutrition audit, higher rates of malnutrition were evident in patients with a serum albumin below 35 g/L on admission, although serum albumin was not significantly associated with length of stay. However in the second audit, there was a positive correlation between a serum albumin levels
and length of hospital stay. Both of these findings are supported in the literature (176-178). This varied finding was not unexpected, as it is well known that serum albumin can be affected by a number of factors and is therefore not a reliable predictor of malnutrition (46, 176). Serum albumin is one of the most commonly used markers for nutritional status in the hospital setting, and was therefore included as an independent marker in this study; however, its interpretation must be made with caution. There are several factors that may influence serum albumin levels and decrease the value of its use as an indicator of malnutrition. Chronic diseases where increased losses or decreased albumin synthesis can occur, inflammation, and drugs commonly administered in the hospital setting, such as corticosteroids can all lower albumin levels (46, 176).

A patient’s nutritional status and subsequent length of hospital stay was found to be related, with malnourished patients having significantly longer periods of hospitalisation than patients deemed well-nourished. This is widely reported in the literature (10, 161). One study conducted in the United States showed, on average, a 4-day longer hospital stay for patients who were either admitted in a malnourished state or experienced a decline in their nutritional status during their admission (10). It must be noted that in the present study, potential confounders such as severity of illness and multiple diagnoses were unable to be accounted for.

The recognition and documentation of malnutrition in the current study was poor, with only 15% of malnourished patients being correctly diagnosed as such.
documentation that occurred after the first malnutrition audit, and the introduction of a new assessment form, identification rates only improved to 31%, indicating further work in this area is required. Dietetic referral and assessment of malnourished patients was also poor, with approximately 50% of malnourished patients actually seen by a dietitian. Other studies looking at malnutrition identification by health professionals within the hospital setting have found similar results, indicating that the inability of medical staff to identify malnourished patients is a real issue and could in part explain the high malnutrition prevalence rate if it is not being actively identified and managed (162, 163, 179). An Australian study found that only one out of 137 malnourished patients was documented as such in the medical histories and only 21 (15%) of the malnourished patients were referred for nutrition intervention (162). A Danish study also reported only 25% of malnourished patients in their hospital was seen by a dietitian during their inpatient stay (180). This may suggest complacency towards the severity of the malnutrition issue, ignorance towards the associated negative outcomes or the belief of medical staff that malnutrition is a co-morbidity that is common and to be expected (162).

Poor documentation of malnutrition is not unique to this study, however the involvement dietitians have with documentation has not been previously considered. Many published studies report the lack of malnutrition documentation and subsequent incorrect coding and reduction in DRG payment that occurs as a result (70, 73, 172, 181), however no other papers have audited dietitians’ documentation nor implemented strategies to improve current practice.
By hypothetically recoding medical histories of malnourished patients, the exact reduction in DRG funding can be calculated. In both audits of this study, it was shown the hospital had foregone a substantial amount of financial reimbursements as a result of misidentification and/or poor documentation. The financial reimbursements may be even greater than stated, as the exclusion criteria of this study likely masked the true prevalence of malnutrition. Several studies have also looked at the financial impact of inadequate documentation of malnutrition in the medical histories (70, 73, 162, 172), with all papers supporting a similar ‘per patient’ difference in funding of the magnitude of thousands of Australian dollars. One such Australian study estimated a similar annual reimbursement figure (AUD 1,677,235) could be generated by adding malnutrition to a patient’s DRG (172). Although optimal patient care and improved patient outcomes must be the driver for adopting nutrition assessment or screening as a part of standard hospital care, the potential additional reimbursements that may be generated as an outcome will certainly attract attention.

An American study focusing on malnutrition documentation and DRG funding concluded that documentation criteria and strict guidelines were required to improve outcomes. They suggested a separate nutrition assessment form with a coloured sticker to alert the medical coders of the presence of malnutrition in the patient (70). However they failed to evaluate the implementation of such a plan. The second part of the study presented herein, with face-to-face dietetic training, education of medical coders and the development of new documentation standards clearly requesting nutritional status be assessed and recorded on a
separate assessment form, provided a possible measurable solution to poor malnutrition identification. The implementation of such a system showed a significant 2-fold increase (p=0.048) in the documentation of malnutrition by dietitians, and subsequently every patient identified as malnourished by the dietitian in the medical history was coded as malnourished by the medical coders.
3.5 Conclusions

It is evident that malnutrition continues to remain largely undiagnosed and documented despite knowing that a high proportion of hospitalised patients are affected by this debilitating condition. Failure to refer malnourished patients for dietetic intervention can compromise the clinical outcome, and therefore it is imperative that regular assessment be introduced to allow early detection and subsequent treatment of these patients. As well as raising awareness of the condition via education and training, a standardised method of documentation of malnutrition assists in ensuring hospitals receive the full reimbursements to which they are entitled, and most importantly may assist in improving patient outcomes.
Chapter Four – Preoperative immunonutrition and its effect on postoperative outcomes in well-nourished and malnourished gastrointestinal surgery patients: a randomised controlled trial

4.1 Introduction

Malnutrition is a highly prevalent condition in hospitalised patients with prevalence rates reported between 20 and 50% (182, 183). Malnutrition, along with stress and starvation associated with major gastrointestinal surgery has been associated with many adverse post-operative outcomes, including increased energy expenditure, depression of the immune system, impaired wound healing, increased infections, longer lengths of hospital stay, higher treatment costs and increased mortality (184-187). Preoperative nutritional status is a significant factor in determining postoperative complication risk, due to its strong influence on postoperative immune-suppression together with a range of other metabolic and physiological symptoms (138, 156). In addition to this, surgery itself can induce an inflammatory response that can deplete the body’s antioxidant defence mechanisms and lead to a suppression of lymphocyte function, a situation termed immunosuppression (141). And more specifically, gastrointestinal surgery can have a greater effect on patients’ nutritional status, due to fasting before and after surgery, and the fact that procedures are generally performed for the treatment of disorders of the gastrointestinal tract, often which effect pre-operative nutritional status (97, 98).
Immunonutrition is defined as the ability of nutrients to influence the activities of cells of the immune system (134). Immunonutrition involves the administration of supranormal amounts of specific nutrients or combinations of nutrients to produce a pharmacological effect on one or more components of the physiologic and biochemical response to surgery, trauma or infection (95, 135). There is a consensus in the literature that immunonutrition has the ability to minimise the early inflammatory response to surgery and the associated tissue injury, to assist in the restoration of optimal immune and inflammatory responses to prevent infections and morbidity and these effects are above those seen even when compared to iso-nitrogenous and iso-caloric nutrition. (102, 136).

Considerable published literature has examined the role immunonutrition plays in enhancing post-operative outcomes, including several systematic reviews (99, 142, 159, 188), however its use is not yet routine. As the majority of studies have used immunonutrition therapy together with post-operative management that is not considered standard in many hospitals (85, 137, 155, 189, 190), there is potential that clinicians have failed to implement immunonutrition protocols as evidence for its straightforward yet effective application is absent. Also, minimal research exists on the role of immunonutrition according to nutritional status, specifically if similar benefits are seen in both well-nourished and malnourished patients.  

Therefore, the aim of this study was to examine the effect of pre-operative immunonutrition supplementation, in the setting of routine post-operative
management, on length of hospital stay, complication rate and hospital costs in well-nourished and malnourished gastrointestinal surgery patients.
4.2 Methods

4.2.1 Study Design

This was a single centre, prospective, randomised control trial conducted at a major tertiary referral teaching hospital between February 2008 and April 2010. Patients attending pre-admission clinic for major elective upper or lower gastrointestinal surgery were invited to participate in the study and written informed consent by the pre-admission clinic nurse was provided. Patients who were immune-suppressed or had chronic infections were excluded from the study due to possible differential effects of nutritional outcome measures. Also excluded were patients with chronic cardiac or respiratory dysfunction, renal failure or hepatic dysfunction (excluding jaundice) and individuals who were unable to provide consent.

Patients were randomised 1:1 into the treatment or control group by random allocation from sequentially numbered sealed opaque envelopes containing a piece of paper labelled ‘treatment’ or ‘control’. The randomisation process was established by the researcher, and recruitment and random allocation was completed by the pre-admission clinic nurse who had no involvement with the randomisation process.

Prior to surgery, one group of patients (treatment group) received Impact® Advanced Recovery (Nestle Nutrition; Minneapolis, USA, Table 4.1) and were instructed to drink three 237ml packs per day for the five days prior to their
surgery. If bowel preparation was required (depending on surgeons' preferences), the course of the supplement was completed prior to the commencement of bowel preparation. All participants in the treatment group were requested to record their compliance with the prescribed supplement using a provided supplement diary. The second group (control group) received no supplementation, in line with current hospital practice.

Table 4.1 Nutritional composition of Impact® Advanced Recovery (Nestle Nutrition; Minneapolis, USA)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Amount per 237ml pack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>1420kJ</td>
</tr>
<tr>
<td>Protein</td>
<td>18.1g</td>
</tr>
<tr>
<td>- L-Arginine</td>
<td>4.2g</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>44.7g</td>
</tr>
<tr>
<td>Fat (total)</td>
<td>9.2g</td>
</tr>
<tr>
<td>- Saturated</td>
<td>4.4g</td>
</tr>
<tr>
<td>- Monounsaturated</td>
<td>1.8g</td>
</tr>
<tr>
<td>- Polyunsaturated</td>
<td>2.8g</td>
</tr>
<tr>
<td>- Linoleic Acid</td>
<td>1.3g</td>
</tr>
<tr>
<td>- Alpha-linolenic Acid</td>
<td>1.1g</td>
</tr>
<tr>
<td>- EPA</td>
<td>672mg</td>
</tr>
<tr>
<td>- DHA</td>
<td>432mg</td>
</tr>
</tbody>
</table>

At the time of recruitment, baseline anthropometric data such as height, presurgical weight and BMI were determined and recorded. Patients were also assessed for malnutrition using the Subjective Global Assessment (SGA) tool (55). SGA assesses nutrition status via completion of a questionnaire which
includes data on weight change, dietary intake change, gastrointestinal symptoms, changes in functional capacity in relation to malnutrition as well as an assessment of fat and muscle stores and the presence of oedema and ascites, and categorises patients into one of 3 categories; A (well-nourished), B (mildly or moderately malnourished) or C (severely malnourished). The SGA is a validated assessment tool with a high level of reproducibility, detail and specificity along with a high level of correlation between objective and subjective measures and interobserver agreement. All patients were given standard preoperative advice and instructions regarding preoperative fasting and procedures.

On patient admission, surgical and other hospital staff were blinded to the patients’ treatment allocation and all surgical procedures and post-operative medical and nursing care were as per normal clinical treatment management pathways at the hospital. The study researchers were unblinded to the participant’s treatment group after the initial surgery; however, all data collected was objective and quantitative in measure and not subject to potential bias. Over the course of the patients’ admission, researchers obtained outcome measures by direct collection from patients’ medical charts and records.

4.2.2 Outcome Measures

The primary outcome measure was length of hospital stay (LOS)(excluding rehabilitation stay), which was determined by treating physicians (who were blinded to the treatment allocation) based on patients’ clinical progress and
standard hospital procedures. Secondary outcome measures included the number of infectious and non-infectious complications (Table 4.2), antibiotic use, intensive care unit (ICU) admission and mortality. Additional outcome measures such as time to first flatus, time to passing of first stool, commencement of fluid intake and meal consumption (as measured by observational plate wastage data) was collected from charts or by direct questioning of the patient.

Table 4.2 Diagnostic criteria used to define infectious and non-infectious complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Diagnostic Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Respiratory</strong></td>
<td>Abnormal chest radiograph with fever (temperature &gt;37.5°C) treated with chest physiotherapy +/- antibiotics</td>
</tr>
<tr>
<td><strong>Wound infection</strong></td>
<td>Any redness, tenderness or purulent discharge of the wound requiring drainage or antibiotic therapy</td>
</tr>
<tr>
<td><strong>Intra-abdominal abscess</strong></td>
<td>Intra-abdominal collection treated with antibiotic therapy or drainage</td>
</tr>
<tr>
<td><strong>Urinary tract infection</strong></td>
<td>&gt; 10⁷ microorganisms per 1 ml of urine</td>
</tr>
<tr>
<td><strong>Infective diarrhoea (clostridium)</strong></td>
<td>Positive clostridium difficile toxin on stool culture</td>
</tr>
<tr>
<td><strong>Septicaemia</strong></td>
<td>Positive blood cultures treated with antibiotic therapy</td>
</tr>
<tr>
<td><strong>Anastomotic leak</strong></td>
<td>Any dehiscence with clinical or radiological evidence</td>
</tr>
<tr>
<td><strong>Deep venous thrombosis</strong></td>
<td>Thrombosis of the pelvic or deep veins of the thigh</td>
</tr>
<tr>
<td><strong>Pulmonary embolus</strong></td>
<td>Thrombus in the pulmonary arteries proven on radiological imaging</td>
</tr>
</tbody>
</table>

89
Thirty days after discharge, patients were contacted by telephone and asked a series of questions to determine if surgical wound infection was present or if any additional complications had occurred as a result of surgery.

Financial data was obtained for each patient’s direct admission costs from hospital records.

4.2.3 Ethical Approval

Ethical approval for the study was obtained from the Melbourne Health Human Research Ethics Committee and the Deakin University Human Research Ethics Committee. Signed informed consent was obtained from all participants taking part in the study.

4.2.4 Statistical Analysis

Differences in LOS between control and treatment groups were determined by Mann-Whitney U test, with differences between gastrointestinal and nutritional recovery markers calculated using unpaired t-tests. Fisher’s exact was used to determine differences in binomial outcome variables between groups such as the number of unplanned ICU admissions, mortality, complication rates, antibiotic use and 30-day wound infection rates. The z-test was used to calculate the difference between Poisson values for complication rates where multiple complications per patient existed. Two-way ANOVA was used in sub-group analysis based on nutritional status to test for interaction between nutritional
status and LOS between groups. An alpha error of p<0.05 was used to determine
statistical significance in all analyses. Data was analysed using SPSS statistical
software (version 17.0). Results are presented as means ± standard deviations
(SD).
4.3 Results

Ninety-five patients participated in the study, as shown in Figure 4.3. Baseline data presented in Table 4.3 shows participants were well balanced for age, weight and nutritional status at; however, there appeared to be a gender imbalance between the groups (63% males versus 40%; control and treatment groups respectively). The majority of patients underwent lower gastrointestinal surgery (n=85, 89%). Twenty-one per cent of patients were classified as malnourished (SGA B and C combined) and these were evenly represented in both groups.

Figure 4.3 Consort Diagram showing participant flow through the study.
Table 4.3 Patient demographics at baseline

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patients</strong></td>
<td>49</td>
<td>46</td>
</tr>
<tr>
<td><strong>Sex (M/F)</strong></td>
<td>31/18</td>
<td>17/29</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td>64.5 ± 15.3</td>
<td>61.2 ± 13.3</td>
</tr>
<tr>
<td><strong>BMI (kg/m²)</strong></td>
<td>26.3 ± 4.4</td>
<td>26.8 ± 6.2</td>
</tr>
<tr>
<td><strong>Nutritional Status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well-nourished (SGA-A)</td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>Malnourished (SGA-B+C)</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td><strong>Surgery Site</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oesophagectomy</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Partial Gastrostomy</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Whipples</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Hernia Repair</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Ostomy reversal</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Colectomy</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Anterior Resection</td>
<td>17</td>
<td>11</td>
</tr>
<tr>
<td>Rectal Resection</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td><strong>Surgical Time (min)</strong></td>
<td>222 ± 78</td>
<td>194 ± 94</td>
</tr>
</tbody>
</table>

Data presented as mean ± SD; BMI = Body Mass Index, SGA-A = Well-nourished, SGA-B+C = Mildly or moderately malnourished / Severely malnourished, GI = gastrointestinal

An intention to treat analysis of outcome measures of all 95 patients is given in Table 4.4. All patients who were recruited and received surgery have data reported, except for one patient who was unable to be contacted for the 30-day follow-up data, and one patient whose data was excluded from LOS calculations due to inpatient mortality. There was a reduction in LOS of 1.7 days (p=0.11) in the treatment group compared to the control group. Total number of patients experiencing complications was reduced in the treatment group by 30%
(p=0.60), and although there was a 50% reduction in antibiotic use in the
treatment group, this failed to achieve statistical significance (p=0.14). Thirty
day follow up of surgical wound healing progress revealed the number of
patients requiring antibiotics for treatment of a wound infection was halved in
the treatment group when compared to the control group (p=0.26).

Table 4.4 Intention to treat results for full study cohort

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Treatment</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>49</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>LOS (days)</td>
<td>8.8 ± 6.5</td>
<td>7.1 ± 4.1</td>
<td>0.11</td>
</tr>
<tr>
<td>Complications¹</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients with complications</td>
<td>10</td>
<td>7</td>
<td>0.60</td>
</tr>
<tr>
<td>Total number of</td>
<td>14</td>
<td>8</td>
<td>0.20</td>
</tr>
<tr>
<td>complications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unplanned ICU Admissions</td>
<td>3</td>
<td>2</td>
<td>1.00</td>
</tr>
<tr>
<td>Mortality</td>
<td>1</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>Patients given antibiotics &gt; 24 hours</td>
<td>14</td>
<td>7</td>
<td>0.14</td>
</tr>
<tr>
<td>30 day Wound Infection prescribed antibiotics</td>
<td>10</td>
<td>5</td>
<td>0.26</td>
</tr>
</tbody>
</table>

Data presented as mean ± SD; LOS = Length of Hospital Stay, ICU = Intensive Care
Unit. ¹Complications are reported as both the number of patients with one or
more complications and total number of complications (including patients with
multiple complications).

Table 4.5 presents intention to treat outcomes for patients categorised by
nutrition status. Considering only malnourished patients, LOS was reduced by 4
days (p=0.21) in the treatment group, and rates of infection, antibiotic use and
30 day follow up for wound infection were reduced, however not significantly. A
sub-group analysis based on nutritional status to test for interaction between nutritional status and LOS also failed to find statistical significance (p=0.36).

### Table 4.5 Intention to treat results for patients categorised by nutritional status

<table>
<thead>
<tr>
<th></th>
<th>Malnourished Patients</th>
<th></th>
<th>Well-nourished Patients</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Treatment</td>
<td>p-value</td>
<td>Control</td>
</tr>
<tr>
<td>Patients</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients</td>
<td>9</td>
<td>11</td>
<td>NA</td>
<td>40</td>
</tr>
<tr>
<td>LOS (days)</td>
<td>12.3 ± 9.5</td>
<td>8.3 ± 3.5</td>
<td>0.21</td>
<td>8.1 ± 5.6</td>
</tr>
<tr>
<td>Patients with complications</td>
<td>3</td>
<td>2</td>
<td>0.62</td>
<td>7</td>
</tr>
<tr>
<td>Unplanned ICU Admissions</td>
<td>3</td>
<td>1</td>
<td>0.28</td>
<td>0</td>
</tr>
<tr>
<td>Mortality</td>
<td>1</td>
<td>0</td>
<td>1.0</td>
<td>0</td>
</tr>
<tr>
<td>Patients given ABx &gt; 24 hours</td>
<td>4</td>
<td>2</td>
<td>0.34</td>
<td>10</td>
</tr>
<tr>
<td>30 day Wound Infection Rx ABx</td>
<td>2</td>
<td>1</td>
<td>0.55</td>
<td>8</td>
</tr>
</tbody>
</table>

Data presented as mean occasions ± SD; LOS = Length of Hospital Stay, ICU = Intensive Care Unit, Rx = prescribed, ABx = antibiotics. Complications are reported as number of patients with complications.

Overall compliance with nutritional supplement consumption was 91%, with 32 patients consuming all three supplements on each of the 5 days, and only seven patients failing to consume more than three supplements over the 5 days. Only two patients reported adverse effects from the supplement: one a spike in blood sugar levels (in a known diabetic) and another diarrhoea like symptoms.
Serum albumin (where requested by the treating surgeon) was not significantly different between well-nourished patients compared to malnourished patients pre-operatively (38.8g/L compared to 36.2g/L, p=0.18), however post-operatively malnourished patients had a statistically significant decrease in serum albumin compared to well-nourished patients (27.1g/L and 31.2g/L, p<0.005).

Table 4.6 examines gastrointestinal and nutritional measurements associated with post-operative recovery. Time to resumption of bowel function (as measured by the passing of flatus and/or stool) was similar in both the treatment and control groups, with no significant differences detected. Commencement of first fluid intake (either clear or free fluids) and diet was also similar, and no difference in overall meal consumption was observed between groups.
Table 4.6 Gastrointestinal and nutritional markers of post-operative recovery

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Treatment</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>49</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>First passed flatus (POD)</td>
<td>2.8±1.5</td>
<td>2.6±1.6</td>
<td>0.57</td>
</tr>
<tr>
<td>First opened bowels (POD)</td>
<td>3.4±1.5</td>
<td>3.4±1.9</td>
<td>1.00</td>
</tr>
<tr>
<td>Commenced fluids (POD)</td>
<td>1.8±2.5</td>
<td>1.5±1.6</td>
<td>0.49</td>
</tr>
<tr>
<td>Commenced oral diet (POD)</td>
<td>4.2±3.8</td>
<td>3.5±2.4</td>
<td>0.33</td>
</tr>
<tr>
<td>Amount of daily oral diet consumed (%)</td>
<td>65</td>
<td>67</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Data presented as mean ± SD; POD = Post Operative Day

Body weight on post-operative day 4 was available for 29 patients in the control group (59%) and 30 patients in the treatment group (65%). Little effect of the intervention was seen on post-operative weight change, with small weight gains observed in both groups (0.2 ± 4.3kg versus 0.1 ± 4.2kg; control and intervention respectively; p=0.932). However, subgroup analysis based on nutritional status found that malnourished patients (regardless of group allocation) had an average of 2.1 ± 4.8kg weight loss in the post operative period, compared to well-nourished patients who had a 0.6 ± 4.0kg weight gain, which approached statistical significance (p=0.071). Furthermore, irrespective of group allocation, malnourished patients also had higher post-surgical antibiotic use compared to
patients classified as well-nourished (35% versus 23% respectively), however this failed to reach statistical significance (p=0.262).

For all patients who commenced on an oral diet (either light or full ward diet) within 48 hours of their surgery (n=19, 20%) no instances of ileus were reported, however in patients where diet resumption was delayed more than 48 hours, (n=74, 80%), 7 instances of ileus were reported (p=0.095). Nutritional status had no effect on this outcome, (2 versus 5 in malnourished and well-nourished patients respectively, p=0.626).

Nutritional status had no effect on post-operative day of diet resumption, with 26% (n=5) of malnourished patients resuming diet within 48 hours of surgery, and 33% (n=25) of well nourished patients resuming diet within the same time period (p=0.784).

Admission costs were lower in the treatment group with an average cost saving per patient of AUD1576, but this was not statistically significant (p=0.37) (Table 4.7). Considering individual components of treatment cost, nursing cost showed the greatest reduction of AUD1000 per patient within the treatment group (p=0.08).
Table 4.7 Average cost per patient of total admission and components of admission for study participants

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Treatment</th>
<th>Between Group Saving (AUD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Admission Cost (AUD)</td>
<td>17,085 ± 8,341</td>
<td>15,509 ± 8,422</td>
<td>1,576</td>
<td>0.37</td>
</tr>
<tr>
<td>Nursing Cost (AUD)</td>
<td>4,769 ± 3,346</td>
<td>3,769 ± 1,929</td>
<td>1,000</td>
<td>0.08</td>
</tr>
<tr>
<td>Allied Health Cost (AUD)</td>
<td>495 ± 538</td>
<td>376 ± 422</td>
<td>119</td>
<td>0.24</td>
</tr>
<tr>
<td>Pathology Cost (AUD)</td>
<td>1,187 ± 723</td>
<td>1,006 ± 661</td>
<td>181</td>
<td>0.21</td>
</tr>
<tr>
<td>Imaging Cost (AUD)</td>
<td>267 ± 610</td>
<td>184 ± 356</td>
<td>83</td>
<td>0.43</td>
</tr>
<tr>
<td>Pharmacy Cost (AUD)</td>
<td>503 ± 557</td>
<td>455 ± 574</td>
<td>48</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Data presented as mean ± SD; AUD = Australian Dollars
4.4 Discussion

This study examined the influence of a preoperative immunonutrition supplement on postoperative outcomes in elective upper and lower gastrointestinal surgery patients. Supported by a large amount of published literature, it was hypothesised that this study would show that use of an inexpensive and easy to implement immuno-enhancing supplement would improve outcomes and reduce costs associated with elective gastrointestinal surgery, with a greater benefit seen in malnourished patients.

As immunonutrition has been shown to reduce post-operative LOS due to its ability to reduce the post-operative inflammatory response and immune-suppression phase, it was hypothesised that pre-operative supplementation with an established dose of a commercially available and previously tested formula (142, 160) would show a reduction in LOS of 2 days. Although this trial demonstrated a positive trend for a decreased LOS of 1.7 days following preoperative supplementation, it did not achieve statistical significance despite the likely clinical significance of the findings. This lack of statistical significance plausibly lies in the study being underpowered. In addition, it was hypothesised that pre-operative supplementation with immunonutrition would lead to a decrease in post-operative complications. A trend towards fewer complications in the treatment group was demonstrated, however this failed to reach statistical significance. Statistically significant differences were likely not observed due to inadequate participant numbers, and the fact that overall surgical complication rates were low.
A further hypothesis of the study was that nutritional status would have an effect on outcomes, given that that pre-operative nutritional status is an important determinant in post-operative recovery. Research has shown that malnourished patients are at elevated risk of morbidity and mortality due to a higher post-operative inflammatory response and immune suppression (100, 191) therefore it was hypothesised that a more substantial benefit would be seen when using immunonutrition in these patients. When considering only the malnourished patients, the LOS difference between the treatment and control groups increased from 1.7 to 4 days, favouring the treatment group. With respect to complication rate, again only considering the malnourished patients, complications were further reduced in the treatment group both during hospital admission and in the 30 day post-discharge period when compared to the control group. Again, these finding were not statistically significant, however, this study was unique in that statistical analysis considered the impact of nutritional status on outcome measures.

In addition, when considering only nutritional status, it was hypothesised that malnourished patients would have worse outcomes than well-nourished patients, regardless of randomisation. However, this was not statistically supported. Although weight loss in the immediate post-operative period was greater in malnourished patients, and in fact well-nourished patients gained a small amount of weight over this time, statistically significant differences were not detected. This may be due to an inadequate sample size (as discussed in more detail following) or due to fluid shifts commonly seen in all patients undergoing gastrointestinal surgery relating to intra and post-operative
intravenous fluid administration (192). Nutritional status also had no impact on ileus development. As malnourished patients are considered at higher risk of developing post-operative complications, they are often treated more conservatively, and more specifically, diet resumption is often delayed (193). This was not supported in the current study, with similar numbers of malnourished and well-nourished patients resuming diet within 48 hours of surgery. Interestingly, no occurrences of ileus were seen in any patients provided diet within 48 hours of surgery, regardless of randomisation and nutritional status. This finding is supported by the literature, with early feeding (defined as resumption of diet within 48 hours of surgery) thought to help prevent post-operative ileus (104, 119, 194). Resumption of food and fluids post-operatively is thought to stimulate the gastrointestinal tract (195).

Although there is a lack of rigorously designed studies to support this assumption (due to a lack of disclosure of confounding elements also thought to have an effect on gastric motility such as analgesia use, nasogastric tubes and initiation of oral feeding (127, 196)), a meta analysis exploring the effect of chewing gum on prevention of post-operative ileus and stimulation of gastric motility has shown positive findings (197). These findings analysed seven trials with 272 patients, where time to first flatus was reduced by 17% (p=0.005) and time to first bowel motion was reduced by 22% (p<0.001) by chewing gum for at least 30 minutes three times per day from post-operative day one. A non-significant trend towards a reduction in length of stay was also noted (12% reduction in hospital stay length, p=0.11).
While positive trends were seen in all outcome measures in favour of immunonutrition intervention, failure to reach statistical significance likely resulted from an underpowered trial, with power calculations indicating a larger sample size of 150 patients were required compared to the 95 recruited for the current study. Not achieving adequate power was a consequence of slow patient recruitment. Data collection was carried out over a 26-month period; therefore, to reduce the influence of procedural differences (due to changing technologies and variation in surgeon techniques and hospital procedures) as a confounder to LOS, the decision to cease recruitment was made. Despite this, the results of this study appear valid when compared to other published literature, some of which also failed to reach statistical significance (140, 198). However, when considered as part of a systematic review and meta-analysis (62, 160, 188), they lead to findings that immunonutrition use contributes to statistically significant reductions in LOS (mean reduction of 2.12 – 3.1 days; p<0.001) and infection rates (OR 0.46-0.49; p<0.001), results that support the magnitude of changes observed in the current study.

While being under-powered is one likely reason the study failed to reach statistical significance, a further explanation could be that the absolute LOS observed during this study (8.8±6.5 and 7.1±4.1 days for control and treatment groups respectively) was far lower than many published trials. Two separate studies examining the effect of preoperative immunonutrition on postoperative outcomes both reported average LOS findings of 14.0 and 12.0 days in the control groups and 12.5 and 9.0 days in the treatment groups respectively (199, 200). Other studies that considered peri-operative immunonutrition use
reported LOS data as high as 29 days (201), with an average of 15.7 days in the control group and 13.9 days in the treatment group (133, 140, 202, 203). It is thought that other techniques not considered as part of this trial (including some components of fast track and enhanced recovery after surgery (ERAS) protocols that are followed at The Royal Melbourne Hospital) may have influenced overall LOS, causing the shorter duration of admission shown in these results, meaning the effect of immunonutrition on LOS was reduced.

A final aim of this study was to investigate whether the use of immunonutrition could be practically and financially justified. In order to determine this, immunonutrition was compared to standard care (no supplementation). Many other publications considered peri-operative immunonutrition use, as opposed to only pre-operative supplementation. Post-operative administration of supplementation is difficult to implement due to many surgeons preferences of diet resumption in the post-operative period. Protocols that require supplementation be administered within the first 24 h post-operatively are often met with resistance by surgeons due to concerns over vomiting and anastomotic breakdown (203). To minimise this difficulty and to ensure practical application, pre-operative supplementation was provided, with all post-operative care under the direction of the treating surgeon.

Based on tender pricing, the cost of the nutritional supplement was AUD3.40 per serving, which equates to a price of AUD51 per 5-day course (204). In consideration of actual cost data for this study cohort, a saving of AUD1576 per patient easily justifies the cost of preoperative immunonutrition.
supplementation. Although few papers have considered the economic benefit of immunonutrition therapy, one study did report a saving of €1,250 per patient (205). Importantly, cost reductions were observed in both nursing and allied health components of patient care. This reduction is suggestive of a decrease in time spent treating patients by those health care providers, which also may have positive effects on health care systems. Not only are the financial savings of benefit to hospitals, but any LOS reduction can have a positive effect on ongoing pressure for bed availability with the potential to provide treatment to greater numbers of patients occurring when shorter treatment durations exist. Additionally, the benefit to individual patients should not be overlooked, especially given that earlier discharge can reduce the exposure of an at risk population to an environment where infection risk is high (206).

With respect to the application of immunonutrition, it appears as a group, gastrointestinal surgery patients are often considered at greatest risk of malnutrition due to cancers (and their treatment) or other conditions causing a decrease in nutrient absorption and intake, often coupled with a rise in metabolic rate and immune suppression (186, 198). And although it has already been determined that immunonutrition administered at a dose of 500mL to 1000mL per day for a duration of 5 to 7 days pre-operatively (compared to peri- or post-operatively) (160, 188), the patient group(s) most likely to benefit have not yet been determined (198). Although this study did not measure lymphocyte, immunoglobulin, T cells or other markers of inflammation or immunity, many other published trials have shown that providing
immunonutrition can positively influence these parameters when compared to control formulas (190, 203).
4.5 Conclusions

The results of this study show a non-significant, but clinically meaningful trend towards a decrease in LOS and infection rate through the administration pre-operative immunonutrition supplementation, however there is a need for additional research with greater patient numbers. There also appears to be a greater benefit of immunonutrition to malnourished patients, however its use in well-nourished patients should not be overlooked.
Chapter Five – Nutritional management of gastrointestinal surgical patients in Victoria’s public hospitals

5.1 Introduction

As previously established in earlier chapters, malnutrition identification via validated screening and assessment tools is a necessary process to identify patients requiring nutrition intervention. Considering poor nutritional status has a strong influence on clinical outcomes in hospitalised patients, exemplified by increased infection and complication rates, compromised wound healing, longer lengths of hospital stay and greater morbidity and mortality result (207-210). Recent Australian studies report malnutrition rates in hospitalised patients to be approximately 35%, (162, 182, 211, 212), however there are specific patient populations within hospitals who have higher malnutrition rates than the reported average. For example, gastrointestinal surgery patients are at higher risk of malnutrition due to often compromised nutritional intake pre-operatively, or fasting and fluid diets habitually prescribed post-operatively (33, 85, 207, 213). A recent New Zealand study reported malnutrition rates in elective surgery patients of 38% (214), highlighting that high rates of malnutrition are established in this patient population.

When considering that patients undergoing elective gastrointestinal surgery who are well nourished have improved outcomes than those who are malnourished, the importance of ensuring proper identification of poor nutritional status, and adequate nutrition intervention prior to and after surgery
is imperative. Historically, gastrointestinal surgical patients underwent significant periods of fasting, often both pre- and post-operatively, due to concerns of gastric aspiration, post-operative ileus and anastomotic breakdown (82, 129). This practice has came about as surgical training has historically been informed by the guild system, where teachers (surgeons) pass on their expertise and surgical method to their students (resident doctors) (193). As these traditional surgical approaches have been considered successful by standard measures, and (until recently) have been unchallenged by way of randomised and controlled evidence based studies, traditional practices have remained in place (193). In recent years, these practices have been challenged, with the publication of evidence based guidelines around surgical patient management (103-105). These guidelines cover all aspects of nutritional care, including reduced pre-operative fasting times, nutritional supplementation, intraoperative fluid, pain and surgical management, post-operative pain and nausea relief and early introduction of oral diet, as well as early mobilisation and discharge. There are also recommendations regarding pre-surgery nutritional assessment and post-operative follow-up. Further, recent Cochrane and systematic reviews regarding pre-operative and post-operative nutrition support in gastrointestinal surgery concluded these aforementioned management practices lead to accelerated recovery, with reduced rates of infections, length of hospital stay (LOS) and healthcare cost (113, 119, 194, 215).

Despite the existence of strong clinical evidence regarding the nutritional management of gastrointestinal surgical patients, many hospitals have failed to, or been slow at, implementing these recommendations due to difficulty
accepting the evidence or questioning that their organisation has the ability to follow ERAS pathways. (193, 216, 217). Amplifying this problem, in many cases, dietitians are not the main decision-maker in the management of patients pre- and post-operative nutritional intake, and are reliant on instruction or permission from the treating surgical team, and this communication can at times be poor or lacking (216). Evidence also shows that understanding other organisations’ current nutrition practices related to gastrointestinal surgery as well as barriers and enablers to successful implementation of evidence-based guidelines is a key first step to practice change (218).

Therefore, the aim of this study is to investigate the current routine pre-, peri- and post-operative nutritional management of gastrointestinal surgery patients in Victorian public hospitals and to compare current nutritional management to best practice guidelines, whilst identifying barriers preventing implementation of best practice nutritional management and identifying ways to overcome these.
5.2 Methods

5.2.1 Survey Development

To investigate the current routine pre-, peri- and post-operative nutritional management of gastrointestinal surgery patients in Victorian public hospitals, a survey tool was developed. In the absence of a previously published survey assessing nutritional management of upper and lower gastrointestinal surgery patients, a questionnaire was developed for telephone use consisting of 30 questions under the following categories: demographics; pre-admission; inpatient stay; post-operative follow up; and nutrition department (Table 5.1). Questions were formulated to address both the aims of the study and to explore any distinctive features about hospital and nutrition department size and location, and dietitians experience in the area of gastrointestinal surgery.

Questions were focused on important aspects of nutritional care for patients undergoing gastrointestinal surgery such as patient access and referral, routine management, decision making and perceived barriers and enablers to providing best practice nutrition management. Patient access and referral was assessed by identifying points in time along the patient’s continuum of care where a dietitian can perform assessments or reviews, or provide nutrition advice, or where others are able to carry out nutrition screening. Routine management was identified by direct questioning about usual pre-, peri- and post-operative care, as was decision making, and this information was benchmarked with published best practice guidelines (103-105). Perceived barriers and enablers were documented using open-ended questions.
Due to state-based models of care and funding in Australian hospitals, and the evidential difference between allied health funding between the public and private sector, the target population used for this study was restricted to Victorian public hospital dietitians.

Table 5.1 Survey questions as asked to participants

<table>
<thead>
<tr>
<th>Question</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How would you describe the location of your hospital?</td>
<td>Inner City Metropolitian Rural / Regional</td>
</tr>
<tr>
<td>2. How many beds does your hospital have?</td>
<td>0-200</td>
</tr>
<tr>
<td></td>
<td>200-400</td>
</tr>
<tr>
<td></td>
<td>400+</td>
</tr>
<tr>
<td>3. What type of gastrointestinal surgery does your hospital offer?</td>
<td>Upper</td>
</tr>
<tr>
<td></td>
<td>Lower</td>
</tr>
<tr>
<td>4. How many surgeons work in each unit?</td>
<td>Numeric</td>
</tr>
<tr>
<td>5. Do you work in</td>
<td>Upper</td>
</tr>
<tr>
<td></td>
<td>Lower</td>
</tr>
<tr>
<td></td>
<td>Both</td>
</tr>
<tr>
<td>6. Have you noticed a significant difference between surgeons in the same unit and the way they manage their patients’ pre and post operatively? If yes, please give details.</td>
<td>Free text</td>
</tr>
<tr>
<td>7. Do you / does a dietitian attend pre-admission clinic (PAC)?</td>
<td>Yes/No</td>
</tr>
<tr>
<td>a. If yes, what basis is it on?</td>
<td>Referral only</td>
</tr>
<tr>
<td></td>
<td>Regular</td>
</tr>
<tr>
<td>8. Does any form of nutrition screening or assessment occur in PAC?</td>
<td>Yes/No/Unsure</td>
</tr>
<tr>
<td>a. If yes, who completes it?</td>
<td>Nurse / Doctor / Dietitian / Nutrition Assistant</td>
</tr>
<tr>
<td>b. What tool us used?</td>
<td>Free Text</td>
</tr>
<tr>
<td>c. What is the outcome? (Supplement prescription,</td>
<td>Free Text</td>
</tr>
<tr>
<td>Question</td>
<td>Response Type</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>10. Do any patients receive routine nutritional supplements pre operatively?</td>
<td>Yes/No</td>
</tr>
<tr>
<td>a. If yes, which one(s)?</td>
<td>Free Text</td>
</tr>
<tr>
<td>11. Do you attend ward rounds?</td>
<td>Yes/No</td>
</tr>
<tr>
<td>12. Do you have any pathways / protocols for managing malnourished GI surgical patients?</td>
<td>Yes/No</td>
</tr>
<tr>
<td>13. Does your hospital currently use any aspects of the ERAS program?</td>
<td>Yes/No</td>
</tr>
<tr>
<td>a. If yes, please give details</td>
<td>Free Text</td>
</tr>
<tr>
<td>15. Who do you feel makes these decisions?</td>
<td>Surgeon/Dietitian Nurse/Surgeon and Dietitian combined</td>
</tr>
<tr>
<td>16. Do you routinely provide your patients with supplements during their IP stay?</td>
<td>Yes/No</td>
</tr>
<tr>
<td>17. Are you satisfied with the way your patients are nutritionally managed?</td>
<td>Yes/No</td>
</tr>
<tr>
<td>a. If no, please give details</td>
<td>Free Text</td>
</tr>
<tr>
<td>18. What changes do you think are needed (by hospital management, surgeons, nurses, dietitians or other staff) to enable you to provide best practice nutrition care to your patients?</td>
<td>Free Text</td>
</tr>
<tr>
<td>19. If you have been successful with changes / implementation of new dietetic care in the past, what did you do to achieve this success?</td>
<td>Free Text</td>
</tr>
<tr>
<td>20. Are you able to follow up your patients after discharge?</td>
<td>Yes/No</td>
</tr>
<tr>
<td>a. If yes, how and where</td>
<td>Free Text</td>
</tr>
<tr>
<td>21. Is there a dietitian regularly attending a GI surgery OP clinic to follow up patients?</td>
<td>Yes/No</td>
</tr>
<tr>
<td>22. How would you rate your confidence working in GI surgery</td>
<td>5 Point Likert</td>
</tr>
</tbody>
</table>
if 1 meant not at all confident and 5 meant extremely confident?  Scale

23. How supported do you feel working in GI surgery by all colleagues (dietetics, surgical, nursing etc.), if 1 meant very unsupported and 5 meant very well supported?  5 Point Likert Scale

24. How many EFT (equivalent full time staff) does your nutrition department have?  1-5/6-10/11-15/15-20/>20

25. How many dietitians (persons) work in GI surgery?  1/2/>2

26. How many EFT is allocated to GI surgery?  <0.2/0.2-0.39/0.4-0.59/0.6-0.79/≥0.8

27. How many years have you worked in GI surgery?  ≤1/1-2/>2

28. Do you feel supported by your employer to attend professional development activities / conferences relevant to GI surgery?  Yes/No

29. Are you a member of any interest groups / journal clubs specific to GI surgery?  Yes/No

30. What do you think is needed as far as professional development or training to support GI surgery dietitians?  Free Text

ERAS = enhanced recovery after surgery, FTE = Equivalent full time, GI = gastrointestinal, NG = nasogastric, OP = out-patient, PAC = pre-admission clinic, PD = professional development.

5.2.2 Survey Pilot

The survey was piloted in New South Wales with four gastrointestinal surgery dietitians identified through professional links made through the Dietitians Association of Australia, which resulted in minor revision of three questions and the development of the finalised survey tool.
5.2.3 Hospital and Participant Identification

Victorian public hospitals were identified via a Government website listing all public health services across Victoria (219). Where possible, hospital websites were examined to identify the presence or absence of gastrointestinal surgery occurring at each health service, and a contact email address for the dietitian(s) responsible for gastrointestinal survey patients or the nutrition department collected. Where any of the aforementioned information was unavailable, health services were contacted by phone to collect this information. Forty-one dietitians were identified and contacted from 31 public hospitals and invited to participate in the telephone survey via email that contained a plain language statement regarding the study purpose. If no response was received after one week, a follow up email was sent again inviting participation. If no response was received after a further week, the dietitian at that hospital was not contacted further.

5.2.4 Survey Undertaking

All respondents who agreed to take part in the survey were telephoned over a three-week period in December 2013. Survey responses were categorised as being related to either upper or lower gastrointestinal surgery, and where a dietitian covered both units, the questions were asked twice (once for each unit) and responses were counted separately. Where two dietitians within one hospital worked in gastrointestinal surgery (one in upper and one in lower), they were both invited to participate and their answers were recorded separately.
Where two dietitians shared the one unit, only the response from the senior dietitian was recorded. To minimise bias, the same researcher conducted all of the interviews from a set script and questions were always asked in the same order.

5.2.5 Statistical Analysis

To assess associations between departmental variables (size, dietitian experience and dietetic time) and outcomes such as traditional versus non-traditional return to diet and dietitian satisfaction with nutritional management, chi-squared analysis was used. An alpha error of p<0.05 was used to determine statistical significance in all analyses. Data was analysed using SPSS statistical software (version 17.0). The study received ethical approval from Deakin University Human Ethics Advisory Group in the Faculty of Health.
5.3 Results

5.3.1 Demographics

Forty-one hospitals where gastrointestinal surgery was performed were identified and their nutrition departments contacted, with dietitians from 26 hospitals consenting to be involved. Of these 26, all but one could be contacted for the survey itself, giving a final response rate of 61%. Of the 25 hospitals represented, there were 8 occasions where upper and lower gastrointestinal surgery patients were managed by different dietitians who both recorded a response, giving a total 33 survey responses (14 dietitians involved in the management of upper gastrointestinal patients and 19 dietitians involved in the management of lower gastrointestinal dietitians, Figure 5.3).
Figure 5.3 Flow chart diagram showing hospital recruitment and dietitian participation

UGI = upper gastrointestinal surgery, LGI = lower gastrointestinal surgery.

Hospital demographics are shown in Table 5.2, and nutrition department demographics are shown in Table 5.3. Due to differences in the nutritional management of patients (as evidenced by best practice guidelines), results for upper and lower gastrointestinal surgery are presented separately.
<table>
<thead>
<tr>
<th>Location</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner City</td>
<td>6 (24%)</td>
</tr>
<tr>
<td>Metropolitan</td>
<td>9 (36%)</td>
</tr>
<tr>
<td>Rural / Regional</td>
<td>10 (40%)</td>
</tr>
</tbody>
</table>

**No. of Beds**

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;200</td>
<td>9 (36%)</td>
</tr>
<tr>
<td>200-400</td>
<td>8 (32%)</td>
</tr>
<tr>
<td>&gt;400</td>
<td>8 (32%)</td>
</tr>
</tbody>
</table>

**Type of Surgery Offered**

<table>
<thead>
<tr>
<th>Type of Surgery Offered</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only Upper GI</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Only Lower GI</td>
<td>10 (40%)</td>
</tr>
<tr>
<td>Both</td>
<td>15 (60%)</td>
</tr>
</tbody>
</table>

GI = gastrointestinal
Table 5.3 Nutrition department demographics

<table>
<thead>
<tr>
<th></th>
<th>Upper GI Surgery</th>
<th>Lower GI Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Departmental FTE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-5</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>6-10</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>10-15</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>16-20</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>FTE in GI surgery</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 0.2</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>0.2-0.4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>0.4-0.6</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Average no. years worked in GI surgery</strong></td>
<td>3.3</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Average self-rated confidence working in GI surgery</strong></td>
<td>4 (2-5)</td>
<td>4 (1-5)</td>
</tr>
<tr>
<td><strong>Average self-rated support from team/department working in GI surgery</strong></td>
<td>4 (3-5)</td>
<td>4 (3-5)</td>
</tr>
</tbody>
</table>

FTE = full time equivalents; GI = gastrointestinal

5.3.2 Pre-Admission Clinic

Very few dietitians provide a service to pre-admission clinic (PAC), with only two upper gastrointestinal surgery dietitians regularly attending clinic to formally assess patients and provide nutritional advice pre-surgery. No lower gastrointestinal dietitians attend a PAC. Despite dietetic absence from PAC, 64% of upper gastrointestinal PACs and 37% of lower gastrointestinal PACs had regular nutrition screening, however in 6 of the 16 clinics where nutrition screening occurs, patients do not receive any nutritional intervention until after
surgery. Additionally, only 12% (n=2) of PACs were funded specifically for
dietetic services, despite the generation of dietetic referrals from nutrition
screening. Only two hospitals offered upper gastrointestinal patients routine
pre-operative supplementation (both using immunonutrition supplementation),
however 31% of PACs (n=6) offered lower GI patients pre-operative
supplementation (either carbohydrate supplements, immunonutrition or
standard supplements or a combination of these).

5.3.3 In-Patient Stay

For both upper and lower gastrointestinal surgery, dietitians felt uninvolved in
nutritional decision-making, and unsatisfied with the current nutritional
management of their patients. In upper gastrointestinal surgery, eight dietitians
(57%) reported patients routinely received jejunal feeding tubes post major
upper gastrointestinal surgery; however, in only five hospitals are feeds started
within 24 to 48 hours of surgery. Two hospitals reported total parenteral
nutrition (TPN) is used as standard nutrition support post operatively after
upper gastrointestinal surgery. When dietitians were asked which nutritional
management they would prefer to implement post upper gastrointestinal
surgery, 65% reported they would like to be able to increase feed rate sooner,
and 33% wanted to participate in pre- and post-admission clinics with the team.

In lower gastrointestinal surgery, although half of the respondents reported
using components of the enhanced recovery after surgery (ERAS) program, only
one site (6%) had implemented the full ERAS program. Two sites reported a
successful funded trial of ERAS, however once funding expired the programs did not continue due to the lack of a program driver. In more than half of the hospitals where ERAS was being followed, the program is not extended to all patients, with surgeons hand-picking patients to participate, or only certain elements of the program being implemented. Two hospitals reported TPN is used routinely after lower gastrointestinal surgery. When asked what changes in nutritional management dietitians would like to see, of 18 respondents, 61% (n=11) wanted a faster return to diet, 27% (n=5) wanted consistent management form all surgeons, and one response each for a clinical pathway and better team communication.

In upper gastrointestinal surgery, only two dietitians reported regularly attending clinic with the team to follow up patients. In lower gastrointestinal surgery, no dietitians reported regularly attending clinic. In both upper and lower gastrointestinal surgery, 64% (n=9) and 77% (n=14) dietitians respectively reported the ability to be able to follow up patients post operatively via an alternative method, however many of these methods do not have specific time allocated to them, are done over the telephone or in a clinic waiting room. Four dietitians reported not being able to follow up patients at all.
### Table 5.4 Inpatient stay characteristics of upper and lower gastrointestinal surgery patients

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Upper GI Surgery Patients</th>
<th>Lower GI Surgery Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Dietitian participates in ward round</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Pathway for management of malnourished patients</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>Use components of ERAS</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Follows ‘traditional’ return to diet</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Dietitian feels they have involvement in nutritional decision making</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Patients provided routine supplements</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Overall, dietitian satisfied with nutritional management</td>
<td>13</td>
<td>1</td>
</tr>
</tbody>
</table>

GI = gastrointestinal; ERAS = enhanced recovery after surgery; N/A = not applicable

5.3.4 Influence of Dietitian Experience, Workload and Department Size

Statistical analysis was performed to assess if there was any relationship between factors such as full time equivalent (FTE) allocation in gastrointestinal surgery workloads, dietitians’ years of experience working in gastrointestinal surgery, or department size on the prevalence of traditional versus non-traditional return to diet, or dietitians’ satisfaction with current patient
nutritional management. In the majority of these analyses, no statistically significant findings were observed (Table 5.5).

There was only one hospital where the dietitians reported satisfaction with the dietetic care their patients were receiving (p=0.002). In this Centre, there was a pathway in place that dictated the nutritional management of all patients admitted for upper and lower gastrointestinal surgery, in line with current best practice guidelines, as opposed to clinical judgment being used to dictate clinical care. In addition to this, nutrition department size had a significant effect on dietitian satisfaction with nutritional management of patients (p=0.001), a finding that appeared independent to FTE allocation to surgery (p=0.121).

Table 5.5 Relationship between differing factors on the prevalence of return to diet and dietitian satisfaction with nutritional management

<table>
<thead>
<tr>
<th></th>
<th>Traditional Return to Diet</th>
<th>Dietitian Satisfaction with Nutritional Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTE Allocation</td>
<td>p=0.194</td>
<td>p=0.913</td>
</tr>
<tr>
<td>Dietitian Experience</td>
<td>p=0.556</td>
<td>p=0.742</td>
</tr>
<tr>
<td>Department Size</td>
<td>p=0.185</td>
<td>p=0.001</td>
</tr>
<tr>
<td>Presence of Pathway</td>
<td>p=0.148</td>
<td>p=0.002</td>
</tr>
</tbody>
</table>

FTE = full time equivalent

5.3.5 Facilitation of Change

When asked what was needed to facilitate change within their hospitals, dietitians reported a mix of strategies, with the majority 70% (n=19) calling for increased dietetic funding to enable additions to current program (for example...
clinic attendance, pre-operative nutrition screening and intervention and attendance on ward rounds for better relationships with surgical teams) or the implementation of a nutritional management pathway that is either led or has significant input from surgeons alongside dietitians to ensure its implementation and success.
5.4 Discussion

This study has captured the usual pre- and post-operative nutritional management practices of the majority of upper and lower gastrointestinal surgery patients in Victoria’s public hospitals. With a sound response rate, the results from this study allow dietitians working in gastrointestinal surgery to compare their nutritional management of patients with others in a similar setting, and provide some insight into implementation strategies that have been successful for others in bringing about change towards best practice. The results also contribute valuable insights into establishing clear recommendations for achieving best practice nutritional care to gastrointestinal surgery patients as part of the work encompassed by this thesis.

The management of the gastrointestinal surgery patient population varies significantly between health care sites. Overall, nutritional management of gastrointestinal surgery patients was shown to be primarily at the discretion of the treating surgical team, with dietitians reporting little involvement in decisions regarding diet prescription, provision of nutrition support and diet progression. It was hypothesised that team involvement by the dietitian (as indicated by FTE allocated to the workload), or dietitian experience (as indicated by number of years working in gastrointestinal surgery) would increase dietetic profile and therefore allow for greater sharing of responsibilities relating to nutrition provision, however this was not found to be the case. In fact, there was only one site where the dietitians felt satisfied and involved in decision making in respect to nutritional management, and this was attributed to the existence of a management pathway developed by the multi-disciplinary team, specifying
standard nutritional intervention for all patients. Published literature supports the use of management pathways to enhance and streamline the implementation and use of evidence based practice in routine care. Most notably in lower gastrointestinal surgery, the development and use of ERAS guidelines (114) has shown reduced length of stay by 2.55 days (p<0.001) and complication rates reduced 53% (p<0.001) in patients after major open colorectal surgery (194). Other examples where clinical pathways have improved nutritional care include use of enteral feeding protocols (220), early nutrition initiation in intensive care units (221) and prevention of unnecessary parenteral nutrition use after surgery (222). In addition, these findings support the role of a cohesive multidisciplinary team approach to patient care, not individual health care workers considering only one aspect of patient recovery.

One limitation to this study was the difficulty of measuring via a telephone survey a direct link between actual patient outcomes and presence of a clinical pathway. However, given the large body of evidence that exists discussing this to be the case in other hospitals, as mentioned above, it is a fair assumption that if implemented in Victorian hospitals, similar improvements would occur.

Although department size was shown to have a significant effect on dietitian satisfaction with nutritional management of patients, this appeared independent of FTE allocation to the gastrointestinal surgical workload. Perhaps this finding can be explained by increased support and mentoring available to staff working in larger departments. Mentoring has been shown to be beneficial in grooming junior dietitians for senior roles and supporting knowledge and skill development (223-226). A recent Australian case study evaluating mentoring in
dietitians described several themes and descriptors identified when exploring mentoring partnerships, which included the importance of mentoring in facilitating professional development and strategic development for change (226). It described benefits to the mentee such as encouragement of risk-taking and professional recognition. These are both important skills when working in a team environment such as a surgical ward, where advocating for proper nutrition for patients is a key element to the dietitians’ role.

Considering the upper gastrointestinal patient population, published guidelines from large international organisations (103, 105, 227) state that nutrition screening and nutrition support (if indicated) prior to surgery should be mandatory, however in this study, only 14% (n=2) of sites performing upper gastrointestinal surgery have funding for a dietitian to attend PAC. In a further two sites, screening occurs by a nurse, then subsequently, a dietitian provides phone or in person consultation with the patient, but this is outside their funded role. The same guidelines also recommend initiation of oral intake early after surgery, and the use of enteral nutrition within 24 h if oral nutrition cannot be initiated. Only 29% (n=4) of sites performing upper gastrointestinal surgery report routine initiation of enteral nutrition within 24 hours of surgery, while another three sites provide ad-hoc enteral nutrition to some patients and commence feeding approximately 48 h after surgery.

A recent Australian study looking at the nutritional status of upper gastrointestinal patients six months or greater after surgery showed that patients lose approximately 9% of body weight within this timeframe (228). It concluded ongoing management and support of these patients is required.
However, of the sites surveyed in this study, only two provided funded, routine post-operative follow up to their upper gastrointestinal surgery patients, potentially placing these patients at greater risk of post-operative weight loss.

Within the lower gastrointestinal surgery population, there are again clear published guidelines discussing best practice management of these patients (103, 105), including specific guidelines such as ERAS (104). ERAS guidelines provide recommendations for various aspects of management, including nutritional management of patients undergoing elective lower gastrointestinal surgery; pre-operative nutrition; fasting guidelines; resumption of diet post operatively; and nutritional supplement use. From the study conducted herein, no sites had a funded dietitian in their PAC for lower GI surgery. However despite this, 31% (n=6) of hospitals do provide some supplementation, although often this supplementation does not meet recommended guidelines. In addition, despite published meta-analysis showing a reduction in length of stay and infections in patients following ERAS (194), only one surveyed site reported implementation of the full program and extension to all patients, with a further three sites reporting only some surgeons implementing some elements of ERAS and not to all patients.

A recent publication from a quaternary referral hospital in Sydney provided an qualitative overview of barriers to implementation of ERAS (216). They reported four key-themed areas of practice that presented barriers: patient-related, practice-related, staff-related and resource-related. In the aforementioned study, dietitians were asked what they perceived as barriers to implementation of best practice management in lower gastrointestinal surgery
were, with responses highlighting changes needed mostly in practice-related (attendance at clinic or ward rounds, presence of a care pathway and regular auditing or professional development discussing ERAS) and staff-related (better communication and teamwork) areas. For both of these practice areas, additional time investment by clinicians would be the only major resource required to achieve this.

Post-operatively, no lower gastrointestinal dietitians reported regularly attending a funded outpatient clinic to follow up patients. Published guidelines report the need to monitor nutritional parameters such as weight, nutritional intake and bowel function until stable (105), however, a timeframe for this is not provided. There appears to be minimal published information regarding long term nutritional status of lower gastrointestinal surgery patients, however with 77% of surveyed dietitians reporting that following up patients after discharge was not allocated dietetic funding, and often occurred in clinic waiting room or via telephone, it appears there is a need for an allocation of hours to allow for such intervention.
5.5 Conclusions

This study shows that the nutritional management of gastrointestinal surgery patients varies considerably at different hospitals, and that overall, adherence to published best practice guidelines in Victorian public hospitals is infrequent. The presence of a protocol for management of gastrointestinal surgery patients greatly improves compliance to best practice, which has been shown elsewhere to improve patient outcomes. Increased presence by the dietitian at clinic and ward rounds was identified as an enabler for better adherence to best practice, as was greater staff communication and teamwork. Further research involving other members of the multidisciplinary team (including surgeons and nurses) would assist in better understanding barriers to best practice nutritional management of gastrointestinal patients.
Chapter Six – Conclusions and Future Directions

6.1 Summary of Major Findings

The work presented in this thesis provides insight into the local scale of an international problem. The three studies conducted describe the prevalence of malnutrition in a representative tertiary teaching hospital, consider the application of malnutrition treatment in the gastrointestinal surgery patient group and present the current nutritional management of surgical patients, with an emphasis in all studies on simple and effective implementation strategies to improve patient and health care system outcomes.

The first study showed that malnutrition prevalence rates were similar to those reported in the literature, and that almost one in five hospitalised patients are malnourished. It also reinforced the need for mandatory nutrition screening in hospitals, due to the large numbers of patients found to be malnourished that received no dietetic intervention or treatment for their condition. The study also went beyond that of other published works, by looking specifically at dietetic documentation of malnutrition because of the relationship between correct documentation and adequate hospital reimbursement. It showed that dietitians were not always adequately documenting patients’ nutritional status within their dietetic assessment, and highlighted the need for education to rectify this.
In a follow up to the first part of this study, education on the importance of malnutrition documentation and assessment was performed for dietitians within the hospital, as was the introduction of a new nutrition assessment form which was developed along side medical coders to ensure accurate detection of malnutrition for reimbursement purposes. The implementation of these strategies was then audited to assess their success. Results showed that these strategies were effective at improving malnutrition documentation, but highlighted the ongoing need for nutrition screening to identify at risk patients for dietetic referral and treatment.

The second study looked specifically at gastrointestinal surgery patients, a population exhibiting high rates of malnutrition and where those effects have been shown to worsen post-operative outcomes. In this study, the provision of an inexpensive, easily accessible and well-tolerated immuno-enhancing supplement was provided to a randomised group of elective gastrointestinal surgery patients, and complication rates and length of hospital stay, as well as other nutritional markers was recorded and compared to a control group. Although other published studies have assessed the benefit of immunonutrition in this patient group, there was an absence of local data and simple trial design that allows for easy implementation of the supplement in Australian hospitals. In addition to this, there was little other work examining only the pre-operative use of immunonutrition, and its effect on patients with differing nutritional status. Although, likely due to an inadequate sample size, significant findings were absent, but the trend seen towards a reduction in infection and length of hospital stay was entirely consistent with other published data. However a
unique element to the study was the insight into the effect of the treatment on malnourished patients, which was seen to be greater than in their well-nourished counterparts.

The third and final study allowed for a wider exploration of the implementation of evidence based guidelines in respect to nutritional management of gastrointestinal surgical patients in Victoria. It described the wide variability in management of these patients, and concluded that best practice nutritional management in this patient group was not common. It was also able to highlight the many barriers and also find some enablers in implementing best practice, and allows for benchmarking of individual hospitals’ nutritional management of this at risk patient group. The dissemination of these findings will no doubt be a powerful tool for dietitians to continue to work alongside surgeons, nursing staff and hospital administrations for the benefit of patient outcomes.

Overall, this work highlights some important findings around easily implementable strategies that have been shown to be effective in improving the nutritional outcomes of patients, and highlights potential financial savings to health care facilities. It also presents local data that will be useful for benchmarking and comparison of current practice, and change facilitation.
6.2 Future Directions and Considerations

The new findings presented within this thesis address some of the unanswered questions around the management of malnourished hospitalised patients, but also lead the development of further interest areas. The following describes future studies designed to further advance current knowledge, and complement current findings contained within this thesis.

6.2.1 Effectiveness of Nutrition Screening in Identification of Malnourished Hospitalised Patients

Aims

1. To establish the effectiveness of a simple validated nutrition screening tool in determining malnutrition risk and therefore allowing for dietetic referral generation
2. To measure the accuracy of dietetic malnutrition assessment and documentation in medical histories
3. To determine the accuracy of malnutrition coding from patient hospital admissions and compare rates to those of study one
4. To calculate shortfalls in hospital reimbursements with mandatory nutrition screening

Proposed Methods

1. Nursing staff to perform a nutrition screen on all newly admitted patients to the hospital over a two-week period.
2. At the end of the two week nutrition screen, all current inpatients to be assessed for malnutrition via SGA as per the same methodology used in study one, part two.

3. On discharge, all patients identified as malnourished by the SGA screen will have their medical histories audited to identify if:
   a. Nutrition screening was successfully carried out
   b. A dietetic referral was generated
   c. The dietitian correctly identified and documented malnutrition
   d. If malnutrition was identified by medical coders
   e. Shortfall in funding received after hypothetical recode, as per study one.

Clinical Significance

Although an improvement in malnutrition identification and documentation by dietitians and medical coders was demonstrated in study one, there were still a large number of patients identified as malnourished by SGA but not referred to a dietitian and who subsequently received no treatment. Being able to capture these at risk patients and to evaluate the addition of nutrition screening in the treatment of malnutrition is an important final step to ensuring adequate nutrition management for all patients. It also has the potential to reduce funding losses currently being experienced by health care facilities.
6.2.2 Implementation of the ERAS Program in Colorectal Surgery Patients: Significance in the Malnourished Patient Population

Aims

1. To evaluate the effectiveness of the ERAS protocol in a large tertiary teaching hospital in colorectal surgery patients on common post-operative outcomes

2. To examine if the outcomes of ERAS are different in malnourished patients compared to well-nourished patients

Proposed Methods

1. To randomise elective colorectal surgery patients to either the ERAS group, or the control group (standard care)

2. To measure differences in standard post-operative outcomes such as infection, length of stay, morbidity and mortality

3. To perform a subgroup analysis looking at the same outcomes as above in malnourished versus well-nourished patients as determined by SGA performed on admission

Clinical Significance

Although ERAS has been shown to be an effective way at improving patient outcomes post-operatively, its effect specifically on malnourished patients has not previously been the focus of research. Often, especially in Australia, patients are selected by surgeons to follow the ERAS protocol, instead of it being extended to all patients. Generally, the selected patients are a healthier cohort (and therefore more likely to do well post-operatively), meaning that
malnourished patients miss out on the potential benefits associated with ERAS. This study would show if there is a greater magnitude of benefit in the malnourished patient population, or if in fact they are worse off with more aggressive nutritional and surgical management.

6.2.3 Implementation of a Protocol for the Nutritional Management of Surgical Patients in a Large Tertiary Teaching Hospital

Aims

1. To form a working party made up of surgical, nursing and allied health professionals to develop a pathway for pre-, peri- and post-operative nutrition management for all patients undergoing upper and lower gastrointestinal surgery

2. To provide education to staff and implement the pathway in gastrointestinal surgery patients

3. To audit the success of the pathway against current practice three months after implementation

Proposed Methods

1. To form a working party with members from both upper and lower gastrointestinal surgery, namely:
   a. One consultant surgeon from each unit
   b. One junior surgeon
   c. Pre-admission nurse
   d. Ward nurse
   e. Pharmacist
   f. Dietitian
g. Physiotherapist

2. Work together to form a pathway of nutritional management based on published best practice guidelines for management of surgical patients

3. Provide a series of education forums to disseminate the newly created pathways to relevant hospital staff

4. Implement pathway in both upper and lower gastrointestinal surgery

5. At three months post implementation, audit current nutritional management of gastrointestinal surgery patients against pathway and present findings to team

Clinical Significance

Due to the nature of rotating medical, nursing and allied health staff in the clinical environment, professionals constantly need to develop new working relationships with different team members. This can make continuity of care difficult. The findings in the third study show best practice management is not currently routine, with the use of a management pathway proving to be the most effective way of ensuring nutritional management of surgical patients is in line with published recommendations. The development and implementation of such a pathway would allow for consistent management even in the face of rotating staff and would remove the need for patients to be selectively chosen for elements of best practice, and allow for equal best practice management of all patients.
6.3 Conclusions

In summary, the major findings of this thesis show that malnutrition is a highly prevalent condition, with poor rates of diagnosis and documentation common. This deprives malnourished hospitalised patients of proper treatment, and health care facilities of entitled reimbursements. Education around the importance of adequate documentation can improve malnutrition recognition, and the implementation of nutrition screening as standard practice allows for identification of at risk patients for appropriate follow up. In addition to this, a simple and inexpensive, and most importantly easily implementable protocol to support the nutritional and immunological status of gastrointestinal surgical patients prior to surgery has been shown to exhibit more benefit in malnourished patients. Effective nutrition screening in the pre-operative phase is essential in identifying at risk patients, and provision of immunonutrition in this patient group offers potential to improve outcomes for both patients and health care facilities. And finally, the implementation of a collaborative nutrition management pathway in gastrointestinal patients has been shown to be the most effective way to implement best practice guidelines in a clinical environment. The implementation of these guidelines has the potential to significantly improve post-operative outcomes for both malnourished and well-nourished patients, and perhaps even encourage a more collaborative approach towards the nutritional management of these patients.
References


19. Nightingale F. Nursing: what it is and what it is not. London: Hanson & Son; 1859.


48. Rubinstein LZ, Harker JO, Salva A, Guigoz Y, Vellas B. Screening for
undernutrition in geriatric practice” developing the short form Mini-Nutritional

Validation of the Mini Nutritional Assessment Short-Form (MNA-SF): a practical
tool for identification of nutritional status. J Nutr Health Aging. 2009;13(9):782-
8.

50. Arrowsmith HA. A critical evaluation of the use of nutrition screening

Screening (NRS 2002): a new method based on analysis of controlled clinical

52. Kruizenga HM, Seidell JC, de Vet HCW, Wierdsma NJ, van Bokhurst-de van
der Schuuren MAE. Development and validation of a hospital screening tool for
2005;24:75-82.

53. Kruizenga HM, de Vet HCW, Van Marissing CM, Stassen EE, Striik JE, van
Bockhorst-de van der Schuuren MA, et al. The SNAQ(RC), an easy traffic light
system as a first step in the recognition of undernutrition in residential care. J

54. Neelemaat F, Kruizenga HM, de Vet HCW, Seidell JC, Butterman M, van
Bockhorst-de van der Schuuren MA. Screening malnutrition in hospital
outpatients. Can the SNAQ malnutrition screening tool also be applied to this


81. Norman K, Kirchner H, Freudenhreich M, Ockenga J, Lochs H, Pilrich M. Three month intervention with protein and energy rich supplements improve muscle function and quality of life in malnourished patients with non-neoplastic


144. Tepaske RE, L. van Deventer, S. Ince, C. Stoutenbeekt, CP. Kesecioglu, J., editor Perioperative immunonutrition in ‘high-risk’ cardiac surgery patients
improves immunological parameters and clinical outcome. 12th Annual Surgical Infection Society; 1999; Oslo, Norway


180. Bavelaar JW, Otter CD, van Bodegraven AA, Thijs A, van Bokhorst-de van der Schueren MA. Diagnosis and treatment of (disease-related) in-hospital


205. Braga M, Gianotti L, Vignali A, Schmid A, Nespoli L, Di Carlo V. Hospital resources consumed for surgical morbidity: effects of preoperative arginine and


