Optimizing Nutrition Therapy in the Intensive Care Unit Through the Evaluation of Barriers to Enterally Feeding Critically Ill Patients

by

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Abstract

The purpose of this thesis was to determine the feasibility of implementing an intervention tailored to overcome barriers to adherence to recommendations of critical care nutrition guidelines in the Intensive Care Unit (ICU). The thesis is comprised of four manuscripts.

The first manuscript described the development of a 26 item questionnaire rating the importance of potential barriers as impediments to the provision of enteral nutrition (EN) in the ICU. Preliminary evaluation demonstrated acceptable face and content validity and internal reliability, but the test retest reliability and within group reliability were poor for some items.

The second manuscript provided evidence to support the construct validity of the developed questionnaire by reporting the results of a multilevel multivariate regression analysis of cross-sectional data from 55 ICUs that demonstrated that a 10 point increase in the overall barrier score was associated with a statistically significant 3.5% (Standard Error (SE) 1.3) decrease in prescribed calories received from EN.

The third manuscript provided data to inform whether the intervention should be tailored to site specific barriers by describing the barriers to enterally feeding critically ill patients identified by 138 nurses, and evaluating whether these barriers differed across the 5 participating sites. Statistically significant differences were found among ICUs for 4 out of the 22 potential barriers.

The fourth manuscript described the results of a pretest posttest study involving 5 ICUs in North America and determined that all participating sites successfully developed the tailored intervention. A statistically significant 10% (Site range -4.3 to -26.0%) decrease in overall barriers score, and a non-significant 6% (Site range -1.5 to17.9%) change in prescribed calories received was observed following the intervention. However, there was variability in the degree of implementation achieved by each site.

Taken together, the results of this thesis demonstrated that adopting a tailored approach to improving nutrition practice is feasible. However, the findings also resulted in revisions to the barriers questionnaire and modifications to the design of the tailored intervention. Thus, the next step is to formally test the hypothesis that a tailored intervention designed to address barriers to feeding critically ill patients will improve nutrition performance.

Co-Authorship

This thesis represents research conducted by Naomi Cahill, under the supervision of Daren Heyland and Heather Stuart.

Chapter 3 – Manuscript 1: *Development and Preliminary Validation of a Questionnaire to Assess Barriers to Feeding Critically Ill Patients.*

The need to develop a questionnaire to measure barriers to the provision of nutrition to critically ill patients stemmed from the results of Naomi Cahill's masters thesis project. Naomi Cahill was responsible for developing and implementing the protocol for questionnaire development with advice from Daren Heyland, Heather Stuart, and Deborah Cook. Naomi Cahill conducted and interpreted the analysis in consultation with Daren Heyland, Heather Stuart, Deborah Cook, and Andrew Day.

Chapter 4 – Manuscript 2: *Do barriers to feeding critically ill patients impede nutrition performance? : A multilevel multivariate analysis*

The idea to correlate nutrition performance data with responses to the barriers questionnaire in order to evaluate construct validity was first suggested by Daren Heyland, and was supported by Naomi Cahill and Heather Stuart. Naomi Cahill developed an analysis plan with input from Daren Heyland and Andrew Day. Lauren Murch, project assistant for the International Nutrition Survey helped with data collection. Miao Wang, data analyst for the International Nutrition Survey assisted with the conduct of the analysis. Naomi Cahill interpreted the results with guidance from her supervisory team.

Chapter 5 – Manuscript 3: *Barriers to Feeding Critically Ill Patients: A Multicenter Survey of Critical Care Nurses* and **Chapter 6 – Manuscript 4:** *Implementing a Multifaceted Tailored Intervention to Improve Nutrition Adequacy in Critically Ill Patients: Results of a Multicenter Field Test*

The motivation to conduct a study to assess the feasibility of a tailored intervention was Naomi Cahill's and Daren Heyland's. The recommendation to include a manuscript describing the barriers identified by the newly developed barriers questionnaire was made by the examining committee during the thesis proposal defense, and supported by Naomi Cahill and her supervisors. Naomi Cahill was responsible for the design and operationalization of the study with guidance and support from Daren Heyland. Lauren Murch, project assistant for the PERFECTIS study helped with study related administration and data collection. Naomi Cahill, Daren Heyland, and Lauren Murch conducted the site visits at participating sites. Naomi Cahill completed the analysis and interpretation of the results with input from Daren Heyland and Deborah Cook.

All components of this thesis, including the manuscripts, were written by Naomi Cahill; with constructive feedback and editorial changes provided by Daren Heyland, Heather Stuart and co-authors.

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I am grateful to the Canadian Critical Care Trials Group for providing the opportunity to present my research and receive invaluable feedback. Your input helped shape this thesis into a high quality piece of writing.

I am grateful to the Canadian Institutes of Health Research, Ontario Graduate Scholarship and the Danone Institute for providing personal financial support for my graduate studies, and to the Academic Health Sciences Centers (AHSC) Alternate Funding Plan (AFP) Innovation Fund and the Canadian Foundation of Dietetic Research for funding the PERFECTIS study and related developmental work.

Thanks to my wonderful family and friends both here in Canada and back ‘home’ in the UK. I am truly blessed to have a network of such loving and caring people around me. Thanks for taking an interest in my scholarly activities, even though most of you don’t have a clue what this PhD is all about! I am especially grateful to my parents, Glyn and Lois Jones, for instilling in me the courage and passion to follow my dreams, whether it was to be a famous actress or the more humble pursuit of dietetics! I am particularly grateful to my mum, mother-in-law, Adele Gibson, and sister-in-law, Angie Murphy, for the hours of free child-care and numerous nourishing meals which enabled me to sit at my desk and write undisturbed. I also need to acknowledgement my sister and best friend, Dr. Sarah Jones. Sibling rivalry has been a BIG impetus behind the completion of this PhD, and even after all these years of study I am not a ‘real’ doctor like you! Thanks for cheering me on every step of the way and occasionally yelling at me to “just get it done”!

And last but not least, my husband, Earl. I could not have achieved this without you. This has truly been a shared endeavour. When I first enrolled in the PhD program in ’07 we had not long been dating, over the past five and half years we have bought our first home (’08), got married (’09), built a resort in paradise and founded a not for profit organization (’10), welcomed a daughter (’11) and a son (’12), and somehow along the way managed to complete this little thing called a PhD! Thank you for your unfailing support and endless encouragement. This thesis is dedicated to you and our gorgeous children. I sincerely hope that I make you all proud.

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Abbreviations

ANOVA	Analysis of Variance
CI	Confidence Interval
CPG	Clinical Practice Guideline
CIHR	Canadian Institutes of Health Research
EN	Enteral Nutrition
ICC	Intraclass Correlation Coefficients
ICU	Intensive Care Unit
IQR	Inter Quartile Range
KT	Knowledge Translation
OR	Odds Ratio
PN	Parenteral Nutrition
QI	Quality Improvement
RCT	Randomized Controlled Trial
REML	Restricted Maximum Likelihood
SD	Standard Deviation
SE	Standard Error
SMD	Standardized Mean Difference

Chapter 1

Introduction

Critical care is a specialty within medicine concerned with the care of patients with immediate life-threatening illness or injury associated with single or multiple organ failure (e.g. cardiovascular dysfunction, trauma, severe burns, and complications from infection). These patients are cared for by a team of specially trained providers within a designated area of the hospital known as the Intensive Care Unit (ICU). The objective of care is to sustain life through constant monitoring and treatment using specialized medical equipment such as mechanical ventilators to assist with breathing and dialysis for kidney problems. Compared to other health care settings, critical care is a high technology and resource intensive environment, and consequently while the daily cost of being treated on a ward is approximately $1000, the cost of being in the ICU is much greater, with the cost of a critical care bed in Canada estimated as $2396[1]. The cost of care in ICUs in Ontario rose from $475 million in 1999-2000 to $662 million in 2003-2004, accounting for 16% of inpatient costs[2]. Although the majority of patients recover following admission to the ICU, the mortality rate remains high at 26%[3].

Due to the severity of their illness, critically ill patients are unable to eat normally; therefore the provision of artificial nutrition is a standard part of the care they receive. Nutritionally balanced solutions are provided via a tube placed through the nose and into the gastrointestinal tract (i.e. enteral nutrition (EN)), or placed directly into a vein (i.e. parenteral nutrition (PN)). Fifty years ago, when artificial nutrition was first developed, it was conceived of as supportive care, as administering metabolic support while the patient recovered from their underlying illness. During this era, few large-scale trials informed nutrition practice, and there was little expectation that nutrition affected clinically important outcomes[4]. Over the past quarter of a century, there have been significant advances in understanding the role of nutrition in the treatment of patients in the ICU[5,6]. Evidence has emerged demonstrating that nutrition therapy is

associated with significant reductions in length of stay, infectious complications, and mortality[5-7]. Undoubtedly some of the positive effects attributed to the provision of nutrition are due to the prevention of malnutrition. But nutrition may also exert effects beyond the correction of nutrient deficiencies, directly supporting the immune system, attenuating oxidative stress, maintaining gastrointestinal structure and function, and modifying the inflammatory response[8]. Accordingly, the role of nutrition in patient care has transitioned from supporting patients while they recover from their underlying illness to active therapy, modulating their disease response and improving their chances of survival [4].

1.1 The Guideline – Practice Gap in Critical Care Nutrition

Several Clinical Practice Guidelines (CPGs) have been published, providing evidence based recommendations on how to optimally feed the critically ill patient [9-13]. Despite the availability of these CPGs to assist providers in making decisions related to the provision of nutrition therapy in the ICU, several observational studies of nutrition practices in critically ill patients have reported considerable variation in practices, demonstrating that guideline recommendations are not being uniformly applied at the bed-side[14-18].

To date, studies evaluating the effectiveness of adopting multifaceted educational strategies to implement nutrition guidelines have failed to demonstrate clinically important changes in nutrition practice[19-21]. The disappointing results of these trials may in part be due to the presence of barriers impeding adherence to guideline recommendations at the bedside[22]. Evaluating the barriers to feeding critically ill patients and tailoring interventions to overcome these obstacles to change may be a strategy to optimize nutrition therapy in the ICU[23].

1.2 Hypothesis

If barriers impede the provision of nutrition to patients in the ICU, then a tailored intervention designed to address these barriers will improve adherence to guideline recommendations and optimize nutrition performance.

1.3 Thesis Purpose

The overall goal of this program of research is to evaluate the effectiveness of tailoring guideline implementation strategies to overcome barriers to feeding critically ill patients compared to usual guideline implementation efforts. However, before moving to the definitive study that will formally test the aforementioned hypothesis, there are several questions that first need to be answered; namely: 1) Can we measure barriers to enterally feeding critically ill patients? 2) Does the presence of barriers impact on the provision of nutrition? 3) Do barriers differ across ICUs? 4) Are ICUs able to develop and implement a tailored intervention to address identified barriers? 5) Does the implementation of a tailored intervention decrease barriers and improve nutrition practice? To this end, the overarching purpose of this thesis is to determine the feasibility of adopting a tailored intervention to overcome barriers to adherence of recommendations of critical care nutrition guidelines related to the provision of enteral nutrition.

1.4 Thesis Objectives and Rationale

Rationale: There is a lack of validated instruments to measure barriers to guideline implementation. There is a need to develop such an instrument so that barriers to the provision of nutrition in the ICU can be identified and addressed.

Objective 1: To develop a questionnaire to measure barriers to feeding critically ill patients and to conduct preliminary validity testing of the new instrument.

Rationale: If the barriers questionnaire developed as part of this thesis is to be a useful tool in identifying barriers to target for change we need some evidence to support its construct validity; namely, that the perceived barriers identified by critical care providers completing the questionnaire actually impede the provision of nutrition in the ICU.

Objective 2: To determine if barriers to feeding critically ill patients are inversely associated with nutrition performance.

Rationale: There is inadequate data to inform the optimal method and level of tailoring (i.e. targeting general barriers vs. site specific barriers). Thus there is a need to identify the barriers faced by critical care providers. If the barriers differ across ICUs, this provides rationale for developing a unique intervention addressing specific barriers at each site, as opposed to a common intervention tailored to general barriers.

Objective 3: To describe barriers to feeding patients across ICUs and examine if they differ by site.

Rationale: The development and implementation of a tailored intervention is complex, thus we need to demonstrate that it is feasible in the critical care setting, and generate preliminary evidence of the effectiveness of this approach.

Objective 4: To examine compliance with and describe changes in barriers and nutrition practice following implementation of a tailored intervention.

1.5 Thesis Organization

This thesis is organized as a manuscript-based thesis according to the 'General Forms of Theses' as stipulated by the School of Graduate Studies and Research, and the Department of Community Health and Epidemiology at Queen's University. The second chapter of this thesis is a comprehensive literature review providing background on knowledge translation and guideline implementation, with a focus on

critical care nutrition. Next, the four manuscripts will be included. Chapter three is the first manuscript and addresses objective 1 and has been submitted to Implementation Science. Chapter four is the second manuscript, addressing objective 2, and has been submitted to BMC Health Service Research. Chapter five is the third manuscript, addressing objective 3, and has been published in the Journal of Critical Care. Chapter six is the fourth manuscript, has been submitted to Critical Care Medicine and addresses objective 4. Following the four manuscripts, chapter seven summarizes the overall results of the thesis and discusses the implications of the findings.

1.6 Overview of Study Sample and Data Source

Intensive Care Units who participated in the studies outlined in the four manuscripts of this thesis are involved in an ongoing quality improvement initiative in critical care nutrition known as the 'International Nutrition Survey' (Figure 1.1).

This initiative is part of research activities at the Clinical Evaluation Research Unit (CERU) based at Kingston General Hospital. This research centre was founded and is directed by the candidates' supervisor, Dr Daren Heyland. The International Nutrition Survey is a point prevalence observational study of nutrition therapy practices in ICUs around the world. The objective of the initiative is to compare current nutrition practices in ICUs to guideline recommendations, as well as within and between countries, thus identifying strengths and weaknesses, and highlighting areas of practice to target for improvement. To date there have been 4 cycles of the survey (i.e. January-May 2007, May-November 2008, September-January 2009, and May-November 2011). Sites are invited to participate through membership lists of nutrition and/or critical care societies, and the research centre's mailing list of providers who have expressed an interest in critical care nutrition. In addition, information regarding the survey is posted on various international websites, including www.criticalcarenutrition.com. To be eligible to participate in

the International Nutrition Survey, ICUs must have at least 8 beds or the capacity to collect data within the study timeframe, and have a dietitian or an individual with knowledge of clinical nutrition to complete data collection. Approximately 1 month prior to commencing data collection, ICUs register for the survey online, this includes providing data on the characteristics of their institution. On the day the study is initiated, ICUs aim to identify 20 consecutive critically ill adult (≥18 years of age) patients who are mechanically ventilated within the first 48 hours of admission to ICU and who remain in ICU for more than 72 hours. Baseline demographics, admission information, and nutrition data are abstracted from hospital records and entered online via a secure web-based electronic data entry system. More than 150 ICUs have participated in each of the 4 cycles. Although the majority of ICUs are new each cycle, there is also a proportion of ICUs that contribute data in each cycle.

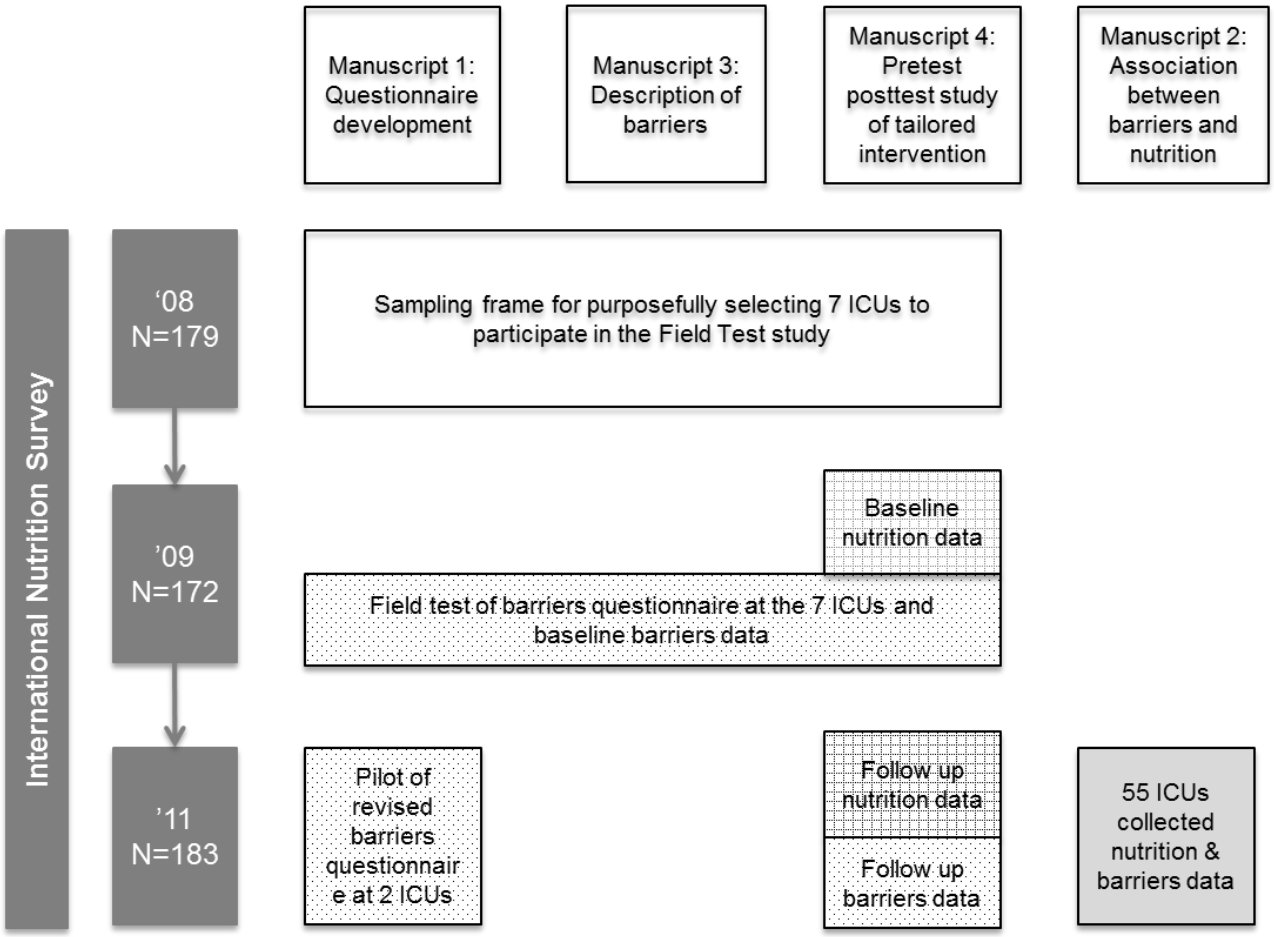
The 7 ICUs involved in the Field Test that forms the focus of this thesis were selected from amongst the ICUs who had participated in the International Nutrition Survey in 2008. Of the 179 ICUs, 14 sites met the eligibility criteria (i.e. 76 were excluded because they did not succeed in entering data on 20 patients, 21 were excluded because they did not have a feeding protocol in place, 6 were excluded because they did not have a dietitian, 62 were excluded because they were not located in North America and/or they achieved >60% prescribed calories received in the 2008 survey cycle. An invite to participate in the field test was sent to all 14 eligible ICUs, and of these, 7 accepted. Reasons for non-participation included the contact person no longer working in the ICU, lack of infrastructure to support research, inadequate time to dedicate to the study, and competing research studies. The 7 sites participating in the Field Test collected data as part of the 2009 and 2011 cycles of the International Nutrition Survey. This information on their nutrition practice formed the baseline and follow-up assessment of their nutrition performance in the pretest posttest study reported in Manuscript 4. In addition to the nutrition practice data, in March/April 2010 these sites also collected data on barriers to enteral feeding through the distribution of the newly developed questionnaire to critical care providers. Manuscript 1 describes how the responses to the questionnaire at these sites were used to assess the psychometric properties of the instrument and further

refine it. Manuscript 3 describes the nurses' responses to the questionnaire. The revised questionnaire was re-distributed to critical care providers at these ICUs in May/June 2011, and Manuscript 4 describes the change in responses observed following implementation of the tailored intervention.

During the recruitment phase for the International Nutrition Survey in 2011, interested ICUs were invited to conduct a barriers assessment (i.e. distribute the newly developed barriers questionnaire to critical care providers). Of the 183 registered ICUs, 70 registered to complete both the barriers and nutrition component of the survey, and 55 of these sites proceeded to collect the required data. This data was used in the analysis reported in Manuscript 2.

Finally, 5 ICUs who had previously been involved in the International Nutrition Survey and had registered to participate again in 2011 were approached to help pilot the revised barriers questionnaire. Of these, 2 ICUs agreed and distributed the questionnaire to nurses. The results of this pilot and test retest assessment are reported in Manuscript 1.

Figure 1.1: Schema Describing Selection of the Study Sample and Data Source



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Chapter 2

Literature Review

2.1 Bridging the Gap Between Knowledge and Clinical Practice

The observation of significant and persisting gaps between research findings and clinical practice is a common finding in clinical and health service research. It is estimated that 35-55% of patients are not receiving care according to scientific evidence, and 20-25% of care provided is not needed or could cause harm[1]. Furthermore, there is considerable delay in the utilization of original research, taking 1 to 2 decades to be incorporated into routine practice[2]. These negative observations have resulted in growing awareness of the gaps between evidence and practice and, together with a heightened focus on quality improvement and evidence informed practice, has stimulated interest in Knowledge Translation (KT). Knowledge Translation is a term increasingly used in healthcare to describe "the methods of closing the knowledge-to-action gaps"[3]. In this context, 'knowledge' is conceptualized as empirically derived (i.e. research based) but may also encompass knowledge gained through individual experience or from peers, and 'action' refers to the use of knowledge by providers, policymakers, patients, and the public[4]. Over 100 other terms have also been used interchangeably to describe the same concept, these include knowledge transfer, knowledge exchange, research utilization, implementation science, dissemination and diffusion[5]. As the major federal agency responsible for funding health research in Canada, KT is a key component of the Canadian Institutes of Health Research (CIHR) mandate. The CIHR formally defines KT as "a dynamic and iterative process that includes synthesis, dissemination, exchange and ethically-sound application of knowledge to improve the health of Canadians, provide more effective health services and products and strengthen the health care system"[6]. The CIHR definition conceptualizes KT as a collaborative, interactive process necessitating multidirectional exchanges between key stakeholders, such as researchers, patients, practitioners, policy makers, and the public.

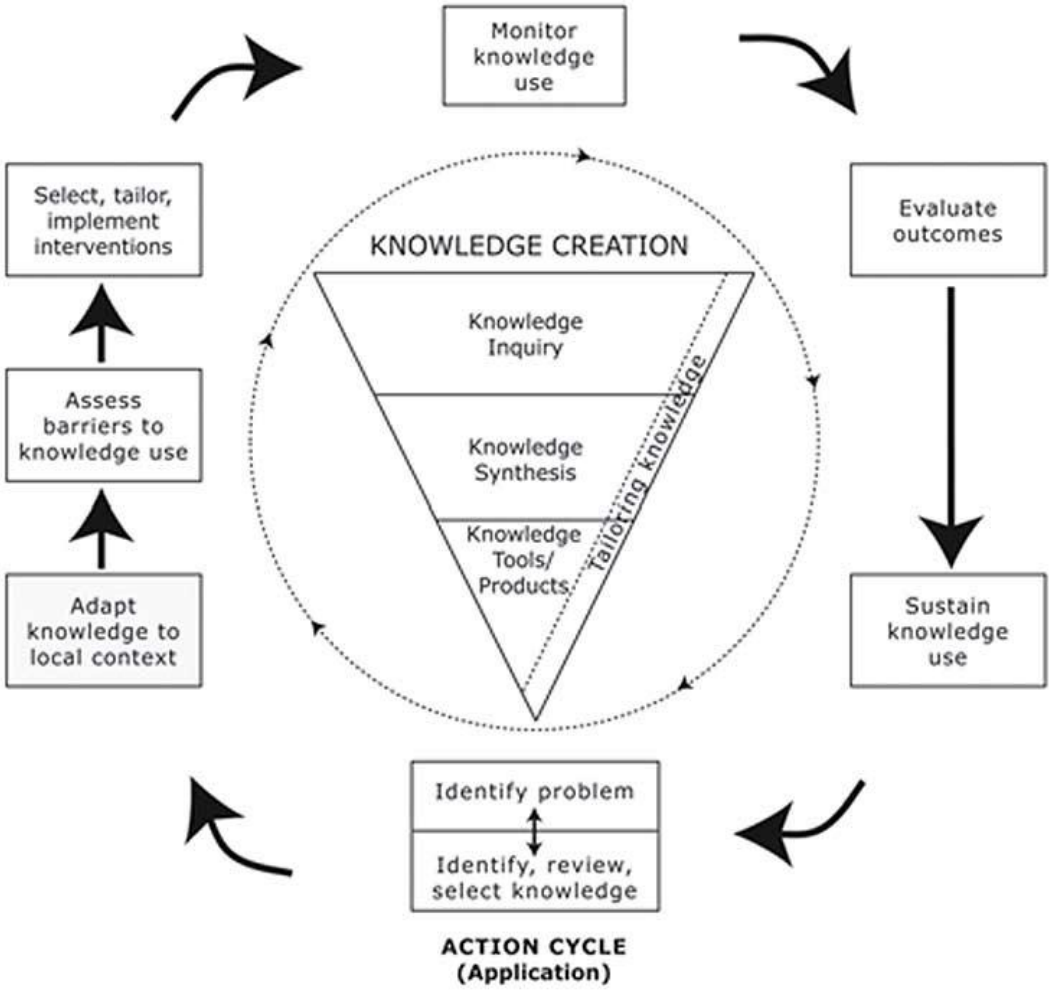
2.2 Theoretical Models of Knowledge Translation

To better understand the complex process of change, theoretical models and/or conceptual frameworks for KT have been proposed[7,8]. Reviews of KT theories have identified over 60 different models or frameworks explaining all or part of the KT process[9-11]. These theories arose from different disciplines such as psychology, sociology, nursing, education and management, and therefore may be applicable to specific contexts or behaviours. Broadly, theories can be classified as 'classical' or 'planned'. Classical theories or models are descriptive in nature and aim to explain the process of change. They are passive and are not intended to guide change in social systems. Thus they are useful for identifying the key determinants of KT. Examples of classical theories are Roger's diffusion theory[12] and Lomas's Diffusion, Dissemination, and Implementation model[13]. In contrast, planned change theories or models are prescriptive; systematically describing the steps of the KT process and the variables that increase or decrease the likelihood of change occurring. Their goal is to promote, plan or implement change. Consequently, planned change theories are much more applicable and useful to researchers, providers, and policy makers seeking to change practice. In their review identifying 28 different planned change models, Ward *et al.* highlighted five common components of these KT theories namely: problem identification and communication; knowledge development and selection; analysis of context; knowledge translation activities or interventions; and knowledge use. From a similar literature review, Graham *et al.* identified 31 planned action theories and from their analysis of these theories developed the Knowledge-to-Action model[4].

In order to truly reflect CIHR's definition of KT and integrate the creation of knowledge with it's application, Graham *et al.* added a knowledge creation process to the model. They conceptualized that each phase can occur sequentially or simultaneously and that the knowledge creation phases can influence the action phases at any point in the cycle. The relationship between the two components and phases are illustrated in Figure 1. The inverted funnel in the centre of the figure symbolizes the component of knowledge creation, and the cycle surrounding the funnel represents the application of the created

knowledge or the action component. This Knowledge-to-Action model has been adopted by CIHR as a guiding framework to define and describe KT, and facilitate the implementation of knowledge[6], and will be used in this thesis to guide the development of an intervention to implement recommendations of critical care nutrition guidelines.

Figure 2.1: Knowledge-to-Action model



[Reprinted with permission from *Journal of Continuing Education in the Health Professionals* 2006;26:13-24. Graham I, Logan J, Harrison M et al.. Lost in Knowledge Translation: Time for a Map?][4]

2.3 Knowledge Creation

According to the Knowledge-to-Action model, knowledge creation consists of 3 phases 1) knowledge inquiry 2) knowledge synthesis and 3) knowledge tools/products. Knowledge inquiry, portrayed as the widest part of the funnel, represents the individual studies of various designs and quality. The next phase of knowledge creation, knowledge synthesis, aggregates the results of individual studies, identifying commonalities, and is therefore particularly useful because it helps to make sense of existing evidence. Systematic reviews and meta-analysis are the primary methods of synthesizing knowledge. Given that approximately 50% of data in published research is later determined to be inaccurate[14], this step is integral in ensuring that only valid evidence is translated. Following this synthesis, the knowledge moves through the funnel and is distilled further into tools or products. It is presumed that knowledge in this format is more useful to those making decisions at the bed-side and therefore more likely to be applied.

Clinical Practice Guidelines (CPGs) are an example of a knowledge tool that has proliferated in recent years, with professional and government bodies producing guidelines on a diverse range of clinical topics. Clinical Practice Guidelines are defined as "systematically developed statements to assist practitioner and patients decisions about appropriate health care for specific clinical circumstances'[15]. Guidelines are typically internationally or nationally developed broad statements of best practice targeted to specific healthcare provider groups (e.g. physicians, nurses, physiotherapists, dietitians) working within specific settings (e.g. hospitals, primary care practices, specialist units). Formulation of guideline recommendations is based on review of the underlying evidence together with valuation of the safety, cost, feasibility, patient preferences and any other aspects pertinent to the specific clinical practice under review. Differing inclusion criteria for evaluated studies, variation in the level of the evidence reviewed, and consideration of different values may results in different recommendations across published guidelines on the same topic. The growth in CPGs as a KT tool has not escaped controversy; critics claim that they de-skill providers, striping them of their professional autonomy, while advocates argue that they are flexible tools which facilitate integrating individual clinical expertise with the best available clinical

evidence from systematic research[16]. Despite this controversy, there is evidence to support that CPGs reduce variations in practice and improve the quality of care provided.[16]

2.4 Knowledge Creation in the Field of Critical Care Nutrition

Since 1980, almost 300 randomized controlled trials (RCTs) involving thousands of critically ill patients have been conducted[17]. However, the inferences that can be made from these individual trials is limited because of the poor methodological quality, the small sample size included in many of these studies, and that the majority tested various nutritional strategies in heterogeneous patient populations, making it difficult to detect effects in homogenous subgroups of critically ill patients[17]. Consequently, this growth in knowledge has led to some confusion regarding what constitutes best nutrition practice. In an attempt to synthesize this body of evidence and distil the data into a format that is more useful for providers making decisions at the bedside, several CPGs pertaining to feeding the critically ill patient have been published [18-22]. A recent review comparing the content of North American critical care nutrition CPGs observed that while there are major differences in several of the recommendations, there is also strong agreement across guidelines for many topics, namely[23]: use and timing of enteral nutrition (EN), use of EN in preference to parenteral nutrition (PN), use of a feeding protocol including monitoring of gastric residual volumes, composition of enteral formulas, body position, small bowel vs. gastric feeding, continuous vs. other methods of infusion, PN vs. standard care, use of parenteral lipids, parenteral glutamine, supplemental antioxidants. Given the consensus across guidelines, these recommended nutrition practices should be adopted as part of routine care in the ICU.

2.5 Identifying the Knowledge-Practice Gap

Although CPGs have been recognized as an important knowledge tool, their development and dissemination are not sufficient to influence provider decision-making[24]. The 7 action phases of the Knowledge-to-Action model outline the processes needed to use this created knowledge[4]. The action cycle

starts with an individual or group identifying the knowledge-practice gaps to be targeted for change. One of the biggest challenges of measuring this 'gap' is identifying objective and quantifiable measures that accurately reflect the care provided. Validity, reliability, sensitivity, clinical relevance, and the ease with which data can be obtained are some of the key attributes required for such 'quality' or 'performance' indicators[25]. To evaluate the knowledge-practice gap, indicators must be compared to an established criterion and the degree of deviation from this criterion assessed[25]. The degree of deviation from a criterion that represents a 'gap' may be determined by established standards such as CPG recommendations, but in the event that standards are lacking, the threshold may be defined by current norms (i.e. usual, average, or best achievable performance)[25]. Table 1 outlines the guidelines recommendations (i.e. standards) and associated quality indicators pertaining to the provision of EN in the ICU.

After selecting appropriate indicators based on current guidelines, the next step is to measure the gap. Several strategies may be employed to perform this gap analysis depending on the study population, location, and timeframe. In the hospital setting, chart audits involving review and assessment of documented care in a patients' medical record are frequently used[26]. Since 2007, our research group has conducted annual international audits of nutrition practices in ICUs offering an opportunity for critical care providers to compare their nutrition practices to guideline recommendations and other ICUs, thereby identifying problems that need addressing[27-29]. We have consistently observed that despite high adherence to some recommendations, large gaps exist between many recommendations and actual practice in ICUs (Table 1)[27]. Adherence to CPG recommendations has been observed to be high for the following recommendations: use of EN in preference to PN, glycemic control, and the presence of a feeding protocol. However, significant practice gaps have been identified for other recommendations. Average time to start of EN is 46.5 hours (site average range: 8.2-149.1 hours). The average use of motility agents and small bowel feeding in patients who had high gastric residual volumes is 58.7% (site average range: 0-100%) and 14.7% (site average range: 0-100%) respectively. Consequently, on average the delivery of

nutrition therapy is sub-optimal, with patients only receiving 59% of the calories that they are prescribed[27]. Efforts to implement guideline recommendations and improve the provision of nutrition are therefore warranted[30].

Table 2.1: Knowledge-to-Action Gaps in Critical Care Nutrition[28]

Guideline Recommendation	Nutrition Practice Indicator	Average Practice	Best Achievable Practice
Enteral nutrition should be used in preference to parenteral nutrition.	% of patients receiving EN	62%	97%
Enteral nutrition should be initiated early (24-48 hours following admission to ICU).	% of patients with EN initiated within 48 hours	39%	100%
An evidence-based feeding protocol should be used.	Feeding protocol in use in the ICU	80% of ICUs	Feeding protocol in use
In patients who have feed intolerance (i.e. high gastric residual volumes, emesis) a promotility agent should be used.	% of patients with high gastric residual volume receiving promotility drugs	59%	100%
Small bowel feeding should be considered for those select patients who repeatedly demonstrate high gastric residual volumes and are not tolerating adequate amounts of EN delivered into the stomach.	% of patients with high gastric residual volume receiving small bowel tubes	15%	100%
Patients receiving enteral nutrition should have the head of the bed elevated to 45 degrees.	Mean Head of Bed elevation (degrees)	32^0	45^0
Hyperglycemia (blood sugars >10 mmol/L) should be avoided.	% of patients glucose measurements >10 mmol/L (excluding day 1; fewest is best)	16%	0%
N/A	Mean proportion of prescribed calories received (%)	59%	94%

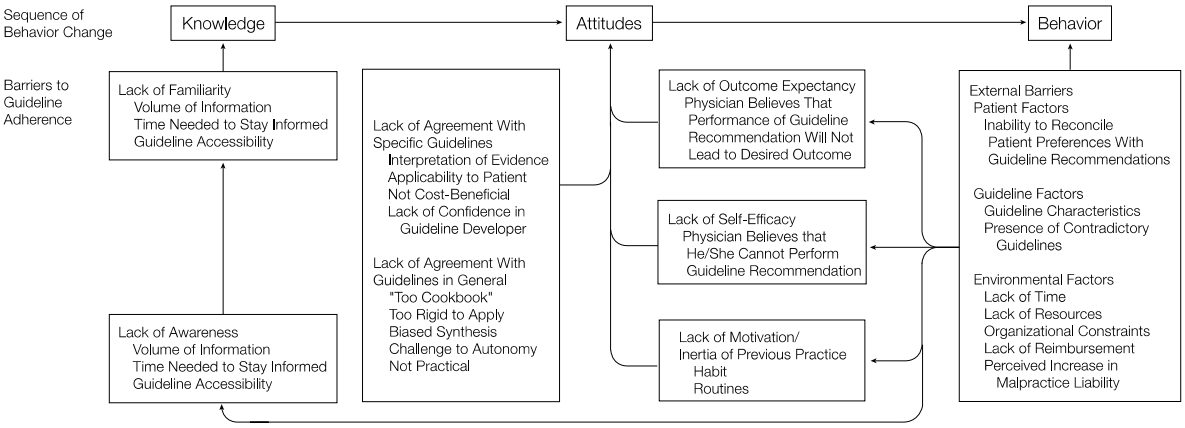
2.6 Determinants of Knowledge Translation

Following identification of the gaps in providing quality care, the next step is to assess the determinants (i.e. barriers and enablers) to using the knowledge, identify the users of the knowledge, and adapt the knowledge to the context or setting in which it is to be used. This information is then used to select appropriate interventions to implement the knowledge.

Multiple factors determine if and how knowledge is integrated into clinical practice. Numerous qualitative and quantitative studies have shown that the determinants of KT operate at different levels of the healthcare system including, the guideline or innovation itself, the individual provider, the patient, the social context, the organizational context, and the economic and political context[31]. These factors may have a positive or negative influence on the KT process. Barriers are factors that impede the implementation of change in practice; while enablers or facilitators are factors that promote or help implement knowledge. A large body of literature supports the need to understand the barriers to change for optimal healthcare delivery[4,32,33]. One of the most frequently cited papers by Cabana *et al.*, reviewed 76 studies that assessed the potential barriers to physician adherence to CPGs and assimilated the results into a framework (Figure 2) [34]. From this review, they identified 293 potential barriers which they grouped into seven general categories of barriers: lack of awareness and lack of familiarity affecting physician *knowledge* of the guideline, lack of agreement, self-efficacy, outcome expectancy, the inertia of previous practice affecting the *attitude* of physicians towards the guideline, and external barriers such as guideline characteristics, patient preferences, lack of resources, time constraints, leadership style and organizational culture, that limit the physicians' ability to perform the *behaviour* recommended by the guideline. More recently, Cochrane *et al.* updated this review and identified 256 articles that met their inclusion criteria[35]. They observed that there had been an increase in the reporting of attitude and behavioural barriers since the 1999 review. These attitude barriers included provider characteristics and self-efficacy. The behavioural barriers included external barriers and environmental factors. The authors concluded that healthcare stakeholders who are planning changes in their practices must assess and address potential

barriers, and that these barrier assessments should be informed by existing theories and models such as the Cabana *et al*s. Knowledge-Attitudes-Behaviour framework[35]. Subsequently, several other authors have revised and expanded this framework to make it more applicable for specific guidelines or innovations[36-38].

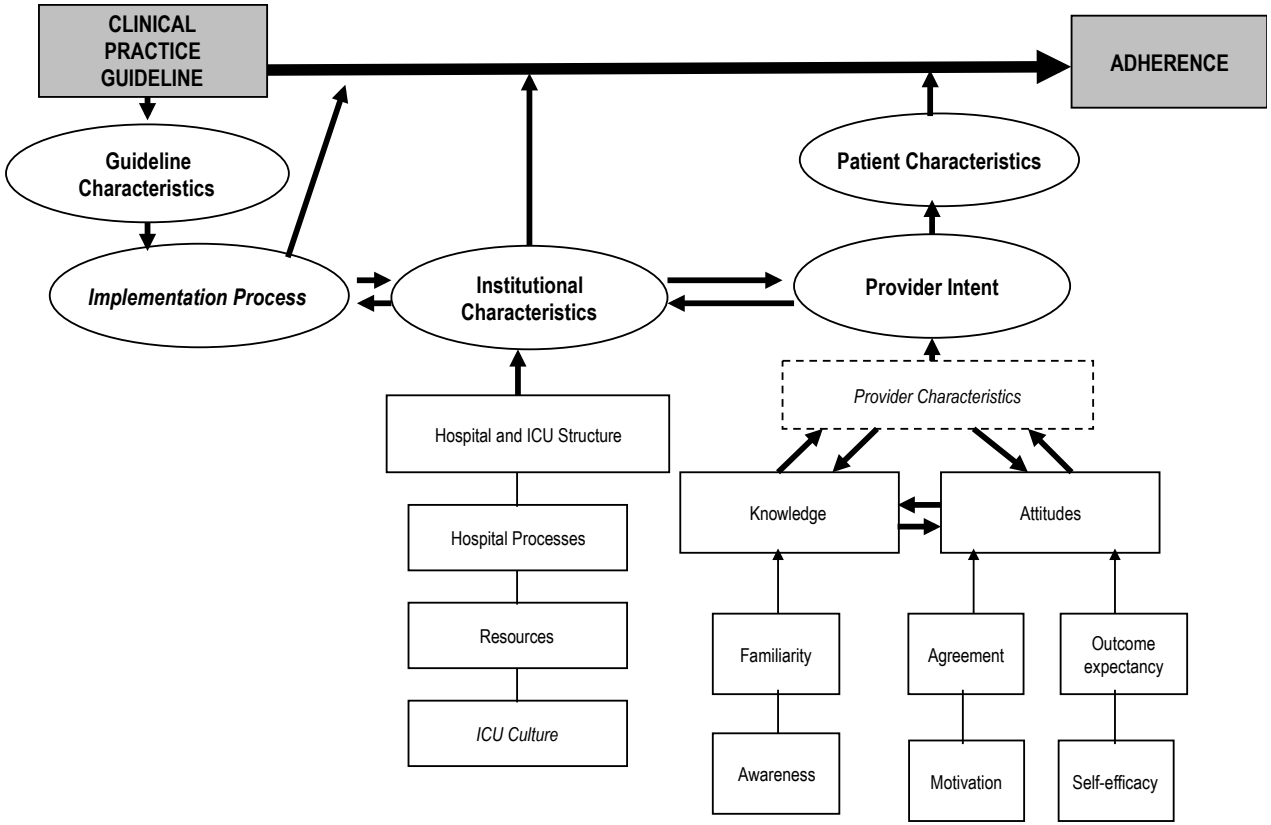
Figure 2.2: Knowledge-Attitude-Behaviour Framework by Cabana *et al.*



Reprinted with permission from the *Journal of the American Medical Association* 1999 Oct 20;282(15):1458-65. Cabana MD, Rand CS, Powe NR et al. Why don't physicians follow clinical practice guidelines? A framework for improvement.[34]

As part of my master's thesis, I adopted a mixed methods approach to identify the barriers and enablers that impact on adherence to nutrition guidelines in the ICU, and proposed a revised and extended barrier categorization based on Cabana *et als.* knowledge-attitude-behaviour framework (Figure 2)[39]. Multi-level regression models identified that academic hospitals, a medical admission category, and male patients were significant predictors of adherence to nutrition guidelines[40]. These quantitative results were corroborated by the results of multiple case studies in 4 ICUs in Canada[41], which included semi-structured interviews with 28 critical care providers (i.e. physicians, nurses and dietitians) to ascertain attitudes and perceptions towards nutrition guidelines. Resistance to change, the characteristics of the critically-ill patient, lack of awareness, information overload, paucity of evidence supporting the guidelines, resource constraints, a slow administrative process, a recommendation advocating a complex procedure, nursing workload, and limited critical care experience were cited as the main barriers to implementation of the nutrition guidelines. Agreement of the ICU team, incorporation into routine practice, the presence of a dietitian, access to the guidelines, ease of application, provision of education, and open discussion, were identified as the primary enabling factors. The resulting revised framework for barriers to adherence to critical care nutrition guidelines included five domains or types of barriers[39]: 1) Guideline Characteristics; 2) Implementation Process; 3) Institutional Factors; 4) Provider Intent; and 5) Patient Characteristics (Figure 3 and Appendix A).

Figure 2.3: Framework for Adherence of Critical Care Nutrition Clinical Practice Guidelines



Reprinted with permission from the *Journal of Parenteral and Enteral Nutrition* 2010 Nov-Dec;34(6):616-24 Cahill NE, Suurdt J, Ouellette-Kuntz H, Heyland DK. Understanding adherence to guidelines in the intensive care unit: development of a comprehensive framework.[39]

At the end of my Masters thesis, I concluded that "the next step in continuing this research is to use this framework as a template to develop a questionnaire to quantitatively assess barriers to guideline adherence…...in order to inform the focus, mode, and recipients of ….educational initiatives to effectively optimize adherence to ….CPGs." Consequently, the development and validation of such a questionnaire forms the first and second objectives of this thesis.

2.7 Effectiveness of Knowledge Translation Implementation Strategies

Over the past 15-20 years there has been a considerable number of studies evaluating the effectiveness of KT implementation strategies, including several systematic reviews and overviews of systematic reviews[32,33,42-45].

The Cochrane Effective Practice and Organisation of Care (EPOC) Review Group; established in 1994, is an international collaborative network of the Cochrane Collaboration that focuses on reviews of interventions designed to improve professional practice[46]. To help evaluate these various guideline implementation strategies and summarize their effectiveness, they developed a taxonomy for describing different types of interventions, namely:[46]

- Professional Interventions (e.g., educational materials, educational meetings, local consensus processes, opinion leaders, educational outreach visits, audit and feedback, reminders, marketing, mass media)
- Financial Interventions (e.g., provider or patient incentives or penalty)
- Organisational Interventions (e.g., revision of professional roles, multidisciplinary teams, communication and case discussion)
- Regulatory Interventions (e.g., licensure, changes in medical liability)

The most recent systematic review of the effectiveness of guideline implementation strategies published in 2004 by Grimshaw *et al.* reviewed 235 studies reporting 309 comparisons of guideline dissemination and implementation strategies[32]. The studies included in this review employed RCTs, controlled clinical trials, controlled before-after studies, and interrupted time series methodologies. They included all health care professionals, all types of change strategies, and used objective measures of provider behaviour and/or patient outcome. They found that 86% of these studies observed improvements in performance with a median effect of approximately 10%. This suggests that it is possible to change health practitioner behaviour, improve quality of care, and potentially have a positive impact on clinically important outcomes.

The review showed that the use of prompts and reminders during consultations and educational outreach such as academic detailing (i.e., targeting individual practitioners for one on one education) are the most commonly evaluated interventions. These studies suggest that reminders and educational outreach are likely to result in moderate (range -1.0 to +34%) and modest (range -4 to +17.4%) improvements in processes of care respectively. Passive educational approaches, such as dissemination of CPGs and journal publications, and audit and feedback also lead to modest improvements in the process of care (range +3.6 to +17.0% and +1.3 to +16% respectively). Only a few studies evaluating educational meetings were identified, the results of which suggest that the effect of such an intervention is small. Furthermore, in contrast to previous reviews, multifaceted interventions, the combination of two or more strategies, did not appear to be more effective than any single intervention implemented in isolation, yielding a median effect size of 6.0% (range -4% to +17.4%). Grimshaw *et al.* concluded that due to the heterogeneity of study designs, populations, implementation strategies, and study quality, there is an 'imperfect evidence base' to support decisions about which change strategies are likely to be efficient under different circumstances[32].

It appears that the effectiveness of interventions varies across different clinical problems, contexts, and organizations. Consequently, we would surmise that due to the heterogeneity of the critically ill

population, the interdisciplinary nature of care delivery, the rapid pace of decision-making, and the high technology environment of the ICU, there are unique challenges when implementing guidelines in this context. To increase our understanding of the optimal strategies to implement knowledge into practice in this unique and complex setting, Sinuff *et al.* conducted a systematic review of RCTs and observational studies examining any KT intervention completed in the ICU compared to management without a KT intervention[47]. Of the 14,431 citations retrieved, data were abstracted on 119 studies (7 RCTs, 112 non-RCTs) on 9 clinical topics, including 10 studies on nutrition. The overall quality of the RCTs was high but the quality of the non-RCTs was low to moderate[48]. Meta-analysis of the included studies showed that interventions that included protocols with or without education were associated with the greatest improvements in continuous process measures (7 non-RCTs and 1 RCT; standardized mean difference (SMD) 0.26, 95% Confidence Interval (CI) 0.1,0.42; p=0.001 and 4 non-RCTs and 1 RCT; 0.83 (95% CI 0.37,1.29); p=0.0004), respectively). The addition of reminders and audit and feedback were associated with a significant improvement in dichotomous process measures (4 non-RCTs; 2.23 (95% CI 1.08,4.59); p=0.03). There were no associated significant improvements in clinical outcomes. In contrast to their *a priori* hypothesis that multifaceted change strategies would be most effective[49], they found that single KT interventions had a larger effect compared to multifaceted ones. However, as in the systematic review by Grimshaw *et al.*[32] any definitive conclusions regarding the most effective KT intervention were hindered by the heterogeneity of the study designs, insufficient data, and poor study quality.

2.8 Effectiveness of Knowledge Translation Implementation Strategies in Critical Care Nutrition

To identify and review the literature on implementation of nutrition guidelines in the ICU, I replicated the systematic search criteria adopted by Grimshaw *et al.*[32] but included the search terms ‘nutrition’ or ‘nutrition support’ and ‘critical care’ or ‘critical illness’ or ‘intensive care units’. My searches spanned from 1980 to September 2012. Personal files and relevant review articles were searched for additional

studies. A total of 331 citations were identified from the search. After screening all titles and abstracts of retrieved studies, only 4 studies evaluating guideline implementation strategies were identified and obtained for full text review[50-53]. One of these studies was subsequently excluded because it employed an uncontrolled before-after design and used a subjective outcome assessment (i.e., health professional questionnaire on utilization of the guidelines)[50]. The remaining three cluster RCTs evaluating various guideline implementation strategies met our inclusion criteria[51-53]. The underlying hypothesis of all three trials was that the implementation of nutrition guidelines using multifaceted strategies would improve the provision of nutrition and patient outcomes compared to usual care.

Martin et al. conducted the first of these studies in 11 community and 3 teaching hospitals in Ontario from October 1997 to September 1998[53]. The primary change strategy employed in this trial was the incorporation of evidence-based recommendations into an algorithm for feeding critically ill patients. The introduction of this algorithm was accompanied by a multifaceted implementation strategy at the intervention ICUs that included opinion leaders delivering an in-service educational session to the interdisciplinary ICU team. This session described the evidence supporting the recommendations and introduced staff to the new algorithm. Laminated copies of the feeding algorithms were then posted in the ICU, and the nurses and physicians were provided with pocket cards. Finally, the dietitian monitored the provision of nutrition daily and provided feedback to the ICU team on their adherence to the recommendations. At the control hospitals, dietitians collected data for the study only. Overall, the results of this study were positive and demonstrated that patients in the intervention arm received more days on EN (6.7 vs. 5.4 per 10 patient days, p=0.042), had a significantly shorter mean stay in hospital (25 vs 35 days; p=0.003 and showed a trend towards reduced mortality (27 vs. 37%; p=0.058) compared to patients in the control arm. However, no difference was observed in the ICU length of stay (10.9 vs 11.8 days, p=0.7).

Jain and colleagues also conducted the second and largest of these three cluster RCTs in Canada[52]. In May 2003, after a baseline survey of current nutrition practices, 58 ICUs across Canada, grouped into 50 clusters, were randomized to either active or passive dissemination strategies. The active arm consisted of multifaceted change strategies where the ICU dietitian, as the local opinion leader, received web-based tools and training kits for conducting interactive workshops and quality improvement. The dietitians were also instructed to implement an enteral feeding protocol, and distributed posters and pocket cards summarizing the guidelines. In addition, data collected at baseline were used to develop an individualized benchmarked performance report, a form of audit and feedback. In contrast, the passive group only received a copy of the CPGs. A follow-up survey of nutrition practices was repeated in May 2004 to determine changes in practice. The primary endpoint was adequacy of EN (i.e. calories received by EN as a proportion of calories prescribed by the dietitian). Despite an increase in EN adequacy in both groups over the study period, there were no significant differences in the change in the EN adequacy between the two arms from baseline to follow-up (8.0% vs. 6.2%, P=0.54). However, significant improvements in EN adequacy in a subgroup of medical patients and in blood glucose control were observed in the active arm compared to the passive arm. No other significant differences in nutrition practices or clinical outcomes were noted between groups.

In the final and most recent cluster RCT, Doig *et al.* performed a complex multifaceted intervention that involved 18 different strategies to change nutrition practice[51]. The trial was intended to validate the earlier observations in the Martin *et al.* study[53]. It was conducted in 27 community and teaching hospitals in Australia and New Zealand. ICUs randomized to receive the intervention participated in a two day guideline development conference which included an educational workshop on the use of the 18 interventions to be used to implement the new guidelines. These interventions included academic detailing by a peer-nominated opinion leader, educational outreach by lead investigators, verbal and passive reminders, didactic presentations, and audit and feedback. The study found that EN was initiated earlier in patients from intervention ICUs (0.75 vs 1.37 days, $p<0.001$) and patients achieved caloric goal more

often (6.10 vs 5.02 days per 10 fed patient-days, p=0.03). Furthermore, more patients were never fed in the control hospitals compared to intervention ICUs (28.2 vs 5.7%, p=<0.001). However, no significant differences were observed in any of the measured clinical outcomes.

Looking across these three cluster RCTs, we observe small changes in nutrition practice but no effect on patient outcomes, therefore convincing evidence to support the hypothesis that implementing nutrition guidelines using multifaceted strategies leads to clinically important changes in nutrition practices and patient outcomes is lacking. The inability to detect larger treatment effects in these studies may have been due to low implementation fidelity at intervention ICUs, potential contamination or Hawthorne effect in the control arms, or the study time periods being inadequate for meaningful changes to occur. In addition, as the effectiveness of guideline implementation interventions have been shown to vary depending on the setting and target group, the heterogeneity of participating ICU sites and patient population may have also played a role. Acquiring an understanding of the nature of the knowledge-practice gap, the target group, the context, and the barriers to change may be an integral first step to developing more effective interventions. None of the three nutrition guideline implementation cluster RCTs included an *a priori* assessment of barriers to use of the guidelines or tailored the intervention to the local setting as advocated by Graham *et al.* in the 'Knowledge-to-Action' model[4]. Consequently, these barriers to change may not have been addressed as part of the multifaceted implementation strategies, thus hindering improvements in practice.

2.9 Effectiveness of Tailored Implementation Strategies

Tailored intervention strategies have been defined as "strategies to improve professional practice that are planned to take account of prospectively identified barriers to change"[54]. A recent Cochrane systematic review of RCTs of interventions tailored to address identified barriers identified 26 studies[54]. The majority of these trials targeted prescribing of specific medications (n=9) or the clinical management of specific

conditions (n=12) by primary care physicians. The results of these studies were mixed both across and within trials; some reported statistically significant improvements in all outcomes, while others observed no effect (adjusted odds ratios (OR) at follow up ranged from 1.07 (95% CI 0.76,1.49) to 12.25 (95% CI 7.22,20.77)). Only 12 of the 26 identified RCTs reported a binary outcome and were subsequently combined in a meta-regression analysis. After adjusting for site clustering and baseline OR's, the pooled OR for these studies was 1.54 (95% CI, 1.16, 2.01; p<0.001). In addition, the authors conducted several subgroup analyses to identify attributes of the tailored intervention associated with its effectiveness. None of the investigated attributes (i.e. methods of identifying barriers, level of tailoring, complexity of the intervention, use of theory) were found to be significantly associated with the effectiveness of the intervention.

At the end of this review, the authors concluded that "although tailored interventions appear to be effective, we do not yet know the most effective ways to identify barriers, to pick from amongst all the barriers those that are most important to address, or how to select interventions likely to overcome them".[54]

In addition to the 26 included studies, the authors identified 14 ongoing studies of tailored interventions for inclusion in a future update[54]. This growth in the number of studies suggests that, increasingly, tailoring is being considered an important step when implementing guidelines. Given the large variation in impact and quality of the reviewed trials, researchers should first fully define and develop the tailored intervention through extensive preliminary work, prior to conducting a rigorous evaluation of the effectiveness of the KT implementation strategy[55]. This approach is supported by the Medical Research Council's framework for the design and evaluation of complex interventions to improve health[56,57], that proposes a sequential approach to implementation involving 1) Developing an optimal intervention through gaining an understanding of the underlying problem and the context, and identifying determinants of and targets for change; 2) piloting methods and assessing feasibility through an exploratory or pilot

study; 3) Evaluating the intervention through a definitive randomized controlled trial; and 4) Large scale and long term implementation. Consequently, this thesis will focus on the second stage of this process.

2.10 Evaluating Barriers to Knowledge Use

Evaluating the barriers to knowledge use is an integral part of tailored guideline implementation strategies. To successfully tailor interventions to overcome barriers to change, barrier assessments must be conducted in a valid and reliable way. Barriers may be identified using quantitative and qualitative methods, including observation, focus group discussions, interviews, surveys of providers', or through analysis of the organization or system. In a systematic review of 256 studies evaluating barriers to guideline adherence, Cochrane *et al.* abstracted descriptions of the methodology employed to identify barriers[35]. Seventy percent of the included studies used survey-type assessment (n=178), 18 studies (7%) used interview methods, 16 (6%) used focus groups, and a total of 44 (17%) used a combination of approaches. Despite being the preferred method of assessing barriers, few studies included in the systematic review utilized well-designed and validated questionnaires.

Questionnaires remain the mainstay of epidemiologic data collection. A recent review of questionnaire use in epidemiologic journals found that 64% of the identified articles used either an interviewer- or self-administered questionnaire[58]. Of these 61% and 34% used the questionnaire to assess the primary exposure or outcome respectively[58]. However, less than half of the articles (46%) discussed the validity of the administered questionnaire, leading the authors of the review to conclude that questionnaire validation and potential impact on data quality is not of central methodological concern for many investigators[58]. Rigorous questionnaire design is imperative because it reduces measurement error and enables the collection of reliable and unbiased data from a representative sample of respondents[59]. A validated questionnaire is one that has been evaluated to demonstrate that it measures what it is intended to measure. An extensive body of literature, spanning over 50 years, is available to guide epidemiologists and health

service researchers needing to develop questionnaires[58]. Adopting a systematic approach to design, develop, evaluate and administer a novel questionnaire is recommended to minimize bias and optimize response rate[60]. Criteria have been proposed for assessing the quality of psychological measures and diagnostic tests[61,62]; and there have been calls for similar standards for questionnaires used in epidemiological research[63]. The questionnaire group of the International Epidemiology Association proposes the following as important elements of the validation procedure: compare with a 'gold standard', compare with other sources of data, examine reliability, use translation and back translation, examine feasibility (e.g. acceptability, time needed to respond, cost etc.), examine variation in response due to data inquiry methods (self-administrated, personal interview, telephone interview etc.)[63].

While we often refer to the validity of the questionnaire; conceptually, validity is "not a property of the test or assessment as such, but rather of the meaning of the test scores. These scores are a function not only of the items or stimulus conditions, but also of the persons responding as well as the context of the assessment[64]." In epidemiological research, our goal is often to quantify attributes that cannot be measured directly (i.e. an underlying construct or theory) and consequently, the validity of a questionnaire depends on the degree to which it reflects the construct that it is intending to assess. Historically, validity was separated into three distinct types, namely, content, criterion, and construct validity. *Content validity* refers to the extent to which the items in a questionnaire are an adequate and representative sample of all the items that might represent the underlying construct. Face validity is a closely related concept that indicates that included items seem appropriate. As there is no statistical test to determine face or content validity, it is often established through the judgment of experts together with a detailed description of the steps taken to develop and select included items. *Criterion validity* examines the extent to which results from the questionnaire are consistent with a previously developed test that is considered the 'gold standard'. However, in many cases, there is no 'gold standard' available, or it is too costly or distant in time to assess. In such cases a surrogate indicator may be used[65]. *Construct validity* reflects the ability of the questionnaire to measure the underlying construct. The current perspective is that all evidence of

validity, including content and criterion validity, is conceptualized as a component of construct validity[66]. Validity is not a dichotomous (valid vs not valid) concept but rather is assessed on a continuum whereby evidence is generated to demonstrate that responses reflect the underlying construct. As such questionnaire validation is viewed as an ongoing process of hypothesis testing[67]. Several statistical methods can be adopted to establish evidence of validity; correlation coefficients, exploratory and confirmatory factor analysis, and regression analysis are some of the most common.

Reliability is a necessary, but not sufficient, component of validity. Reliability refers to the stability or consistency of the questionnaire and the extent to which it produces similar results when administered repeatedly over time to the same respondent under the same conditions. It can be defined as the proportion of the total variance (True plus Error (i.e. random plus systematic)) that is due to differences between respondents[68]. The goal when developing a questionnaire is to achieve acceptable reliability by reducing measurement error. Reliability is usually reported as a correlation coefficient ranging from 0 to 1, were 0 indicates no reliability and 1 indicates perfect reliability. There are two types of reliability, the internal consistency and stability of a questionnaire. *Internal consistency* assesses whether several items that intend to measure the same underlying construct produce similar scores. Cronbach's alpha, Kuder-Richardson, and split-halves are commonly used to calculate the correlations[67]. Assessment of internal consistency is based on a single administration of a questionnaire. The *stability* or reproducibility of the questionnaire can be evaluated when the questionnaire is administered on different occasions (e.g. test re-test, inter-rater). Pearson correlation, intraclass correlation coefficient (ICC), Kappa, Bland and Altman plots, or Phi are commonly used to assess this type of reliability[67].

There are a few questionnaires that assess the barriers to implementing guideline recommendations that are supported by some evidence of reliability and validity[69-71]. One of these questionnaires, the 'Attitudes Regarding Practice Guidelines' tool, is based on Cabana *et als.* knowledge-attitudes-behaviour framework[34,70]. The purpose of this questionnaire is to examine the attitudes of providers towards CPGs in

general, and hand hygiene guidelines specifically. The questionnaire has 2 sections. The first part includes 18 items focusing on attitudes to guidelines in general, and the second part includes 18 items pertaining to the hand hygiene guidelines. Respondents are asked to rate the degree to which they agree with the item statements on a 6 point likert scale of 'strongly disagree' to 'strongly agree'. The face, content and construct validity of the tool was tested through 4 focus groups with infection control and infectious disease physicians (3-6 per group) from 7 hospitals in the United States and mailed review by 12 other experts. In addition, test re-test reliability was assessed through administration of the questionnaire to a convenience sample of 21 providers (i.e. physicians and nurses) 2 weeks apart. The resulting reliability co-efficient was 0.86 and Cronbach alpha was 0.80, indicating acceptable reliability in that sample. The authors acknowledged that this testing was preliminary and recommended that further adaptation and evaluation of the tool be completed.

The 'Barriers and facilitators assessment' questionnaire was developed in the Netherlands to identify perceived barriers to improvement in patient care, with a focus on preventative care[71]. Questionnaire items were generated from a literature review and an expert panel. The questionnaire consists of 24 items divided into four categories: 1) innovation characteristics; 2) care provider characteristics; 3) patient characteristics; and 4) characteristics of the organisational, social, political, and societal context. Respondents were asked to rate the degree to which they agree with the included statements on a 5 point likert scale of 'fully disagree' to 'fully agree'. The questionnaire has been used in more than 12 implementation studies in the Netherlands[71]. One of these studies used the questionnaire to evaluate barriers to use of quality indicators in the ICU[72]. Several items were not relevant to the context of the ICU setting or to quality indicators and were removed. Assessment of the remaining 11 items resulted in 3 factors with reasonable reliability (Cronbach alpha 0.73, 0.74, and 0.71).

In 1987, Funk et al. developed the BARRIERS scale to assess nurses' perceptions of barriers to the utilization of research findings in practice[69]. Rogers' diffusion of innovation theory guided the

development of the questionnaire[12]. Items were derived from the literature, research data, and an existing questionnaire. The scale consists of 28 items, divided into four parts (derived from exploratory factor analysis) labeled as: 1) the characteristics of the adopter (8 items); 2) characteristics of the organization (8 items); 3) characteristics of the innovation (6 items); 4) characteristics of the communication (6 items). Respondents were asked to rate the degree to which they perceived each item to be a barrier to the use of research findings on a 4 point likert scale of 'to no extent' to 'to a great extent'. Assessment of internal reliability in a sample of 1,989 nurses yielded Cronbach's alpha for the 4 subscales of 0.80, 0.80, 0.72, and 0.6 respectively. Evaluation of test retest reliability in a sample of 17 nurses that answered the questionnaire twice, 1 week apart, resulted in a Pearson product moment correlation of 0.68 to 0.83. Therefore psychometric testing, indicated that the responses to the questionnaire had acceptable internal and test retest reliability in the study sample. A recent systematic review of the use of the BARRIERS scale in research studies identified 63 studies with a total of 19,920 respondents[73]. The majority of the included studies were cross-sectional and their quality was generally weak to moderate. Looking across these studies, the authors concluded that despite being reliable (i.e. overall Cronbach alpha values of 0.84 to 0.96), there was little evidence to support the construct validity of the scale, as demonstrated by exploratory and confirmatory factor analyses resulting in different factor solutions to those identified by Funk *et al.* in the initial psychometric evaluation, and sparse data supporting an association between perceived barriers and actual research use. As the BARRIERS scale identifies general barriers to research use, the authors recommended that the BARRIERS scale not be used for selecting tailored interventions, arguing that barriers need to be measured specific to the type of innovation and local context.

Overall, these existing barriers questionnaires have been developed for use with specific guidelines (e.g. hand hygiene), healthcare professional groups (e.g. nurses), and clinical contexts (e.g. primary care) and their applicability for use with multidisciplinary critical care providers in the ICU setting is questionable. Consequently, there is a need to develop a questionnaire to specifically measure the barriers to implementation of critical care nutrition guideline recommendations.

2.11 Summary

Applying the Knowledge-to-Action Model proposed by Graham *et al.* to the substantive area of critical care nutrition may aid in informing a KT research agenda on how we may optimize the nutrition care of critically ill patients. Evidence from systematic reviews summarized in guideline recommendations suggests that the provision of EN can reduce morbidity and mortality[20,23,74]. In contrast, international audits of nutrition practice in ICUs have demonstrated that although EN is the preferred route of feeding patients, strategies to maximize provision of EN are not routinely adopted[27]. Based on this review, I would hypothesize that this observed gap in care is caused by the presence of factors that impede or prevent critical care providers adhering to nutrition guideline recommendations. Some of these barriers may be unique to each ICU setting, while others may be common across all units. Some may be modifiable (i.e. amenable to change), while others may be rigid or difficult to change at the local level. Overcoming these barriers through a tailored intervention will improve the provision of EN and enable caloric goals to be met. However, prior to formally testing this hypothesis, there are several methodological and feasibility issues that need to be addressed; this will form the focus of the manuscripts in this thesis.

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Chapter 3

Development and Preliminary Validation of a Questionnaire to Assess Barriers to Feeding Critically Ill Patients

Abstract

Background: To successfully implement the recommendations of critical care nutrition guidelines, one potential approach is to identify barriers to providing optimal enteral nutrition in the Intensive Care Unit (ICU), and then address these barriers systematically. Therefore, the purpose of this study was to develop a questionnaire to measure barriers to enterally feeding critically ill patients and to conduct preliminary validity testing of the new instrument.

Methods: The content of the questionnaire was guided by a published conceptual framework, literature review and consultation with experts. The questionnaire was pre-tested on a convenience sample of 32 critical care practitioners, and then field tested with 186 critical care providers working at 5 hospitals in North America. The revised questionnaire was pilot tested at another ICU (n=43). Finally, the questionnaire was distributed to ICU nurses twice, 2 weeks apart, to determine test retest reliability (n=17). Descriptive statistics, exploratory factor analysis, Cronbach alpha, intraclass correlations (ICC), and kappa coefficients were conducted to assess validity and reliability.

Results: We developed a questionnaire with 26 potential barriers to delivery of enteral nutrition (EN) asking respondents to rate their importance as barriers in their ICU. Face and content validity of the questionnaire was established through literature review and expert input. The factor analysis indicated a 5-factor solution and accounted for 72% of the variance in barriers: guideline recommendations and implementation strategies, delivery of EN to the patient, critical care provider attitudes and behaviour, dietitian support, and ICU resources. Overall, the indices of internal reliability for the derived factor subscales and the overall instrument were acceptable (subscale Cronbach alphas range 0.84-0.89). However, the test retest reliability and within group agreement was variable (item ICC's range -0.13 to 0.70 and 0.0 to 0.82 respectively).

Conclusions: We developed a questionnaire to identify barriers to enteral feeding in critically ill patients. Additional studies are planned to further validate the instrument.

Keywords: barriers, critical care, factor analysis, guideline implementation, instrument development, nutrition, reliability, validity

Background

Clinical Practice Guidelines (CPGs) focusing on nutrition therapy for mechanically ventilated critically ill patients have been developed to assist critical care practitioners in managing the rapid proliferation of new information in this area, and make informed decisions regarding feeding [1-5]. However, despite the publication and dissemination of these CPGs, there continues to be considerable variation in nutrition practice across Intensive Care Units (ICUs) [6-10]. Consequently, efforts to implement guideline recommendations and narrow this gap in quality care are warranted[11].

A systematic review of studies on the implementation of these guidelines [12] identified 3 cluster randomized trials evaluating multi-faceted change strategies aimed at optimizing nutrition[13-15]. These trials demonstrated small changes in nutrition practice but no significant effect on clinically important endpoints. These results may reflect omission of an initial barriers assessment; understanding the barriers to change has been identified as key for optimal healthcare delivery[16]. Identifying barriers to nutrition guideline implementation and subsequent adherence may aid in designing more effective interventions[17]. But to successfully identify barriers to change, valid, reliable assessment methods are needed[18].

A recent systematic review of 256 studies evaluating barriers to guideline adherence[16], observed that the majority of these studies (n=178) used a questionnaire to identify barriers. However, the survey-type instruments adopted in these studies were not rigorously designed. While several questionnaires have undergone some psychometric testing [19-22], they were primarily developed for specific guidelines (e.g., hand hygiene), certain professional groups (e.g., nurses), or unique clinical contexts (e.g., primary care). Therefore, the suitability of these questionnaires for administration to multidisciplinary critical care providers is uncertain. The objective of this report is to describe the development and psychometric evaluation of a questionnaire designed to identify barriers to adherence to critical care nutrition guidelines for enterally feeding critically ill patients.

Methods

Conceptual Framework

We conducted a multiple case study in 4 ICUs in Canada[23], which included semi-structured interviews with 28 critical care providers (i.e., physicians, nurses and dietitians) to ascertain attitudes and perceptions about nutrition guidelines. The qualitative analysis was guided by Cabana *et al's* knowledge-attitude-behaviour framework[24] and led to an extended and revised framework for barriers to adherence to critical care nutrition guidelines[25]. The schema and explanatory tables that describe this framework have been published elsewhere[25]. A brief description of the 5 domains included in the framework follows:

1) Guideline Characteristics: Guidelines consisting of complex statements that are difficult to interpret, or are based on outdated or weak evidence, are barriers to adherence.

2) Implementation Process: Lack of adequate resources in terms of time to plan, conduct and attend educational sessions prohibit effective implementation of changes and consequently are barriers to adhering to them in practice.

3) Institutional Factors: Small, non-teaching hospitals in rural locations with an open ICU structure (i.e., any attending physician can admit to the ICU) are institutional barriers to guideline adherence. Resource constraints (e.g., staff, materials, specialty services) and a slow administrative process are additional barriers to adherence. A negative ICU culture; lacking leadership, lacking a cohesive multi-disciplinary team structure, or with poor communication is also a barrier to adherence.

4) Provider Intent: Lack of intent to adhere to the guideline may translate into the behaviour of not adhering to guideline recommendations and is therefore a significant barrier. A provider's lack of intent is a consequence of inadequate knowledge of, and negative attitudes towards, the guidelines. Inadequate knowledge is a function of unfamiliarity and unawareness of the guideline recommendations. A negative attitude is a function of poor outcome expectancy (i.e., belief that following the recommendation will not benefit the patient), lack of self-efficacy (i.e., belief that one does not have the skills to implement the

recommendation), lack of motivation (i.e., unwilling to change) or disagreement with the guideline recommendations.

5) Patient Characteristics: Guideline adherence may be more difficult in patients with a poor prognosis or for whom there are other more urgent care priorities.

Item Generation

We intended the questionnaire to be administered to individual providers to determine their perception of the barriers to enterally feeding critically ill patients in the ICU in which they primarily work. To maximize the usefulness of the questionnaire, *a priori* it was decided to focus only on barriers that are amenable to change and can be targeted by intervention strategies to improve practices, rather than non-modifiable barriers such as hospital teaching status and patient case-mix. Acknowledging that national or society guidelines are frequently adapted locally, the questionnaire did not refer to any specific set of published critical care nutrition guidelines but asked respondents to refer to the guidelines currently being used to inform decisions about feeding in their respective ICUs. In addition, we focused on recommendations related to the provision of enteral nutrition (EN) only, rather than parenteral nutrition, nutrient supplementation, or nutritional assessment, because these recommendations are uniformly endorsed across published guidelines[1-5], are supported by the highest level of evidence, and critical care providers generally agree with the recommendations[26].

In addition to our conceptual framework[25], potential items were identified through a literature review of studies of barriers to guideline adherence and by examining the content of existing barrier questionnaires developed in other settings[19-22]. This initial list of potential items was circulated to experts to obtain input on item comprehensiveness and wording. Redundant (i.e., duplicate) or irrelevant items (i.e., represented non-modifiable barriers, or were not applicable to the ICU) were eliminated. Following item generation and reduction, a draft paper-based version of the questionnaire composed of 62 items divided into 4 sections was pre-tested with a convenience sample of 32 critical care practitioners (11 physicians, 11

nurses and 10 dietitians) from across Canada (Appendix C). Based on this pre-test, the questionnaire was revised and reduced further to 49 items divided into 4 parts (Appendix D).

Part A consisted of general questions about the ICU environment, the implementation of guidelines both in general and nutrition specifically (9 items). Part B asked respondents about their level of agreement with the recommendations of critical care nutrition CPGs pertaining to enteral feeding (8 items). Part C focused on barriers to delivering adequate amounts of EN (22 items). Each item in Part A, B and C used a 7-point likert scale, to maximize the potential to discriminate among barriers and to allow a neutral response[27]. The items in Part A and B were formulated positively and end-anchored by the adjectives '1=Fully disagree' and '7=Fully agree' and included a 'don't know' option. Parts A and B were intended to assess attitudes towards nutrition in general and the guideline recommendations specifically, as attitudes may influence an individual's intention to feed and subsequent behaviour, such that lack of agreement with these items indicates a barrier to feeding critically ill patients. The items in Part C were formulated negatively and end-anchored with the adjectives '1=Not at all important' and '7=very important', with 'very important' indicating that the item is a major barrier and 'not important' indicating that it is not a barrier in their ICU. Each item in Part A, B and C maps on to one of the 5 domains of the framework. In addition, Part C included 4 open-ended questions asking respondents to list additional important barriers to delivering adequate EN in their ICU, to list the most important barriers in their ICU, and to highlight strategies to overcome these barriers. In Part D (6 items), characteristics of the respondent, such as age, sex, profession, work experience and seniority are captured.

Field Test

The sampling pool for field testing was provided by 7 ICUs from 5 hospitals in North America who were participating in a pre-test post-test study evaluating the feasibility of a tailored guideline implementation strategy (The PERFECTIS study [ClinicalTrials.gov identifier: NCT01168128]). At each ICU, all full and part-time physicians, nurses, dietitian(s), the Nurse Manager and the ICU Manager were invited to

complete the questionnaire (n=409). If the nursing pool exceeded 85, a random sample of 60 nurses was used. To maximize the response rate, the questionnaire was distributed according to a modified Dillman's tailored design method[28], and respondents were provided with the option of completing a web-based (survey monkey[29]), electronic (fillable pdf), or paper-based version of the questionnaire.

On-site Observational Visits

To confirm the results of the field testing and further refine the questionnaire, we conducted on-site observational visits at all 5 hospitals included in the field test. Half-day focus groups were completed with ICU physician and nursing leaders, bed-side nurses, and dietitian(s). Participants were first asked to reflect on EN provision in their ICU and identify areas where they perform well and areas for improvement. During these discussions, we explored the reasons (i.e., barriers and enablers) for high or poor performance. Results of the barriers questionnaire were then presented to the group and compared with the reasons provided in the earlier discussion.

Data Analysis to Determining the Psychometric Properties of the Questionnaire

First, we conducted a descriptive analysis (e.g., missing data, variance, mean, histograms etc). The frequency of non-response was examined, and items with a non-response of greater than 10% were reviewed and considered for re-wording or eliminated. The standard frequency distributions of responses to each item in the questionnaire were then examined for floor and ceiling effects. Items with a very high (>0.8) or low (<0.2) endorsement frequency (i.e., proportion of respondents responded 'fully agree', 'agree' or 'somewhat agree' in Part A or B and ''very important', 'important' or 'somewhat important' in Part C) were considered for elimination, because responses to these items can be predicted and including them does not improve the scales psychometric properties[30].

Exploratory Factor Analysis

To refine the content of the barriers questionnaire, reduce the number of items and ensure the most parsimonious representation of the underlying constructs, we conducted an exploratory factor analysis.

Missing values were treated as truly missing without imputation. A principal components analysis with varimax (orthogonal) rotation and kaiser normalization was used[31]. Eigenvalues of > 1 (Kaiser criteria), the cumulative percentage of variance explained by successive factors, a scree plot, and at least 3 items with factor loadings greater than 0.50 were used, together with the underlying conceptual framework, to identify the number of factors. Factor loadings of >0.5 were considered acceptable for item retention on a single factor[31]. Items that cross-loaded at >0.5 or loaded 0.4-0.5 on a single factor were evaluated by the research team on a case-by-case basis, retained or eliminated based on the item's conceptual importance, its unique contribution to the factor, and whether it was strongly related conceptually to another factor. Following the descriptive and exploratory factor analysis, we revised the questionnaire.

Generating Barriers Scores

Each factor identified by the exploratory factor analysis corresponded to a subscale. Item scores were calculated by awarding 1, 2, or 3 points if the respondent identified an item as a 'somewhat important', 'important' or 'very important' barrier respectively. If an item was rated 1-5 (i.e., 'not at all important' to 'neither important or unimportant' it was awarded 0 points. The barrier score was calculated by dividing the awarded points for each item by the maximum number of potential points (i.e., 3), and multiplied by 100. The subscale and overall barriers scores were calculated as the mean score of all items within each subscale and mean of all items respectively.

Internal Reliability

We examined the reliability of the overall questionnaire and evaluated factor analysis derived subscales using Cronbach's alpha. As individual questionnaire responses were intended to be aggregated to the ICU

level to identify barriers pertinent to the ICU and inform a tailored intervention, a minimum overall and subscale co-efficient alpha of 0.8 was considered desirable, and any item for which alpha significantly increased if the item was deleted from the scale was considered for removal[30].

Aggregating Responses to the Unit Level

Respondents were instructed to complete the questionnaire so that responses reflected the average situation in their ICU. To assess whether responses might be aggregated to the ICU level to obtain a single estimate of site-level barriers, we used 3 indices of within-group agreement and group mean reliability to examine each questionnaire item, subscale, and overall score[32] 1) intraclass correlation coefficient(1) (ICC[1]) (or Shrout and Fleiss model 1,1[33]), 2) ICC(2) (or Shrout and Fleiss model 1,k where k=35 respondents[33]) and 3) the F-test p-value. The variance components to compute the ICCs were calculated using mixed linear regression models with Restricted Maximum Likelihood (REML) estimation, and the F-test p-values were derived from a one-way analysis of variance (ANOVA). The aggregated data were considered reliable if the F tests' p-values were <0.05 indicating that responses differ in different ICUs and / or ICC(2) (an estimate of the reliability of group means) was >0.60[34]. ICC(1) is the ratio of between-group variance to total variance and is an estimate of the degree of reliability associated with a single providers assessment of the unit mean. Values of ICC(1) between 0.05 and 0.20 are typical in organizations[32].

Sample Size

A priori, we estimated that each ICU participating in the field test would have approximately 80 staff members to whom the questionnaire would be distributed, and that the response rate would be approximately 50%, giving a sample size of 280 and a sample size to item ratio of 7 to 1. This sample size surpasses the recommended minimum of 150 cases and a sample size to number of items ratio of no lower than 4 to 1 for exploratory factor analysis[35].

Qualitative analysis

Responses to the open-ended questions were reviewed to determine whether respondents identified barriers that were not already included in Part C.

We reviewed minutes from the focus group sessions at the 5 field test sites for evidence supporting content and construct validity (i.e. to identify additional barriers, and evaluate if themes that emerged from the focus group sessions mapped on to the identified factor structure).

Pilot Testing

Following completion of the analysis of the field test data, the research team met to review the results and revise the questionnaire. A revised version of the barriers questionnaire was circulated to ICU providers who had provided feedback on earlier questionnaire drafts during the pre-test and field test. In March 2011, the final version of the barriers questionnaire was pilot-tested with 43 providers working in a 20 bed closed ICU at a 404 bed teaching hospital in Canada. Using an open-ended format, respondents were asked for feedback on the questionnaire and to report the time to completion; we made further revisions where required.

Test-retest

Finally, in May 2011 we administered the barriers questionnaire to nurses working in a 16 bed closed ICU in a 472 bed Canadian teaching hospital to assess test-retest reliability. The questionnaire was distributed on 2 occasions, 2 weeks apart, using the same methods of distribution as in the field test. ICC (Shrout and Fleiss model 2,1[33]) was calculated between the item responses, subscale and overall scores at the two time points. An ICC >0.7 was considered acceptable[36]. For each item, we also dichotomized nurses responses based on their rating of importance (i.e., <=5 = not a barrier and > 5 = barrier) and calculated kappa co-efficients. A kappa of 0.0-0.2 was considered poor agreement, 0.2-0.4 as fair agreement, 0.4-0.6 as moderate agreement, 0.6-0.8 as substantial agreement, and 0.8-1.0 as perfect agreement[37].

Ethical Considerations

The Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board, Kingston, Ontario and the 5 hospitals participating in the field test approved this survey. Return of the completed questionnaire and/or attendance at the focus groups implied informed consent on the part of participating critical care providers.

Results

Field Test

Descriptive Statistics

A total of 186 completed questionnaires out of 409 distributed questionnaires (45.5%) were received. Table 3.1 and 3.2 describe the characteristics of the 5 participating hospitals and the field test respondent demographics, respectively.

Descriptive statistics of the individual questionnaire items are shown in Table 3.3. The proportion of missing values did not exceed 10% for any item. In Parts A and B, greater than 80% of respondents agreed with the majority of statements, resulting in medians skewed to the left and little variance in responses. As a consequence of the lack of variability, items in Parts A and B were omitted from subsequent analyses. For items 9 and 10 in Part A and 4 in Part B the proportion of respondents who endorsed (i.e., proportion of respondents responded 'fully agree', 'agree' or 'somewhat agree') the statements were less than 80% (i.e. 67.2%, 77.4% and 60.5%, respectively), and therefore these items were reworded to become negative statements representing a barrier and were grouped with the other barriers (Part C of the field test version of the questionnaire). Endorsement was also less than 80% for item 7 in Part B but through the focus groups, we found that the wording of the item (i.e., Patients receiving enteral nutrition should have the head of the bed elevated to 45 degrees) did not accurately reflect current guideline recommendations

regarding head of the bed elevation which include the caveat *'….where this is not possible, attempts to raise the head of the bed as much as possible should be considered,'*[3] and we surmised that if this qualifying statement was included, endorsement would have exceeded 80%, therefore the item was eliminated. For the 22 items in Part C, greater variance was observed, with responses spanning the likert scale for the majority of items.

Factor Analysis

Observations with missing values on any of the items in Part C were omitted from the factor analysis (27 of 186 observations) resulting in 159 respondents for this analysis. The principal components analysis indicated a 5 factor solution accounting for 72% of the variance. The eigenvalues for each factor and the factor loadings for each item after orthogonal rotation are shown in Table 3.4. The identified factors closely reflected the conceptual framework that guided the development of the barriers questionnaire.

Factor 1: Guideline recommendations and implementation strategies

'Guideline Recommendations' and 'Guideline Implementation strategies' were identified as 2 separate domains in the conceptual framework. However, in our factor analysis, the first factor included all 6 items from these 2 domains.

Factor 2: Delivery of enteral nutrition to the patient

Items associated with the 'Patient Factor' domain of the theoretical framework were represented in the second factor. Item C.22 (Lack of agreement among ICU team on the best nutrition plan of care for the patient) did not load on any factor at the cut-off criteria of 0.5 but did load at 0.458 on Factor 2. However, following feedback at the focus group sessions and discussion among the investigative team, the item was reworded to better reflect the barrier of poor communication rather than lack of agreement. Item C.22 was therefore omitted from subsequent analyses. *A priori*, we hypothesized that item C.12 (Delay in physician ordering the initiation of EN) would be associated with the 'critical care provider domain'. In our factor

analysis, it did not load on any factor at the cut-off of >0.5 but loaded on factors 2,3, and 4 at 0.42, 0.40, and 0.45 respectively. Despite loading more highly on factor 4 (dietitian support), we considered this to be more theoretically aligned with the items in factor 2. The title of this factor was changed from 'Patient factor' to 'Delivery of EN to the patient' to better reflect specific barriers that lead to a delay in EN provision.

Factor 3: Critical care provider attitudes and behaviour

The third factor represented the items associated with the 'Critical care provider behaviour' domain of the framework. Two items (C.12 and C.13) originally conceptualized to belong to this domain loaded on other factors. Through discussion, the investigative team agreed that the remaining items reflected behaviours that arose from attitudinal beliefs about nutrition and how best to feed critically ill patients, therefore the title of this factor was changed to 'Critical care provider attitudes and behaviour' to better reflect this association.

Factor 4: Dietitian support

Four items referring to the role of the dietitian (Table 3(c) C2, C3, C9, C13), identified in numerous domains of the original conceptual framework, were represented by a single factor in the analysis.

Factor 5: ICU resources

The fifth factor represented the items associated with the 'ICU environment' domain of the original framework. The title of this factor was changed to 'ICU resources' to better reflect that the factor focused on the barrier of inadequate staff and equipment rather than the general environment.

Internal Reliability

The Cronbach alpha coefficient for the barriers scale was 0.94. The alpha coefficients for the factor subscales all exceeded the acceptable cut-off of >0.8, ranging from 0.84 to 0.89.The alpha when an item

was deleted remained stable for each item, with the exception of one item in Factor 5 (Not enough nursing staff to deliver adequate nutrition) (Refer to Table 3.4).

Aggregating Responses to the Unit Level

The variance components and indices to assess the reliability of aggregating individual provider responses to the unit level are shown in Table 3.5. A total of 11 of the 21 questionnaire items included in the analysis and subscales 2,3,4 and 5, demonstrated statistically significant F statistics and ICC(2) values >0.6 in the acceptable range. The ICC(1) was greater than 0.05 typically observed in the organizational literature for 10 of the 21 items. However, the values for all 3 indices were not acceptable for the overall and subscale 1 scores.

Open-ended Questions

A total of 52 out of 186 respondents (28%) completed the open-ended question 'are there any other barriers that hinder your ability to deliver adequate amounts of enteral nutrition?', of these, 22 indicated 'no' and 22 described a barrier that was already included in the questionnaire or a non-modifiable barrier (e.g., patient's clinical condition) and therefore were not considered further. Of the remaining 8 responses, 4 described feeds being held for diarrhea, and 4 described waiting for x-ray confirmation of tube placement as important barriers. The latter 2 barriers were highlighted for inclusion as new items in the revised questionnaire.

On-Site Observational visits

A total of 46 critical care providers participated in the 5 focus groups, ranging from 3 to 14 attendees per group. Overall, the barriers identified by the barriers questionnaire were corroborated by the discussions on nutrition performance during the 5 focus groups.

Revised Barriers Questionnaire and Pilot Test

The final barriers questionnaire presented (Appendix E and available at www.criticalcarenutrition.com) in this paper consists of 2 sections. The first section lists 26 potential barriers to delivery of EN and asks the respondent to rate their importance as barriers in their ICU. These 26 items were followed by 2 open ended questions. The first open ended question asked respondents if there are any other barriers that hinder their ability to deliver adequate EN, and the second asked respondents to reflect on the 26 potential barriers to the provision of adequate EN and rank the 3 most important in their ICU. Part B included 6 questions about the personal demographics of the respondent.

The pilot test of the revised questionnaire in a separate sample of 43 nurses demonstrated that the time to complete the questionnaire was less than 5 minutes. No further changes were made based on the pilot test feedback.

Test-retest

A total of 17 nurses completed the questionnaire on two occasions, two weeks apart. The ICC for total barriers score was 0.64, with subscale scores ranging from 0.39-0.62. Only 1 of the individual items demonstrated acceptable correlation of >0.70. Item ICCs ranged from -0.13 to 0.70. The kappa coefficients were similar to the ICC, with 3 items demonstrating substantial or almost perfect agreement (refer to Table 3.6).

Discussion

We aimed to develop a novel questionnaire to identify barriers to implementing guideline recommendations pertaining to enterally feeding critically ill patients and to conduct preliminary psychometric testing of this new instrument. The content of the questionnaire has a sound theoretical base, derived from a recently developed framework that describes barriers to implementation of critical care

nutrition CPGs[25]. The face and content validity of the questionnaire have been established through review by experts, and through pre-testing and pilot testing with critical care providers. The descriptive and exploratory factor analysis led to the elimination of several items, resulting in a more parsimonious representation of the underlying conceptual model. Overall, the indices of internal reliability for the derived factor subscales and the overall instrument were acceptable. However, the assessment of test-retest reliability suggested that the temporal stability of the questionnaire was poor to moderate for the majority of items, with only 2 items demonstrating acceptable reliability.

In designing the barriers questionnaire, we originally structured the questionnaire in 4 parts: Part A addressing attitudes to nutrition and guidelines in general; Part B addressing agreement with guideline recommendations pertaining to EN, Part C addressing specific barriers to feeding critically ill patients, and Part D personal characteristics of the respondent. We hypothesized that attitudes towards nutrition and guidelines in general may function as a barrier to feeding by influencing a providers' intent to adopt a specific recommendation and their subsequent behaviour. However, our analysis revealed very high endorsement for all these general items in Parts A and B. The positive attitudes observed in our field test were also observed in our previous international survey of the attitudes of physicians and dietitians towards the Canadian Critical Care Nutrition CPG recommendations[26]. When results of this previous survey were compared to observational data of nutrition practices[10], despite supportive evidence underlying the recommendations and uniform endorsement of these recommendations amongst providers, practice did not follow recommendations at the bed-side. This supports our questionnaire field test results suggesting that negative attitudes towards guidelines and lack of agreement with guideline recommendations are not important barriers to the provision of EN in the ICU.

As the content of the barriers questionnaire was guided by the 5 domains of our framework for understanding adherence to guidelines in the ICU[25], we expected that the exploratory factor analysis would reveal a 5-factor solution, with individual items relating to a specific domain loading onto a factor

related to that domain. Although we did observe a 5-factor structure to the data, there were some differences between these factors and the conceptual framework domains. The factor analysis revealed that all items relating to the role of the dietitian loaded as a distinct factor. As the dietitian has primary responsibility for nutritional care, it is intuitive that 'dietitian support' would be a single factor distinct from the role of other critical care providers or ICU resources. This assumption is supported by our previous analysis showing that the presence of a dietitian was associated with higher nutrition performance[38]. In contrast, items related to the two domains of guideline recommendations and guideline implementation strategies in our conceptual framework all loaded as a single factor, suggesting that ICU providers do not perceive the guideline documents and their method of implementation as different types of barriers but all related to the same concept.

While preliminary evaluation revealed acceptable internal reliability, we observed that test retest reliability and the reliability of aggregated responses was poor for some items. *A priori*, we surmised that a critical care providers' perception of barriers to enterally feeding would not change over a two week period. Nurses may have altered their responses as a consequence of being prompted to think more about the barriers to feeding their patients following the first administration of the questionnaire, or providers may respond based on their most recent experiences with an individual patient rather than their general experience. Our sample size of 17 nurses may have been inadequate to evaluate test retest accurately. Although greater than 50% of items demonstrated acceptable reliability as aggregated variables, several items including those associated with subscale 1 were problematic. Items in subscale 1 focused on characteristics of nutrition guideline recommendations, therefore we may surmise that there will be greater variation in individuals responses surrounding these general items compared to other items focusing on routine practice in their ICU. Larger samples representing more ICUs would inform whether specific items or the response scale should be revised to improve reliability.

The multi-phase development and testing of this questionnaire on barriers to enterally feeding critically ill patients was methodologically rigorous and involved multidisciplinary critical care providers and several ICUs. The utility of this instrument to inform quality improvement activities in the busy ICU environment is promising, its feasibility enhanced by its brevity (taking only 5 minutes to complete), and its focus on aspects of nutrition care that are modifiable.

There are several limitations to this work. First, this report represents the first field test of the questionnaire in convenience sample of 5 ICUs in North America with a moderate response rate of 46%. However, the response rate is similar to other surveys in this setting[39], and the field test sample of 159 responses used in the factor analysis provided a sample size to item ratio of 7:1 (i.e. 159 responses:22 items), surpassing the minimum recommendation of 4:1[35]. Second, 75% of our participants were nurses, consequently the proportion of dietitians and physicians who are the primary decision makers for nutrition therapy was small. We did not involve non-ICU physicians or residents whose attitudes towards the nutrition recommendations may differ. To this end, further testing is planned in a larger international sample of providers. Third, items in the questionnaire are those that providers perceive to be important barriers to EN in the ICU, but other studies are needed to evaluate whether addressing these perceived barriers actually improves the provision of EN in practice. Fourth, analyses using different datasets are required to confirm the 5-factor solution derived from this field test and to establish the questionnaire's construct validity.

Conclusions

We have developed a questionnaire for assessing barriers to feeding critically ill patients, and have provided preliminary evidence to support the validity and internal consistency of the derived factor subscales and the overall instrument. In addition to the planned validation studies, this questionnaire is currently being utilized in a pretest posttest study assessing the feasibility of adopting an intervention

tailored to overcome identified barriers as a strategy to improve nutrition practices in the ICU ('PERFormance Enhancement of the Canadian nutrition guidelines by a Tailored Implementation Strategy: The PERFECTIS Study' (ClinicalTrials.gov identifier: NCT01168128).

List of abbreviations

ANOVA: Analysis of Variance

CPGs: Clinical Practice Guidelines

EN: enteral nutrition

ICU: Intensive Care Unit

ICC: Intraclass Correlation Coefficient

REML: Restricted Maximum Likelihood

Competing Interests

The authors declare that they have no competing interests.

Author's contributions

NC and DKH were responsible for the study conception and design, obtaining the grant to fund this work, and leading the observational site visits. NC performed the data analysis and was responsible for drafting the manuscript. AD, DKH and DC provided methodological and statistical expertise, helped to interpret the results, and made critical revisions to the manuscript.

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Table 3.1: Characteristics of the Five Hospitals Participating in the Field Test

ICU [#]	Country	Hospital Type	Hospital Size	ICU Structure	ICU Size
1	USA	Non-Teaching	361	Closed[&]	20
2	Canada	Teaching	497	Closed	16
3*	USA	Teaching	600	Open^	32
4	Canada	Non-Teaching	400	Open	13
5	Canada	Teaching	759	Closed	30

[*]3 units combined due to common infrastructure and shared staffing
[#]ICU=Intensive Care Unit
^ Open=patient under care of any attending physician
[&]Closed=patient under care of an intensivist

Table 3.2: Personal Characteristics of Field Test Sample

Characteristic	**N (%)**
Sex	*N=171*
Male	28 (16.4)
Female	143 (83.6)
Age	*N=172*
20-34	75 (43.6)
35-49	68 (39.5)
≥ 50	29 (16.9)
Clinical Specialty	*N=186*
Dietitian	25 (13.4)
Nurse	138 (74.2)
Physician	12 (6.5)
Other^	11 (5.9)
Time dedicated to ICU[#]	*N=173*
Full-time	120 (69.4)
Part-time	45 (26.0)
Other[&]	8 (4.6)
Length of time working in critical care	*N=173*
0-5	77 (44.5)
6-10	45 (26.0)
11-15	20 (11.6)
>15	31 (17.9)
Leadership role*	*N=171*
Yes	53 (31.0)
No	118 (69.0)

*Examples of a leadership role include charge nurse, clinical nurse specialist, nurse manager
[#]ICU=Intensive Care Unit
^ e.g. pharmacist, nurse attendant, student nurse, resident
[&] e.g. casual, trainee placement,

Table 3.3: Descriptive Statistics of Barrier Questionnaire Items

(a) Part A: General Barriers

Item	Median	Mode	Range	Don't Know (%)	Missing (%)	Endorsement (%)
ICU environment						
1. Overall, our unit functions very well together as a team.	6.0	6.0	3-7	1 (0.5)	1 (0.5)	96.2
2. Our ICU team engages in joint decision-making in planning, coordinating and implementing nutrition therapy for our patients.	6.0	6.0	1-7	1 (0.5)	0	93.6
3. Overall, it is easy for me to openly talk with other members of the ICU team about matters related to the nutritional needs of my patient.	7.0	7.0	1-7	1 (0.5)	0	95.7
4. In our ICU, implementing best practices, as defined by clinical practice guidelines, is intrinsic to our culture.	6.0	6.0	2-7	2 (1.1)	1 (0.5)	93.0
5. Our ICU Managers/Directors are supportive of implementing nutrition guidelines.	6.0	7.0	2-7	7 (3.8)	1 (0.5)	82.7
Attitudes towards nutrition						
6. Nutrition is very important for my critically ill patients.	7.0	7.0	6-7	2 (1.1)	1 (0.5)	98.9
7. I feel responsible for ensuring that my patients receive adequate nutrition while in the ICU.	7.0	7.0	5-7	1 (0.5)	3 (1.6)	99.5
8. I am familiar with our current national guidelines for nutrition in the ICU.	6.5	6.0	2-7	10 (5.4)	0 (0.0)	67.2
9. If the recommendations of the current national guidelines for nutrition are followed in our ICU, patient outcomes will improve.	6.0	6.0	1-7	19 (10.2)	0 (0.0)	77.4

Responses options for Part A: 1=fully disagree 2=disagree 3=somewhat disagree 4=no opinion 5=somewhat agree 6=agree 7=fully agree
Endorsement = % respondents who responded 'fully agree', 'agree' or 'somewhat agree' in Part B

(b) Part B: Guideline Recommendations for Enteral Nutrition

Item		Median	Mode	Range	Don't Know (%)	Missing (%)	Endorsement (%)
10.	Enteral nutrition should be used in preference to parenteral nutrition.	7.0	7.0	4-7	3 (1.6)	0 (0.0)	95.7
11.	Enteral nutrition should be initiated early (24-48 hours following admission to ICU).	6.0	7.0	3-7	1 (0.5)	0 (0.0)	97.9
12.	An evidence-based feeding protocol should be used.	7.0	7.0	2-7	1 (0.5)	1(0.5)	96.8
13.	If a feeding protocol is used, it should tolerate a higher gastric residual volume (i.e. > 250mls) before holding feeds.	6.0	7.0	1-7	9 (4.8)	1 (0.5)	60.5
14.	In patients who have feed intolerance (i.e. high gastric residual volumes, emesis) a promotility agent should be used.	6.0	6.0	1-7	3 (1.6)	0 (0.0)	96.2
15.	Small bowel feeding should be considered for those select patients who repeatedly demonstrate high gastric residual volumes and are not tolerating adequate amounts of enteral nutrition delivered into the stomach.	6.0	6.0	1-7	10 (5.4)	0 (0.0)	91.4
16.	Patients receiving enteral nutrition should have the head of the bed elevated to 45 degrees.	6.0	7.0	1-7	2 (1.1)	2 (1.1)	78.3
17.	In all critically ill patients, hyperglycemia (blood glucose > 10 mmol/l or 180mg/dl) should be avoided by minimizing intravenous dextrose and using insulin administration when necessary.	6.0	6.0	2-7	2 (1.1)	0 (0.0)	94.6

Responses options for Part B: 1=fully disagree 2=disagree 3=somewhat disagree 4=no opinion 5=somewhat agree 6=agree 7=fully agree
Endorsement = % respondents who responded 'fully agree', 'agree' or 'somewhat agree' in Part B

(c) Part C: Barriers to delivery of enteral nutrition

Item		Median	Mode	Range	Missing (%)	Endorsement (%)
ICU Environment						
18.	Not enough nursing staff to deliver adequate nutrition.	3.0	1.0	1-7	2 (2.2)	30.2
19.	Not enough dietitian time dedicated to the ICU during regular weekday hours.	3.0	2.0	1-7	5 (2.7)	38.1
20.	No or not enough dietitian coverage during weekends and holidays.	5.0	6.0	1-7	5 (2.7)	60.8
21.	Enteral formula not available on the unit.	4.0	6.0	1-7	4 (2.2)	50.0
22.	No or not enough feeding pumps on the unit.	5.0	6.0	1-7	5 (2.7)	58.0
Guideline Recommendations						
23.	Current scientific evidence supporting some nutrition interventions is inadequate to inform practice.	4.0	5.0	1-7	13 (7.0)	46.8
24.	The current national guidelines for nutrition are not readily accessible when I want to refer to them.	5.0	5.0	1-7	7 (3.8)	55.3
25.	The language of the recommendations of the current national guidelines for nutrition are not easy to understand.	4.0	4.0	1-7	11 (5.9)	38.3
Guideline Implementation Strategies						
26.	Not enough time dedicated to education and training on how to optimally feed patients.	5.0	5.0	1-7	6 (3.2)	57.8
27.	No feeding protocol in place to guide the initiation and progression of enteral nutrition.	4.0	1.0	1-7	7 (3.8)	45.3
28.	Current feeding protocol is outdated	4.0	4.0	1-7	13 (7.0)	34.1
Critical Care Provider Behaviour						
29.	Delay in physicians ordering the initiation of EN.	5.0	5.0	1-7	5 (2.7)	65.2
30.	Waiting for the dietitian to assess the patient.	4.0	6.0	1-7	6 (3.2)	48.3
31.	Non-ICU physicians (i.e. surgeons, gastroenterologists) requesting patients not be fed enterally.	5.0	6.0	1-7	6 (3.2)	57.8
32.	Nurses failing to progress feeds as per the feeding protocol.	4.0	6.0	1-7	4 (2.2)	45.6

33.	Fear of adverse events due to aggressively feeding patients.	4.0	5.0	1-7	5 (2.7)	48.6
34.	Feeding being held too far in advance of procedures or operating room visits.	5.0	5.0	1-7	6 (3.2)	58.9
Patient Factors						
35.	No feeding tube in place to start feeding.	5.0	6.0	1-7	4 (2.2)	54.4
36.	Delays in initiating motility agents in patients not tolerating enteral nutrition (i.e. high gastric residual volumes).	5.0	5.0	1-7	4 (2.2)	55.5
37.	Delays and difficulties in obtaining small bowel access in patients not tolerating enteral nutrition (i.e. high gastric residual volumes).	5.0	6.0	1-7	5 (2.7)	67.4
38.	In resuscitated, hemodynamically stable patients, other aspects of patient care still take priority over nutrition.	5.0	6.0	1-7	5 (2.7)	68.0
39.	Lack of agreement among ICU team on the best nutrition plan of care for the patient.	3.0	2.0	1-7	4 (2.2)	32.4

Response options for Part C: 1 =not at all important 2=unimportant 3=somewhat important 4=neither important or unimportant 5=somewhat important 6=important 7=very important. Endorsement = % respondents responded ’very important’, ‘important’ or ‘somewhat important’ in Part C. Items ordered in table as per questionnaire distributed during field test

Table 3.4: Barriers Questionnaire Factor Analysis and Internal Reliability

Questionnaire items and New Subscale Names	**Eigenvalue**	**Variance explained**	**Loading on Factor 1**	**Loading on Factor 2**	**Loading on Factor 3**	**Loading on Factor 4**	**Loading on Factor 5**	**Alpha**	**Alpha if item deleted**
Subscale 1: Guideline Recommendations and Implementation Strategies	10.01	47.67						0.89	
•Current scientific evidence supporting some nutrition interventions is inadequate to inform practice.			**0.68**	0.15	0.30	0.24	0.23		0.87
•The current guidelines for nutrition are not readily accessible when I want to refer to them.			**0.84**	0.19	0.07	0.17	0.20		0.86
•The language of the recommendations of the current guidelines for nutrition are not easy to understand.			**0.77**	0.25	0.12	0.12	0.31		0.85
•No feeding protocol in place to guide the initiation and progression of enteral nutrition.			**0.54**	0.38	0.15	0.34	0.31		0.87
•Current feeding protocol is outdated.			**0.63**	0.31	0.21	0.31	0.14		0.86
Subscale 2: Delivery of Enteral Nutrition to the Patient	1.68	8.00						0.86	
•Delay in physicians ordering the initiation of EN.			0.19	**0.42**	0.41	0.45	0.17		0.85
•No feeding tube in place to start feeding.			0.26	**0.82**	0.12	0.12	0.27		0.81
•Delays in initiating motility agents in patients not tolerating enteral nutrition (i.e. high gastric residual volumes).			0.19	**0.78**	0.32	0.07	0.24		0.81
•Delays and difficulties in obtaining small			0.16	**0.72**	0.27	0.27	-0.02		0.84

bowel access in patients not tolerating enteral nutrition (i.e. high gastric residual volumes).									
•In resuscitated, hemodynamically stable patients, other aspects of patient care still take priority over nutrition.			0.32	**0.52**	0.17	0.23	0.17		0.85
Subscale 3: Critical Care Provider Attitudes and Behaviour	1.20	5.72						0.87	
•Non-ICU physicians (i.e. surgeons, gastroenterologists) requesting patients not be fed enterally.			-0.24	0.27	**0.67**	0.31	0.04		0.83
•Nurses failing to progress feeds as per the feeding protocol.			0.09	0.26	**0.82**	0.09	0.19		0.79
•Fear of adverse events due to aggressively feeding patients.			0.33	0.24	**0.60**	0.07	0.33		0.84
•Feeding being held too far in advance of procedures or operating room visits.			0.10	0.11	**0.87**	0.15	0.07		0.81
Subscale 4: Dietitian Support	1.13	5.36						0.84	
•Waiting for the dietitian to assess the patient.			0.37	0.26	0.19	**0.63**	0.18		0.79
•Not enough dietitian time dedicated to the ICU during regular weekday hours			0.03	0.26	0.09	**0.70**	0.49		0.80
•No or not enough dietitian coverage during evenings, weekends and holidays.			0.27	0.13	0.15	**0.77**	0.19		0.77
•There is not enough time dedicated to education and training on how to optimally feed patients.			0.51	0.08	0.29	**0.60**	-0.05		0.83
Subscale 5: ICU Resources	1.10	5.23						0.84	
•Not enough nursing staff to deliver adequate nutrition.			0.15	0.25	0.22	0.38	**0.66**		0.84
•Enteral formula not available on the unit.			0.31	0.23	0.07	0.24	**0.74**		0.71
•No or not enough feeding pumps on the unit.			0.32	0.08	0.21	0.04	**0.80**		0.75

Table 3.5: Statistical Justification for Aggregating Data to the Unit Level

	Site Specific Barrier Score mean±SD					Variance Components				
Questionnaire items	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**σ_b^{2*}**	**$\sigma_w^{2\#}$**	**ICC^**	**ICC (35)$^{\&}$**	**F-test P-value**
N	**37**	**32**	**36**	**29**	**52**					
Overall Barriers	**32.2±26.9**	**31.3±20.9**	**33.3±33.3**	**39.9±35.5**	**26.8±19.0**	**7.67**	**522.66**	**0.01**	**0.34**	**0.2**
Subscale 1: Guideline Recommendations and Implementation Strategies	**27.5±28.6**	**38.2±25.0**	**22.4±27.9**	**26.4±21.6**	**21.4±21.0**	**0.00**	**602.27**	**0.00**	**0.00**	**0.77**
Current scientific evidence supporting some nutrition interventions is inadequate to inform practice.	23.8±31.9	28.7±34.2	18.6±29.8	29.5±30.3	22.4±26.7	0.00	908.80	0.00	0.00	0.6
The language of the recommendations of the current guidelines for nutrition are not easy to understand.	28.7±33.9	26.4±34.9	18.6±29.8	33.3±33.3	12.2±27.8	46.18	998.05	0.04	0.62	0.03
The current guidelines for nutrition are not readily accessible when I want to refer to them.	35.2±35.6	31.1±31.5	24.5±35.1	34.6±35.2	33.3±35.5	0.00	1196.27	0.00	0.00	0.71
No feeding protocol in place to guide the initiation and progression of enteral nutrition.	25.0±33.2	25.3±34.1	31.4±33.3	26.2±29.2	19.6±28.4	0.00	984.31	0.00	0.00	0.56
Current feeding protocol is outdated.	23.8±36.7	16.0±29.8	19.0±30.6	15.4±25.4	20.7±26.8	0.00	891.70	0.00	0.00	0.8
Subscale 2: Delivery of Enteral Nutrition to the Patient	**33.0±31.2**	**38.2±25.0**	**39.3±27.0**	**54.6±29.0**	**30.5±22.5**	**62.18**	**714.14**	**0.08**	**0.75**	**0.005**

Delay in physicians ordering the initiation of EN.	33.3±39.0	41.1±28.6	43.5±36.4	49.4±39.6	30.1±29.0	29.36	1175.27	0.02	0.47	0.11
No feeding tube in place to start feeding.	31.5±39.0	24.4±34.9	37.0±33.6	59.5±34.4	26.3±31.9	155.32	1197.87	0.11	0.82	0.0006
Delays in initiating motility agents in patients not tolerating enteral nutrition (i.e. high gastric residual volumes).	25.9±37.5	35.6±37.1	33.3±30.9	53.6±36.7	24.4±28.1	97.41	1124.24	0.08	0.75	0.004
Delays and difficulties in obtaining small bowel access in patients not tolerating enteral nutrition (i.e. high gastric residual volumes).	34.3±37.8	48.9±32.4	40.7±34.8	56.8±33.1	32.1±31.6	70.09	1150.70	0.06	0.68	0.02
In resuscitated, hemodynamically stable patients, other aspects of patient care still take priority over nutrition.	39.8±35.5	41.1±33.5	41.7±34.2	53.6±37.8	37.3±35.1	0.00	1236.48	0.00	0.00	0.39
Subscale 3: Critical Care Provider Attitudes and Behaviour	**27.9±30.3**	**44.7±29.5**	**20.8±26.2**	**31.8±29.5**	**33.0±24.3**	**51.15**	**764.14**	**0.06**	**0.70**	**0.01**
Non-ICU physicians (i.e. surgeons, gastroenterologists) requesting patients not be fed enterally.	34.4±33.3	60.0±32.0	24.1±33.4	30.9±33.2	32.7±36.2	148.80	1154.98	0.11	0.82	0.0006
Nurses failing to progress feeds as per the feeding protocol.	22,2±34.7	35.6±38.1	14.8±25.8	27.4±31.5	34.0±35.2	44.12	1115.92	0.04	0.58	0.05
Fear of adverse events due to aggressively feeding patients.	28.7±33.9	28.9±34.7	23.1±31.7	36.9±36.7	24.2±30.6	0.00	1096.86	0.00	0.00	0.48

Feeding being held too far in advance of procedures or operating room visits.	24.8±34.6	54.4±38.6	21.3±31.7	33.3±36.3	41.8±33.2	143.22	1166.23	0.11	0.81	0.0006
Subscale 4: Dietitian Support	**33.3±37.1**	**37.9±28.0**	**28.1±28.3**	**40.4±25.7**	**23.4±21.7**	**35.26**	**710.07**	**0.05**	**0.63**	**0.03**
Waiting for the dietitian to assess the patient.	27.6±40.8	34.4±33.3	27.8±33.3	37.0±33.8	21.8±28.7	7.73	1137.44	0.01	0.19	0.32
Not enough dietitian time dedicated to the ICU during regular weekday hours.	21.3±33.0	34.4±33.3	21.9±33.3	35.7±38.4	11.5±24.6	76.09	1014.70	0.07	0.72	0.005
No or not enough dietitian coverage during evenings, weekends and holidays.	30.6±38.5	52.2±37.8	29.5±35.9	51.2±34.5	32.1±30.9	91.75	1241.46	0.07	0.72	0.009
There is not enough time dedicated to education and training on how to optimally feed patients.	27.8±29.3	32.2±35.1	31.5±31.8	36.9±35.5	28.1±30.1	0.00	1011.24	0.00	0.00	0.78
Subscale 5: ICU Resources	**42.9±32.8**	**28.7±29.5**	**23.1±30.7**	**43.7±34.3**	**20.5±24.4**	**95.09**	**892.58**	**0.10**	**0.79**	**0.0009**
Not enough nursing staff to deliver adequate nutrition.	18.5±29.2	17.8±27.3	17.6±34.3	38.1±42.3	10.3±23.4	76.36	953.62	0.07	0.74	0.006
Enteral formula not available on the unit.	53.7±44.6	33.3±37.1	32.4±36.1	42.9±38.3	17.9±28.4	149.67	1330.97	0.10	0.80	0.0003
No or not enough feeding pumps on the unit.	56.5±42.0	37.9±38.5	19.4±32.2	50.0±38.0	33.3±33.7	172.74	1343.58	0.11	0.82	0.0003

Variance components calculated using mixed linear regression model with Restricted Maximum Likelihood estimation (REML):
σ_b^2 = between group (i.e. ICU) variance # σ_w^2 = within group (i.e. ICU) variance ^ICC = Intraclass correlation coefficient = $\sigma_b^2 / (\sigma_b^2 + \sigma_w^2)$
&ICC(35) = $\sigma_b^2/(\sigma_b^2 + \sigma_w^2/k)$ where k = 35 respondents per group

Table 3.6: Test Retest Reliability and Agreement (N=17)

Questionnaire items	ICC	Kappa*
Overall Barriers Score	**0.64**	**0.35**
Guideline Recommendations and Implementation Strategies	**0.31**	**0.06**
1. Current scientific evidence supporting some nutrition interventions is inadequate to inform practice.	0.36	0.24
2. The language of the recommendations of the current guidelines for nutrition are not easy to understand.	0.37	0.38
3. I am not familiar with our current guidelines for nutrition in the ICU.	0.35	0.23
4. The current guidelines for nutrition are not readily accessible when I want to refer to them.	0.51	0.30
5. No feeding protocol in place to guide the initiation and progression of enteral nutrition.	-0.13	-0.03
6. Current feeding protocol is outdated.	0.31	0.20
ICU Resources	**0.57**	**0.60**
7. Not enough nursing staff to deliver adequate nutrition.	0.70	0.60
8. Enteral formula not available on the unit.	0.34	0.27
9. No or not enough feeding pumps on the unit.	0.51	0.27
Dietitian Support	**0.39**	**0.34**
10. Waiting for the dietitian to assess the patient.	0.15	0.21
11. Not enough dietitian time dedicated to the ICU during regular weekday hours.	0.43	0.34
12. No or not enough dietitian coverage during evenings, weekends and holidays.	0.52	0.34
13. There is not enough time dedicated to education and	0.32	0.20

training on how to optimally feed patients.		
Delivery of Enteral Nutrition to the Patient	**0.55**	**0.47**
14. No feeding tube in place to start feeding.	0.51	0.51
15. Delay in physicians ordering the initiation of EN.	0.37	0.13
16. Waiting for physician/radiology to read x-ray and confirm tube placement.	0.22	0.30
17. Delays in initiating motility agents in patients not tolerating enteral nutrition (i.e. high gastric residual volumes).	0.43	0.16
18. Delays and difficulties in obtaining small bowel access in patients not tolerating enteral nutrition (i.e. high gastric residual volumes).	0.52	0.65
19. In resuscitated, hemodynamically stable patients, other aspects of patient care still take priority over nutrition.	0.59	0.52
20. Needles delays in relaying information regarding the initiation and progression of nutrition.	0.36	0.32
Critical Care Provider Attitudes and Behaviour	**0.62**	**0.35**
21. Non-ICU physicians (i.e. surgeons, gastroenterologists) requesting patients not be fed enterally.	0.57	0.43
22. Nurses failing to progress feeds as per the feeding protocol.	0.09	0.19
23. Feeds being held due to diarrhea.	0.46	0.50
24. Fear of adverse events due to aggressively feeding patients.	0.53	0.33
25. Feeding being held too far in advance of procedures or operating room visits.	0.69	0.65
26. General belief among ICU team that provision of adequate nutrition does not impact on patient outcome	0.60	0.87

*Agreement between nurses who responded that an item was ‘somewhat important’ to ‘very important’ (5-7) vs ‘not at all important’ to ‘neither important’ or ‘unimportant’ (1-4)

Items ordered in table as per questionnaire distributed during pilot test

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Chapter 4

Do barriers to feeding critically ill patients impede nutrition performance? : A multilevel multivariate analysis

Abstract

Background: A growing body of literature supports the need to identify and address barriers to knowledge use as a strategy to improve care delivery. To this end, we developed a questionnaire to assess barriers to enterally feeding critically ill adult patients, and sought to gain evidence to support the construct validity of this instrument by testing the hypothesis that barriers identified by the questionnaire are inversely associated with nutrition performance.

Methods: We conducted a multilevel multivariate regression analysis of data from an observational study in 55 Intensive Care Units (ICUs) from 5 geographic regions. Data on nutrition practices were abstracted from 1153 patient charts, and 1439 critical care nurses completed the Barriers to Enterally Feeding critically Ill Patients questionnaire. Our primary outcome was adequacy of calories from enteral nutrition (proportion of prescribed calories received entrally) and our primary predictor of interest was a barrier score derived from ratings of importance of items in the questionnaire.

Results: The mean adequacy of calories from enteral and total nutrition were 48 (Standard Deviation (SD) 17)% and 60 (SD 16)%, respectively. Evaluation for effect modification and confounding identified patient type, proportion of nurse respondents working in the ICU greater than 5 years, and geographic region as important covariates. In a regression model adjusting for these covariates plus evaluable nutrition days and APACHE II score, we observed that a 10 point increase in overall barrier score is associated with a 3.5 (Standard Error (SE)1.3)% and 4.9 (SE 1.5)% decrease in enteral and total nutrition adequacy respectively (p-values <0.01).

Conclusion: Our results provide evidence to support our *a priori* hypothesis that barriers negatively impact the provision of nutrition in ICUs, suggesting that our recently developed questionnaire may be a promising tool to identify these important factors, and guide the selection of interventions to optimize nutrition practice. Further research is required to illuminate if and how the type of barrier, profession of the provider, and geographic location of the hospital may influence this association.

Key words: barriers, critical care, enteral nutrition, instrument development, nutrition therapy, quality improvement, multi-level regression analysis, validity

Background

In many areas of healthcare there is a gap between what research evidence indicate ought to be done and what actually happens in clinical practice[1]. The recognition of this problem, together with a heightened focus on quality improvement and evidence-informed practice has stimulated interest in research examining the causes of this 'knowledge-practice gap'[2]. A growing body of literature supports the need to identify factors that limit or restrict implementation of best practices,[2-6] so that interventions can be selected to address these barriers and improve care delivery.

For instance, when we consider nutrition therapy in critically ill patients, on the one hand, several Clinical Practice Guidelines (CPGs) have been published summarizing evidence from over 200 randomized controlled trials (RCTs)[7-12]; while on the other, observational studies of nutrition practice consistently report large variation in practices across Intensive Care Units (ICUs) [13-16]. Overall, the provision of nutrition therapy is suboptimal, with patients, on average receiving less than 60% of their prescribed calories and protein[13].

To gain a better understanding of the reasons for this knowledge-practice gap in critical care nutrition, we conducted multiple case studies in 4 ICUs in Canada[17]. This qualitative analysis was guided by one of the most often cited theoretical frameworks regarding barriers to knowledge use, the knowledge-attitudes-behaviour framework, by Cabana *et al* [6]. The analysis led to the development of an extended and revised framework which provided a comprehensive description of factors impeding adherence to critical care nutrition guidelines[18]. Although useful in illuminating potential barriers, this framework did not enable the identification and measurement of these barriers. The ability to assess and quantify barriers is necessary to be successful at tailoring interventions to overcome them and improve practice[5]. Consequently, we developed the 'Barriers to Feeding Critically Ill Patients' Questionnaire[19].

If this questionnaire is to be a useful tool in identifying barriers to target for change we need some evidence that the perceived barriers identified by critical care providers completing the questionnaire actually impede the provision of nutrition in the ICU. Thus the purpose of the present study is to gain evidence to support the construct validity of our developed questionnaire by testing the hypothesis that provision of nutrition is lower in ICUs that report the presence of important barriers. As items in the questionnaire focused on the provision of EN, a priori we surmised that while we expected to observe an inverse association between barriers to feeding critically ill patients and the amount of total prescribed calories received, the association would be stronger with prescribed calories received from EN.

Methods

Study Design

The data were collected as part of the International Nutrition Survey, an ongoing global quality improvement initiative in critical care nutrition.[20] This initiative, launched in January 2007, aims to describe and compare nutrition practices in ICUs across the world, enabling the identification of gaps between current nutrition practice and the recommendations of CPGs; a second component is monitoring of change in practices over time. ICUs are invited to participate through mail-outs to membership lists of critical care and nutrition associations from around the world, and advertisements at various international conferences and on websites including our own research groups: www.criticalcarenutrition.com. To be eligible, ICUs must have a minimum of 8 beds and have an individual with adequate knowledge of clinical nutrition to be able to complete the data collection (e.g., registered dietitian). The initiative involves a bi-annual audit of nutrition practice. To date, there have been 4 survey cycles involving more than 150 ICUs in each year. The most recent survey commenced in May 2011. As part of this 2011 cycle, ICUs were also invited to distribute the 'Barriers to Feeding Critically ill Patients' questionnaire to their ICU staff. As there is no remuneration for participating in the International Nutrition Survey, we provided an incentive of a travel bursary to a scientific meeting to the individuals responsible for co-ordinating data collection at sites who completed both the nutrition audit and the barriers questionnaire.

Data Collection: Nutrition Audit

Participating ICUs identified 20 consecutive adult patients who were mechanically ventilated within the first 48 hours of admission to ICU and who remained in ICU for more than 72 hours. Data were retrospectively abstracted from the patients' hospital records on their sex, age, admission category (surgery vs. medical), APACHE II score and diagnosis category, height, weight, and baseline nutrition assessment (i.e. energy and protein prescribed by the dietitian). Daily nutrition information was collected on the type and amount of nutrition received (total calories and protein received) from ICU admission for a maximum of 12 days unless death or ICU discharge occurred sooner. Patients were followed while in hospital and their ICU and hospital outcomes determined at 60 days. Abstracted data were entered online using a secure web-based data collection tool (REDCap Software, Version 3.3.0, © 2012 Vanderbilt University).

Data Collection: Barriers Questionnaire

Development of the questionnaire was guided by our conceptual framework[18], literature review, and existing barriers questionnaires developed for use in other settings[21-24]. As critical care nurses are the primary providers implementing the nutrition plan of care for patients at the bed-side, the questionnaire was intended to be administered to nurses to identify modifiable barriers (i.e., factors amenable to change through a tailored intervention) to enterally feeding critically ill patients. We focused on the provision of enteral nutrition (EN), rather than other aspects of nutrition therapy such as parenteral nutrition (PN), nutrient supplementation, or nutritional assessment, because practice recommendations related to EN are uniformly endorsed across published guidelines[7-11], are supported by the highest level of evidence, and critical care providers generally agree with the recommendations[25]. Pilot testing of the questionnaire established content and face validity, and acceptable internal reliability. Exploratory factor analysis indicated an orthogonal 5-factor solution that accounted for 72% of the variance in barriers. We labeled the factors: 1) guideline recommendations and implementation strategies, 2) ICU resources, 3) dietitian

support, 4) delivery of EN to the patient, and 5) attitudes and behaviour of critical care provider. Details of the development and preliminary validation of the questionnaire have been reported elsewhere[19].

The developed questionnaire is composed of 2 sections. The first section lists 26 potential barriers to delivery of EN and asks the respondent to rate their importance as barriers in their ICU on a 7-point likert scale. These 26 items are divided into 5 subscales corresponding to the 5 factors. Part B includes 6 questions about the personal demographics of the respondent. Table 4.1 provides an overview of the content of the questionnaire.

At the same time as the nutrition audit, the barriers questionnaire was administered to all full and part-time nurses working in participating ICUs. If the nursing pool exceeded 85, a random sample of 60 nurses was used. The questionnaire was distributed according to a modified Dillman's tailored design method[26], including a pre-contact memo and multiple reminders. The modes of distribution and methods of capturing responses were determined by the dietitian or provider responsible for the study locally. The questionnaires were either e-mailed, hand delivered, or placed in staff mailboxes. Questionnaires could be completed online (SurveyMonkey®, Palto Alto, California) or on paper. Paper-based questionnaires were returned to a box placed in the ICU and entered online by the local investigator. Questionnaires responses entered online automatically populated a database.

Primary Outcome: Adequacy of Calories from Enteral Nutrition

The primary outcome was defined as the average daily calories received from EN during the first 12 ICU days expressed as a percentage of the baseline caloric prescription. Patients with a contraindication to EN (i.e. mechanical bowel obstruction, bowel ischemia, small bowel ileus, small bowel fistulae, gastrointestinal perforation, and short gut syndrome) were excluded from the analysis. Days without EN including days with exclusive PN were counted as 0% adequacy. Days following permanent progression to exclusive oral intake were excluded from the calculation of EN adequacy.

Secondary Outcome: Adequacy of Total Nutrition

Adequacy of total nutrition included calories from PN and propofol in addition to EN and did not exclude patients with a contradiction to EN but was otherwise calculated the same as the primary outcome.

Primary Predictor: Overall Barrier Score

Individual nurses' responses to the barriers questionnaire were averaged to the ICU level. Each item was awarded 1, 2, or 3 points if the respondent identified it as a 5= 'somewhat important', 6='important' or 7='very important' barrier respectively. If an item was rated 1-4 (i.e. 'not at all important' to 'neither important or unimportant' a 0 score was awarded. The scores of each individual item included in a given subscale was divided by the maximum potential score (i.e. 3) and multiplied by 100, giving a potential range for the barrier score of 0 to 100. The mean score for all 26 items was then calculated to obtain an overall barrier score for each site. We selected to evaluate a 10 point change in barriers score because in the recent pretest posttest field test of tailored guideline implementation strategies (The PERFECTIS Study), we observed a 10 point change in barriers score across the 5 participating sites following the intervention. Consequently, we inferred that a 10-point change is clinically achievable.

To explore if the association between barriers and nutrition differed by the type of barrier, we also ran models with the mean barriers score for each of the 5 subscales as the primary predictor of interest. In addition, we were concerned that the mean site level barrier score might be a biased estimate of the true site average if only a few questionnaires were completed at a site, therefore we conducted a sensitivity analysis by running models excluding ICUs with less than 10 completed barrier questionnaires.

Covariates: ICU and Patient

ICU level covariates considered in the analysis included: geographic region, hospital type (i.e., teaching vs. non-teaching), ICU type (open (i.e., patient under the care of any attending physician) vs. closed (i.e.,

patient under the care of an intensivist), hospital size, ICU size, proportion of nurse respondents working in the ICU for greater than 5 years and proportion of nurse respondents working in a leadership role.

Patient level covariates included: type of admission (surgical vs. medical), admission diagnosis, sex, age, Body Mass Index (BMI), and Acute Physiology and Chronic Evaluation (APACHE) II score (i.e., measure of severity of illness).

Statistical Analysis

ICU and patient level variables were summarized using standard descriptive statistics. The two level hierarchical data with patients (i.e., level I) nested within ICUs (i.e., level II) were analyzed using a mixed effects model with random intercepts to account for site clustering. As provider level data were not associated with specific patients, provider level data (including barriers score) were averaged to the site level and treated as site-level variables. Statistical analysis was completed using PROC MIXED in SAS v9.1.3 (SAS Institute Inc., Cary, NC, USA).

Assessment of Effect Modification

A priori we hypothesized that the association between barriers score and adequacy of EN may differ within different levels of hospital type, ICU type and admission category. We assessed potential effect modification by including an interaction term between barriers score and the potential effect modifier in the primary predictor-outcome models . A p-value of <0.10 for interaction terms was considered significant. If no significant interaction was observed we proceeded to include these variables in our assessment of confounding.

Selection of Potential Confounders

All analyses were adjusted for evaluable nutrition days and APACHE II score. As nutrition is often started gradually with little received in the first few days of ICU stay, we needed to account for the confounding

effect of length of time in the ICU on nutrition adequacy (i.e., patients with short length of stays have lower adequacy than patients will longer length of stay). In addition, as it is difficult to provide adequate nutrition to sicker patients, *a priori* we aimed to account for the effect of severity of illness by including APACHE II scores in all models.

To reduce the number of variables to be evaluated as potential confounders, we first examined the association between the primary outcome and each individual covariate. A p-value of <0.25 in these single predictor models was used to identify covariates for further evaluation[27]. Confounders were selected for inclusion in the adjusted models using the change in estimate method, with a 10% change considered important [28].

Sample Size

With 55 participating centres, we obtain about 80% power at a two-sided alpha=0.05 if the partial correlation after controlling for covariates between the site average in the barrier scores and the site average in nutritional adequacy was 0.36 (i.e. R-squared=13%). Thus, we have adequate power to detect moderate to large correlations between nutritional adequacy and site averaged barrier scores. However, the study had limited power for the assessment of effect modification (interaction) which was considered a secondary exploratory study aim.

Institutional ethics approval was obtained from the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board, Kingston, Ontario, Canada, for the conduct of the International Nutrition Survey and at additional centers if required for their participation. The need for informed patient and provider consent was waived given the observational nature and de-identified data capture of this study.

Results

In total, 55 ICUs were included in the analysis, and 1153 patients were accrued across these sites. Figure 4.1 shows how the study sample was determined. Table 4.2 and 4.3 report the ICU and patient characteristics. The majority of ICUs were closed units (78%) in teaching hospitals (75%) located in Australia and New Zealand (40%) or North America (33%). Included patients had a mean age of 61 years (standard deviation (SD)) 17, were predominantly admitted with a medical condition (65%) and a mean APACHE II score of 22 (SD 8). Twenty three percent died within 60 days of their ICU admission.

The mean adequacy of calories from EN and total nutrition were 48% (SD 17) and 60% (SD 16) respectively (Table 4.4). Figure 4.2 illustrates the adequacy of calories from EN for all sites and by the 5 geographic regions across the 12 days of observation. A total of 1439 completed barriers questionnaires were included in the analysis. On average the response rate was 30% (range 6 to 62%), equating to a mean of 23 completed questionnaires per ICU (site range 1 to 65). The mean overall barrier score was 23 (SD 11). Table 4.4 describes the overall and subscale barriers scores by geographic region. Figure 3 is a bubble chart illustrating the unadjusted association between adequacy of calories from EN, overall barrier score and number of completed barrier questionnaires at each of the 55 ICUs.

None of the models evaluating potential effect modification were significant at a p-value of <0.1. Table 4.5 reports the results of the bivariate analysis of the association between the individual covariates and adequacy of EN. Sex, patient admission type, patient admission diagnosis, proportion of nurse respondents working in the ICU for greater than 5 years, and geographic region were significant at $p<0.25$ and were selected, together with hospital and ICU type, to be evaluated as potential confounders using the change-in-estimate criterion. Admission diagnosis was highly collinear with admission type, and as the latter contributed less degrees of freedom than the former, admission diagnosis was not considered further. The estimates changed by greater than 10% between the unadjusted and adjusted models for 4 of the evaluated variables, namely; geographic region (236%), hospital type (13%), patient type (17%), and proportion of

respondents working in the ICU > 5 years (51%). Consequently all adjusted analyses controlled for evaluable days, APACHE II score, geographic region, hospital type, patient admission type, and proportion of respondents working in the ICU > 5 years.

Table 4.6 shows the results of the unadjusted and adjusted regression models of the association between overall and subscale barrier scores and adequacy of enteral and total nutrition. A significant inverse association was observed, indicating that a 10 point increase in overall barrier score has a negative impact on nutrition practice, resulting in a 3.5 (Standard error (SE) 1.3) and 4.9 (SE 1.3)% decrease in adequacy of calories from enteral and total nutrition respectively. Although a significant association was observed for each of the 5 subscale barrier scores and adequacy of total nutrition, the association was not significant for subscales 1 and 2 with the primary outcome of adequacy of calories from EN. The effect size observed in the sensitivity analysis excluding ICUs contributing less than 10 questionnaires (N=49) was similar (-3.0 (SE1.3)% and -4.9 (SE 1.3)% for enteral and total nutrition adequacy respectively (p-values <0.05).

Discussion

In all areas of healthcare there is a growing interest in identifying and addressing barriers to achieving best practices. However, empirical data demonstrating the negative impacts of barriers or the benefit of overcoming them is sparse, partly due to a lack of validated instruments to measure barriers. To this end we developed a questionnaire to identify important barriers to enterally feeding critically ill patients. The present study provides evidence to support the construct validity of this questionnaire by confirming our *a priori* hypothesis that barriers negatively impact the provision of nutrition in ICUs. Our analysis of data from an observational study involving 1153 patients and 1439 critical care nurses from 55 ICUs across 5 geographic regions demonstrated that after adjusting for important confounding factors, that a 10 point increase in overall barriers score derived from the responses to the questionnaire was associated with a 3.5% decrease in the adequacy of calories from EN.

The results of our analysis are corroborated by the results of our recently completed prospective study evaluating the feasibility of a guideline implementation intervention tailored to overcome barriers to feeding critically ill patients (i.e PERFormance Enhancement of the Canadian nutrition guidelines by a Tailored Implementation Strategy: The PERFECTIS Study)[29]. In that study, which also utilized the Barriers to Enterally Feeding Critically Ill Patients questionnaire, we observed a 10 point decrease in overall barriers score and a 5% increase in total nutrition adequacy following implementation of the tailored intervention. This magnitude of change is equivalent to the change in estimate seen in our regression analysis providing further evidence that barriers are an important factor leading to poor adherence to guideline recommendations in clinical practice.

We would expect that the association between nurse reported barriers to enterally feeding patients and our primary outcome of adequacy of calories from EN to be stronger than with our secondary outcome of adequacy of calories from total nutrition (EN + PN + propofol), because the questionnaire focuses on barrier to the provision of EN and not PN. However, in our regression analyses we observed a 3.5% decrease in EN adequacy compared to 5% with total nutrition adequacy. Furthermore, we observed a significant relationship between all 5 subscales of the barriers questionnaire and total nutrition adequacy,but no association between subscales 1 and 2 with EN adequacy. Further study is required to confirm these observations, explore the reasons for them, and conclude if the association with nutrition adequacy differs by the type of barrier. This knowledge may lead to revisions to the barriers questionnaire and inform the design of interventions whereby barriers that have the greatest impact on nutrition adequacy are targeted.

Although the magnitude of our observed association was statistically significant, the clinical significance of a 3 to 5% change in nutrition adequacy is unclear. Given that on average patients in our study were prescribed 1800Kcals, a 5% decrease in nutrition adequacy would be equivalent to providing 90 less kcals,

which in layman's terms is the same as a single glass of apple juice per day. We have previously demonstrated that an increase of 1000 kcals per day is associated with a 24% decrease in mortality in this patient group[30]. Consequently, when using this questionnaire, interventions need to target much larger changes in barriers score to ensure that the impact on nutrition outcomes is clinically relevant.

The geographic region in which the ICU was located was identified as an important confounding factor of the association between barriers and nutrition adequacy in our dataset. The number of ICUs in each region was small (i.e. 7 to 22), negating our ability to conduct subgroup analyses to better understand the nature of the confounding. Further study is required with more ICUs to confirm this observation. However, it is possible that this variable is a composite measure of other variables that may be associated with the presence of barriers and provision of nutrition such as the type of health care system, models of care delivery, staffing ratios, and education.

There are several limitations that should be considered when interpreting our results. First, participating ICUs were not a random sample of sites but rather a voluntary sample; consequently this sampling strategy may have introduced selection bias if participating sites have a greater interest in nutrition or desire to improve practice compared to the target population. Participating ICUs were predominantly closed units in academic centers, which are two factors that have been associated with higher performance[31]. This may limit the generalizability of our findings. There may have also been selection bias associated with the response rate of 30% for the barriers questionnaire if the perceptions of respondents differed from non-responding nurses. Second, the barriers questionnaires was distributed to critical care nurses, responses may differ by profession therefore the observed association needs to be confirmed amongst dietitians and physicians. Third, the barriers questionnaire was distributed at the same time as the chart audit of nutrition practice; however, we cannot be certain that the nurses who completed the questionnaire are the same as those who cared for the patients included in the study. However, respondents were asked to identify important barriers based on their general experience in the ICU and not

with regard to a specific patient, therefore this discrepancy should not have biased the results. Fourth, as with any self-administered survey, responses to the barriers questionnaire reflect factors that the nurses' perceive to be important barriers in their ICU, which may not be synonymous with 'true' barriers. Consequently, the averaged site-level responses can only approximate the true ICU average barrier score with measurement error, resulting in regression dilution. This may have attenuated our estimates of the association between nutrition adequacy and the true barriers score at the ICU. Fifth, the nutrition practice data were abstracted from the patients' hospital chart; therefore the accuracy of these data depends on accurate chart documentation. Sixth, there is considerable controversy in the nutrition literature as to the optimum nutrition requirements during critical illness. In our study, the prescription of goal calories was determined at the local site by the dietitian or physician and therefore their clinical judgment may have influenced the primary and secondary outcome of enteral and total nutrition adequacy. Finally, as in any observational study, there may be residual or unmeasured confounding not accounted for by the regression model.

Conclusion

In a large sample of international ICUs, we observed that barriers to enterally feeding critically ill patients (measured by a recently developed questionnaire) are inversely associated with nutrition adequacy (measured by a chart audit). Our results provide evidence to support the conceptual underpinnings of knowledge translation research that barriers impede adherence to guideline recommendations in clinical practice. Further research is required to evaluate whether the strength of the observed association differs by type of barrier, profession of the critical care provider, or geographic location of the hospital, and if identifying barriers using our questionnaire can inform interventions that optimize nutrition practice.

Acknowledgments

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Table 4.1: Summary of the Barriers to Enterally Feeding Critically Ill Patient Questionnaire

Questionnaire Section	Rationale	Number of items	Example item
Part A: Barriers to Delivery of Enteral Nutrition*			
Subscale 1: Guideline Recommendations and Implementation Strategies	The characteristics of the guidelines themselves and the methods selected to implement them can impede their application (e.g. wording, level of supporting evidence, format)	6	The current national guidelines for nutrition are not readily accessible when I want to refer to them.
Subscale 2: ICU Resources	Resource constraints hinder staffs ability to adhere to recommendations	3	Enteral formula not available on the unit.
Subscale 3: Dietitian Support	As the provider most responsible for nutrition, lack of dietitian support can impede the provision of adequate nutrition	4	No or not enough dietitian coverage during evenings, weekends, and holidays
Subscale 4: Delivery of Enteral Nutrition to the Patient	Guideline adherence may be more difficult in complex patients	7	In resuscitated, hemodynamically stable patients, other aspects of patient care still take priority over nutrition.
Subscale 5: Critical Care Provider Attitudes and Behaviour	Inadequate knowledge of or negative attitudes towards nutrition guidelines may translate into the behaviour of not adhering to guideline recommendations	6	Fear of adverse events due to aggressively feeding patients
Part D: Personal Characteristics of Respondent	-	6	-

[b]*= 1=Not at all important, 2=Unimportant, 3=Somewhat unimportant, 4=Neither important or unimportant, 5=Somewhat important, 6=Important, and 7=Very important

Barriers to Enterally Feeding Critically Ill Patients Questionnaire is available online at www.criticalcarenutrition.com

Table 4.2: Characteristics of Participating Intensive Care Units (n=55)

Intensive Care Unit Characteristic	N	%
Region		
Canada	7	12.7
Australia and New Zealand	22	40.0
USA	11	20.0
Europe	8	14.5
Asia	7	12.7
Hospital Type	14	25.5
Non-teaching		
Teaching	41	74.5
ICU Type		
other	1	1.8
closed	43	78.2
open	11	20.0
Case Mix		
medical	48	87.3
neurological	31	56.4
surgical	51	92.7
neurosurgical	25	45.5
trauma	28	50.9
cardiac surgery	10	18.2
pediatrics	5	9.1
burns	10	18.2
	Mean	**SD**
Size of Hospital (Beds)		
	535	313
Size of ICU (Beds)		
	18	11
% Questionnaire respondents worked in the ICU > 5years		
	55	24
% Questionnaire respondents with leadership role		
	36	19

Table 4.3: Personal Characteristics and Clinical Outcomes of Patients (n=1153)

Patient Characteristics	**N**	**%**
Sex		
Male	687	59.6
Female	466	40.4
Type of Admission		
Medical	748	64.9
Surgical Elective	119	10.3
Surgical Emergency	286	24.8
Admission Diagnosis	143	12.4
Cardiovascular/vascular*		
Respiratory*	294	25.5
Gastrointestinal*	204	17.7
Neurologic*	146	12.7
Sepsis	122	10.6
Trauma*	114	9.9
Other	143	12.4
Contraindication to Enteral Nutrition	1074	93.1
No		
Yes	79	6.9
Reasons Enteral Nutrition Contraindicated		
Mechanical bowel obstruction	11	13.9
Bowel ischemia	13	16.5
Small bowel ileus	18	22.8
Small bowel fistulae	1	1.3
Gastrointestinal perforation	33	41.8
Short gut syndrome	3	3.8
	Mean	**SD**
Age (years)	61	17
Apache II Score	22	8
Body Mass Index	27.5	8
Clinical Outcomes at 60 days	**Median**	**IQR**
Length of ICU stay (days)[#]	8.8	5.7-15.9
Length of hospital stay (days)[#]	18.9	10.6-35.6
Length of mechanical ventilation (days)[#]	5.8	2.9-12.5
	N	**%**
Patient died within 60 days of ICU admission	259	22.5

**includes operative and non-operative admission diagnoses [#]Restrict to 60-day survivors*

Table 4.4: Mean Adequacy of Calories from Enteral and Total Nutrition and Barrier Scores Overall and By Geographic Region

	Asia		**Australia and New Zealand**		**Canada**		**Europe**		**USA**		**All**	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
N	7		22		7		8		11		55	
Adequacy of Calories												
Enteral Nutrition	72	11	44	13	55	7	47	22	35	13	48	17
Total Nutrition	74	10	58	12	64	9	71	22	46	12	60	16
Barriers Scores												
Overall	29	17	26	11	19	5	21	14	18	5	23	11
Subscale 1: Guidelines	30	16	24	12	22	12	16	17	19	8	22	13
Subscale 2: Resources	32	18	18	12	13	11	20	23	15	11	19	15
Subscale 3: Dietitian	30	17	26	12	23	7	27	15	16	6	24	12
Subscale 4: Patients	28	17	30	13	21	9	25	14	25	6	27	12
Subscale 5: Providers	27	17	25	10	15	9	19	11	13	6	21	12

Table 5: Effect of Patient and ICU Level Variables on Adequacy of Calories from Enteral Nutrition

	df	Single Predictor Models Estimate (SE)	P-value
Patient Level Variables			
Age (per decade)	1	-0.16 (0.46)	0.73
Female (versus male)	1	4.19 (1.58)	0.008
Surgical Admission Type (vs Medical)	1	-18.16 (1.79)	<0.0001
Admission Diagnosis	6		<0.0001
Trauma*		Referent	
Cardiovascular/Vascular*		0.48 (3.17)	
Gastrointestinal*		-24.75 (3.01)	
Neurologic*		9.22 (3.03)	
Respiratory*		11.93 (2.88)	
Sepsis		3.20 (3.27)	
Other		0.51 (3.18)	
Apache II Score	1	-0.12 (0.11)	0.27
BMI	1	-0.09 (0.10)	0.39
Site Level Variables			
Region	6	Not shown§	<0.0001
USA		Referent	
Asia		31.49 (5.78)	
Australia and New Zealand		10.34 (4.54)	
Canada		18.85 (5.86)	
Europe		8.09 (5.67)	
Teaching (versus non-teaching)	1	-3.40 (4.76)	0.47
Hospital Size (per 1000 beds)	1	-0.20 (6.60)	0.98
ICU beds (per 10 beds)	1	0.20 (0.18)	0.28
Open ICU (versus closed/other)	1	1.28 (5.17)	0.80
% Respondents working in ICU >5 years	1	-0.19 (0.08)	0.02
% Respondents in leadership role	1	0.01 (0.11)	0.91

* Includes operative and non-operative patients
N = 1070 (due to missing data on 4 patients)

Table 4.6: Change in Adequacy of Enteral and Total Nutrition Associated with a 10 point Increase in Overall and Subscale Barrier Score

	Unadjusted[1]			Adjusted[2]		
	Estimate	**SE**	**p-value**	**Estimate**	**SE**	**p-value**
Adequacy of Enteral Nutrition						
Overall Barriers Score	-1.01	1.84	0.58	-3.54	1.31	0.007
Subscale 1: Guidelines	0.02	1.60	0.99	-1.84	1.20	0.13
Subscale 2: Resources	0.90	1.35	0.51	-1.42	1.04	0.17
Subscale 3: Dietitian	-0.71	1.72	0.68	-3.49	1.25	0.005
Subscale 4: Patient	-3.48	1.65	0.04	-4.11	1.11	0.0002
Subscale 5: Providers	0.06	1.77	0.97	-3.61	1.38	0.009
Adequacy of Total Nutrition						
Overall Barriers Score	-2.82	1.73	0.10	-4.86	1.29	0.0003
Subscale 1: Guidelines	-2.08	1.51	0.17	-3.02	1.20	0.01
Subscale 2: Resources	-1.22	1.30	0.35	-3.24	1.00	0.001
Subscale 3: Dietitian	-0.71	1.65	0.67	-3.72	1.30	0.004
Subscale 4: Patient	-4.58	1.52	0.0027	-4.90	1.10	<0.0001
Subscale 5: Providers	-1.38	1.69	0.42	-4.83	1.37	0.0004

1. Adjusted for evaluable days only
2. Adjusted for evaluable days, APACHE II score, hospital type, patient admission type, % respondents working > 5 years in the ICU, and region

Figure 4.1: Flow Diagram of Study Sample

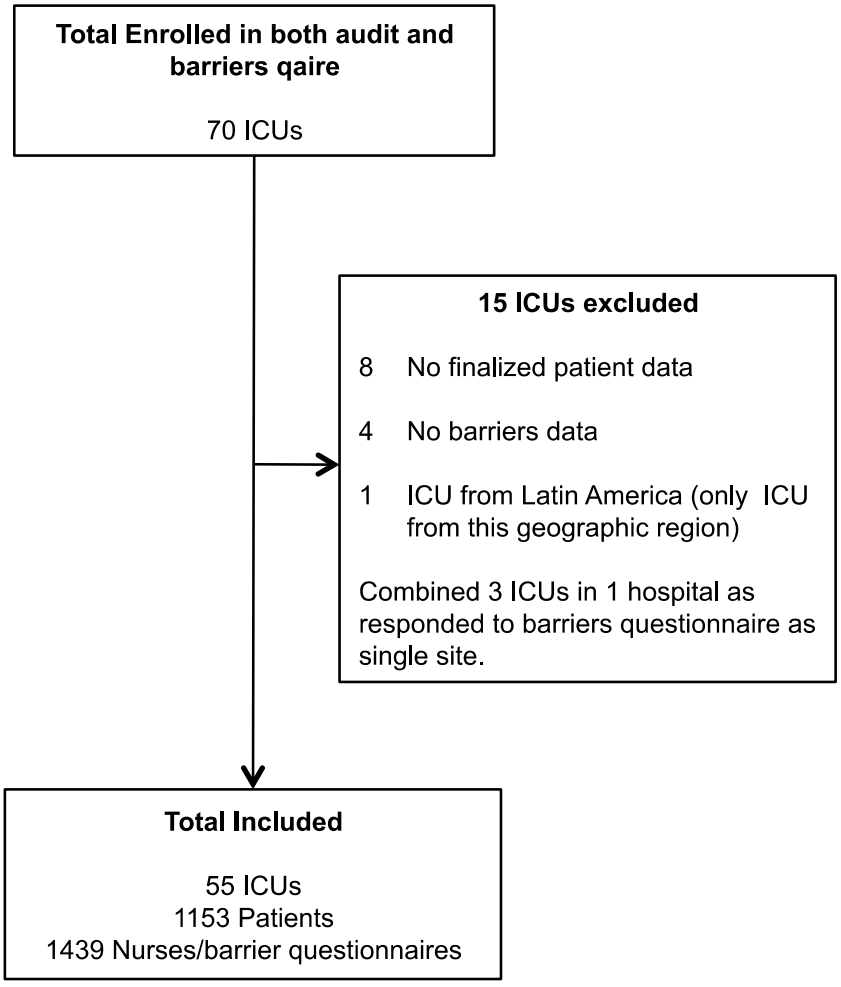


Figure 4.2: Mean Adequacy of Calories from Enteral Nutrition Overall and By Geographic Region Across the 12 Days of Observation

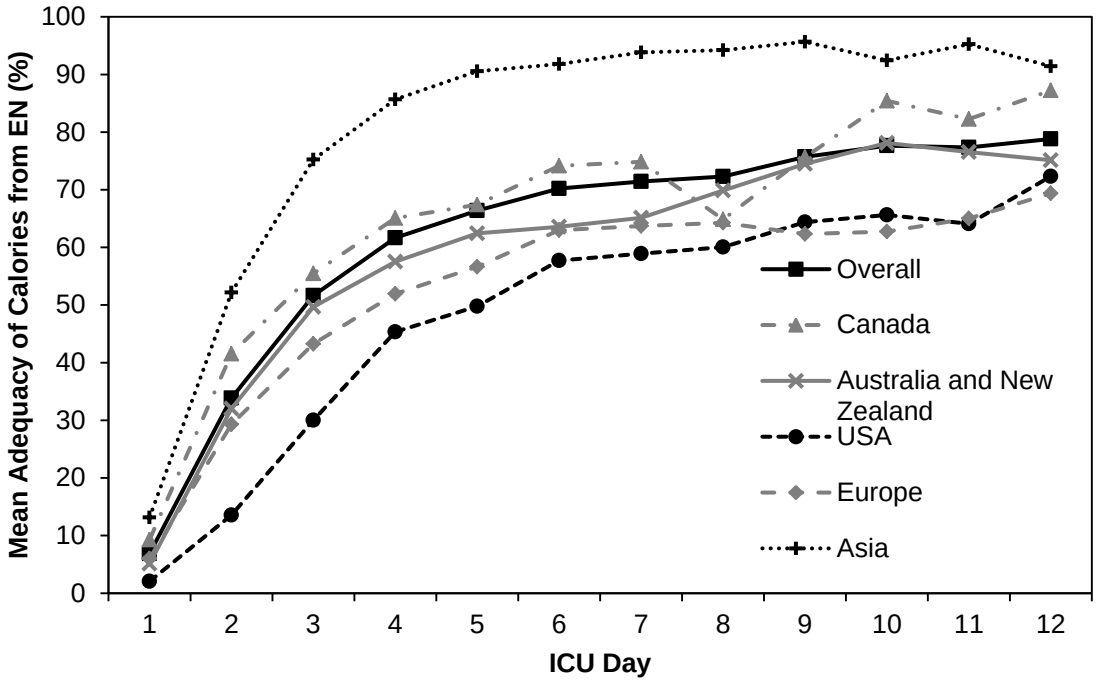
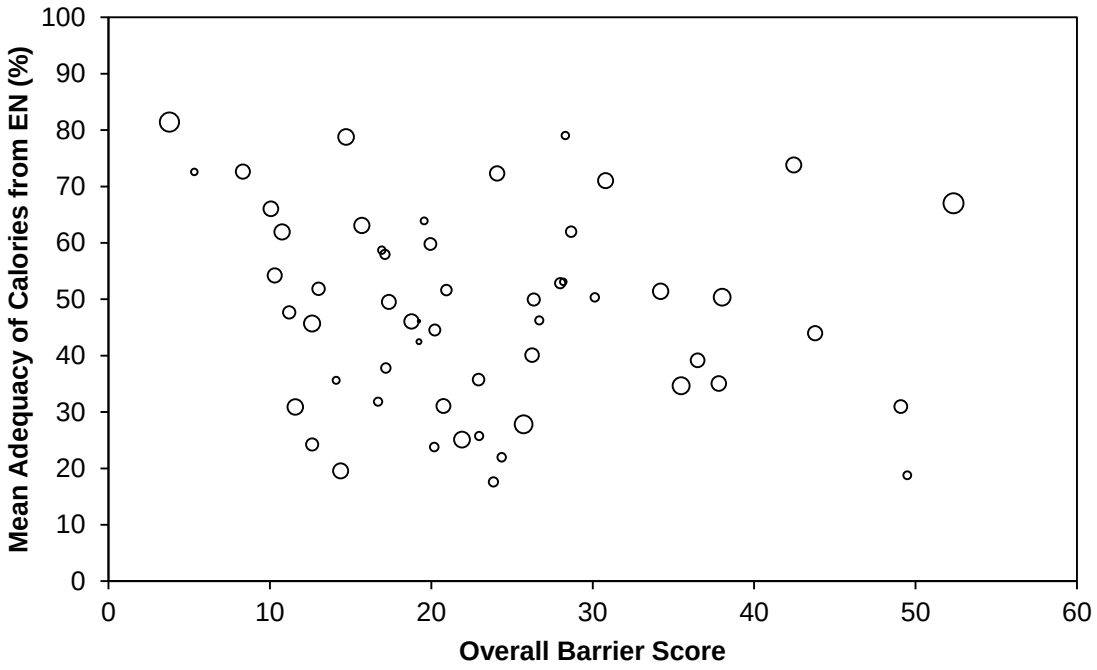


Figure 4.3: Bubble Plot of Mean Adequacy of Calories from Enteral Nutrition, Overall Barrier Score, and Number of Questionnaires Completed at the 55 Participating Intensive Care Units



EN = enteral nutrition
o = Intensive Care Unit, size of the bubble corresponds to the number of questionnaires completed by nurses at the site (range 1-65)

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Chapter 5

Barriers to Feeding Critically Ill Patients: A Multicenter Survey of Critical Care Nurses

Abstract

Purpose: To describe the barriers to enterally feeding critically ill patients from a nursing perspective and to examine whether these barriers differ across centers

Materials and Methods: A cross-sectional survey was conducted in 5 hospitals in North America. A 45 item questionnaire was administered to critical care nurses to evaluate barriers to enterally feeding patients.

Results: A total of 138/340 critical care nurses completed the questionnaire (response rate of 41%). The 5 most important barriers to nurses, were 1) Other aspects of patient care taking priority over nutrition; 2) Not enough feeding pumps available; 3) Enteral formula not available on the unit; 4) Difficulties in obtaining small bowel access in patients not tolerating EN and 5) No or not enough dietitian coverage during weekends and holidays. For 18/22 (81%) of the potential barriers, the rated magnitude of importance was similar across the 5 ICUs.

Conclusion: Nurses in our multicenter survey identified important barriers to providing adequate EN to their critically ill patients. The importance of these barriers does not appear to differ significantly across different clinical settings. Future research is required to evaluate if tailoring interventions to overcome these identified barriers is an effective strategy of improving nutrition practice.

Word Count = 200

Introduction

Observational studies of nutrition practices in the Intensive Care Unit (ICU) have consistently demonstrated gaps between what evidence based guidelines recommend should be done and what is actually done at the bedside[1]. Studies aimed at narrowing this gap through multifaceted guideline implementation strategies[2-4] have been disappointing, demonstrating small changes in nutrition process measures (e.g., proportion of prescribed calories received, time to initiation of feeding) but no improvement in clinical outcomes.

The Knowledge to Action Model proposed by Graham *et al* is a theoretical framework that outlines steps necessary for effective translation of knowledge into practice[5]. This framework proposes seven action steps that may not have been considered by previous guideline implementation cluster randomized controlled trials (RCTs) in critical care nutrition. These steps include assessing barriers to knowledge use and subsequent tailoring of interventions to overcome the identified barriers. Barriers are factors that impede adherence to guideline recommendations, and thus contribute to the observed guideline-practice gap. Understanding barriers to optimal practice may lead to the design and selection of more effective interventions to enhance knowledge translation, and improve outcomes[6].

To identify barriers that impact adherence to critical care nutrition Clinical Practice Guidelines (CPGs), we conducted multiple case studies in 4 ICUs in Canada[7]. Semi-structured face-to-face interviews were conducted with the ICU medical director, nurse manager, clinical nurse educator, dietitian, 2 physicians, and a bedside nurse at each site. The results of this qualitative analysis were incorporated into a conceptual framework categorizing barriers into 5 types or domains: 1) characteristics of the guidelines, 2) the implementation process, 3) institutional factors, 4) individual provider behaviour and 5) the clinical condition of the patient[8]. The magnitude of influence of each barrier appeared to differ by site and profession, supporting the need to better understand the barriers faced by each profession and how they differ according to the local context.

Historically, dietitians and/or physicians have been the focus of nutrition guideline implementation activities[2-4]. However, critical care nurses play a key role in implementing the nutrition plan of care for patients in the ICU. As enteral nutrition (EN) is the primary mode of delivering nutrition to the critically ill patient[1], a better understanding of the barriers nurses face in providing optimal EN will inform the design of future quality improvement (QI) interventions in this area.[9]

To this end, we conducted a cross-sectional survey to describe the barriers that nurses face when providing EN to critically ill adult patients. In addition, we hypothesized that although some barriers may be common across settings, the frequency and magnitude of some barriers will differ across ICUs due to unique elements of the local context[7,10]. If barriers differ across ICUs, tailoring interventions to overcome these local barriers, may be a strategy to improve nutrition practice[11].

Materials and Methods

Study Design and Setting

This cross-sectional survey of barriers to enterally feeding was conducted between April and June 2010 in adult ICUs from 5 hospitals. One hospital had 3 geographically separate units caring for critically ill patients but because of common infrastructure and shared staffing, they were considered as 1 ICU for the purpose of this survey. Participating ICUs were enrolled in a field test evaluating a tailored guideline implementation strategy and the questionnaire was distributed as part of the baseline data collection for this study. These ICUs were recruited through an existing international network of ICUs participating in ongoing QI work in nutrition[12]. Potential sites were identified according to the following inclusion criteria: 1) ICU with a minimum of 8 beds 2) affiliated with a registered dietitian 3) Located in North America and 4) previous nutrition practice audit demonstrating average prescribed calories received <60%[12].

Barriers to Feeding critically Ill Patients Questionnaire

Development of the questionnaire was guided by our conceptual framework,[8] with each item mapping on to one of the 5 domains. The questionnaire was intended to be administered to critical care providers to identify modifiable barriers (i.e., factors amenable to change through a tailored intervention) to enterally feeding critically ill patients. Pilot testing of the questionnaire established content and face validity, and acceptable internal reliability. Details of the development and preliminary validation of the questionnaire have been reported elsewhere[13]. The questionnaire was composed of 45 items divided into 4 sections, with each item rated on a 7-point likert scale'''. Table 5.1 provides an overview of the content of the questionnaire. In addition to the 45 items we included an open-ended question asking respondents about additional barriers to delivering adequate EN in their ICU.

Data Collection

The nurse manager at each participating site provided the research team with a list of all nurses working full-time or part-time in their ICU, which formed the sampling frame from which to identify nurses using simple random sampling without replacement. If the total number of nurses working in a single ICU was less than 85, the questionnaire was sent to all nurses. The questionnaire was distributed according to a modified Dillman's tailored design method[14], including a pre-contact memo at least 1 week prior to distribution and 2 follow-up reminders (one week and 2 weeks after the initial questionnaire distribution). The final reminder included a second copy of the questionnaire. There were 3 options for survey completion: web-based (SurveyMonkey©), electronic (fillable pdf), or paper-based. Local investigators e-mailed, hand delivered, or placed each correspondence in the mailboxes of identified nurses. Paper surveys were returned via a box placed in the ICU and mailed to the research team. A research assistant who was not otherwise involved in the survey entered the responses from these paper surveys into an electronic database. Participation was voluntary and respondents were assured that confidentiality and anonymity would be maintained at all times.

Data Analysis

Descriptive statistics were used to describe the sample of nurses and their responses to the questionnaire. To identify barriers to enterally feeding critically ill patients, responses to each item in Part A and B were expressed as the proportion of nurses who responded 'Fully disagree', 'Disagree', or 'Somewhat disagree', and in Part C, the proportion of nurses that responded that an item was a 'somewhat important', 'important' or 'very important' barrier. The Chi-square test was used to evaluate differences in the responses to Part C across the 5 ICUs. Statistical analysis was completed using SAS v9.1.3 (SAS Institute Inc., Cary, NC, USA). All tests were two-sided with statistical significance considered as a P-value < 0.05 and a trend towards statistical significance as a P-value <0.2.

Ethics Approval

Ethics approval to conduct the study was received by the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board, Kingston, Ontario and from the respective boards at the 5 participating institutions. The need for written informed consent was waived.

Results

The barriers questionnaire was distributed to 340 nurses across the 5 participating sites. A total of 138 completed questionnaires were received (87 paper based, 50 online, and 1 pdf), for an overall response rate of 41% (site range 31-57%). Table 5.2 describes the characteristics of the 5 participating ICUs. The majority of respondents were female nurses (96%). Over 75% worked in the ICU full-time, with over half working in this setting for five years or less. However, 30% reported playing a leadership role in the ICU, of these 75% (30/40) were charge nurses.

Less than 5% of respondents disagreed with the attitudinal statements regarding nutrition therapy and guidelines in Part A of the questionnaire, with the exception of one item namely "I am familiar with our

current national guidelines for nutrition in the ICU" where 23% responded 'Somewhat disagree', 'Disagree', or 'Fully disagree'. (See Table 5.E1 presenting the proportion of nurses who disagreed with each item in Part A of the questionnaire). Across all items in Part A, less than 5% of respondents selected the 'don't know' option, with the exception of items 8 (I am familiar with our current national guidelines for nutrition in the ICU) and 9 (If the recommendations of the current national guidelines for nutrition are followed in our ICU, patient outcomes will improve) where 6% and 12% respectively responded 'don't know'.

In Part B, the proportion of nurses responding 'Somewhat disagree', 'Disagree', or 'Fully disagree' was less than 3% for 6 of the 8 guideline recommendations. For the recommendations that 'If a feeding protocol is used, it should tolerate a higher gastric residual volume (i.e., > 250mls) before holding feeds', and 'patients receiving EN should have the head of the bed elevated to 45 degrees', 34 and 23% of respondents selecting 'Fully disagree', 'Disagree', or 'Somewhat disagree' respectively. (See Table 5.E2 presenting the proportion of nurses who disagreed with the guideline recommendations pertaining to enterally feeding critically ill patients in Part B of the questionnaire). The 'don't know' option was selected in less than 10% of all observations in Part B.

Figure 5.1 presents the proportion of nurses overall and by site who rated items as 'somewhat important', 'important' or 'very important' barriers to enterally feeding critically ill patients in Part C of the questionnaire. The proportion of nurses rating items as 'somewhat important', 'important' or 'very important' barriers did not exceed 50% for any single item overall but greater proportions were observed at individual sites. The 10 most important barriers to nurses, were 1) In resuscitated, hemodynamically stable patients, other aspects of patient care still take priority over nutrition (50% (site range 47-65%), 2) No or not enough feeding pumps on the unit (50% (site range 27-70%)), 3) Enteral formula not available on the unit (48%, site range 27-70%), 4) Delays and difficulties in obtaining small bowel access in patients not tolerating EN (i.e. high gastric residual volumes) (43% (site range 32-65%)), 5) No or not

enough dietitian coverage during weekends and holidays (41% (site range 33-58%)) 6) No tube in place to start feeding (40% (site range 25-80%)) 7) Delay in physician ordering the initiation of EN (40% (site range 26-50%)) 8) Non-ICU physicians requesting patients not be fed enterally (38% (site range 27-58%)) 9) Delays and difficulties in initiating motility agents in patients not tolerating EN (i.e. high gastric residual volumes) (38% (site range 29-65%)) and 10) Waiting for the dietitian to assess the patient (35% (site range 26-45%). The barriers perceived to be least important overall were 'Current feeding protocol is outdated' (23% (site range 17-33%)) and 'Not enough nursing staff to deliver adequate nutrition' (23% (site range 12-45%)).

Two additional barriers were identified by the open-ended question in Part C, namely 'feeds being held for diarrhoea' (n=4) and 'waiting for x-ray confirmation of tube placement' (n=4).

Statistically significant differences were found among ICUs for 4 out of the 22 items in Part C, namely items 'Enteral formula not available on the unit', 'No or not enough feeding pumps on the unit', 'No feeding tube in place to start feeding', and 'Feeding being held too far in advance of procedures or operating room visits'. A trend towards statistical significance (i.e. p value <0.2) was observed for an additional 5 items (see Figure 5.1).

Discussion

We conducted a cross-sectional survey of barriers to feeding critically ill adult patients in 5 ICUs in North America to better understand the factors that hinder nurses' ability to provide optimal EN. Overall, nurses reported working in a supportive ICU environment and believed that nutrition was important for their patients. The majority of nurses agreed with the recommendations of current guidelines pertaining to EN. Thus, neither nurses' general attitudes regarding nutrition therapy and guideline recommendations, or the culture of the setting in which they work were found to be important barriers in our sample. However, several specific items were identified which nurses perceived to be important barriers to optimally feeding

their critically ill adult patients. These important barriers were primarily factors associated with the delivery of EN to the patient (e.g., no feeding tube in place, delays in physicians ordering, delays in initiation of motility agents and small bowel feeding) and ICU resources (e.g., lack of availability of enteral formula and/or feeding pumps). Other important barriers that were highlighted were non-ICU physicians requesting that patients not be fed enterally and other aspects of care taking priority over nutrition. Despite observing variation in the rating of importance of each barrier across the 5 sites, these differences did not reach statistical significance for the majority of items, indicating that the majority of items were perceived with the same degree of importance by nurses independent of the setting in which they worked.

Our finding that almost all nurses considered nutrition therapy important for their patients is consistent with the results of our previous international survey of beliefs and attitudes towards the Canadian Critical Care Nutrition guidelines[15]. Of the 514 physicians and dietitians who responded to this survey, 91.4% considered nutrition therapy to be 'very important'. However, as in our previous survey, in this study, we again observed some unfamiliarity with current guidelines; specifically, 23% of nurses disagreed with the statement that they were familiar with current national guidelines for nutrition and 9% responded 'don't know'. In our previous survey[15], 27.5% of dietitians and 39.9% of physicians responded that they were 'not very' or 'not at all' familiar with the Canadian Critical Care Nutrition CPGs, suggesting that although attitudes towards nutrition are positive, unfamiliarity with the evidence may be a barrier to optimal nutrition care across professions. Strategies to increase awareness of the evidence supporting guideline recommendations amongst all members of the ICU team may be warranted in some settings.
Overall in both this study and our prior survey[15], respondents agreed with the recommendations of current guidelines pertaining to EN. However, disagreement was higher amongst nurses in the current survey compared to physicians and dietitians in the previous survey for 2 recommendations: 1) 'if a feeding protocol is used, it should tolerate a higher gastric residual volume (i.e., > 250mls) before holding feeds' (33.6% vs 9.2%); and 2) 'patients receiving EN should have the head of the bed elevated to 45 degrees'

(22.6% vs. 3.6%). For the former, disagreement may stem from inertia of historical practices, unfamiliarity with more recent literature suggesting that a higher gastric residual volume is safe, or previous experience of adverse events due to aspiration[16]. For the latter, disagreement may stem from experience that achieving a head of bed elevation of 45 degrees is difficult in practice[17], or due to discrepancies between the thresholds recommended in the guidelines and the local policy documents (e.g., local policy might be to raise the head of bed to 30 degrees and not 45 degrees).

In our survey, 'in resuscitated, hemodynamically stable patients, other aspects of patient care still take priority over nutrition' was ranked as the top barrier to enterally feeding critically ill adult patients. This is a reflection of the high technology, rapidly changing environment of the modern ICU where the interdisciplinary team concurrently manages several care priorities. Given that this barrier remains, despite the positive attitude among respondents that nutrition is important, nurses may be unfamiliar with the evidence that feeding the hemodynamically stable critically ill patient appears to impact favourably on mortality[18]. We postulate that combining education with a unit-level intervention that integrates nutrition into routine daily practice may successfully prioritize nutrition to overcome this barrier. We recently demonstrated the safety, feasibility, and acceptability of such a unit- level intervention[19]. The "enhanced Protein-Energy Provision via the Enteral Route in Critically Ill: PEP uP Protocol" is an innovative nurse-driven feeding protocol that uses pre-printed orders and bed-side algorithms coupled with a nursing educational intervention to improve the provision of EN[19]. Results of a recently completed cluster RCT evaluating the impact of this unit- level intervention on nutritional and clinical end-points are pending (Clinicaltrials.gov identifier: NCT01167595).

According to the Knowledge-to-Action model, after identifying the important barriers to enterally feeding critically ill patients, the next step is to link or tailor interventions to these barriers[5]. There is currently insufficient evidence on the most efficient and effective method of selecting and implementing such interventions[11]. To this end, we are currently completing a pretest-posttest study to evaluate the feasibility

of implementing a tailored intervention to overcome barriers to enterally feeding critically ill adult patients [PERFormance Enhancement of the Canadian nutrition guidelines by a Tailored Implementation Strategy: The PERFECTIS study [ClinicalTrials.gov identifier: NCT01168128)].

Our study has several strengths. First, to our knowledge this is the first survey of nurses' attitudes towards nutrition and the barriers they face in feeding critically ill adult patients. As the provider charged with operationalizing the initiation, progression, and ongoing delivery of EN, nurses are uniquely positioned to provide insight into the reasons why gaps exist between guideline recommendations and actual practice. Second, our survey included nurses from 5 ICUs of varying size, teaching status, and type, allowing evaluation of barriers across different settings. Third, the instrument distributed to evaluate barriers was rigorously developed and clinimetrically evaluated using validity and reliability testing[13]. Although 2 new barriers were identified through the open-ended question, these barriers were only highlighted by very few nurses, suggesting that the items included in the questionnaire are a comprehensive list of potential barriers.

The main limitation of our survey is that it was conducted in a non-random purposefully selected sample of North American ICUs, in one professional group, and with a modest sample size; accordingly, generalizibility of the results to other geographic regions and critical care providers is limited. The sample sizes at the site level ranged from 20 to 34 which may have been inadequate to detect significant differences in nurses' rating of the importance of each barrier across ICUs. In addition, we did not evaluate whether and how ICU characteristics (e.g., teaching status, geographic region) or nurse characteristics (e.g., critical care experience, education level) influenced the identified barriers. As with any self-administered survey, our results reflect the perceived importance of each barrier, which may not be synonymous with the actual impact of the barrier on providing EN to the patient. Although the overall response rate for the survey was only 41%, this is similar to other nursing surveys in critical care[20,21]. However, we cannot exclude the possibility of selection bias. The included ICUs were participating in an

ongoing initiative to improve nutrition therapy, therefore nurses who responded may have had a greater interest in nutrition or may have had greater involvement in this study compared to non-responders.

Conclusion

In our multicenter survey of critical care nurses of barriers to enterally feeding critically ill patients, we observed several important barriers hindering the adequate provision of EN to their patients. Nurses' attitudes towards nutrition and guideline recommendations were not observed to be important barriers in our sample. Despite observing variation in the rating of importance across the 5 sites, these differences did not reach statistical significance for the majority of items.

Our results provide a greater understanding of modifiable barriers that ICU nurses face in providing optimal EN to critically ill patients, highlighting some of the factors contributing to the observed gap between nutrition guideline recommendations and current practice. Overcoming these identified barriers may be a successful strategy to improve nutrition practice and close the guideline-practice gap. Given the diversity of the barriers identified in our survey, future interventions should be multi-level (i.e. target hospital administration, ICU management, and individual providers), multi-faceted (i.e. include staff education, system tools, improved access to resources etc), and tailored to the local context. Further research is required to evaluate the effectiveness of such an approach.

Acknowledgments

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Table 5.1: Summary of the Barriers to Enterally Feeding Critically Ill Patient Questionnaire

Questionnaire Section		Rationale	Number of items	Example item(s)
Part A: General Barriers[a]		Higher level aspects of daily practice (i.e. the ICU environment) and beliefs (i.e. general attitudes towards guidelines and nutrition) may impact on an individual's ability to perform specific nutrition-related tasks	9	In our ICU, implementing best practices, as defined by clinical practice guidelines, is intrinsic to our culture. I feel responsible for ensuring that my patients receive adequate nutrition while in the ICU.
Part B: Guideline Recommendations for Enteral Nutrition[a]		Attitudes towards a specific nutrition practice may influence an individuals intent to perform that practice	8	Enteral nutrition should be initiated early (24-48 hours following admission to ICU).
Part C: Barriers to Delivery of Enteral Nutrition[b]				
	Subscale 1: ICU Resources	Resource constraints hinder staffs ability to adhere to recommendations	5	Enteral formula not available on the unit.
	Subscale 2: Guideline Recommendations	The characteristics of the guidelines themselves can impede their application (e.g. wording, supporting evidence, access)	3	The current national guidelines for nutrition are not readily accessible when I want to refer to them.
	Subscale 3: Guideline Implementation Strategies	Ineffective implementation is a barriers to following guidelines in practice	3	Not enough time dedicated to education and training on how to optimally feed patients.
	Subscale 4: Critical Care Provider Behaviour	Inadequate knowledge of or negative attitudes towards nutrition guidelines may translate into the behaviour of not adhering to recommendations	6	Delay in physicians ordering the initiation of EN. Feeding being held too far in advance of procedures or operating room visits.
	Subscale 5: Patient Factors	Guideline adherence may be more difficult in complex patients	5	In resuscitated, hemodynamically stable patients, other aspects of patient care still take priority over nutrition.

[a] = Scale: 1=Fully disagree, 2=Disagree, 3=Somewhat disagree, 4=No opinion, 5=Somewhat agree, 6=Agree, 7=Fully agree, 8=Don't know

[b] = 1=Not at all important, 2=Unimportant, 3=Somewhat unimportant, 4=Neither important or unimportant, 5=Somewhat important, 6=Important, and 7=Very important

Table 5.2: Characteristics of Participating Intensive Care Units

ICU #	Country	Hospital Type	Hospital Size	ICU[b] Structure	ICU Size	Clinical Specialty	Case Mix
1	USA	Non-Teaching	361	Closed[d]	20	Mixed medical/surgical	Medical Neurological Surgical Neurosurgical
2	Canada	Teaching	497	Closed	16	Mixed medical/surgical	Medical Surgical
3a[a]	USA	Teaching	600	Open[c]	12	Surgical Trauma	Medical Surgical Trauma Neurological Neurosurgical
3b	USA	Teaching	600	Open	10	Neurological	Medical Surgical Trauma Neurological Neurosurgical
3c	USA	Teaching	600	Open	10	Medical	Medical Surgical Trauma Neurological
4	Canada	Non-Teaching	400	Open	13	Mixed medical/surgical	Medical Surgical
5	Canada	Teaching	759	Closed	30	Mixed medical/surgical	Medical Surgical Trauma Neurological

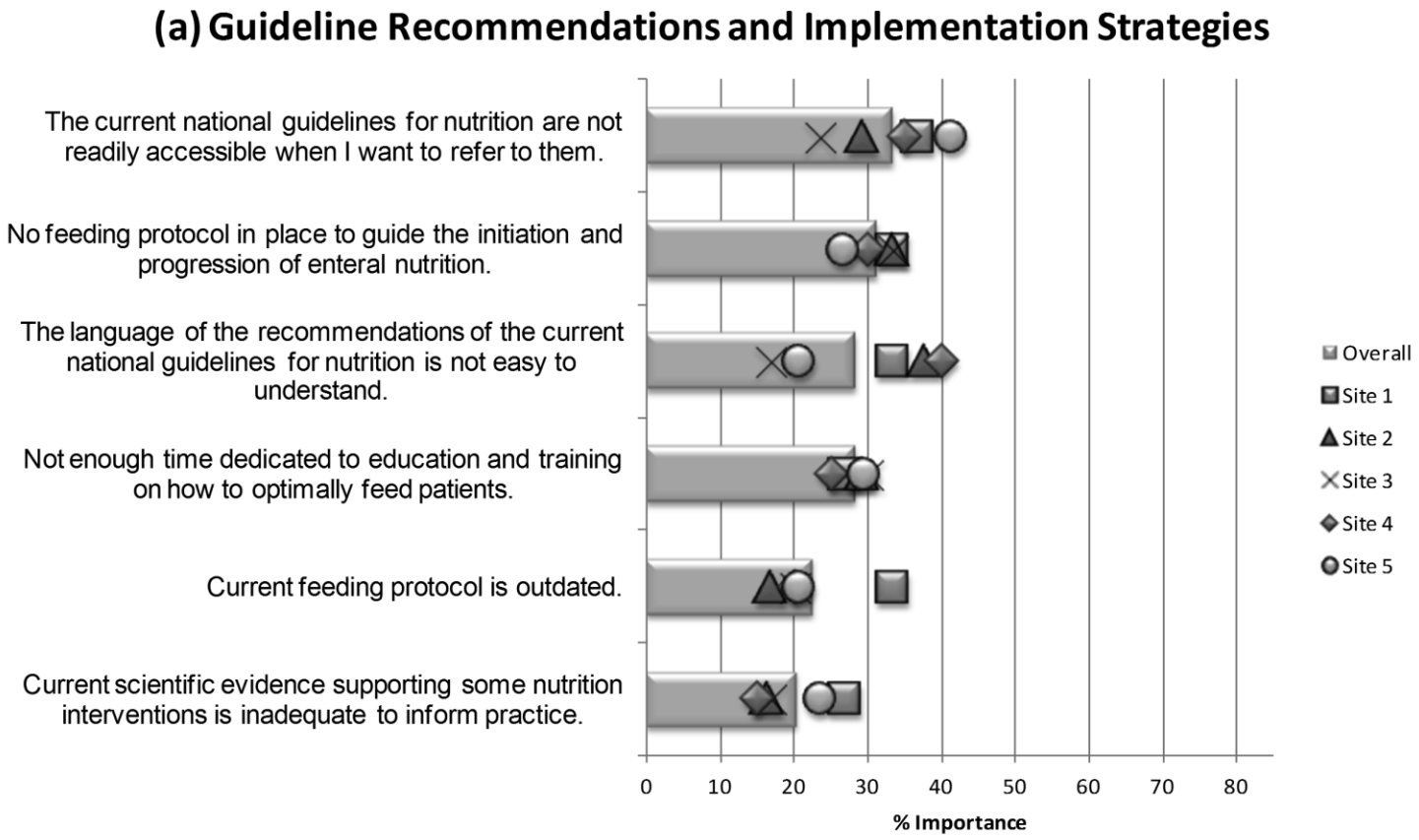
[a]3 units combined in the analysis due to common infrastructure and shared staffing [b]ICU=Intensive Care Unit
[c] Open=patient under care of any attending physician [d]Closed=patient under care of an intensivist

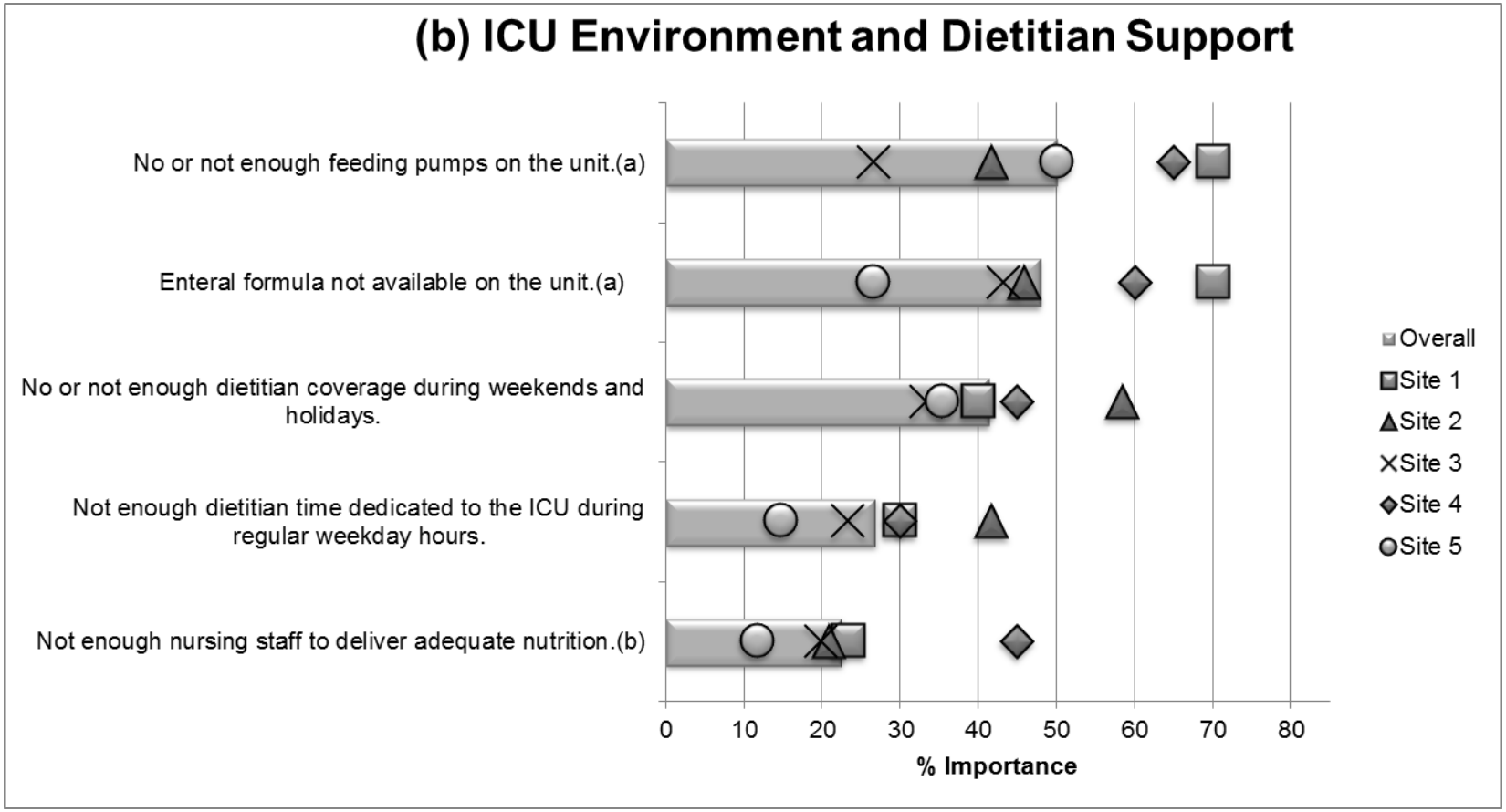
Table 5.3: Personal Characteristics of Nurses

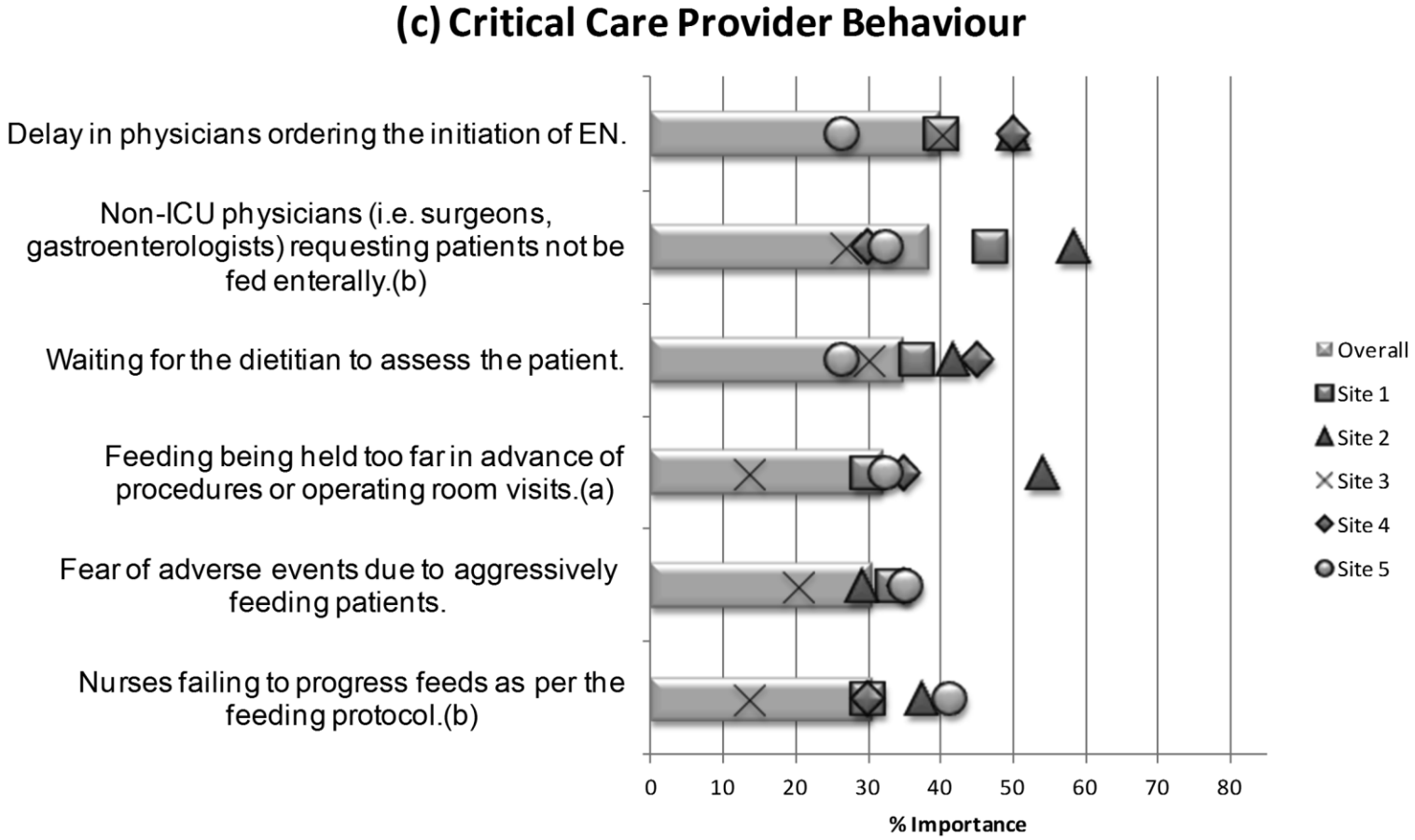
Characteristic	**N (%)**
Sex	*N=132*
Male	6 (4.5)
Female	126 (95.5)
Age (years)	*N=133*
20-34	67 (50.4)
35-49	46 (34.6)
≥ 50	20 (15.0)
Time dedicated to ICU	*N=134*
Full-time	101 (75.4)
Part-time	31 (23.1)
Other[a]	2 (1.5)
Length of time working in critical care (years)	*N= 135*
0-5	70 (51.9)
6-10	31 (23.0)
11-15	13 (9.6)
>15	21 (15.6)
Leadership role[a]	*N=132*
Yes	40 (30.3)

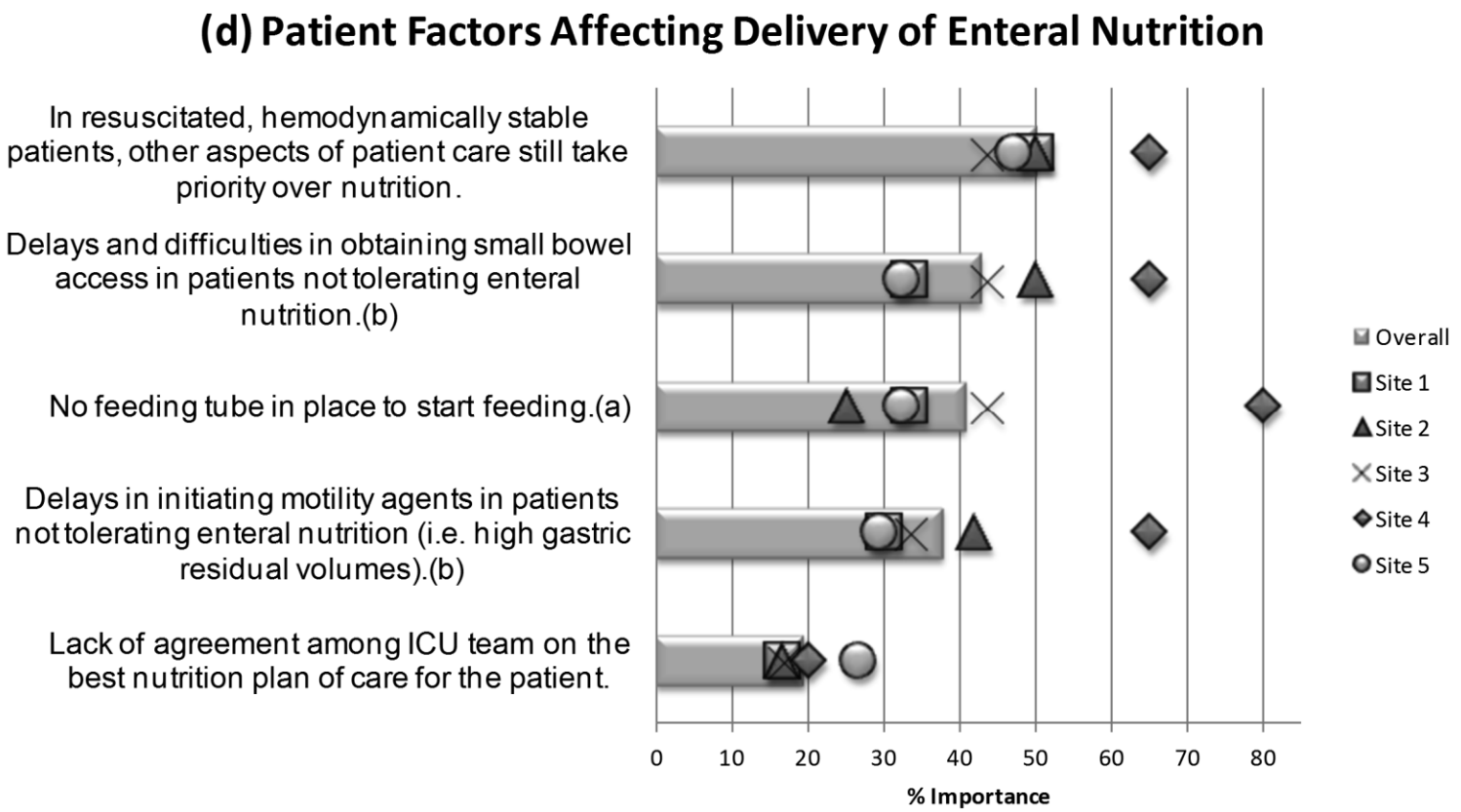
[a] e.g. casual, trainee placement
[b]Examples of a leadership role include charge nurse, clinical nurse specialist, nurse manager
ICU=Intensive Care Unit

Figure 5.1: Proportion of nurses rating items as somewhat important, important, and very important barriers to enterally feeding patients in their Intensive Care Unit




(b) ICU Environment and Dietitian Support
No or not enough feeding pumps on the unit.(a)
Enteral formula not available on the unit.(a)
No or not enough dietitian coverage during weekends and holidays.
Not enough dietitian time dedicated to the ICU during regular weekday hours.
Not enough nursing staff to deliver adequate nutrition.(b)
0
10
20
30
40
50
60
70
80
% Importance
Overall
Site 1
Site 2
Site 3
Site 4
Site 5


(c) Critical Care Provider Behaviour
Delay in physicians ordering the initiation of EN.
Non-ICU physicians (i.e. surgeons, gastroenterologists) requesting patients not be fed enterally.(b)
Waiting for the dietitian to assess the patient.
Feeding being held too far in advance of procedures or operating room visits.(a)
Fear of adverse events due to aggressively feeding patients.
Nurses failing to progress feeds as per the feeding protocol.(b)
0
10
20
30
40
50
60
70
80
% Importance
Overall
Site 1
Site 2
Site 3
Site 4
Site 5



Bar chart represents overall responses, symbols represent site level responses

[a] = statistically significant differences across sites (p value < 0.05) [b] = trend towards statistical significant difference across sites (p value < 0.2)

Table 5.E1: Proportion of nurses who responded Fully disagree, Disagree, or Somewhat disagree, overall and by ICU site to attitudinal statements in Part A of the barriers to enterally feeding critically Ill patients questionnaire

Item	Overall	Site 1	Site 2	Site 3	Site 4	Site 5
N	**138**	**30**	**24**	**30**	**20**	**34**
	%	**%**	**%**	**%**	**%**	**%**
ICU environment						
1. Overall, our unit functions very well together as a team.	3.7	0.0	0.0	0.0	0.0	12.1
2. Our ICU team engages in joint decision-making in planning, coordinating and implementing nutrition therapy for our patients.	2.9	0.0	4.1	0.0	0.0	8.8
3. Overall, it is easy for me to openly talk with other members of the ICU team about matters related to the nutritional needs of my patient.	2.2	0.0	4.2	0.0	0.0	5.9
4. In our ICU, implementing best practices, as defined by clinical practice guidelines, is intrinsic to our culture.	4.4	0.0	4.2	3.3	0.0	5.9
5. Our ICU Managers/Directors are supportive of implementing nutrition guidelines.	1.5	0.0	4.2	0.0	0.0	2.9
Attitudes towards nutrition						
6. Nutrition is very important for my critically ill patients.	0.0	0.0	0.0	0.0	0.0	0.0
7. I feel responsible for ensuring that my patients receive adequate nutrition while in the ICU.	0.0	0.0	0.0	0.0	0.0	0.0
8. I am familiar with our current national guidelines for nutrition in the ICU.	23.2	20.0	12.5	30.0	15.0	32.4
9. If the recommendations of the current national guidelines for nutrition are followed in our ICU, patient outcomes will improve.	2.9	3.3	4.2	6.7	0.0	5.9

ICU= Intensive Care Unit

Table 5.E2: Proportion of nurses who responded fully disagree, disagree, or somewhat disagree, overall and by ICU site to statements summarizing guideline recommendations for provision of enteral nutrition in Part B of the barriers to enterally feeding critically Ill patients questionnaire

Item	Overall	Site 1	Site 2	Site 3	Site 4	Site 5
	%	%	%	%	%	%
1. Enteral nutrition should be used in preference to parenteral nutrition.	0.7	0.0	0.0	3.3	0.0	0.0
2. Enteral nutrition should be initiated early (24-48 hours following admission to ICU).	1.5	3.3	0.0	3.3	0.0	0.0
3. An evidence-based feeding protocol should be used.	1.5	0.0	0.0	3.3	0.0	2.9
4. If a feeding protocol is used, it should tolerate a higher gastric residual volume (i.e. > 250mls) before holding feeds.	33.6	30.0	25.0	33.3	31.6	44.1
5. In patients who have feed intolerance (i.e. high gastric residual volumes, emesis) a promotility agent should be used.	2.2	3.3	0.0	6.7	0.0	0.0
6. Small bowel feeding should be considered for those select patients who repeatedly demonstrate high gastric residual volumes and are not tolerating adequate amounts of EN delivered into the stomach.	1.5	0.0	0.0	3.3	0.0	2.9
7. Patients receiving enteral nutrition should have the head of the bed elevated to 45 degrees.	22.6	6.7	41.7	26.7	10.5	26.5
8. In all critically ill patients, hyperglycemia (blood glucose > 10 mmol/l or 180mg/dl) should be avoided by minimizing intravenous dextrose and using insulin administration when necessary.	1.6	0.0	4.2	3.3	0.0	0.0

ICU=Intensive Care Unit

Chapter 6

Implementing a Multifaceted Tailored Intervention to Improve Nutrition Adequacy in Critically Ill Patients: Results of a Multicenter Field Test

Abstract

Objective: To determine the feasibility of a multifaceted, interdisciplinary, tailored intervention aimed at improving adherence to critical care nutrition guidelines for the provision of enteral nutrition

Design: A pretest posttest study

Setting: 5 hospitals in North America

Subjects: Full- or part-time critical care providers working at participating sites and mechanically ventilated adult critically ill patients admitted to participating sites

Interventions: During a 3-month pre-implementation phase, each ICU completed a nutrition practice audit to identify guideline-practice gaps and a barriers assessment to identify obstacles to practice change. During a 1 day meeting, the results of the audit and barriers assessment were reviewed and used to develop a site-specific tailored action plan. The tailored action plan was then implemented over a 12-month period.

Measurements and Main Results: Compliance with the tailored action plan was determined by the proportion of items in the action plan that were completely implemented. In addition, we examined exposure to the intervention through staff responses to an evaluation questionnaire. Audits of nutrition practice and barriers assessments were conducted at baseline and follow-up to determine changes in barriers and nutrition practices. All 5 sites successfully completed all aspects of the study. However, their ability to fully implement all of their developed action plans varied from 14 to 75% compliance. Nurses, on average; rated the study-related activities and resources as ‘somewhat useful’ and a third of respondents agreed or strongly agreed that their nutrition practice had changed as a result of the intervention. We observed a statistically significant 10% (Site range -4.3 to -26.0%) decrease in overall

barriers score, and a non-significant 6% (Site range -1.5 to17.9%) and 4% (-8.3 to 18.2%) change in the adequacy of total nutrition from calories and protein, respectively.

Conclusions: The multifaceted tailored intervention appears to be feasible but further refinement is warranted prior to testing the effectiveness of the approach on a larger scale.

Key words: critical care; evidence-based practice; guideline adherence; enteral nutrition; quality improvement; feasibility studies;

Background

Clinical Practice Guidelines (CPGs) on nutrition therapy in the Intensive Care Unit (ICU) have been published to help clinicians make decisions regarding feeding their critically ill patients.[1-5] Although there are several discrepancies between guidelines on other topics, there is agreement for recommendations pertaining to enteral nutrition (EN).[6] These recommendations include: using EN in preference to parenteral nutrition (PN), initiating EN within 24-48 hours of ICU admission, the use of a feeding protocol that tolerates a higher gastric residual threshold, the use of motility agents and small bowel feeding tubes in patients with high gastric residual volumes, head of bed elevation, and avoidance of hyperglycemia. Energy and protein targets are more likely to be met if these guideline recommendations are followed[7]. However, numerous reports highlight that the quality of nutrition care is poor[8-12], with ICUs providing less than 60% of prescribed calories and protein.[8] Efforts to close this gap between guideline recommendations and actual practice are warranted.[13]

There have been three cluster Randomized Controlled Trials (RCTs) employing multifacteted educational interventions to implement nutrition guideline recommendations and improve ICU nutrition practices.[14-16] These RCTs observed small improvements in nutritional outcomes (e.g. days fed, provision of prescribed calories) but no impact on clinical outcomes (e.g. ICU length of stay, hospital mortality). Since then, the importance of identifying barriers to change and tailoring interventions to overcome these barriers has been recognized.[17] In the complex high technology environment of the ICU, multiple factors can hinder the provision of adequate EN. In a previous qualitative study we developed a framework for understanding these potential barriers, and proposed that barriers can be categorized based on whether they are associated with the guidelines, the implementation process, the institutional characteristics, the knowledge, attitudes, and behaviour of individual providers, or patient status.[18]

Once the local barriers to change have been identified, the next step is to link specific guideline implementation strategies to these barriers.[19] These tailored intervention strategies have been defined as "strategies to improve professional practice that are planned to take account of prospectively identified barriers to change"[20]. A Cochrane review identified 26 RCTs that adopted this tailored approach to guideline implementation.[20] Most of these trials were conducted in a primary care setting, targeting physician prescribing behavior. While the impact on process outcomes varied both across and within studies, it appears that interventions tailored to overcome identified barriers are more effective at changing practice than no intervention or passive dissemination of guidelines. However, the optimal methods of identifying barriers and selecting interventions to address these barriers are unclear.

We hypothesized that a tailored intervention designed to overcome barriers to adherence to critical care nutrition guidelines for enterally feeding critically ill patients would improve nutrition practices compared to non-tailored guideline implementation. Prior to formally testing this hypothesis and evaluating change in nutrition practice in a large representative sample of ICUs, we completed several preliminary steps. First, we developed and validated a questionnaire to measure barriers to the provision of EN.[21] Second, we conducted the PERFormance Enhancement of the Canadian nutrition guidelines by a Tailored Implementation Strategy (PERFECTIS) study [ClinicalTrials.gov identifier: NCT01168128)] to demonstrate that barriers and improvement plans varied enough across sites to warrant a tailored approach[22,23], and to establish that a site-specific tailored plan is feasible, that sites will comply with what is expected of them and work towards creating change. The purpose of this report is to document the results of the PERFECTIS Study.

Materials and Methods

Study Design and Overview

We conducted a pretest-posttest study to field test a tailored intervention to improve the provision of EN in the ICU (Figure 6.1: Study Schema). Participating ICUs were recruited through an international ICU

network for quality improvement [24]. Of the 81 ICUs, 14 (17%) met our inclusion criteria and were invited to participate: 1) ICU with a minimum of 8 beds (smaller units do not routinely care for patients ventilated for >24 hours and who therefore require EN) 2) affiliated with a registered dietitian (a predictor of higher nutrition performance[24]) 3) Located in North America (EN guideline recommendations in Canada and USA are similar [1,3,5]). 4) Previous nutrition audit demonstrating average nutrition adequacy was <60%[24] (our goal was to improve nutrition practice and lower baseline performance has been associated with greater improvement[25]). In addition, we purposefully aimed to include a mix of teaching status (teaching vs. non-teaching) and ICU types (open vs. closed) as these factors can influence nutrition practice[26,27]. Five hospitals agreed to participate. One hospital had 3 geographically separate units but common infrastructure and staffing, so they developed and implemented one tailored action plan for all 3 units.

An interdisciplinary local guideline implementation team consisting of the ICU dietitian(s), attending physician, and a nurse was formed at each site. Team members self-identified as local nutrition opinion leaders. The local teams were responsible for study coordination, data collection, and implementing the tailored intervention.

Intervention

The design of the tailored intervention was informed by theoretical models for successful knowledge translation[19,28,29], previous experiences from nutrition guideline implementation studies[14-16], and existing literature on tailoring interventions to overcome barriers.[17] We aimed to address both individual and organizational barriers amenable to change through a local intervention rather than barriers that are less modifiable (e.g., hospital teaching status and case-mix). The development and implementation of the site-specific tailored intervention has been described elsewhere[23] but is summarized in Table 6.1. In brief, this process consisted of 5 steps (Figure 6.1: Study Schema): 1) An audit of nutrition practices to identify guideline-practice gaps at each site. 2) Distribution of the barriers to feeding critically ill patients questionnaire to ICU staff to identify local barriers to practice change. 3) Prioritization of barriers and

development of individualized tailored action plan through 1 day brainstorming meetings with key stakeholders (e.g., ICU manager, nurse manager, intensivists, dietitians, nurses, clinical educators) at each site. 4) Implementation of the tailored action plan. 5) Evaluation of the intervention.

The study took place between September 2009 and September 2011, and the intervention occurred over 12 months (May/June 2010 – May 2011).

Data Collection and Management

Data on nutrition practices were collected as part of the ongoing International Nutrition Survey.[8] Data collection details were reported previously.[8] Starting on 16 September 2009 and 11 May 2011, the local guideline implementation team at participating ICUs identified 20 consecutive adult patients who were mechanically ventilated within the first 48 hours of ICU admission and who remained in ICU for more than 72 hours. Data were retrospectively abstracted from hospital records on patient characteristics and baseline nutrition assessment (i.e., energy and protein prescribed by the dietitian). Daily nutrition information was collected on the type (route of delivery, type of solution provided) and amount (total calories and protein received) of nutrition, as well as strategies to enhance delivery (motility agents and small bowel feeding tubes) and morning blood glucose. Daily information was recorded from ICU admission for a maximum of 12 days unless death or ICU discharge occurred sooner. Data on head of the bed elevation was obtained through direct observation on the day of enrollment. Patients were followed to determine their ICU and hospital outcomes at 60 days. Data were entered using a secure web-based data collection tool (REDCap Software, Version 3.3.0, © 2012 Vanderbilt University).

In March/April 2010 and May/June 2011, the barriers to enterally feeding critically ill patients questionnaire was administered to all full and part-time ICU physicians, managers, dietitian(s) and nurses. If more than 85 nurses were employed, a sample of 60 nurses was identified at each site by simple random sampling without replacement. The Barriers to Feeding Critically ill Patients questionnaire was developed for this study.[21] Based on feedback following baseline administration, the questionnaire was revised. In

this report we focus on items that were common to both versions of the questionnaire, namely a list of 21 potential barriers to delivery of EN divided into 5 subscales: 'guideline recommendations and implementation', 'ICU resources', 'dietitian support', 'delivery of EN to the patient', and 'critical care provider attitudes and behavior'. Respondents were asked to rate on a 7-point likert scale the importance of each item as a barrier in their ICU. To maximize response rate, the questionnaire was distributed according to a modified Dillman's tailored design method[30], including a pre-contact memo, multiple reminders, and sending a second copy of the questionnaire. The modes of distribution and capturing responses (i.e., web vs. paper based) were determined by the local guideline implementation team. The questionnaires were either e-mailed, hand delivered, or placed in staff mailboxes.

To determine compliance with the tailored action plan, at the end of the 12 month implementation phase, the local guideline implementation team ranked their progress towards implementing each action using a scale where 0=no action, 1=initial steps taken but no steps complete, 2=implementation in progress and some steps complete, 3=implementation 50% complete, 4=implementation 100% complete, and 5=target/objectives exceeded. To further evaluate the intervention, in May/June 2011 a brief questionnaire was distributed to ICU staff using the same methodology as for the barriers questionnaire. Respondents were asked about their exposure to and usefulness of each 'action' in their tailored action plan using a scale where 1= useless and 5 = very useful. In addition, we asked about nutrition practice change as a result of PERFECTIS study participation.

Outcome Measures

The primary outcome of this field test was compliance with the tailored action plan defined as the proportion of strategies with a progress rank of 4 or 5 out of the total number of strategies in the site's action plan. To further examine compliance with the intervention, we examined staff responses to the evaluation questionnaire.

Secondary outcomes included change in barriers score and change in nutrition practice indicators. Barriers scores were calculated by awarding 1, 2, or 3 points if the respondent identified an item as a '5=somewhat important', '6=important' or '7=very important' barrier respectively. If an item was rated 1-4 (i.e., 'not at all important' to 'neither important or unimportant' it was awarded 0 points. The barriers score was calculated by dividing the awarded points for each item by the maximum potential points (i.e., 3) and multiplied by 100. The overall, subscale and prioritized barriers score was the mean score awarded by respondents for all the items, subscale items, and items selected as priority for action by each site, respectively. Change in barriers scores were calculated as the score at baseline subtracted from score at follow-up with a decrease in score indicating a decrease in the perceived importance of the item.

Nutrition practice indicators evaluated included adequacy of calories and protein from enteral nutrition, adequacy of calories and protein from total nutrition, proportion of patients who achieved >80% adequacy of calories from total nutrition within 72 hours of ICU admission, proportion of patients receiving EN, proportion with EN initiated within 48 hours, time from start of EN to >80% adequacy of calories from total nutrition, proportion with high gastric residual volumes receiving motility agents and/or small bowel tubes, mean head of bed elevation, and proportion of patients with hyperglycemia.

Analysis

As the objective of this pretest posttest study was to evaluate the feasibility of a tailored intervention to overcome barriers to adherence to ICU nutrition guideline recommendations rather than to evaluate its impact on barriers score or nutrition performance, no formal sample size or power calculation was completed. Consequently, analyses of secondary outcome measures are hypothesis-generating.

The purpose of the intervention was to address modifiable barriers; however, following tailored action plan development, each site identified items that were non-actionable or outside the locus of control of the local team (e.g., purchasing additional feeding pumps, funding for additional dietitian time).

Consequently, we calculated compliance for the original action plan (i.e., primary analysis) and compliance omitting these non-actionable items (i.e., secondary analysis).

The tailored intervention targeted change at the ICU level; therefore, all patient and provider level data were aggregated to the site level. Categorical variables are reported as counts and percents and compared between baseline and follow-up by the Fisher's Exact test. Continuous variables are described by their means and standard deviations (SD) or medians and interquartile range (IQR) and compared by using a mixed model. Nutrition adequacy was calculated as the amount of calories or protein received (from either EN or 'appropriate' parenteral nutrition (PN) (i.e., presence of clinical contraindication to EN) but not oral intake) plus propofol, divided by the amount prescribed as per the baseline assessment and expressed as a percentage. Days without EN or PN, and days with 'inappropriate' PN were included and counted as 0% adequacy. Days following permanent progression to exclusive oral intake were excluded from the calculation of nutrition adequacy. To account for the confounding effect of duration of nutrition exposure, the prescribed calories received by each patient was adjusted for evaluable nutrition days.[31] Statistical analyses were completed using SAS v9.1.3 (SAS Institute Inc., Cary, NC, USA). All tests were two-sided with statistical significance considered as a P-value < 0.05.

Institutional ethics approval was obtained from the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board, Kingston, Ontario and participating hospitals. The need for informed patient and staff consent was waived given the quality improvement design.

Results

All 5 participating ICUs successfully completed data collection at baseline and follow-up, and developed and implemented a tailored action plan. Characteristics of participating ICUs are shown in Table 6.2, reflecting a range of sizes, closed (i.e. patient under the care of an intensivist) and open (i.e. patient under

care of any attending physician) structures, teaching and non-teaching institutions and 2 health care systems.

Table 6.3 presents the primary and secondary analyses of compliance with the action plans. Across the 5 sites the developed action plans consisted of either 7 or 8 action items, each site identified 1 item that was non-modifiable with a progress rank of 0, with the exception of site 2 that identified 2 such items. The median progress rank was 4 indicating implementation 100% complete. For the secondary evaluation, omitting non-modifiable barriers, the ability of sites to successfully implement their action items varied from achieving a 4 or 5 progress rank for 1 of the 6 action items (17% compliance) at Site 3 to 6 out of 7 action items (86% compliance) at Sites 1 and 5. However, at the time of follow up data collection, several sites had partially implemented action items and their efforts to complete implementation were ongoing.

The questionnaire evaluating the implementation of the action plans was completed by 82 nurses (24% response rate). Eighty percent of respondents knew all members of the local guideline implementation team, and 59% had discussed nutrition with these members on a 'daily' or 'weekly' basis. As a result of the study, prescribed calories received or caloric deficit was reported on daily rounds 'often' or 'all the time', according to 52% of respondents; 32% 'agreed' or 'strongly agreed' that they had changed their nutrition practice as a result of study participation. On average nurses were exposed to 7 (site range 3 to 7) study-related activities or resources, and on average rated these as 4 = 'somewhat useful'. Table 6.3 describes the results of the evaluation questionnaire by site (see Supplemental Digital Content 6.1: for table of ICU staff ratings of the exposure to and usefulness of the various strategies used to implement the action plans).

A total of 182 critical care staff (134 (74%) nurses, 25 (14%) physicians,12 (7%) dietitians and 11 (6%) other) responded to the Barriers to Enterally Feeding Critically Ill Patients questionnaire at baseline, and 118 (93 (79%) nurses, 12 (10%) physicians, 10 (9%) dietitians and 3 (3%) other) at follow up; for an

overall response rate of 45% (39% for nurses, 44% for physicians, and 100% for dietitians) and 29% (27% for nurses, 21% for physicians, and 83% for dietitians) at the two respective time-points. Respondent characteristics were similar at baseline and follow-up. Over half were experienced staff working in ICU for greater than five years, and two-thirds worked full-time.

Figure 6.2 illustrates the change in prioritized barriers score reflecting barriers targeted for improvement by the tailored action plans at each site. The prioritized barriers score decreased in all sites between baseline and follow-up with a mean change of -13%, ranging from -5% (SD 29) at Site 1 to -26% (SD 19) at Site 4. We observed a 10% (site range -4 to -26%) reduction in overall barriers score. The barriers score decreased for all 21 items in the questionnaire and this change was statistically significant for 16 items (item range -1 to -18%). The greatest change was observed in subscales 4 (delivery of EN to the patient) and 5 (provider attitudes and behaviour) with a change in barriers score of -12% (-2 to -36%) and -11% (-3 to -22% respectively). Although the barriers score decreased at all sites for most items, the magnitude of change varied (See Supplemental Digital Content 6.2: Table of Change in Overall and Item Barriers Scores).

There were 140 patients accrued in the nutrition practice audit at baseline and 138 at follow up. Patient characteristics and clinical outcomes were similar at both time points, 55% were male with a median age of 61 years (IQR 51 to 72), and Body Mass Index of 27Kg/m^2 (IQR 23 to 32). The majority were medical patients (80%) and the median APACHE II score was 22 (IQR 17 to 28). Median lengths of mechanical ventilation and ICU stay were 5 days (IQR 2 to10) and 8 days (IQR 5 to14) respectively, and 60 day hospital mortality was 25.5%.

Figure 6.3 shows the change in caloric adequacy from total nutrition at each site. While some sites did not improve, an increase of >10% was observed at two sites (51 to 63% at Site 1, and 39 to 57% at Site 4). We did not observe any significant changes in nutrition indicators (Table 6.4).

Discussion

In this multicenter study of a tailored intervention to improve the provision of EN to critically ill patients, we demonstrated that this multi-faceted, interdisciplinary intervention is feasible with all 5 sites successfully developing and implementing their action plans. However, the degree of implementation varied across sites, with no ICU completely implementing all proposed strategies in their action plan within the 12-month implementation phase. Although this study was not powered to evaluate differences in nutrition outcomes, we did observe significant decreases in barrier scores and small improvements in some nutrition practices.

These results contribute to the rapidly growing body of evidence on customized approaches to knowledge translation. The Cochrane review of tailored interventions published in 2010 identified 26 trials[20], 11 more than the 15 included in the 2005 publication.[32]. Awareness of 14 ongoing studies on this topic for the next update underscores how tailoring is being incorporated in guideline science. However, no prior or ongoing studies focused on nutrition guidelines or the ICU, raising questions about the generalizibility of prior studies, and the need for context-specific evaluation. Our study provides new data on a tailored intervention in the acute care setting aiming to change a range of professional practices. The Cochrane review categorized the complexity and extent to which tailored interventions were adjusted to local barriers as low, moderate, or high. In our study, the complexity of both the barriers assessment and tailoring was 'high', meaning that we used multiple methods to identify site-specific barriers including a staff survey, provider focus groups, and nutrition performance data, customizing the intervention to site-specific barriers identified by local staff. A unique feature of our study was the development and implementation of a tailored action plan led by a local team rather than prescribed by external researchers, which proved feasible in teaching and non-teaching hospitals, open and closed ICUs, urban and rural locations, and in sites with demonstrated difficulties in adhering to nutrition guideline recommendations.

The effect of the tailored intervention was not uniform across sites. To optimize practice improvements in all sites, we need a better understanding of the intra-institutional factors that either facilitated or hindered change at the site level. Some of this variation may be due to differences in the change strategies employed by the sites or different degrees of uptake of action plan items. Given the nature of this multi-faceted, complex intervention, we are unable to determine which elements of the intervention were effective or which were ineffective; further, we are unable to quantify the 'dose' of each strategy that individual staff members received.

We also observed variation in the rate of implementation of the tailored action plans. The duration of the implementation phase was 12 months. While some sites only partially implemented their action plans in this time, others implemented each item within 6 months. In developing the action plans, sites were asked to consider the feasibility of completing each action within the study time frame. Understanding the reasons for the delays experienced by some sites and why some action items were not implemented may help future initiatives to set appropriate timelines or provide additional resources to support lagging sites. Our results suggest that sites may require more than 12 months to completely implement all the planned changes.

The barriers to enterally feeding critically ill patients questionnaire was a survey instrument developed for this study.[21] Although we observed decreased barrier scores derived from the results of this questionnaire, indicating the staff perceived barriers to be less important following the tailored intervention, we are uncertain about the clinical significance of these change scores. We have not formally assessed the responsiveness to change of the questionnaire (i.e., that the questionnaire is able to measure a meaningful or clinically important change in nutrition practice), but this validation is planned.

Our study has a number of limitations. First, the 5 ICUs were invited to participate from a group of ICUs previously participating in quality improvement initiatives. Observed practice changes may have been

influenced by their prior involvement in quality improvement projects rather than the tailored intervention per se; furthermore, sites accepting the invitation to participate may differ from those declining, introducing selection bias. Second, the response rate to the barriers questionnaire was only 45% at baseline and 29% at follow up, perhaps reflecting staff fatigue from frequent surveys external to this study or lack of interest in improving nutrition practice; consequently, a response bias may be operant if responding staff had a greater interest in nutrition than non-responders. Third, we did not assess the cost-effectiveness of the intervention or the time-commitment required by the local guideline implementation team. These are important factors to consider when assessing the feasibility of adopting a tailored approach. Finally, there are several components of our intervention that may limit its generalizability to the 'real world'. The external research team played an active role in the intervention; presenting at grand rounds, facilitating the action plan development meetings, and coaching the local guideline implementation team through the implementation phase. This role could be completed by quality improvement officers employed at some hospitals, or through networks or shared exchanges whereby teams from different sites support each other. In addition, our resource-intense methods of assessing barriers and tailoring were classified as 'high'. Given that many of the identified barriers were common across participating sites and that the subsequently selected change strategies were also similar (data not shown)[23], an intervention tailored to these common barriers may be as effective as one that includes the additional steps of a local barriers assessment and tailoring to these site-specific barriers. Further investigation is required to clarify the optimal tailoring method in this context.

Conclusion

The results of the PERFECTIS study are promising, indicating that a multifaceted, interdisciplinary tailored approach to improving adherence to critical care nutrition guidelines is feasible, and may decrease barriers to enterally feeding critically patients. However, the complexity of this approach may attenuate its application in practice. From the research perspective, before proceeding to conduct a cluster randomized trial to evaluate the effect of a tailored approach compared to a non-tailored approach on

nutrition practice change; the rationale for each component of the intervention, and reasons for compliance and outcome variation need careful consideration. Refining the intervention based on the 'lessons learned' from this preliminary study will ensure a more parsimonious intervention that can be successfully operationalized both within and outside the context of a study.

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Table 6.1: Description of Tailored Intervention

Intervention	Description	Rationale	Example of activity/resource
Audit and Feedback	Summary of nutrition performance data collected by abstracting data from the charts of 20 consecutive mechanically ventilated critically ill	Demonstrating the gap between actual and desired performance motivates providers to change practice to reduce the gap.	Benchmarked performance report comparing current nutrition practice to guideline recommendations and to other ICUs Review of performance with small group, discussion of reasons for poor performance, and identification of 'opportunities for improvement'
Educational Outreach Visit	Personal visit by an external nutrition expert to critical care providers in their own setting, including: 1. a 1 hour interactive presentation with the following content o evidence supporting nutrition guideline recommendations o strategies to optimize EN o rationale for tailored intervention 2. feedback on nutrition performance 3. opportunity for discussion	Current evidence based information is communicated to providers, increasing their knowledge of nutrition, awareness of guideline-practice gaps, and leading to practice change.	Grand Rounds with ICU providers Face-to-face discussions with physicians
Tailored Action Plan to overcome identified barriers	Site-specific bundle of interventions selected to overcome local barriers to the provision of EN. Developed at 1 day meeting attended by the local guideline implementation team	Strategies selected to address identified barriers, reduce the influence of these barriers leading to practice improvements	System/organizational: o Addition of EN initiation to ICU admission order set o Stock of enteral formula in the ICU

	and key stakeholders and facilitated by the external research team; involving identification of and prioritization of barriers to target for change, brainstorming of feasible and impactful solutions, and development of a step by step action plan for implementation. Action plan included interventions targeting at both individual provider and system supports		Individual provider: ○ Education through lunch and learns / bedside huddles ○ Information sheets summarizing current evidence/guideline recommendations Reminders ○ Posters ○ checklist
Performance Coaching	External research team provide support to the local guideline implementation team while they implement their action plan	By receiving advice and guidance while going through the action plan implementation process local teams are more likely to achieve their goals	Facilitation of bi-monthly teleconference calls monitoring the progress of the implementation of the tailored action plans
Local Opinion Leaders	Physician, dietitian and nurse who work in the ICU and are knowledgeable about nutrition therapy	Opinion leaders change practice by influencing the attitudes and behaviour of their peers through informal guidance	Informal discussions at the bed-side regarding provision of EN to the patients
Networking meeting	Half day meeting with all participating sites, where each site present the successes and challenges experienced implementing their action plans	Engaging with others with similar experiences leads to sharing of knowledge and motivates change.	Informal discussions

Table 6.2: Characteristics of Participating Intensive Care Units

ICU #	Country	Hospital Type	Hospital Size	ICU Structure	ICU Size	Medical Director	Clinical Specialty	FTE Dietitian per 10 beds
1	USA	Non-Teaching	315	Closed	20	Yes	Mixed medical/surgical	0.2
2	Canada	Teaching	587	Closed	16	Yes	Mixed medical/surgical	0.4
3a	USA	Teaching	600	Open	12	Yes	Surgical Trauma	0.4
3b	USA	Teaching	600	Open	10	Yes	Neurological	0.5
3c	USA	Teaching	600	Open	10	Yes	Medical	0.5
4	Canada	Non-Teaching	420	Open	13	Yes	Mixed medical/surgical	0.5
5	Canada	Teaching	830	Closed	30	Yes	Mixed medical/surgical	0.4

Characteristics based on 2011 data collection
ICU: Intensive Care Unit
FTE: Full-time equivalent
Closed: under the care of an intensivist Open: under the care of any attending physician

Table 6.3: Evaluation of Tailored Intervention

	Overall	Site 1	Site 2	Site 3	Site 4	Site 5
Compliance with Tailored Action Plan						
Primary Analysis of Compliance with Action Plan[a]	57%	6/8 (75%)	4/8 (50%)	1/7 (14%)	5/7 (71%)	6/8 (75%)
Secondary Analysis of Compliance with Action Plan	68%	6/7 (86%)	4/6 (67%)	1/6 (17%)	5/6 (83%)	6/7 (87%)
Median (range) Progress Rank for Items in the Action Plan	4 (0-5)	4 (2-5)	3.5 (0-5)	3 (0-5)	4 (0-5)	4 (0-4)
Nurses Responses to Evaluation Questionnaire						
Know all members of Guideline Implementation Team	66/82 (80%)	12/13 (92%)	16/23 (70%)	15/23 (65%)	17/17 (100%)	6/6 (100%)
Discussed nutrition with Guideline Implementation Team daily or weekly	50/81 (62%)	10/13 (77%)	6/22 (27%)	17/23 (74%)	13/17 (77%)	4/6 (67%)
Prescribed calories received / caloric debt reported on rounds often or all the time	42/81 (52%)	9/13 (69%)	6/23 (26%)	12/23 (52%)	12/16 (75%)	3/6 (50%)
Agree or Strongly Agree nutrition practice changed as a result of PERFECTIS	25/79 (29%)	7/13 (54%)	2/21 (9.5%)	9/23 (39%)	4/16 (25%)	1/6 (17%)
Number PERFECTIS activities/resources as part of Action Plan[d]	8	9	9	7	7	9
PERFECTIS related activities/resources exposed to (median [range])	7 (0-9)	7 (5-9)	3 (0-9)	7 (1-7)	7 (2-7)	6.5 (2-8)
Rating[e] of usefulness of PERFECTIS activities/resources exposed to (median [range])	4 (1-5)	4 (1-5)	4 (1-5)	4 (1-5)	4 (1-5)	4.5 (2-5)

[a] The proportion of actions with a progress rank of 4 or 5 out of the total number of action items in the action plan
[b] The proportion of actions with a progress rank of 4 or 5 out of the total number of action items in the action plan excluding items addressing non-modifiable barriers with a progress rank of 0
[c]Progress rank: 0=no action, 1=initial steps taken but no steps complete, 2=implementation in progress and some steps complete, 3=implementation 50% complete, 4=implementation 100% complete, and 5=target/objectives exceeded

[d] Number of activities/resources may not correspond to the number of action plan items because some action items may have involved more than one strategy/resource (e.g. development of protocol, education session, and newsletter article) and some strategies (e.g. educational session) may have been employed for several action items.
[d] Rating scale: 1=useless, 2=somewhat useless, 3=neutral, 4=somewhat useful, 5=very useful

Table 6.4: Change in Nutrition Practice Indicators

Nutrition Practice	Before (2009)		After (2011)		Change	Range		
	N=140		N=138			Min	Max	p-value [e]
Adequacy of calories from total nutrition								
mean SD	42.9	(29.6)	49.0	(31.2)	6.1	-1.6	18.0	0.23[f]
Adequacy of protein from total nutrition								
mean SD	40.7	(31.6)	45.1	(31.8)	4.4	-8.3	18.2	0.67f
Adequacy of calories from EN								
mean SD	36.1	(29.7)	37.6	(29.1)	1.4	-5.5	8.8	0.76f
Adequacy of protein from EN								
mean SD	38.7	3(1.5)	40.3	(31.0)	1.6	-8.3	12.2	0.75f
Patients who achieved >80% adequacy from calories within 72 hours of ICU admission								
n(%)	36	(26)	44	(32)	6	-15	30	
Type of Nutrition n(%)								0.45
EN Only	98	(70)	100	(72)	2	-12	15	
PN Only	6	(4)	8	(6)	2	-5	5	
EN+PN	12	(9)	10	(7)	-2	-5	1	
None	24	(17)	20	(15)	-2	-15	12	
EN initiated within 48hrs								
n (%)	71	(65)	77	(75)	10	-13	38	0.16
Time from ICU admission to initiation of EN (hours) mean SD	40.3	(36.5)	39.8	(43.7)	-0.5	-25	23	0.94
Time from start of EN to >80% adequacy of calories (days) median (IQR)	6.8	(3.8, 12)	5.8	(2.8,12)	-1.0	-7.6	1.1	
Use of motility agents in patients with GRV n(%)	7	(50)	11	(58)	8	-50	2	0.88

Use of small bowel feeding in patients with GRV n (%)	0	(0)	0	(0)	0	0	0	N/A
Head of Bed Elevation degrees	34.0	(17.2)	32.0	(5.8)	-2.0	-6.7	5.4	0.59
Morning Blood Glucose > 10 mmol/l patient days (%)	165	(16)	162	(15)	-1	-18	6	0.68[g]

[a] included propofol, EN, and appropriate PN.
[b] only included patients who ever received EN.
[c] only included patients who ever had high GRV.
[d] P-values were calculated by using mixed model for continuous outcomes and Fisher's Exact test for categorical outcomes.
[e] P-values account for ICU level clustering, by using random ICU and ICU by year effects for continuous outcomes and Rao-Scott Chi-Squared method clustering by ICU for categorical outcomes.
[f] adjusted for evaluable nutrition days.
[g] P-values account for ICU and patient level clustering by using Rao-Scott Chi-Squared method.

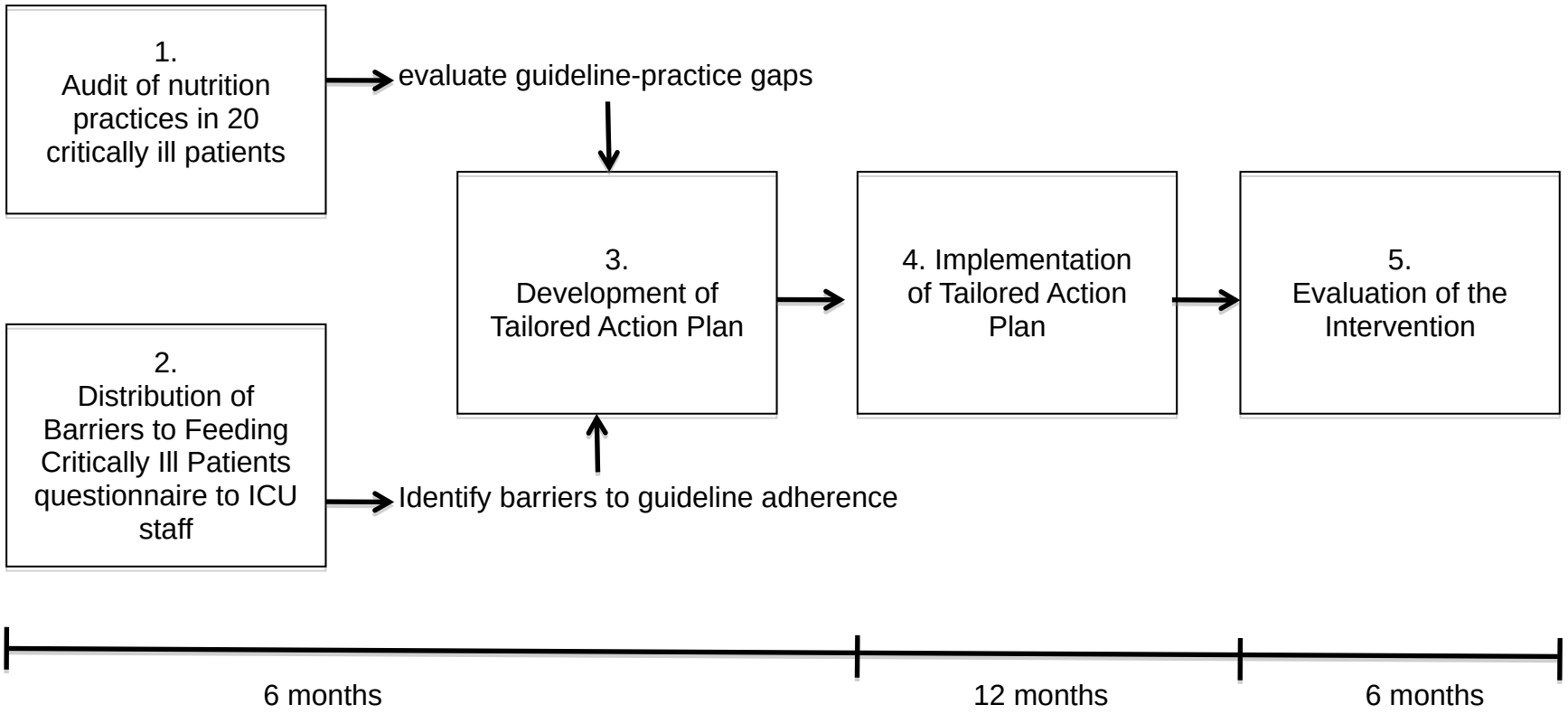


Figure 6.1: Study Schema

The tailored 'action plan' was developed through a 5-step process: 1) nutrition practice audit to determine gaps between guideline recommendations and actual practice, 2) staff survey to identify barriers to enterally feeding patients, 3) focus group to prioritize these barriers and brainstorm interventions to overcome the prioritized barriers, 4) a 12-month implementation phase including bi-monthly progress meetings and 5) evaluation of the intervention.

Figure 6.2: Change in Prioritized Barriers Score for Questionnaire Items Targeted by the Tailored Intervention Overall and By Site

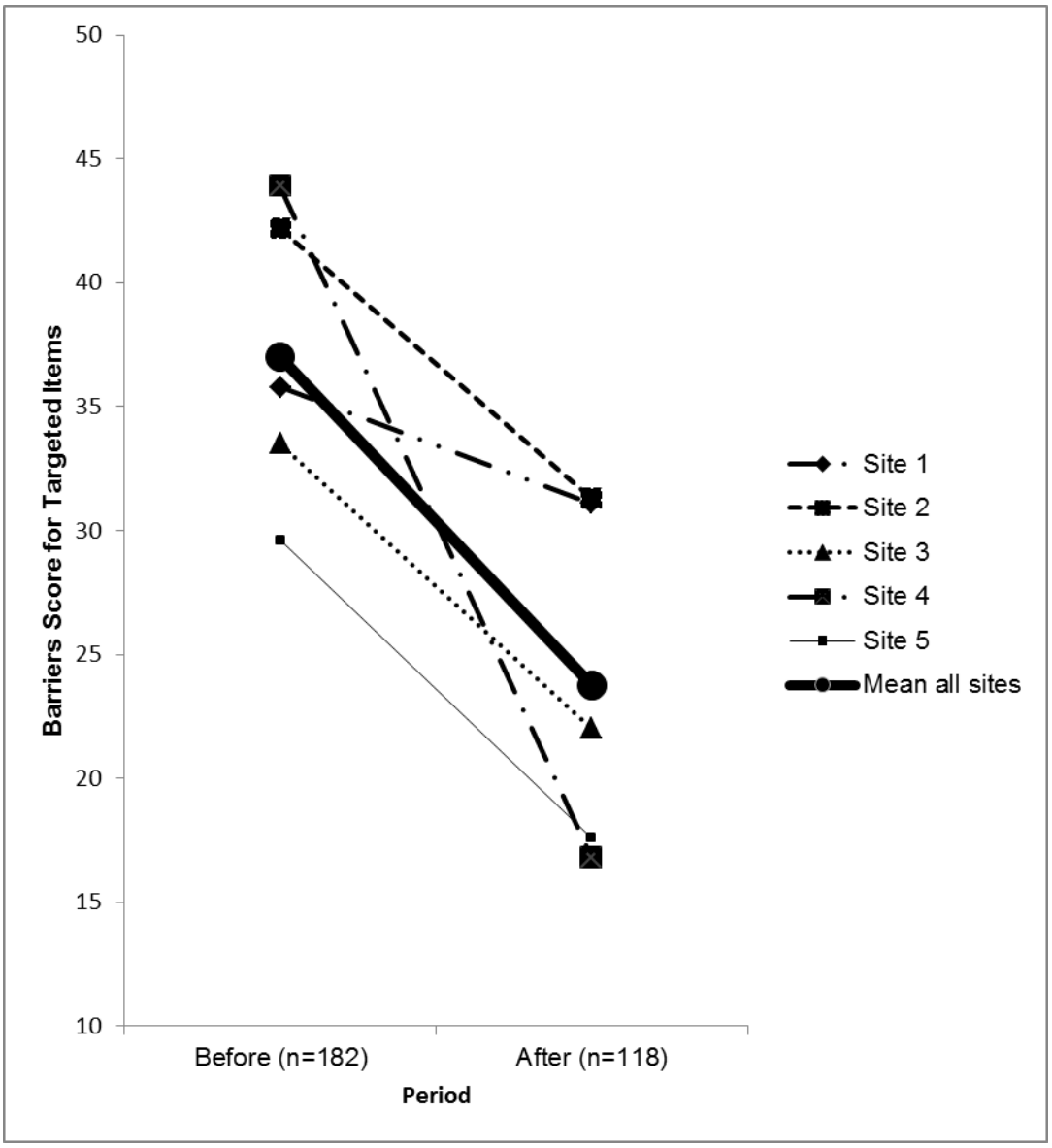
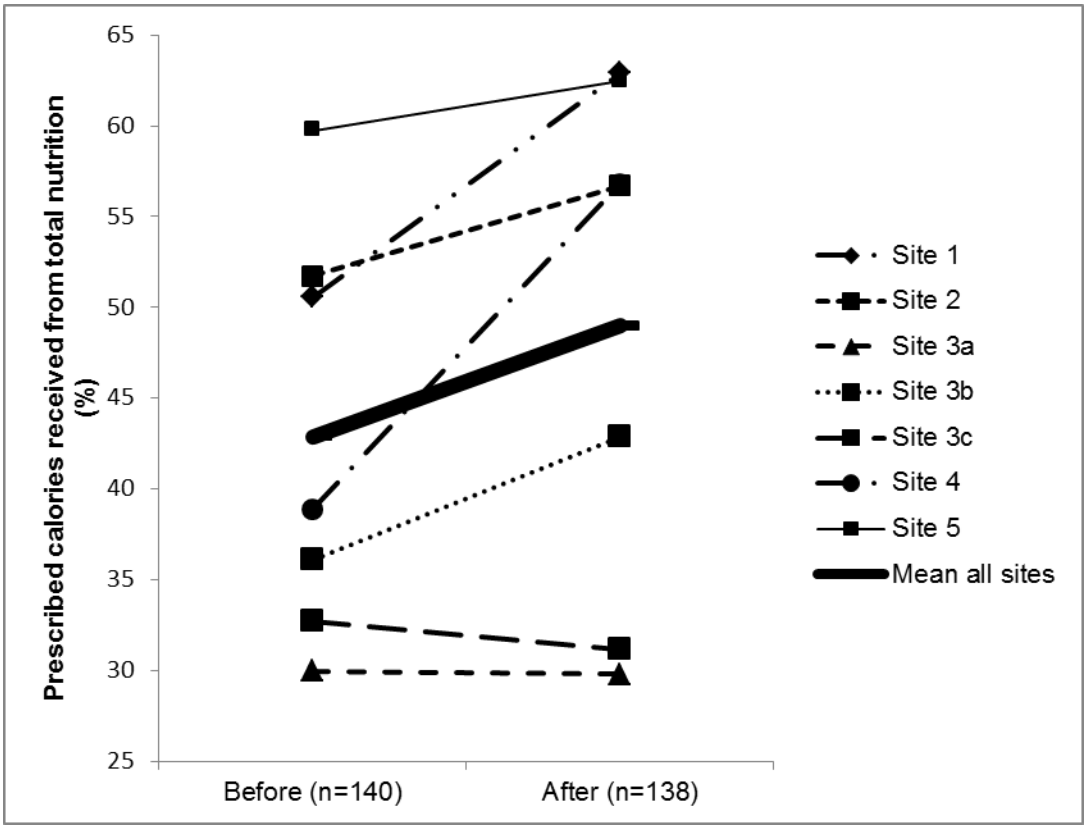


Figure 6.3: Change in Adequacy of Calories from Total Nutrition Overall and By Site



Supplemental Digital Content 6.1: Table Describing Exposure to and Nurses Ratings of the Usefulness of Strategies used to Implement the Action Plans

	Exposed		Useful[a]
	n/N (%)	Site range	Median (Site range)
Bed-side Tools			
EN Initiation orders and/or bedside algorithm	65/80 (81%)	59-92%	4 (4-5)
Motility agent order	10/13 (77%)	N/A	4 (N/A)
Protocol for withholding feeds	5/6 (83%)	N/A	5 (N/A)
Change volume for interruptions	33/39 (85%)	77-94%	4 (4-4)
Daily monitoring checklist	13/13 (100%)	N/A	4 (N/A)
Access to Resources			
Par stock of EN formula	71/81 (88%)	83-91%	4 (4-5)
RD coverage schedule	29/41 (71%)	59-85%	4 (3-5)
Education/ Information			
Nutrition section in ICU protocol	16/21 (76%)	N/A	4 (N/A)
Bedside huddles	53/72 (74%)	46-94%	4 (4-4)
Informal education by RD on rounds	35/38 (92%)	86-100%	4 (4-4)
Lunch and learns	4/6 (67%)	N/A	4 (N/A)
Nutrition Information Sheets (NIBBLE)	41/79 (52%)	0-82%	4.5 (3.5-4)
Newsletter	6/12 (50%)	N/A	2.5 (N/A)
Intranet posting	10/21 (48%)	N/A	3.5 (N/A)
Grand Rounds presentation	11/27 (41%)	33-67%	4 (4-4.5)
Reminder			
Posters	63/77 (82%)	67-94%	4 (3-4.5)

[a] Rating scale: 1=useless, 2=somewhat useless, 3=neutral, 4=somewhat useful, 5=very useful
N/A – strategy employed at single site only

Supplemental Digital Content 6.2: Table describing the barriers score at baseline and follow up and the change in barriers score for each item, subscale, and overall

	Before (n=182)	After (n=118)		Site Range		
Barrier	**Mean Score (SD)**	**Mean Score (SD)**	**Change in Score**	**Min**	**Max**	**P-value**
Overall Score	**30.5 (23.1)**	**20.8 (22.7)**	**-9.7**	**-4.3**	**-26.0**	**0.0004**
Subscale 1: Guideline Recommendations and implementation Strategies	**23.8 (24.4)**	**16.9 (26.7)**	**-6.9**	**-1.6**	**-18.1**	**0.02**
1. Current scientific evidence supporting some nutrition interventions is inadequate to inform practice.	22.9 (29.9)	17.8 (29.8)	-5.1	0.8	-21.0	0.15
2. The current national guidelines for nutrition are not readily accessible when I want to refer to them.	31.3 (26.3)	15.8 (29.5)	-15.5	-7.2	-25.0	<0.0001
3. The language of the recommendations of the current national guidelines for nutrition are not easy to understand.	21.6 (31.9)	13.8 (27.0)	-7.8	-2.7	-27.4	0.03
4. No feeding protocol in place to guide the initiation and progression of enteral nutrition.	24.5 (31.3)	19.5 (33.6)	-5.1	1.1	-15.1	0.19
5. Current feeding protocol is outdated.	18.5 (29.4)	17.5 (32.2)	-1.0	0.8	-15.7	0.79
Subscale 2: ICU Resources	**30.5 (31.1)**	**20.9 (28.7)**	**-9.6**	**0.3**	**-34.1**	**0.008**
6. Not enough nursing staff to deliver adequate nutrition.	18.9 (31.8)	11.9 (27.4)	-7	0.2	-33.3	0.05
7. Enteral formula not available on the unit.	34.2 (38.3)	22.3 (36.2)	-11.9	-3.8	-30.2	0.007
8. No or not enough feeding pumps on the unit.	38.3 (38.5)	28.5 (36.5)	-9.7	2.3	-38.9	0.03
Subscale 3: Dietitian Support	**29.7 (26.9)**	**21.1 (28.5)**	**-8.6**	**-1.4**	**-18.1**	**0.009**
9. Waiting for the dietitian to assess the patient.	28.2 (33.8)	17.2 (30.7)	-11.0	-5.0	-23.0	0.004
10. Not enough dietitian time dedicated to the ICU during regular weekday hours.	22.9 (32.8)	13.8 (27.7)	-9.1	-2.6	-19.8	0.01
11. No or not enough dietitian coverage during weekends and holidays.	37.4 (36.2)	28.0 (36.7)	-9.4	-2.4	-19.4	0.03
12. Not enough time dedicated to education and training on how to optimally feed patients.	30.4 (31.8)	25.4 (36.6)	-5.0	2.2	-17.9	0.21
Subscale 4: Delivery of Enteral Nutrition to	**37.4 (27.7)**	**25.4 (27.3)**	**-12.0**	**-2.3**	**-36.0**	**0.0003**

the Patient								
13. Delay in physicians ordering the initiation of EN.	37.9	(34.6)	27.7	(33.3)	-10.2	-2.1	-27.0	0.01
14. No feeding tube in place to start feeding.	34.2	(36.1)	24.0	(36.4)	-10.2	0.8	-46.8	0.02
15. Delays in initiating motility agents in patients not tolerating enteral nutrition (i.e. high gastric residual volumes).	32.8	(34.6)	21.8	(31.8)	-11.0	2.2	-44.0	0.005
16. Delays and difficulties in obtaining small bowel access in patients not tolerating enteral nutrition (i.e. high gastric residual volumes).	40.5	(34.7)	29.9	(35.5)	-10.5	-0.1	-35.7	0.01
17. In resuscitated, hemodynamically stable patients, other aspects of patient care still take priority over nutrition.	41.6	(35.2)	23.7	(32.4)	-17.8	-12.7	-26.6	<0.0001
Subscale 5: Critical Care Provider Attitudes and Behaviour	**31.1**	**(28.0)**	**19.8**	**(23.6)**	**-11.4**	**-2.6**	**-21.9**	**0.0003**
18. Non-ICU physicians (i.e. surgeons, gastroenterologists) requesting patients not be fed enterally.	35.2	(35.5)	28.8	(35.9)	-6.4	-2.0	-20.3	0.13
19. Nurses failing to progress feeds as per the feeding protocol.	27.1	(33.9)	14.4	(26.3)	-12.7	-0.3	-22.6	0.0003
20. Fear of adverse events due to aggressively feeding patients.	27.5	(33.1)	14.4	(26.7)	-13.1	-8.9	-25.8	0.0002
21. Feeding being held too far in advance of procedures or operating room visits.	34.8	(35.7)	21.4	(31.9)	-13.3	4.1	-23.8	0.0011

Barriers scores were calculated by awarding 1, 2, or 3 points if the respondent identified an item as a 'somewhat important', 'important' or 'very important' barrier respectively. If an item was rated 1-4 (i.e. 'not at all important' to 'neither important or unimportant' it was awarded 0 points. The barriers score was calculated by dividing the awarded points for each item by the maximum potential points (i.e. 3) and expressed as a percentage. The Overall and Domain barriers score is the mean score for all the items, and domain items, respectively. Change in barriers score were calculated as the score at baseline subtracted from score at follow-up.

Chapter 7

General Discussion

7.1 Summary of Findings

A growing body of literature advocates identifying and addressing barriers to knowledge use as a strategy to improve care delivery. This thesis has provided evidence to support adopting such a tailored intervention to overcome barriers to adherence of recommendations of critical care nutrition guidelines related to the provision of enteral nutrition. To this end, I have determined that we are able to measure barriers to enterally feeding patients using a novel questionnaire, that important barriers reported using this questionnaire are inversely associated with the provision of calories, and that there are differences in the rating of importance of these barriers across ICUs providing rationale for tailoring interventions to the local context. Through a pretest posttest study in 5 hospitals, we demonstrated that individual sites were able to develop and implement such a tailored intervention and we observed changes in reported barriers and nutrition practice following implementation.

The primary objective of the first manuscript was to develop a questionnaire to measure barriers to enterally feeding critically ill patients and to conduct preliminary validity testing of the new instrument. Using a systematic multi-phase approach involving item generation and questionnaire formatting; pretesting, field testing and pilot testing the draft questionnaire; and statistical analyses to reduce items and assess validity and reliability; I successfully developed a 26 item questionnaire that asked critical care providers to rate the importance of items as barriers to the provision of EN in their ICU. Face and content validity of the questionnaire was established through literature review and expert input. A factor analysis indicated a 5-factor solution that was similar to the 5 domains of the theoretical framework which guided the content of the questionnaire namely: guideline recommendations and implementation strategies,

delivery of EN to the patient, critical care provider attitudes and behaviour, dietitian support, and ICU resources. Overall, the indices of internal reliability for the derived factor subscales and the overall instrument were acceptable, but assessment of test retest reliability and within group agreement was poor for many items. This suggests that while these data provide some evidence to support the validity of this novel instrument, further revisions and assessment of validity and reliability using different samples are needed.

The primary objective of the second manuscript was to gain evidence to support the construct validity of the newly developed barriers questionnaire by testing the hypothesis that the amount of prescribed calories received by critically ill patients (measured by a chart audit) is lower in ICUs that report the presence of important barriers to providing EN in their ICU (measured by responses of critical care nurses to the barriers questionnaire). A multilevel multivariate regression analysis of the data from this cross-sectional study of 55 international ICUs found that after adjusting for important confounding factors, that there was a statistically significant inverse association between a barriers score derived from the questionnaire responses and the adequacy of calories from nutrition. Thus, these results provide empirical data to support my conceptual framework for barriers to adherence to critical care nutrition guidelines that acted as a template for development of the barriers questionnaire.

The third manuscript described the barriers to enterally feeding critically ill patients identified by critical care nurses who completed the barriers questionnaire. The 5 most important barriers were 1) Other aspects of patient care taking priority over nutrition; 2) Not enough feeding pumps available; 3) Enteral formula not available on the unit; 4) Difficulties in obtaining small bowel access in patients not tolerating EN and 5) No or not enough dietitian coverage during weekends and holidays. A secondary objective of this manuscript was to test the hypothesis that identified barriers differ across ICUs due to unique elements of the local context. Thus we compared the ratings of importance of the potential barriers across the 5 participating sites and observed statistically significant differences for 4 out of the 22 items, namely items

'Enteral formula not available on the unit', 'No or not enough feeding pumps on the unit', 'No feeding tube in place to start feeding', and 'Feeding being held too far in advance of procedures or operating room visits'. In contrast to the *a priori* hypothesis, the results suggest that the majority of barriers were perceived with the same degree of importance by nurses independent of the setting in which they worked. This raises questions regarding the optimal level of tailoring in the critical care setting; suggesting that an intervention tailored to common barriers may be as effective as tailoring to local barriers.

Finally, the fourth manuscript presents the results of a pretest posttest study assessing the feasibility of a multifaceted, interdisciplinary intervention tailored to overcome barriers to adherence of recommendations of critical care nutrition guidelines related to the provision of EN. The development and implementation of the tailored intervention involved a 5-step process: 1) nutrition practice audit to determine gaps between guideline recommendations and actual practice, 2) administration of the 'Barriers to Enterally Feeding Critically Ill patients' questionnaire to critical care providers to identify local barriers 3) focus group to prioritize these barriers, 4) brainstorming to select interventions to overcome the prioritized barriers, and 5) a 12-month implementation phase including monthly progress meetings. All 5 sites successfully completed the study. However, the degree of implementation of the intervention varied across sites, with no ICU completely implementing all proposed strategies within the 12-month implementation phase. Although this study was not powered to evaluate differences in outcomes, we did observe significant decreases in barrier scores and small improvements in the proportion of prescribed calories received following implementation of the tailored intervention.

In summary, the primary methodological contributions of this thesis was the development and preliminary validation of a questionnaire to assess barriers to adherence of critical care nutrition guidelines and the utilization of this instrument to develop an intervention to overcome barriers and improve nutrition practice. Furthermore, the results of this thesis provide empirical data to support the theoretical

underpinnings of KT research pertaining to the presence of barriers as impediments to knowledge use as described in the action cycle of the Knowledge-to-Action model.

7.2 Limitations, Challenges and Reflections

This thesis builds on a program of research in KT at the Clinical Evaluation Research Unit at Queen's University directed by my supervisor Dr. Daren Heyland. Specifically, the four manuscripts herein were strongly influenced by the conceptual framework for adherence to critical care nutrition guidelines developed as part of my masters thesis. The main strength of this thesis is the application of latest theoretical thinking and empirical data on the implementation of evidence based practice to a significant problem currently faced by the health care system. I have demonstrated that there is strong rationale for assessing barriers to knowledge use and tailoring interventions to identified barriers. To this end, I adopted a methodologically rigourous approach to the development of a questionnaire to measure barriers to enterally feeding critically ill patients and generated preliminary evidence to support its internal consistency and validity for use with critical care providers. In addition, I conducted a multilevel multivariate regression analysis of the association between barriers measured by the developed questionnaire and the provision of nutrition to demonstrate that the questionnaire is measuring what it purports to measure (i.e. evidence to support its construct validity). The practical application of the developed instrument is further enhanced by its theoretical underpinnings, its focus on modifiable barriers to the specific practice of providing EN in the ICU, and its brevity, taking only 5 minutes to complete. Another strength of this thesis is that I also demonstrated the feasibility of using the developed questionnaire to tailor interventions to identified barriers. Consequently, I believe that the questionnaire and the proposed stepwise approach to developing and implementing a tailored intervention may be used by clinicians wishing to improve patient care, and also by KT researchers.

The overarching purpose of the thesis was to determine the feasibility of adopting a tailored intervention to overcome barriers to adherence of critical care nutrition guidelines. By definition, feasibility studies aim to answer the question 'can this study be done?'. The emphasis is not on hypothesis testing and evaluating the outcome of interest[1]. The guidelines for the design and evaluation of complex interventions explicitly recommends that preliminary studies, such as the feasibility work described in this thesis, be conducted prior the conduct of large randomized trials[2]. Therefore, my choice of study design was largely influenced by this philosophy and recommendations. This feasibility work is a crucial step in the development of an optimal intervention, ensuring a greater understanding of contextual and methodological factors that influence the implementation process, and informing how best to evaluate the intervention[3].

There are limitations to my thesis work that may influence the results and inferences arising from my studies. First, due to the nature of questionnaire validation as an ongoing process of evaluation, involving replication in different samples by different investigators[4], I was unable, within the scope of this single thesis, to collect adequate data to support the validity of the instrument. However, I adopted a systematic and methodologically rigourous approach to its development and statistical evaluation[5-7]. Providing some preliminary evidence that important barriers identified by the questionnaire hinder the provision of EN in the ICU. Later in this chapter I highlight some recommendations for revising the questionnaire and further validation of the instrument.

A second limitation is that the nonprobability sampling strategy may have resulting in selection bias. Participating sites were a volunteer sample invited from amongst ICUs involved in an ongoing quality improvement initiative. This sampling frame may not be representative of the target population of all ICUs who treat mechanically ventilated patients for greater than 3 days because their involvement in a quality improvement network suggests that they have a greater interest in nutrition than non-participating sites. Local investigators at sites involved in this thesis may have been more motivated than non-

participating sites and prepared to commit to championing a change in practice. These sites may also have greater resources and support to participate in research projects. I also received feedback from some sites that the procedure of gaining institutional ethics approval was an impediment to participation. Although these factors may have resulted in more effective distribution of the barriers questionnaire and/or greater implementation of the intervention, it is unlikely that all critical care providers working within these units share the investigators interest in nutrition and improving practice. However, despite including numerous strategies to maximize response, low to moderate response rates to the barriers questionnaire were observed across sites (6 to 65%). Some critical care providers may have been apathetic towards the topic of the survey, especially if it had been poorly promoted within their unit or if there was other surveys being distributed at the same time. Although I provided instructions on the how to distribute the questionnaire and templates for reminders and other communications, I cannot be certain that these were followed at each site. Local investigators selected the method of administration (web vs paper based) and the selected method may not have been optimal for the setting (e.g. lack of access to the internet). Finally, there may have been wording and formatting of the barriers questionnaire that affected response. The provision of a small incentive (e.g. voucher for coffee or entry into a prize draw) to individuals who received the questionnaire may have improved response. Planned revisions to the questionnaire may also positively affect response in the future. Another potential source of selection bias was the method of recruiting patients for the evaluation of the primary outcome of adequacy of calories from EN. These patients were identified as consecutive admissions to the ICU. However, the baseline demographics of patients included in this thesis are similar to critically ill patients included in RCTs of nutrition interventions[8,9], suggesting that the included patients were representative of the target population.

A third limitation is potential measurement error associated with reliance on the newly developed questionnaire to measure my primary exposure of barriers to the provision of EN. Respondents were asked to rate the importance of potential barriers based on their experience working in the ICU. An individuals' perceptions are a proxy measure for the 'true' barriers and therefore are inherently measured

with error. However, this random measurement error dilutes the true association and biases the effect estimate towards the null[10]. The questionnaires were self-administered and therefore I cannot be certain that respondents interpreted the questions or response scale appropriately. The poor test re-test reliability suggests that more recent experiences with feeding patients may have had a greater influence on a respondents rating than their overall general experience. It is difficult to predict the effect of this measurement bias on the observed barriers scores, as it may have resulted in respondents systematically rating barriers as more or less important. In addition, I identified some concerns regarding the reliability of aggregating individual responses to the questionnaire to the site level for the overall barriers score and subscale 1. Finally, there may be measurement error associated with inaccuracy of data from patients' medical charts used to ascertain the amount of calories received to calculate the primary outcome of adequacy of calories from EN.

Fourth, in the analytic cross-sectional study conducted to evaluate the association between modifiable barriers to provision of EN and the proportion of prescribed calories received, I measured important co-variates, of which several were determined to confound the association of interest. Given the complexity of the ICU environment and the heterogeneity of the critically ill population there may be other potential confounders that were not measured and controlled for in the analysis such as organizational culture and staffing levels. Furthermore, some of the measured confounders were measured poorly which may have led to residual confounding. For example, geographic region was assessed as the main confounder of the association but with the available sample size of 55 ICUs I was unable to categorize ICUs into homogenous geographic regions and therefore, the resulting 5 geographic categories ranged from 6 to 22 sites each and included different countries, health care systems, education etc.

As is common in preliminary work of this nature, a fifth limitation was that the sample size was driven by convenience (i.e. the number of sites who volunteered to participate) and not by statistical parameters. Prior data on error or ICC was lacking, therefore an *a priori* sample size was not calculated.

Consequently, 'rules of thumb' commonly used in questionnaire development[6] and experiences of responses to other surveys conducted in this setting[11] were used to inform sample size requirements for evaluation of the questionnaire. The obtained sample sizes were adequate to achieve the feasibility objectives of this thesis and data from this feasibility work is available to calculate the required sample size for the definitive study.

The adoption of the pretest posttest study design may be viewed as another limitation of this work. In the PERFECTIS study, we observed significant decrease in barrier scores and small non-significant increases in the adequacy of nutrition. The absence of a comparison group minimize ones ability to make inferences about observed changes in practice. These changes may have been due to temporal trends or due to the involvement of sites in the larger quality improvement initiative. Sites with low baseline nutrition performance were preferentially selected therefore observed improvements may also have been due to regression to the mean.

A final limitation of this thesis pertains to external validity. The 5 sites in the PERFECTIS study were a highly selective subgroup of ICUs (i.e. based in North America, minimum 8 beds, low performing, presence of a dietitian), and several of my analyses were restricted to nurses who responded to the questionnaire. Therefore, although generalizability was not within the intended scope of this thesis, the feasibility of developing and implementing a tailored intervention in ICUs with different characteristics, cultures, or health care systems is unknown.

7.3 Original Contribution of The Thesis

This thesis is innovative and as such has several components that represent an original contribution to the fields of epidemiology, health service research, and knowledge translation. This includes the development of a novel questionnaire to measure barriers to practice change and the generation of

evidence to supports its validity for use with critical care providers in the ICU. Furthermore, through the administration of this questionnaire, I have provided empirical data to support the theoretical underpinnings of the Knowledge-to-Action model that barriers impede the translation of new knowledge into practice, and have described the important barriers nurses face in providing EN to critically ill patients and how these differ across ICUs. Finally, I have proposed a pragmatic iterative stepwise approach to using the developed questionnaire to tailor interventions to identified barriers, and provided some data to support the feasibility of this approach.

A criticism of existing reviews of questionnaire development and KT interventions is the lack of transparent reporting on how these instruments and strategies were developed and implemented[2,12]. Thus, the publication of these 4 manuscripts constitutes an important contribution to this sparse body of data.

7.4 Suitability of this Dissertation for a Doctorate in Epidemiology

I believe that the work reported herein is high quality, and of adequate breadth and depth to be awarded a Doctorate in Epidemiology. The experiences gained through the conduct of this thesis provided ample opportunities to develop and demonstrate the necessary skills required to become an independent investigator. The extremely involved process included 1) using my practical experience in clinical nutrition together with a systematic review of the literature to identify a gaps in knowledge in order to provide an 'original contribution' to the field 2) applying my training in epidemiology to develop a program of research using appropriate methods for the stage of the research 3) writing a study protocol and together with my Primary Supervisor obtaining funding to conduct the proposed study 4) using project management skills to complete complex and extremely involved primary data collection 5) applying advanced statistical techniques, including factor analysis and multilevel modeling, to optimize the development of a novel questionnaire and account for the real life complexity of the critical care environment when assessing the association between barriers to feeding patients and the proportion of

prescribed calories received 6) Demonstrating an understanding of both the importance and limitations of preliminary feasibility studies in the context of epidemiological investigations and how these weaknesses might be addressed by the design of a definitive study powered to evaluate the effectiveness of tailoring interventions to identified barriers 7) Recognizing the importance of disseminating the results of the thesis through multiple mode of publications (e.g. journals, poster and podium presentations, internet postings) and networking with clinical researchers and critical care providers.

7.5 Recommendations for Modifications to the Barriers Questionnaire

As with any new questionnaire, the initial development and assessment of the 'Barriers to enterally feeding critically ill patients' questionnaire completed as part of this thesis is only the first phase in an ongoing process of refinement and accrual of evidence to support its validity. Through the four manuscripts I have presented data suggesting that the face, content and construct validity and internal reliability of the instrument is acceptable. Furthermore, I have demonstrated the utility of administrating the questionnaire to critical care providers for the purpose of describing barriers to the provision of EN in the ICU, tailoring interventions to identified barriers, and evaluating change in barriers following a tailored intervention. However, the preliminary evaluation of the questionnaire suggested that test retest reliability and within group agreement were not acceptable for several items, and feedback following its administration in over 50 ICUs from 7 geographic regions also highlighted some concerns with the current version of the questionnaire. Given that response options and ordering of items in a questionnaire can affect responses and rate of response[7], I believe that both the practical application and psychometric properties of the questionnaire may be enhanced by some modifications to item wording and the item response format. The revised version of the questionnaire can be found in Appendix F and the main changes are outlined below.

Following administration of the questionnaire during the follow up period of the PERFECTIS study and the International Nutrition Survey, I received feedback from respondents in the open ended comments section of the questionnaire, and from communication with the local investigators, that critical care providers had difficulty interpreting the response scale of 'not at all important' to 'very important' and that some of the statements describing potential barriers were ambiguous and overly complex. Respondents were confused whether they were to respond that they believed the item was important in general or whether it was an important barrier in their ICU. The reasoning behind using degree of importance as the scale response anchors was to try to capture both the frequency with which the barrier occurred and the magnitude to which it impeded the provision of EN. Surprisingly, the importance response scale was not highlighted as a problem during the pretest or field test, perhaps because in the version of the questionnaire which was administered, the section using this response option was preceded by 2 sections where 'agreement' was used as the scale response anchors and the ordering of items within this section were also different. Only 2 of the 43 respondents in the pilot test of the version used during the follow-up phase of the PERFECTIS study and in the International Nutrition Survey commented that the questions were difficult to answer using the response scale.

A second limitation of the current response scale is that as the primary purpose of the scale is to identify barriers, not all the information collected on the scale is used. For example, when using the scale for the purpose of tailoring interventions or when deriving subscale and overall scores from the individual item responses we focused on the upper end of the scale only; i.e. '5-somewhat important', '6-important' or '7-very important' as we were not interested in factors that were not perceived to be important barriers by respondents (i.e., '1-not at all important', '2-unimportant', '3-somewhat important', '4-neither important or unimportant'. Consequently, by using only 3 points of the scale we may have lost important information regarding the magnitude of the barrier. Furthermore, these limitations associated with the response scale may have led to a reduction in the reliability of the questionnaire. A more intuitive and useful response scale may be to add a filter question with a dichotomous response option indicating if the

item is a barrier or not (i.e. yes/no) and if the respondent indicates 'yes' they are asked to rate the magnitude and frequency of the barrier in their ICU on a 5 point likert scale (Appendix F).

My experiences administrating the questionnaire in the context of the PERFECTIS study and International Nutrition Survey also raised concerns regarding the usefulness of items in subscale 1 of the questionnaire (i.e.; guideline recommendations and implementation strategies). These potential barriers were not rated as important by respondents, were not targeted for change in the tailored intervention, and no significant association was observed between this subscale and prescribed calories received from EN. Furthermore, the ICCs calculated to assess test retest reliability and within group agreement were 0.06 and 0.00 respectively; indicating that the barrier score for this subscale was not reliable across time or when aggregated to the ICU level. One strategy to improve the reliability and utility of items in this subscale is to modify the wording of the statements to increase clarity. Alternatively, given that these potential barriers did not appear to be important for the purpose of tailoring interventions they could be omitted.

Given these significant revisions to the 'Barriers to enterally feeding critically ill patients' questionnaire, further piloting and additional studies in different ICUs are required to gain evidence to support the validity of the latest version of the questionnaire.

7.6 Recommendations for Modifications to the Tailored Intervention

In addition to the revisions to the questionnaire itself, lessons learned through its application in the context of the PERFECTIS study will also be used to inform revisions to the tailored intervention. One of the proposed modifications is to incorporate the components of the tailored action plan that were common across sites as standard facets of the overall intervention. Although the development and implementation of the site-specific tailored action plan was the primary component of the multifaceted, interdisciplinary intervention, several other strategies were also employed which were not tailored to the site level, these

included audit and feedback, educational outreach, opinion leaders, and networking. The components of the tailored action plans that were common across the 5 participating sites, included the addition of the initiation of EN to standardized ICU admission order sets, bed-side algorithm for the initiation and progression of EN, and the education of staff about nutrition therapy. Implementation of EN initiation orders addresses the barriers of 'delay in physicians ordering initiation of EN', 'waiting for the dietitian to assess the patient', and 'no or not enough dietitian coverage at evenings and weekends'. A bed-side algorithm addresses the barriers of 'delays in initiation of motility agents and small bowel feeding', and 'nurses failing to progress feeds'. Education addresses the barrier of 'not enough time dedicated to education on nutrition', 'non-ICU physicians requesting patients not be fed', and 'fear of adverse events'. All 3 components address the barriers of 'other aspects of patient care take priority over nutrition', which was identified as the most important barrier across participating sites. There was variable success in implementation of these 3 components of the tailored action plans across the sites. In particular site 3 faced many challenges. First, their EN initiation order was part of a hospital wide nutrition policy document and not specific to the ICU. Consequently, the committee did not approve some of the proposed changes that were specific to critically ill patient population. Second, a paper-based order set was produced and placed at the patient's bedside, but the majority of physicians used a computer patient order entry rather than paper orders. Thirdly, this ICU had an open structure, therefore there were many physicians taking care of patients who were unaware of the new order set. In contrast, site 1 was successful in implementing the new EN initiation order in a short time frame. First, the change was incorporated into the existing ICU admission order set. Second, the change was championed by the ICU director, who presented the order set to numerous committees and liaised with the IT department to ensure it was added to the computer patient order entry system in a timely manner. Third, the default order was to start EN on ICU admission and physicians' had to actively decline to start feeding. The variable success in implementing these common components of the action plan suggests that if they were included as part of the multifaceted intervention, a step-by-step plan for implementation, specific to the local context, would need to be developed to facilitate their successful implementation. The provision of educational

resources may also help to increase compliance with these components. The results of a recently completed cluster RCT support the inclusion of these unit level interventions[13]. This trial evaluated the impact of a new innovative feeding protocol, the Enhanced Protein-Energy Provision via the Enteral Route Feeding Protocol (PEP uP protocol), combined with a nursing educational intervention on nutritional intake compared to usual care and demonstrated a modest but statistically significant increase in the provision of calories and protein[13].

Results of the PERFECTIS study indicate that there was wide variation in the compliance with the intervention and the subsequent magnitude of change in nutrition practice indicators across the 5 sites. In the pretest posttest study, we assessed the barriers to adherence of critical care nutrition guideline recommendations and charged the local guideline implementation team with leading the development and implementation of the tailored action plan. There may have been barriers associated with the implementation of the practice change that were not part of the scope of the questionnaire. When individual providers are asked about barriers their responses are based on their day-to-day experiences at the bed-side and they may not consider 'higher' level barriers or other contextual factors. In addition, the individuals on the guideline implementation team were volunteers who self-identified as opinion leaders for nutrition in their ICUs and may not have been the most effective change agents. Complementing the baseline nutrition practice audit and barriers assessment with a readiness to change assessment to evaluate the ICUs ability to manage and accept the proposed changes[14], the administration of a sociometric questionnaire to identify the key opinion leaders to promote the change[15-17], and training for the Guideline Implementation Team on teamwork, may be additional strategies that can be employed to increase compliance with the intervention. In addition, at several sites, implementation of some action plan items were still in progress at the end of the 12 month implementation period, therefore a longer implementation period or assessment of change in practice after several time intervals (e.g. 12, 18, 24, 36 months) could be considered.

7.7 Future Research

The purpose of this thesis was to determine the feasibility of a tailored intervention to overcome barriers to adherence of critical care nutrition guideline recommendations. Following the completion and promising findings of these preliminary investigations, there is a need to pilot the proposed changes to the barriers to enterally feeding critically ill patients questionnaire and to the modified components of the intervention prior to proceeding to designing and conducting a large interventional study to evaluate the effectiveness of this approach. Cluster randomized controlled trials (cRCTs) are viewed as the 'gold standard' design for evaluating group or system level interventions, such as this guideline implementation strategy targeted at changing practice within an ICU[18]. Participating ICUs would be randomized to the tailored intervention or a non-tailored (i.e. audit and feedback). This definitive trial in a representative sample of international ICUs would be powered to detect differences in nutrition outcomes between the two groups. In addition, this trial should include collection of financial data to enable an evaluation of the cost-effectiveness and sustainability of the intervention.

In parallel to the preparations for this trial, the revised questionnaire requires further validation by other investigators and different ICUs. Given the difficulties some respondents highlighted with comprehending the response scale and some questionnaire items, detailed cognitive testing should be completed to evaluate if respondents understand what is being asked. In addition, the questionnaire has been translated into Spanish for use in Latin America; therefore evidence to support its validity for use in this language and setting is required. To provide additional evidence of construct validity, there is a need to complete a confirmatory factor analysis to confirm the five underlying constructs/subscales identified in the exploratory factor analysis, as well as examining how barrier scores correlate with scores from other instruments with which conceptually we would hypothesize they would or would not be associated. For example, correlation of questions pertaining to organizational culture in the barriers questionnaire and responses to the Shortell Organizational Culture ICU-Nurse Physician Questionnaire an instrument

examining the organization and management practices of ICUs related to communication, coordination, conflict management, leadership, perceived unit team effectiveness, and organizational culture[19].

Outside this program of research in critical care nutrition KT there are several methodological issues, gaps in knowledge, and controversies faced by the fields of clinical nutrition and KT; where the generation of additional data may complement the findings of this thesis and inform the future direction of the research. This includes 1) defining the optimal caloric requirements for critically ill patients to enable more accurate measurement of the primary outcome adequacy of the nutrition provided[20]. 2) Acquiring data on the nutritional status and nutritional intake of patients post ICU discharge, as the benefits of optimizing nutrition within the ICU may be compromised if post discharge provision is poor. 3) Complementing the study on barriers with the measurement of enablers (i.e. factors that facilitate the implementation of guideline recommendations in practice) and how capitalizing on the presence of these favourable contextual factors and provider attributes may augment a tailored intervention. 4) Investigating the influence of the health care system and specific policies on higher level factors that are considered non-actionable in this thesis (e.g. open structure of the ICU, physician remuneration and its linkage to accountability, institutional accreditation). 5) Evaluating the adoption of information technology as a strategy to implement critical care nutrition guideline recommendations (e.g. use of applications on handheld devices to provide real-time feedback on the provision of nutrition and reminders/prompts).

7.8 Conclusions

Observational studies of nutrition practices in the critical care setting have consistently demonstrated a gap between what recommendations of evidence based guidelines state ought to be happening and the actual nutrition therapy received by critically ill patients. This thesis has successfully developed a questionnaire to identify factors that impede the provision of EN in the ICU that may be contributing to this knowledge-practice gap. Using data from the administration of this questionnaire, the thesis has

provided evidence to support the underlying hypothesis that identified barriers are inversely associated with the provision of nutrition, and data to describe the specific barriers faced by critical care providers including the differences and commonalities across ICUs. Finally, the thesis demonstrated the feasibility of using the developed questionnaire to tailor interventions to identified barriers as a strategy for improving nutrition practice. The results of this thesis have informed modifications to the questionnaire and tailored intervention, necessitating further pilot testing and validation prior to proceeding to conduct a cRCT to formally test the hypothesis that tailored guideline implementation interventions are more effective than usual guideline implementation efforts.

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Appendix A

Explanatory Table Supporting the Framework for Adherence to Critical Care Nutrition Clinical Practice Guidelines

Table Supporting the Framework for Adherence to Critical Care Nutrition Clinical Practice Guidelines

Factor	Barrier	Enabler
CPG Characteristics	• Outdated • Vague or complex statements	• Evidence – based • Respected developer • User friendly format • Action-orientated
Implementation Process	• Lack of availability of all ICU Team to attend meetings, educational sessions etc. • No dedicated individual willing to 'champion' the guidelines • Time commitment to develop and implement educational strategies • Restricted access to computers • Displacement of posters and pamphlets over time	• Multiple approaches • Support of Clinical educator + Medical Director • Tailored to specific needs of individual • Reminders (e.g. checklist) • Protocols • Academic detailing (i.e. one-on-one education) • Educational sessions • Audit and feedback • E-mail / web-based tools • Opinion leader (e.g. the Dietitian)
Institutional Characteristics Hospital and ICU Structure	• Community hospital • Open structure • Rural location • Small hospital and / or ICU • Lack of geographical consolidation	• Large hospital and / or ICU • Closed structure • Critical care residency program • Dedicated, stable workforce
Hospital Processes	• Long, slow administrative process • Disconnect between priorities of management and clinical personnel • Organizational constraints on practice	• Support for evidence-based practice • Efficient, flexible administrative process
Resources for Implementation	• Shortage of staff • Limited budget • Lack of appropriate equipment / materials • Lack of access to specialist services	• Adequate resources available (i.e. level of staffing, equipment, budget for implementation activities) • New, contemporary facilities
Prevailing Culture of ICU	• No cohesive, multi-disciplinary team structure • No multi-disciplinary daily rounds • Unresolved conflict or disagreements between ICU team members • Reliance on written communication (e.g. Cardex, paper notes) • Leadership not physically present on unit • Poor communication	• Established multi-disciplinary team • Leadership Support • Collaborative decision-making • Patient centred approach • Formal / informal mentorship • Group learning • Respect for expertise of each ICU Team member • Innovation: embracing change • Informal, open communication • Positive work environment

Factor	Barrier	Enabler
Provider Intent Provider Characteristics Professional Roles	• Circle of influence of nursing staff and allied healthcare professionals (e.g. dietitian) dependent on support of physician and leadership team	• Attending physician responsible for patient care. • Nurse Manager and ICU Medical Director accountable for management of ICU
Critical Care Expertise	• Junior, novice staff • Locum or casual staff	• Older, experienced staff • Full-time in ICU
Educational Background	• Clinical training > 10 years • Reliance on expert opinion	• Recent graduate • Training in Evidence Based Medicine and critical appraisal • Training in large, academic institution
Personality	• Type B personality[#] • Uncooperative • Laggard / skeptic	• Type A personality* • Team-player • Innovator / early adopter
Knowledge Familiarity	• CPGs infrequently used due to rare clinical condition or narrow case-mix	• Part of daily routine • Visibility / access to CPGs on ICU
Awareness	• Conflicting and numerous CPGs on same topic • Information overload • Time required to remain updated • Poor dissemination	• Effective implementation process
Attitudes Outcome Expectancy	• Experience of adverse event from following guideline	• Belief that best for patient • Positive experience from following guideline
Self-efficacy	• Labour-intensive • Complex procedure • Limited circle of influence	• Recommendation simple and quick to perform • Procedure frequently performed successfully • Possession of skills and training to perform procedure • Procedure within usual scope of practice
Motivation	• Inertia of previous practice, especially among experienced, older staff • Physician resistance, especially locums, surgeons and non-ICU physicians. • High cost / work burden associated with following the guideline	• Shared team goal to optimize patient care • Enforcement or incentive to perform task
Agreement	• Paucity of evidence supporting recommendation • Lack of generalizability to critical care and/or specific patient groups	• Buy-in of attending physicians • Buy-in of all members of the ICU Team • Understanding rationale behind recommendation
Patient Characteristics	• Poor prognosis • Other priorities of care • Unstable clinical condition/contraindication • Surgical patients • Reconciliation with family preferences	• Medically stable • Functioning gastrointestinal tract

Appendix B

Research Ethics Board Approval

QUEEN'S UNIVERSITY HEALTH SCIENCES AND AFFILIATED TEACHING HOSPITALS
ANNUAL RENEWAL

Queen's University, in accordance with the "Tri-Council Policy Statement, 1998" prepared by the Medical Research Council, Natural Sciences and Engineering Research Council of Canada and Social Sciences and Humanities Research Council of Canada requires that research projects involving human subjects be reviewed annually to determine their acceptability on ethical grounds.
A Research Ethics Board composed of:

Dr. A.F. Clark	**Emeritus Professor, Department of Biochemistry, Faculty of Health Sciences, Queen's University (Chair)**
Dr. H. Abdollah	**Professor, Department of Medicine, Queen's University**
Dr. M. Evans	**Community Member**
Dr. S. Horgan	**Manager, Program Evaluation & Health Services Development, Geriatric Psychiatry Service, Providence Care, Mental Health Services** **Assistant Professor, Department of Psychiatry**
Dr. L. Keeping-Burke	**Assistant Professor, School of Nursing, Queen's University**
Ms. D. Morales	**Community Member**
Dr. W. Racz	**Emeritus Professor, Department of Pharmacology & Toxicology, Queen's University**
Dr. B. Simchison	**Assistant Professor, Department of Anaesthesiology, Queen's University**
Dr. A.N. Singh	**WHO Professor in Psychosomatic Medicine and Psychopharmacology** **Professor of Psychiatry and Pharmacology** **Chair and Head, Division of Psychopharmacology, Queen's University** **Director & Chief of Psychiatry, Academic Unit, Quinte Health Care, Belleville General Hospital**
Dr. E. Tsai	**Associate Professor, Department of Paediatrics and Office of Bioethics, Queen's University**
Rev. J. Warren	**Community Member**
Ms. K. Weisbaum	**LL.B. and Adjunct Instructor, Department of Family Medicine (Bioethics)**
Dr. S. Wood	**Director, Office of Research Services (Ex Officio)**

has reviewed the request for renewal of Research Ethics Board approval for the project **"Performance Enhancement of the Canadian Nutrition Guidelines By A Tailored Implementation Strategy: The PERFECTIS Study"** as proposed by Ms. Naomi Cahill of the Clinical Evaluation Research Unit, Kingston General Hospital, at Queen's University. The approval is renewed for one year, effective July 9, 2010. If there are any further amendments or changes to the protocol affecting the subjects in this study, it is the responsibility of the principal investigator to notify the Research Ethics Board. Any unexpected serious adverse event occurring locally must be reported within 2 working days or earlier if required by the study sponsor. All other adverse events must be reported within 15 days after becoming aware of the information.

for A. Clark — July 9, 2010

Chair, Research Ethics Board — Date

ORIGINAL TO INVESTIGATOR - COPY TO DEPARTMENT HEAD- COPY TO HOSPITAL(S) - FILE COPY-BINDER
Renewal 1[x] Renewal 2 [ ] Extension [ ]
REB# EPID-293-09

QUEEN'S UNIVERSITY HEALTH SCIENCES AND AFFILIATED TEACHING HOSPITALS
ANNUAL RENEWAL

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Ms. K. Weisbaum	**LL.B. and Adjunct Instructor, Department of Family Medicine (Bioethics)**
Dr. S. Wood	**Director, Office of Research Services (Ex Officio)**

has reviewed the request for renewal of Research Ethics Board approval for the project **"Improving the Practice of Nutrition Therapy in the Critically Ill: An International Quality Improvement Project"** as proposed by Dr. Daren Heyland of the Department of Medicine, at Queen's University. The approval is renewed for one year, effective October 10, 2010. If there are any further amendments or changes to the protocol affecting the subjects in this study, it is the responsibility of the principal investigator to notify the Research Ethics Board. Any unexpected serious adverse event occurring locally must be reported within 2 working days or earlier if required by the study sponsor. All other adverse events must be reported within 15 days after becoming aware of the information.

Albert Clark
Chair, Research Ethics Board

Oct 18, 2010
Date

ORIGINAL TO INVESTIGATOR - COPY TO DEPARTMENT HEAD- COPY TO HOSPITAL(S) - FILE COPY - BINDER COPY
Renewal 1[ ] Renewal 2 [ ] Extension [x]
REB# DMED-984-06

Queen's UNIVERSITY
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November 4, 2010

Dr. Daren Heyland
Department of Medicine
Clinical Evaluation Unit, Angada 4
Kingston General Hospital

Re: "Improving the Practice of Nutrition Therapy in the Critically Ill: An International Quality Improvement Project" DMED-994-06

Dear Dr. Heyland,

I am writing to acknowledge receipt of the request for approval of an amendment to the above-named study:

- Participating ICUs will be invited to also complete an assessment of their barriers to feeding critically ill patients in the upcoming 2011 International Nutrition Survey
- Provision of a copy of the Barriers Questionnaire
- Provision of a copy of the Sample Barriers Report

I have reviewed this request and hereby give my approval. Receipt of these materials will be reported to the Health Sciences Research Ethics Board.

Yours sincerely,

Albert Clark

Albert Clark, Ph.D.
Chair
Research Ethics Board

AFC/kr

c.c.: Naomi Cahill, Project Leader ✓

Appendix C

Barriers to Enterally Feeding Critically Ill Patients Questionnaire: Pretest Version (Manuscript 1)

PRETESTING

Barriers Questionnaire Evaluation

Thank you for agreeing to help us pre-test the barriers questionnaire.

As you complete the questionnaire we have provided space after each item for your comments. Specifically, it would be useful if you could comment on the following:

- Any words or questions that are ambiguous or confusing
- Any questions that you felt uncomfortable answering
- Any questions that feel too repetitive
- Any questions that feel too superficial
- Any other annoying features associated with the wording or formatting

At the end we have included a few additional questions regarding your overall impressions about the questionnaire.

After completing the questionnaire please return by mail or e-mail to the address below:

Critical Care Nutrition

Naomi Cahill, RD PhD(c)
Project Leader
Clinical Evaluation Research Unit (CERU)
Angada 4,
Kingston General Hospital,
76 Stuart Street ,
Kingston, ONT
K7L 2V7

e-mail: cahilln@kgh.kari.net
www.criticalcarenutrition.com

Tel: (613) 549 6666 X 2812
Fax: (613) 548 2428

PERFormance Enhancement of the Canadian nutrition guidelines by a Tailored Implementation Strategy: The PERFECTIS Study

Barriers Questionnaire (DRAFT)

The purpose of this survey is to gain an understanding of the barriers that critical care providers face in implementing guidelines in their setting and specifically in adhering to the recommendations of the Canadian Critical Care Nutrition Clinical Practice Guidelines (CPGs).

These guidelines were published in the Journal of Parenteral and Enteral Nutrition (Volume 27, Issue 5, pages 355 – 373) in 2003. They have been recently updated in January 2009, a summary of the recommendations pertaining to enteral nutrition are included at the end of the questionnaire for your reference, and are also available at www.criticalcarenutrition.com. For brevity, the terms 'Canadian Critical Care Nutrition CPGs' or 'the guidelines' will be used to refer to these specific guidelines during this survey.

The questionnaire is divided into 4 sections and should take you approximately 20 minutes to complete. Please read the instructions before completing the questionnaire:

- Read each question, including the answering options, before giving an answer
- Choose the answer that is most applicable to your situation
- Choose only one answer, unless stated differently
- Fill in the questionnaire only for yourself and the situation in your ICU from your perspective.
- If you have any additional comments regarding the guidelines, or questions/concerns with respect to this survey, please write them in the space allotted at the end of the questionnaire.

Thank you for your participation.

Part A: General Barriers

Please read the following statements and circle the number that best represents what you believe about working according to the Canadian Critical Care Nutrition CPGs IN GENERAL. By circling number 1, you are fully disagreeing with the statement, by circling number 7 you are fully agreeing with the statement.

Questions 1-8 refer to your knowledge and attitudes towards working according to the guidelines.

1. I am familiar with the Canadian Critical Care Nutrition CPGs.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

2. The Canadian Critical Care Nutrition CPGs are readily accessible in our ICU if I want to refer to them

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

3. It is easy to apply and adapt the Canadian Critical Care Nutrition CPGs to my daily routine.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

4. I believe that providing nutrition as directed by the Canadian Critical Care Nutrition CPGs is very important for my critically ill patients.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

5. If necessary, I am willing to change my routines and habits in order to implement the recommendations of the Canadian Critical Care Nutrition CPGs.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

6. In general guidelines / protocols help to standardize care and assure that patients are treated in a consistent way.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

7. I feel competent in feeding my patients in accordance with the guideline recommendations

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

8. If the recommendations of the Canadian Critical Care Nutrition CPGs are followed in my ICU, patient outcomes will improve.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

Questions 9-13 refer specifically to the characteristics of the guidelines

9. The language of the recommendations of the Canadian Critical Care Nutrition CPGs makes it easy to use.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

10. The summaries of topics and recommendations on the www.criticalcarenutrition.com website make the guidelines easy to use.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

11. The web-based quality improvement tools (e.g. posters, algorithms) make the guidelines easy to use.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

12. I have confidence that the Canadian Critical Care Nutrition Guidelines committee are well qualified and knowledgeable about nutrition therapy in the ICU.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

13. Overall, the guidelines are based on sound scientific evidence.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

Questions 14-16 refer to your patient population

14. The recommendations of the guidelines are relevant to my patient population.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

15. Working according to the Canadian Critical Care Nutrition CPGs leaves enough room for me to take into account the clinical condition of the patient

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

16. In general, it is easy to reconcile applying the recommendations of the Canadian Critical Care Nutrition CPGs and the preferences of the patient's family.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

Questions 17-22 refer to the ICU environment in which you work

17. Overall, I believe the critical care providers in our ICU (i.e. physicians, nurses, dietitian, pharmacist, managers) function well together as a team.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

18. Our ICU team engages in shared responsibility and joint decision-making in planning, coordinating and implementing nutrition therapy for our patients.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

19. Overall, I feel supported to share my ideas when we meet as a team on daily rounds.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

20. As it pertains to the provision of nutrition therapy, I am able to function to my full potential, based on my knowledge level, skill competencies and scope of practice.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

21. In our ICU, practice guidelines are important.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

22. Managers / Directors support me in applying the Canadian Critical Care Nutrition CPGs by:

a. Facilitating quality improvement activities

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

b. Planning educational sessions and resources

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

c. Protecting staff time for training

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

d. Ensuring availability of a dietitian to assess patients and monitor feeding

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

Part B: EN recommendations

This section relates to your agreement with specific recommendations of the updated 2009 version of the Canadian Critical Care Nutrition CPGs. Please read each statement and fill in the circle that best represents your level of agreement. By circling number 1, you are fully disagreeing with the statement, by circling number 7 you are fully agreeing with the statement. If you do not have a strong opinion, please try to find out if it is more like 'agree' or more like 'disagree'.

1. We strongly recommend that enteral nutrition should be used in preference to parenteral nutrition.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

2. We recommend early enteral nutrition. (Within 24-48 hours following admission to the ICU)

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

3. When starting enteral nutrition in critically ill patients, strategies to optimize delivery of nutrients (starting at target rate, higher threshold of gastric residual volumes, use of prokinetics and small bowel feedings) should be considered.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

4. An evidence based feeding protocol should be considered as a strategy to optimize delivery of enteral nutrition.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

5. If a feeding protocol is used, it should tolerate a higher gastric residual volume (i.e. ! 250ml)

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

6. In patients who experience feed intolerance, we recommend the use of a promotility agent.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

7. Small bowel feeding should be considered for those select patients who repeatedly demonstrate high gastric residual volumes and are not tolerating adequate amounts of EN delivered into the stomach, or for patients at high risk of developing intolerance.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

8. We recommend that patients receiving EN should have the head of the bed elevated to 45 degrees if possible and if there is no contraindication.

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

9. In all critically ill patients, we recommend avoiding hyperglycemia. (Blood glucose > 10mmol/l)

Fully disagree 1 2 3 4 5 6 7 Fully agree

Comment:

Part C: Barriers to delivery of Enteral Nutrition

This section relates specifically to barriers to the provision of adequate enteral nutrition (EN) in your ICU. A barrier is something that hinders your ability to deliver adequate amounts of EN. Below are some potential barriers to feeding your critically ill patients. Please read each reason and circle the option that best represents how important a barrier the reason is in your ICU. By circling number 1 (Not at all important) you believe that this reason is not a barrier. By circling number 7 (Very important) you believe that it is a barrier.

1. Not enough nursing staff.

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

2. Not enough dietitian time dedicated to the ICU

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

3. Required enteral formulas not readily available on the unit.

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

4. Patients not having a feeding tube in place when I want to start EN

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

5. Difficulties obtaining small bowel access.

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

6. Feeding pumps not readily available on the unit.

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

7. Motility agents not prescribed.

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

8. No feeding protocol in place or current protocol is outdated.

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

9. Past experience of adverse events due to aggressively feeding patients.

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

10. Other aspects of patient care take priority over nutrition.

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

11. Physicians /residents are slow to order the initiation of EN.

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

12. Waiting for the dietitian to assess the patient.

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

13. Lack of communication between team members about

(a) when to initiate feeding

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

(b) how to progress the rate of feeding to goal rate

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

(c) patients not receiving target volume

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

14. Your lack of skills and training on how to achieve goal calories.

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

15. Patients not having an intact GI tract.

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

16. Patients not tolerating enteral nutrition.

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

17. Feeding being frequently interrupted unnecessarily.

Not at all important 1 2 3 4 5 6 7 Very Important

Comment:

18. Are there any other barriers to delivering adequate EN in your ICU?

19. For me, the 3 most important barriers to the provision of adequate EN in out ICU are:

    1.

    2.

    3.

20. What strategies do you believe would improve the delivery of EN in your ICU?

Comments on open-ended questions:

Part D: Personal Characteristics

Please check the box that best corresponds to you.

1. What is your sex? Male ☐ Female ☐

2. How old are you?
   - 34 years or less ☐
   - 35-49 years ☐
   - 50-64 years ☐
   - 65 years or older ☐

3. What is your primary clinical specialty?
   - Dietitian ☐
   - Nurse ☐
   - Physician ☐ Please select one:
     - Intensivist (Medical) ☐
     - Intensivist (Surgical) ☐
     - Anaesthesia ☐
     - Emergency Medicine ☐
     - Internal Medicine ☐
     - Surgeon ☐
     - Other clinical specialty ☐ Please specify _____

4. How would you describe your current employment status in the ICU?
   - Full-time ☐
   - Part-time ☐ Full-time equivalent:_____
   - Locum ☐
   - Casual ☐
   - Trainee ☐
   - Other ☐ Please specify _____

5. How long have you been working in the ICU?
   - 0 - 5 years ☐
   - 6 - 10 years ☐
   - 11 - 15 years ☐
   - Greater than 15 years ☐

6. Do you play a leadership role in the ICU? Yes ☐ No ☐
   If yes, please specify:
   - Medical Director ☐
   - Nurse Manager ☐
   - Clinical Nurse Specialist ☐
   - Charge Nurse ☐
   - Other ☐

Additional Comments

You have completed the questionnaire, your contribution is valued. Please use the space provided for any additional comments or questions you have about barriers to adherence of the recommendations of the Canadian Critical Care Nutrition CPGs at your site or the survey itself.

Thank you for taking the time to complete this survey.

PRETESTING Barriers Questionnaire Overall Evaluation

Please read these questions and provide your feedback on the questionnaire you just completed.

1. Overall, did you find the survey easy to understand?

2. As it relates to potential barriers, are there any additional items that we should be asking about?

3. Approximately how long did it take you to complete the survey?

4. Was the survey too long?

5. Is it helpful to include the summary of the Critical Care Nutrition Clinical Practice Guidelines with the Barriers Questionnaire?

6. Please write down anything else you may have had trouble with or if you have any suggestions to improve the questionnaire.

THANK YOU FOR YOUR COMMENTS

Appendix D

Barriers to Feeding Critically Ill Patients Questionnaire: Field Test Version (Manuscript 1, 3 and Baseline Data in Manuscript 4)

Barriers to Feeding Critically Ill Patients

The purpose of this questionnaire is to understand the barriers that critical care providers face in implementing the recommendations of nutrition guidelines in their setting - specifically barriers to providing adequate enteral nutrition (EN).

Several Clinical Practice Guidelines (CPGs) pertaining to critical care nutrition have been developed and published in recent years (e.g., The Canadian Critical Care Nutrition Guidelines published in 2003 and updated in 2009, and the SCCM/ASPEN Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient published in 2009). These CPGs are typically nationally developed broad statements of best practice that refer to the average mechanically ventilated critically ill adult patient. For brevity, during this survey, the term 'current national guidelines for nutrition' will be used to refer to the nutrition guidelines currently used to inform decisions about feeding patients in your ICU.

This questionnaire is divided into 4 sections and should take you approximately 10 minutes to complete. Please read these instructions before starting:

- Read each question, including all the options, before giving an answer.
- Choose the answer that is most applicable to your situation.
- Choose only one answer, unless requested otherwise.
- Complete the questionnaire from your perspective of the situation in your ICU – do not consider what you think others would say.
- If you have any additional comments, questions or concerns regarding nutrition guidelines, barriers to delivering enteral nutrition, or this survey, please write them in the space allotted at the end of the questionnaire.

By completing the questionnaire you are consenting for your responses to be used as part of ongoing quality improvement work in your unit. However, your responses are strictly confidential. You have the option of completing the questionnaire online or completing a paper-based version of the questionnaire. Paper-based versions of the questionnaire are to be placed in the secure box provided. Questionnaires will be sent to the Clinical Evaluation Research Unit for analysis, where they will be kept in a locked office with a password-protected computer. All analyses will be based on aggregate responses only. If any single subgroup has less than 5 responses the results with be combined with another group. Your opinions are very important! Of course, your participation is voluntary.

If you have any questions or comments, please contact us:

Naomi Cahill RD MSc
Project Leader / Doctoral Candidate
Clinical Evaluation Research Unit (CERU), Angada 4,
Kingston General Hospital
Kingston, ON K7L 2V7
Tel: (613) 549 6666 X 2812
e-mail: cahilln@kgh.kari.net

Thank you for your participation!

Part A: General Barriers

Please read the following statements and circle the number that best represents your answer. By circling number 1, you are fully disagreeing with the statement, by circling number 7 you are fully agreeing with the statement.

Questions 1-5 refer to the ICU environment in which you work.

		Fully Disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Fully agree	Don't know
1.	Overall, our unit functions very well together as a team.	1	2	3	4	5	6	7	8
2.	Our ICU team engages in joint decision-making in planning, coordinating and implementing nutrition therapy for our patients.	1	2	3	4	5	6	7	8
3.	Overall, it is easy for me to openly talk with other members of the ICU team about matters related to the nutritional needs of my patient.	1	2	3	4	5	6	7	8
4.	In our ICU, implementing best practices, as defined by clinical practice guidelines, is intrinsic to our culture.	1	2	3	4	5	6	7	8
5.	Our ICU Managers/Directors are supportive of implementing nutrition guidelines.	1	2	3	4	5	6	7	8

Questions 7-9 refer to your general attitudes towards nutrition therapy and the nutrition guidelines used in your ICU.

6.	Nutrition is very important for my critically ill patients.!	1	2	3	4	5	6	7	8
7.	I feel responsible for ensuring that my patients receive adequate nutrition while in the ICU.	1	2	3	4	5	6	7	8
8.	I am familiar with our current national guidelines for nutrition in the ICU.	1	2	3	4	5	6	7	8
9.	If the recommendations of the current national guidelines for nutrition are followed in our ICU, patient outcomes will improve.	1	2	3	4	5	6	7	8

Part B: Guideline Recommendations for Enteral Nutrition

This section relates to your agreement with recommendations of CPGs about enteral nutrition. Remember, these guidelines are meant to apply to the average mechanically ventilated adult critically ill patient. There are always exceptions to the rule but we are asking your level of agreement in the typical situation. Please read each statement and fill in the circle that best represents your level of agreement. By circling number 1, you are fully disagreeing with the statement, by circling number 7 you are fully agreeing with the statement.

		Fully Disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Fully agree	Don't know
1.	Enteral nutrition should be used in preference to parenteral nutrition.	1	2	3	4	5	6	7	8
2.	Enteral nutrition should be initiated early (24-48 hours following admission to ICU).	1	2	3	4	5	6	7	8
3.	An evidence-based feeding protocol should be used.	1	2	3	4	5	6	7	8
4.	If a feeding protocol is used, it should tolerate a higher gastric residual volume (i.e. > 250mls) before holding feeds.	1	2	3	4	5	6	7	8
5.	In patients who have feed intolerance (i.e. high gastric residual volumes, emesis) a promotility agent should be used.	1	2	3	4	5	6	7	8
6.	Small bowel feeding should be considered for those select patients who repeatedly demonstrate high gastric residual volumes and are not tolerating adequate amounts of EN delivered into the stomach.	1	2	3	4	5	6	7	8
7.	Patients receiving enteral nutrition should have the head of the bed elevated to 45 degrees.	1	2	3	4	5	6	7	8
8.	In all critically ill patients, hyperglycemia (blood glucose > 10 mmol/l or 180mg/dl) should be avoided by minimizing intravenous dextrose and using insulin administration when necessary.	1	2	3	4	5	6	7	8

Part C: Barriers to Delivery of Enteral Nutrition

This section relates specifically to barriers to providing adequate enteral nutrition to patients in your ICU. A barrier is something that hinders your ability to deliver adequate amounts of EN. Below is a list of items that have been identified as barriers to feeding critically ill patients. For each potential barrier, circle the number that best reflects on average the situation in your ICU. By circling number 1 (Not at all important) you believe that it is not a barrier. By circling number 7 (Very important) you believe that it is a major barrier.

	Not at all Important	Unimportant	Somewhat Unimportant	Neither Important or Unimportant	Somewhat Important	Important	Very Important
ICU Environment							
1. Not enough nursing staff to deliver adequate nutrition.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
2. Not enough dietitian time dedicated to the ICU during regular weekday hours.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
3. No or not enough dietitian coverage during weekends and holidays.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
4. Enteral formula not available on the unit.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
5. No or not enough feeding pumps on the unit.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Guideline Recommendations							
6. Current scientific evidence supporting some nutrition interventions is inadequate to inform practice.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
7. The current national guidelines for nutrition are not readily accessible when I want to refer to them.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
8. The language of the recommendations of the current national guidelines for nutrition are not easy to understand.	**1**	**2**	**3**	**4**	**5**	**6**	**7**

	Not at all Important	Unimportant	Somewhat Unimportant	Neither Important or Unimportant	Somewhat Important	Important	Very Important
Guideline Implementation Strategies							
9. Not enough time dedicated to education and training on how to optimally feed patients.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
10. No feeding protocol in place to guide the initiation and progression of enteral nutrition.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
11. Current feeding protocol is outdated.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Critical Care Provider Behaviour							
12. Delay in physicians ordering the initiation of EN.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
13. Waiting for the dietitian to assess the patient.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
14. Non-ICU physicians (i.e. surgeons, gastroenterologists) requesting patients not be fed enterally.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
15. Nurses failing to progress feeds as per the feeding protocol.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
16. Fear of adverse events due to aggressively feeding patients.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
17. Feeding being held too far in advance of procedures or operating room visits.	**1**	**2**	**3**	**4**	**5**	**6**	**7**

	Not at all Important	Unimportant	Somewhat Unimportant	Neither Important or Unimportant	Somewhat Important	Important	Very Important
Patient Factors							
18. No feeding tube in place to start feeding.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
19. Delays in initiating motility agents in patients not tolerating enteral nutrition (i.e. high gastric residual volumes).	**1**	**2**	**3**	**4**	**5**	**6**	**7**
20. Delays and difficulties in obtaining small bowel access in patients not tolerating enteral nutrition (i.e. high gastric residual volumes).	**1**	**2**	**3**	**4**	**5**	**6**	**7**
21. In resuscitated, hemodynamically stable patients, other aspects of patient care still take priority over nutrition.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
22. Lack of agreement among ICU team on the best nutrition plan of care for the patient.	**1**	**2**	**3**	**4**	**5**	**6**	**7**

23. Reflecting on the 22 barriers to providing enteral nutrition listed above, are there any other barriers that hinder your ability to deliver adequate amounts of enteral nutrition?

24. Reflecting on the 22 barriers to providing enteral nutrition listed above, enter the number corresponding to the items that you believe are the 3 most important barriers to the provision of adequate EN in your ICU:

- First most important barrier: ☐
- Second most important barrier: ☐
- Third most important barrier: ☐

25. What strategies do you believe would improve the delivery of EN in your ICU?

26. In what format would you prefer to receive education on nutrition therapy and current nutrition guidelines? Select all that apply.

Powerpoint presentation at multidisciplinary rounds !
Powerpoint presentation online !
Small group in-person teaching sessions !
One-on-one teaching sessions !
Bed-side booklet of nutrition guideline recommendations and reference articles !
FAQs sheet !
Bedside illustrations (e.g. posters, head of bed elevation signs) !
Newsletters !
Email bulletins !
Other, please specify: _____ !

Part D: Personal Characteristics

Please check the box that best corresponds to you.

1. What is your sex? Male ☐ Female ☐

2. How old are you?
   - 34 years or less ☐
   - 35-49 years ☐
   - 50-64 years ☐
   - 65 years or older ☐

3. What is your primary clinical specialty?
   - Dietitian ☐
   - Nurse ☐
   - Physician ☐ Please select one:
     - Intensivist (Medical) ☐
     - Intensivist (Surgical) ☐
     - Anaesthesia ☐
     - Emergency Medicine ☐
     - Internal Medicine ☐
     - Surgeon ☐
     - Other clinical specialty ☐ Please specify _____

4. How would you describe your current employment status in the ICU?
   - Full-time ☐
   - Part-time ☐ Full-time equivalent:_____
   - Locum ☐
   - Casual ☐
   - Trainee ☐
   - Other ☐ Please specify _____

5. How long have you been working in the ICU?
   - 0 - 5 years ☐
   - 6 - 10 years ☐
   - 11 - 15 years ☐
   - Greater than 15 years ☐

6. Do you play a leadership role in the ICU? Yes ☐ No ☐
   If yes, please specify:
   - Medical Director ☐
   - Nurse Manager ☐
   - Clinical Nurse Specialist ☐
   - Charge Nurse ☐
   - Other ☐

Additional Comments

You have now completed the questionnaire – thank you! In the space below, please make any additional comments you wish to make about barriers or solutions to providing adequate enteral nutrition to patients in your ICU.

Thank you very much for taking the time to complete this questionnaire.
Your contribution is valued.

Appendix E

Barriers to Feeding Critically Ill Patients Questionnaire:

Revised Version Used in Manuscript 2 and Follow up data in Manuscript 4

Barriers to Feeding Critically Ill Patients

The purpose of this questionnaire is to understand the barriers that critical care providers face in implementing the recommendations of nutrition guidelines in their setting - specifically barriers to providing adequate enteral nutrition (EN).

Several Clinical Practice Guidelines (CPGs) pertaining to critical care nutrition have been developed and published in recent years (e.g., The Canadian Critical Care Nutrition Guidelines published in 2003 and updated in 2009, and the SCCM/ASPEN Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient published in 2009). These CPGs are typically nationally developed broad statements of best practice that refer to the average mechanically ventilated critically ill adult patient. Often, these guidelines are adapted for local use, and incorporated into local policy documents and bed-side protocols/algorithms. For brevity, throughout this survey, the term 'current guidelines for nutrition' will be used to refer to the nutrition guidelines currently used, if any, to inform decisions about feeding patients in your ICU. When we refer to feeding protocols, we are referring to tools designed to operationalize the guidelines at the bedside for patient care.

This questionnaire is divided into 2 sections and should take you approximately 5 minutes to complete. Please read these instructions before starting:

- Read each question, including all the options, before giving an answer.
- Choose the answer that is most applicable to your situation.
- Choose only one answer, unless requested otherwise.
- Complete the questionnaire from your perspective of the situation in your ICU – do not consider what you think others would say.
- If you have any additional comments, questions or concerns regarding nutrition guidelines, barriers to delivering enteral nutrition, or this survey, please write them in the space allotted at the end of the questionnaire.

By completing the questionnaire you are consenting for your responses to be used as part of ongoing quality improvement work in your unit. However, your responses are strictly confidential. You have the option of completing the questionnaire online or completing a paper-based version of the questionnaire. Paper-based versions of the questionnaire are to be placed in the secure box provided in the ICU. Questionnaires will be sent to the Clinical Evaluation Research Unit in Kingston, Ontario, Canada for analysis, where they will be kept in a locked office with a password-protected computer. All analyses will be based on aggregate responses only. If any single subgroup has less than 5 responses the results with be combined with another group. Your opinions are very important! Of course, your participation is voluntary.

If you have any questions or comments, please contact:

Thank you for your participation!

Part A: Barriers to Delivery of Enteral Nutrition

This section relates specifically to barriers to providing adequate enteral nutrition to patients in your ICU. A barrier is something that hinders your ability to deliver adequate amounts of EN. Below is a list of items that have been identified as barriers to feeding critically ill patients. For each potential barrier, circle the number that best reflects on average the situation in your ICU. By circling number 1 (Not at all important) you believe that it is not a barrier. By circling number 7 (Very important) you believe that it is a major barrier.

	Not a Barrier → Major Barrier						
	Not at all Important	Unimportant	Somewhat Unimportant	Neither Important or Unimportant	Somewhat Important	Important	Very Important
Guideline Recommendations and Implementation Strategies							
1. I am not familiar with our current guidelines for nutrition in the ICU.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
2. Current scientific evidence supporting some nutrition interventions is inadequate to inform practice.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
3. The language of the recommendations of the current guidelines for nutrition are not easy to understand.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
4. The current guidelines for nutrition are not readily accessible when I want to refer to them.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
5. No feeding protocol in place to guide the initiation and progression of enteral nutrition.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
6. Current feeding protocol is outdated.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
ICU Resources							
7. Not enough nursing staff to deliver adequate nutrition.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
8. Enteral formula not available on the unit.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
9. No or not enough feeding pumps on the unit.	**1**	**2**	**3**	**4**	**5**	**6**	**7**

	Not a Barrier						Major Barrier
	Not at all Important	Unimportant	Somewhat Unimportant	Neither Important or Unimportant	Somewhat Important	Important	Very Important
Dietitian Support							
10. Waiting for the dietitian to assess the patient.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
11. Not enough dietitian time dedicated to the ICU during regular weekday hours.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
12. No or not enough dietitian coverage during evenings, weekends and holidays.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
13. There is not enough time dedicated to education and training on how to optimally feed patients.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Delivery of Enteral Nutrition to the Patient							
14. No feeding tube in place to start feeding.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
15. Delay in physicians ordering the initiation of EN.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
16. Waiting for physician/radiology to read x-ray and confirm tube placement.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
17. Delays in initiating motility agents in patients not tolerating enteral nutrition (i.e. high gastric residual volumes).	**1**	**2**	**3**	**4**	**5**	**6**	**7**
18. Delays and difficulties in obtaining small bowel access in patients not tolerating enteral nutrition (i.e. high gastric residual volumes).	**1**	**2**	**3**	**4**	**5**	**6**	**7**
19. In resuscitated, hemodynamically stable patients, other aspects of patient care still take priority over nutrition.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
20. Poor communication amongst the ICU team regarding the nutrition management resulting in delays in initiating or progression of EN.	**1**	**2**	**3**	**4**	**5**	**6**	**7**

	Not a Barrier → Major Barrier						
Critical Care Provider Attitudes and Behaviour	**Not at all Important**	**Unimportant**	**Somewhat Unimportant**	**Neither Important or Unimportant**	**Somewhat Important**	**Important**	**Very Important**
21. Non-ICU physicians (i.e. surgeons, gastroenterologists) requesting patients not be fed enterally.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
22. Nurses failing to progress feeds as per the feeding protocol.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
23. Feeds being held due to diarrhea.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
24. Fear of adverse events due to aggressively feeding patients.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
25. Feeding being held too far in advance of procedures or operating room visits.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
26. General belief among ICU team that provision of adequate nutrition does not impact on patient outcome.	**1**	**2**	**3**	**4**	**5**	**6**	**7**

27. Reflecting on the 26 barriers to providing enteral nutrition listed above, are there any other barriers that hinder your ability to deliver adequate amounts of enteral nutrition?

_____
_____ _____
_____
_____
_____ __

28. Reflecting on the 26 barriers to providing enteral nutrition listed above, enter the number corresponding to the items that you believe are the 3 most important barriers to the provision of adequate EN in your ICU:

- First most important barrier: ☐
- Second most important barrier: ☐
- Third most important barrier: ☐

Part B: Personal Characteristics
Please check the box that best corresponds to you.

1. What is your sex? Male ☐ Female ☐

2. How old are you?
   - 34 years or less ☐
   - 35-49 years ☐
   - 50-64 years ☐
   - 65 years or older ☐

3. What is your primary clinical specialty?
   - Dietitian ☐
   - Nurse ☐
   - Physician ☐ Please select one:
     - Intensivist (Medical) ☐
     - Intensivist (Surgical) ☐
     - Anaesthesia ☐
     - Emergency Medicine ☐
     - Internal Medicine ☐
     - Surgeon ☐
     - Other clinical specialty ☐ Please specify _____

4. How would you describe your current employment status in the ICU?
   - Full-time ☐
   - Part-time ☐ Full-time equivalent:_____
   - Locum ☐
   - Casual ☐
   - Trainee ☐
   - Other ☐ Please specify _____

5. How long have you been working in the ICU?
   - 0 - 5 years ☐
   - 6 - 10 years ☐
   - 11 - 15 years ☐
   - Greater than 15 years ☐

6. Do you play a leadership role in the ICU? Yes ☐ No ☐
   If yes, please specify:
   - Medical Director ☐
   - Nurse Manager ☐
   - Clinical Nurse Specialist ☐
   - Charge Nurse ☐
   - Other ☐

Additional Comments

You have now completed the questionnaire – thank you! In the space below, please make any additional comments you wish to make about barriers or solutions to providing adequate enteral nutrition to patients in your ICU.

Thank you very much for taking the time to complete this questionnaire.
Your contribution is valued.

Appendix F

Proposed Revisions to the Barriers to Feeding Critically Ill Patients Questionnaire

Barriers to Feeding Critically Ill Patients

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Several Clinical Practice Guidelines (CPGs) pertaining to critical care nutrition have been developed and published in recent years. These CPGs are typically nationally developed broad statements of best practice that refer to the average mechanically ventilated critically ill adult patient. Often, these guidelines are adapted for local use, and incorporated into local policy documents and bed-side protocols/algorithms. For brevity, throughout this survey, the term 'current guidelines for nutrition' will be used to refer to the nutrition guidelines currently used, if any, to inform decisions about feeding patients in your ICU. When we refer to feeding protocols, we are referring to tools designed to operationalize the guidelines at the bedside for patient care.

This questionnaire is divided into 2 sections and should take you approximately 5 to 10 minutes to complete. Please read these instructions before starting:

- Read each question, including all the options, before giving an answer.
- Choose the answer that is most applicable to your situation.
- Choose only one answer, unless requested otherwise.
- Complete the questionnaire from your perspective of the situation in your ICU – do not consider what you think others would say.
- If you have any additional comments, questions or concerns regarding nutrition guidelines, barriers to delivering enteral nutrition, or this survey, please write them in the space allotted at the end of the questionnaire.

By completing the questionnaire you are consenting for your responses to be used as part of ongoing quality improvement work in your unit. However, your responses are strictly confidential. Your opinions are very important! Of course, your participation is voluntary.

If you have any questions or comments, please contact us:

Thank you for your participation!

Part A: Barriers to Delivery of Enteral Nutrition

A barrier is something that hinders your ability to deliver adequate amounts of EN. Below is a list of 20 items that have been identified as barriers to feeding critically ill patients. Read each one carefully. If the item is a barrier in your ICU, indicate its MAGNITUDE and how OFTEN it occurs by circling the appropriate number. By circling number 1 (a little) you believe that it results in some delay or interruption to the provision of EN. By circling number 5 (a great deal) you believe that the provision of EN is severely affected when this factor is present. By circling number 1 (infrequently) you believe that this barrier affects less than 10% of patients. By circling number 5 (most or all the time), you believe that this barrier affects more than 90% of your patients. If the item is NOT a barrier in your ICU, circle 0. For each potential barrier, circle the number that best reflects on average the situation in your ICU.

	Not a Barrier	If Yes, To what DEGREE does it hinder the provision of EN?					If Yes, How OFTEN does it occur?				
		A little				A great deal	Infrequently				Most or all the time
Delivery of Enteral Nutrition to the Patient											
1. Delay in physicians ordering the initiation of EN.	0	1	2	3	4	5	1	2	3	4	5
2. Waiting for physician/radiology to read x-ray and confirm tube placement.	0	1	2	3	4	5	1	2	3	4	5
3. Frequent displacement of feeding tube, requiring reinsertion.	0	1	2	3	4	5	1	2	3	4	5
4. Delays in initiating motility agents in patients not tolerating enteral nutrition (i.e. high gastric residual volumes).	0	1	2	3	4	5	1	2	3	4	5
5. Delays and difficulties in obtaining small bowel access in patients not tolerating enteral nutrition (i.e. high gastric residual volumes).	0	1	2	3	4	5	1	2	3	4	5
6. In resuscitated, hemodynamically stable patients, other aspects of patient care still take priority over nutrition.	0	1	2	3	4	5	1	2	3	4	5
7. Nutrition therapy not routinely discussed on patient care rounds.	0	1	2	3	4	5	1	2	3	4	5
ICU Resources											
8. Enteral formula not available on the unit.	0	1	2	3	4	5	1	2	3	4	5
9. No or not enough feeding pumps on the unit.	0	1	2	3	4	5	1	2	3	4	5

	Not a Barrier	If Yes, To what DEGREE does it hinder the provision of EN?					If Yes, How OFTEN does it occur?				
		A little				A great deal	Infrequently				Most or all the time
Critical Care Provider Attitudes and Behaviour											
10. Non-ICU physicians (i.e. surgeons, gastroenterologists) requesting patients not be fed enterally.	**0**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
11. Nurses failing to progress feeds as per the feeding protocol.	**0**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
12. Feeds being held due to diarrhea.	**0**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
13. Fear of adverse events due to aggressively feeding patients.	**0**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
14. Feeding being held too far in advance of procedures or operating room visits.	**0**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
15. Lack of familiarity with current guidelines for nutrition in the ICU.	**0**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
16. General belief among ICU team that provision of adequate nutrition does not impact on patient outcome.	**0**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Dietitian Support											
17. Waiting for the dietitian to assess the patient.	**0**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
18. Dietitian not routinely present on weekday patient rounds.	**0**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
19. No or not enough dietitian coverage during evenings, weekends and holidays.	**0**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
20. Not enough time dedicated to education and training on how to optimally feed patients.	**0**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**

Part B: Personal Characteristics
Please check the box that best corresponds to you.

1. What is your sex? Male ☐ Female ☐

2. How old are you?
   - 34 years or less ☐
   - 35-49 years ☐
   - 50-64 years ☐
   - 65 years or older ☐

3. What is your primary clinical specialty?
   - Dietitian ☐
   - Nurse ☐
   - Physician ☐ Please select one:
     - Intensivist (Medical) ☐
     - Intensivist (Surgical) ☐
     - Anaesthesia ☐
     - Emergency Medicine ☐
     - Internal Medicine ☐
     - Surgeon ☐
     - Other clinical specialty ☐ Please specify _____

4. How would you describe your current employment status in the ICU?
   - Full-time ☐
   - Part-time ☐ Full-time equivalent:_____
   - Locum ☐
   - Casual ☐
   - Trainee ☐
   - Other ☐ Please specify _____

5. How long have you been working in the ICU?
   - 0 - 5 years ☐
   - 6 - 10 years ☐
   - 11 - 15 years ☐
   - Greater than 15 years ☐

6. Do you play a leadership role in the ICU? Yes ☐ No ☐
   If yes, please specify:
   - Medical Director ☐
   - Nurse Manager ☐
   - Clinical Nurse Specialist ☐
   - Charge Nurse ☐
   - Other ☐

Additional Comments

You have now completed the questionnaire – thank you! In the space below, please make any additional comments you wish to make about barriers or solutions to providing adequate enteral nutrition to patients in your ICU.

Thank you very much for taking the time to complete this questionnaire.
Your contribution is valued.