Optimizing Enteral Nutrition in Critically Ill, Mechanically Ventilated Adult Patients

Submitted by

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A Direct Practice Improvement Project Presented in Partial Fulfillment

of the Requirements for the Degree

Doctor of Nursing Practice

Grand Canyon University

Phoenix, Arizona

April 7, 2020

GRAND CANYON UNIVERSITY

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Abstract

Research has indicated that many instances of iatrogenic malnutrition among critically ill adults was connected to inadequate feeding practices within the critical care units. The purpose of this quantitative, quasi-experimental project was to determine if or to what degree the implementation of an evidence-based enteral nutrition protocol would impact enteral caloric intake and increase serum albumin levels for critically ill, mechanically ventilated patients in a mixed medical-surgical intensive care unit at a community hospital in the metropolitan Phoenix area over four weeks. The quality improvement project was based on the theoretical frameworks of Maslow and Neuman, in addition to, the Nutritional Care Process Model to govern the assessment and implementation process for an enteral feeding program. A total of seven patients were identified who met criteria for the pre-intervention group and a total of five patients were identified who met criteria for inclusion in the post-intervention group. A Mann-Whitney *U* statistical analysis was used to show the differences between the pre-intervention group and the post-intervention groups. The post-intervention group showed an increase in cumulative caloric intake as compared to the pre-intervention group (U=2.00; p=0.01). However, there was no statistically significant difference between the changes in albumin for the pre-intervention group and the post-intervention group (U=7.50; p=0.177) Therefore, the findings suggested that the implementation of an enteral nutrition protocol to guide clinical practice may improve enteral caloric intake for mechanically ventilated, critically ill patients. Recommendations included extending the project in other units who have mechanically ventilated patient over a longer period with an aim of attaining a larger sample size in order to analyze serum albumin levels.

Keywords: Enteral nutrition, critically ill, malnutrition, protocols, and clinical outcomes

Dedication

I firmly believe that the only way to the other side of something is to go through it. I believe that every experience has a purpose. I would like to dedicate this manuscript to all my cheerleaders. This is for all my friends and family who have kept me on track. This is also for my friends and family who have forgiven me my absences over the past couple of years but still hold me close. This is for those who have given me an enormous amount of support and encouragement. Without all of you, I would not have been able to make it to this point in my academic career. I love you, all!

Acknowledgements

I would like to acknowledge my boss, Dr. Kristina Zimmermann, who allowed me a great deal of latitude with my work schedule so that I could have enough time to pursue this academic path. I would like to acknowledge my local chairperson, Dr. Donna Egnatios, who entertained multiple calls and emails on a weekly basis during this journey. I would like to acknowledge and thank everyone who served as mentors and guides throughout this program. Very special thank you to Dr. Laura Smith who encouraged me to “go for it!” when I a questioned this fool-hearted decision to pursue my doctorate. My life has been filled with an amazing group of remarkable individuals who continue to help me grow. I am blessed beyond measure!

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Chapter 1: Introduction of the Project

Iatrogenic malnutrition has been defined as malnutrition related to inadequate nutritional intake while hospitalized and under the care of medical professionals (Butterworth, 1974). Iatrogenic malnutrition has a corollary relationship with increased hospital expenditures, morbidity, and mortality in critically ill, mechanically ventilated patients (Allard et al., 2016; Argarwal et al., 2013, Curtis et al., 2017). Critically ill, mechanically ventilated patients exhibit an accelerated metabolism (Kuslapuu, Jogela, Starkopf, & Blaser, 2015; Yeh et al., 2016; Yin et al., 2015) that requires a nutritional plan that compensates for the increased metabolic needs (Wang et al., 2017). Critically ill, mechanically ventilated patients require provider intervention in order to receive essential nutrients that support substantive bodily functions (Rubinsky & Clark, 2012). Failure to meet the metabolic needs of critically ill, mechanically ventilated patients can result in catabolism that causes compromised bodily functions, considerable muscle wasting, and poor clinical outcomes (Singer, 2019). Patients who fall into the vicious cycle of catabolism are in danger of experiencing iatrogenic malnutrition (Iwuoha & Akwaowo, 2014).

Existing literature estimates that nearly 40% of critical ill, hospitalized adult patients experience iatrogenic malnutrition (Corkins et al., 2014; Mauldin & O’Leary-Kelley, 2015). Enteral feeding is the preferred route for providing nutrition to critically ill, mechanically ventilated patients because it preserves the function of the gastrointestinal tract and prevents the translocation of intestinal bacteria (Rubinsky & Clark, 2012). Despite numerous studies indicating a number of enteral nutrition protocols in place to provide for the nutritional needs of critically ill, mechanically ventilated patients (Li et al., 2017; Stewart, 2014; Stewart et al., 2017), iatrogenic malnutrition persists and places patients at risk for negative clinical outcomes in critically ill, mechanically ventilated patients (Blaser et al., 2017; Samadi, Zeinali, Habibi, &

Ghotbodin-Mohammadi, 2016). The provision of optimal nutrition is essential to ensuring the best possible outcomes in critically ill, mechanically ventilated patients (Yeh et al., 2016); therefore, efforts to support adequate nutrition in this vulnerable population is paramount to prevent iatrogenic malnutrition (Orinovsky & Raizman, 2018).

The critical care unit that was the site for this project did not have an enteral nutrition protocol in place. Practice among bedside clinicians was considered inconsistent by medical and dietary staff. The intention of this Direct Practice Improvement (DPI) project was to implement an evidence-based enteral nutrition protocol for the purpose of evaluating whether a specific protocol improved enteral nutrition intake in the intensive care unit (ICU) of an Arizona hospital. Additionally, the quality improvement project evaluated if the serum albumin levels of critically ill patients who were treated with the guidance of the protocol remained steady or improve as an indication of nutritional status.

This chapter acquaints readers with the various facets of the DPI project. A background of the project follows this introduction and relays the history of the problem. Existing evidence related to the institution of enteral nutrition protocols for critically ill, mechanically ventilated patients is provided to add support. Then, this chapter offers a problem statement that indicates the affected population and provides commentary on the need for the project. Next, a discussion of the purpose of the project ensues to illuminate why the subject matter was worthy of exploration and how the project contributed to improving practice.

Two clinical questions are presented in this chapter to describe the variables that were investigated, and the implications gleaned in conjunction with this project. The intent to advance scientific knowledge and address the need for further evidence has been discoursed within this chapter, followed by significance of the project, the rationale for the methodology selected, the nature of the project, a list of terms with definitions used within the project, assumptions, limitations, and delimitations of the project. This chapter concludes with a summation of chapter content and a discussion of how the remainder of the project will be organized.

Background of the Project

Existing research into enteral feeding practices in critical care units globally has revealed an ongoing opportunity to improve early assessments of nutritional requirements, timely initiation of enteral feeding, and maintaining adequate daily caloric intake to promote the best outcomes in critically ill, mechanically ventilated patients (Stewart et al., 2017). Other deficiencies noted in literature are inconsistencies in clinical practice among bedside nurses which underscores a lack of understanding of current evidence for nutritional support for critically ill, mechanically ventilated patients (Morphet, Clarke, & Bloomer, 2016). The existence of knowledge deficits related to appropriate enteral nutritional practices among bedside nurses remains detrimental to patient healing and overall outcomes (Van Blarcom & McCoy, 2018).

Educational gaps among bedside nurses have been shown to negatively affect patient outcomes (Kalaldeh & Shahein, 2014); however, there are other consequences to harboring malnutrition in critical care units (Avelino-Silva & Jaluul, 2017; Cox & Rasmussen, 2014). The considerable complications associated with iatrogenic malnutrition secondary to inadequate enteral nutrition can suborn a cascade of events that affect clinical outcomes and allocation of hospital resources (Hoffer & Bistrian, 2016; Serena, Yaakov, DeLegge, & Mayhugh, 2018). Poor wound healing, suppression of the immune system, and physical deconditioning are just some of the problems that stem from iatrogenic malnutrition in critically ill, mechanically ventilated patients (Preiser et al., 2015). Thus, early assessments for the nutritional requirements for every critically ill, mechanically ventilated patient along with timely commencement of an enteral nutrition prescription is vital to supporting the proper metabolic foundation for optimal outcomes (Cox & Rasmussen, 2014).

A comprehensive enteral nutrition program which delivered the caloric requirements for critically ill, mechanically ventilated patients has been noted as a vital aspect of the plan of care (Blaser et al., 2017). Patients with serious illnesses exhibit excessively high metabolic requirements (Kuslapuu et al., 2015); therefore, clinicians must be attuned to the catabolic state of critically ill, mechanically ventilated patients (Ostergaard et al., 2015). An enteral nutrition program must take into account the metabolic deficits associated with critical illness in order to avoid catastrophic metabolic imbalances and poor outcomes (Kirkland, Kashiwagi, Brantley, Scheurer, & Varkey, 2013; Norman, Pichard, Lochs, & Parlich, 2008). Failure to properly address the nutritional requirements of critically ill, mechanically ventilated patients can have dire consequences for patient outcomes.

The critical care unit in the project site consisted of 84 nurses with various educational backgrounds and skill levels. Some nurses felt that enteral nutrition should be interrupted for patient repositioning to prevent aspiration, although there was no evidence to support that stance (DiLibero, Lavieri, O'Donoghue, & DeSanto-Madeya, 2015). Also, many nurses felt that gastric residual volumes (GRV) should be assessed frequently and that once a certain volume was obtained, enteral nutrition should be interrupted. Current evidence did not support discontinuation of enteral nutrition for high GRV as the first line of action, and there was no consensus within the literature as to the volume that qualifies as a high GRV (Ozen et al., 2016).

The absence of a standardized enteral nutrition protocol has led to an inconsistent approach to delivering enteral nutrition. Since frequent interruptions in enteral feeding has resulted in critically ill patients not receiving their allotted daily allowance of calories (Wiese, Rogers, Way, & Ballard, 2019), it was plausible that the patients in the critical care unit of the project site were being underfed which could theoretically put them risk for iatrogenic malnutrition. The implementation of an evidence-based enteral nutrition protocol could have improved enteral feeding practices in the critical care unit and reduced the number of patients who succumb to iatrogenic malnutrition.

Problem Statement

It was not known if the use of a specific evidence-based enteral nutrition protocol would improve the three-day cumulative caloric intake of acute critically ill, mechanically ventilated adults over a six-week time frame. The established practice for the commencement of enteral feeding entailed a physician order for a dietary consultation for an enteral nutrition prescription that was usually placed within the electronic medical record or verbalized to the nursing staff within 48 hours of a critically ill patient being initiated on mechanical ventilation. Assuming the order was placed correctly, a registered dietitian prescribed an enteral formula and rate that was designed to meet the critically ill patient's daily caloric needs. It was the responsibility of the bedside nurse to initiate and maintain the enteral nutrition regimen.

Bedside nurses have reported differing levels of knowledge when it came to enteral feeding practices as it related to hemodynamic instability, patient positioning issues, feeding intolerance, and other clinical presentations (Kim & Chang, 2019). Enteral feeding may be delayed due to low prioritization of nutritional needs in favor of more pressing life-threatening demands or other distracting clinical issues (Orinovsky & Raizman, 2018). The discrepancies in both established practice and current knowledge of the evidence that supported optimal nutrition in critically ill, mechanically ventilated patients have had considerable, long-term consequences in terms on increased lengths of stays, morbidity, and mortality (Singer, 2019).

The overwhelming majority of existing evidence supported the use of a sensible, standardized, evidence-based enteral nutrition protocol for critically ill, mechanically ventilated patients to advance the best possible outcomes (Orinovsky & Raizman, 2018). To improve patient care and safeguard patients against underfeeding, an evidence-based nutritional support protocol was applied in a 25-bed critical care unit. The introduction of the protocol included some education for bedside clinicians in terms of best practice advice and encouragement for compliance in the implementation of the protocol to improve the three-day cumulative caloric intake of critically ill, mechanically, ventilated patients.

Purpose of the Project

The purpose of this quantitative, quasi-experimental project was to assess the efficacy of an evidence-based protocol aimed at optimization of enteral nutrition for critically ill, mechanically ventilated patients to improve the cumulative caloric intake over three days from the time of intubation. Additionally, there was an assessment of the patient's serum albumin level on the day of feeding initiation and three days later for use as an indication of nutritional status. The data extrapolated came from a single 25-bed ICU located within an Arizona community, non-trauma hospital staffed with a total of 84 nurses who provided care to up to 25 critically ill, mechanically ventilated patients. The clinical site was a mixed medical and surgical unit that only admitted adults over the age of 18.

Previous attempts have been made to improve enteral nutrition intake in the ICU. Over a year ago, a plan was introduced to implement a volume-based enteral nutrition feeding plan. The volume-based plan called for patients who have had their enteral nutrition interrupted to have their hourly rates of enteral nutrition infusion increased to make up for enteral nutrition formula that was missed during the period of enteral feeding interruption (McClave et al., 2016). The intention of the volume-based feeding plan was to attain the prescribed volume goal for the 24-hour period.

Practice has remained inconsistent among registered nurses (RN), and the registered dietitians (RD) had expressed concern that patients were still not receiving their daily prescription for caloric intake via enteral nutrition. An exploration of the relationship between implementing an enteral nutrition protocol with clinical practice guides and the provision of an optimized nutritional regimen was thought to improve enteral nutrition intake and clinical outcomes.

The link between the inception of an enteral nutrition protocol to guide clinical practice and the provision of the daily prescription for caloric intake was assessed through data collected from the electronic medical record (EMR) at the site over a six-week period. The independent variable was the nurse-driven enteral nutrition protocol with clinical triggers to guide clinical practice. The dependent variable was the cumulative caloric intake of patients over three days and the serum albumin level on the first day of intubation and day three after intubation.

The pre-intervention data consisted of a review of charts for critically ill, mechanically ventilated patients who were intubated for at least three days for the time period of December 1, 2018 to January 11, 2019. The pre-intervention data included the registered dietitian (RD) notes for the daily enteral nutrition prescription. Additionally, the registered nurse’s (RN) notes for intake and output and the laboratory report of serum albumin levels on the day of intubation and day three after intubation were included.

The post-intervention data was performed through a review of charts for a period of six weeks after the enteral nutrition protocol was implemented. Post-intervention data collection included critically ill, mechanically ventilated patients who were intubated at least three days. The post-intervention data included the cumulative caloric intake of patients for three days and the serum albumin level for those patients on the day of intubation and day three of intubation.

Literature has demonstrated that critically ill, mechanically ventilated patients continue to be underfed while in the ICU (Chakravarty, Hazarika, Goswami, Ramasubban, 2013; Correia et al. 2014). The results of this quality improvement project were used to validate the usefulness of an evidence-based enteral nutrition protocol to ensure that critically ill, mechanically ventilated patients are fully fed. Thus, the outcomes of this project will contribute to the existing body of knowledge to promote the use of standardized, systematic enteral nutritional protocols.

Clinical Questions

The intention of this quality improvement intervention was to improve the nutritional status of critically ill, mechanically ventilated adult patients using an evidence-based enteral nutrition protocol. The clinical questions allowed for the composition of a PICOT question that hypothesized whether the implementation of an evidence-based enteral nutrition protocol could improve enteral nutrition intake for critically ill, mechanically ventilated patients within the ICU project site. The following clinical questions served as a guide for this quantitative project:

Q1. Was the three-day cumulative caloric intake of enteral nutrition improved in adult critically ill, mechanically ventilated patients following the implementation of an evidence-based enteral nutrition protocol over a six-week period?

Q2. Did implementing an evidence-based algorithm to enhance enteral nutrition practices maintain or improve serum albumin levels of critically ill, mechanically ventilated patients as compared to the current standard of care in six weeks?

The intervention assessed whether the use of the algorithm to guide clinical practice positively influenced a specific metabolic profile of critically ill, mechanically ventilated adult patients. The enteral nutrition protocol that was used was validated previously in a European hospital by Orinovsky and Raizman (2018). The intervention phase began with a 20-minute in-service to educate nursing staff regarding the background of the project and introduced the enteral nutrition protocol. The in-service offered a brief insight into contradictions that exist between current practice and available evidence in support of an enteral nutrition protocol.

In the first clinical question, the dependent variable was the cumulative three-day caloric enteral nutrition intake before and after the intervention; the independent variable was the evidence-based enteral nutrition protocol implemented to affect enteral nutritional intake. In the second clinical question, an additional independent variable was added to assess the enteral nutrition protocol's (independent variable) influence upon the serum albumin level at day three of intubation (dependent variable). The addition of a second dependent variable to the quantitative project expanded the results of the study and served to further validate the enteral nutrition protocol tool that was utilized.

The facility IRB exempted the project from full board review on November 19, 2019. Institutional Review Board (IRB) for the university exempted the project from full board review on December 2, 2019 (See Appendix A). This project employed a quasi-experimental, quantitative design to observe the influence of an enteral nutrition protocol on the cumulative caloric intake for critically ill, mechanically ventilated patients for three days after intubation in the ICU of an Arizona community hospital. A quasi-experimental design was chosen to forego the ethical conflicts that could arise related to withholding beneficial care for critically ill, mechanically ventilated patients. Therefore, all the critically ill, mechanically ventilated patients received care guided by the enteral nutrition protocol for the six-week duration of the quality improvement project.

Advancing Scientific Knowledge

Past decades have amassed a host of research into iatrogenic malnutrition and enteral nutrition practices for critically ill patients (Avelina-Silva & Jaluul, 2017; Butterworth, 1974; Campos-Machado, Caruso, De Azevedo-Lima, Tiexeira-Damasceno, Garcia-Soriano, 2015). Several validated enteral nutrition protocols have been found in the literature that have yielded variable positive results (Blaser et al., 2017; Bousie, Van Blokland, & Van Zanten, 2016; Li et al., 2017; Orinovsky & Raizman, 2018). A gap in knowledge and practice existed as there was no consensus on a validated method or tool to ensure that adult critically ill patients had enteral nutrition implemented in a timely fashion despite agreements in the literature regarding the need for early assessment and intervention to prevent iatrogenic malnutrition (Allingstrup et al., 2017; Correia et al, 2014).

The enteral protocol that was chosen for the DPI project was implemented in a European hospital and has contributed to the body of available knowledge (Orinovsky & Raizman, 2018). This quantitative project implemented the same enteral nutrition protocol used in that study to improve clinical practice and the provision of enteral nutrition for critically ill, mechanically ventilated patients in the ICU of an Arizona community hospital. This specific enteral nutrition protocol for this project was purposely selected for its simplicity and ease to follow. The presence of an uncomplicated protocol was aimed at increasing the likelihood of staff compliance and usability in other clinical settings (Brown, Snyder, & Bobrowsky, 2019).

The project highlighted the relationship that existed between optimizing patient nutrition and improving the cumulative intake of caloric intake in critically ill, mechanically ventilated patients in the acute care setting. This quantitative, DPI project added further validation to the use of an enteral nutrition protocol; thereby, advancing scientific knowledge into the use of enteral nutrition protocols to standardize clinical practice and improve patient care.

The project was built on the Neuman's (1972) systems model, Maslow's (1943) hierarchy of needs, and the Nutrition Care Process Model (Hammond, Myers, & Trostler, 2014). Neuman's (1972) systems model stressed that patients were in a constant state of being influenced by the outside environment in contribution to either a state of wellness or illness. Under Neuman's (1972) model, nurses were responsible for recognizing threats from the environment and enacting interventions that return patients to a state of wellness. Maslow (1943) claimed that nutrition was a basic human need that must be realized before any higher needs to be met. By using the Neuman's systems model as the foundation for the project, the interrelatedness of nutrition and clinical outcomes could be appreciated and prompt an improvement in clinical practice (Ahmadi & Sadeghi, 2017; Neuman & Fawcett, 2011; Neuman & Young, 1972). If nurses recognized the threat that iatrogenic malnutrition poses to critically ill, mechanically ventilated patients, then they could have taken the necessary steps to ensure that patients received adequate enteral nutrition (Schaefer et al., 2018).

Abraham Maslow (1943) theorized that nutrition was part of the basic foundation of human existence. Critically ill, mechanically ventilated patients have been reliant upon their care providers for vital sustenance. Therefore, care providers were responsible for ensuring that critically ill patients received adequate enteral nutrition. The Nutritional Care Process Model (NCPM) provided a framework for the systematic assessment of patient-specific needs and the implementation of a comprehensive enteral nutrition plan for critically ill patients (Hammond, Myers, & Trostler, 2003). The NCPM is intended to govern RD practice, but there has always been an interprofessional relationship that has existed between nurses and dietitians to best meet the patients' needs (Schellhardt, 2017). The relationship has functioned synergistically in the provision of care for critically ill, mechanically ventilated patients. An evidence-based enteral nutrition protocol has been noted to strengthen the collaborative relationship and guide nurses toward the best clinical practices to provide optimal nutrition (Li et al., 2017; Orinovsky & Raizman, 2018).

The quantitative DPI project was built upon these theoretical frameworks and contributed to a better understanding of the need for evidence-based enteral nutrition protocols. The accumulation of evidence served to improve nursing knowledge regarding enteral practices that met the needs of patients under their care. Through the project, scientific knowledge was advanced, and the quality of care was improved for critically ill, mechanically ventilated patients in the intensive care unit.

Significance of the Project

This project had the potential for important implications. The objective of the project was to evaluate the effectiveness of implementing an evidence-based enteral nutrition protocol to improve the cumulative caloric intake of adult critically ill, mechanically ventilated patients in an ICU of an Arizona community hospital. The introduction of an enteral nutrition protocol in the ICU facilitated the standardization of clinical practice based on current evidence (Li et al., 2017). It was expected that an enteral nutrition protocol kept nurses from making uninformed or ill-informed choices regarding enteral nutrition; thereby, allowing for patients to receive optimal enteral nutritional care.

Along with the standardization of care, bedside nurses were educated on current evidence that supported components of the enteral nutrition protocol. There was an opportunity to improve the knowledge of bedside nurses and enhance their engagement in evidence-based practice. Research has indicated that nursing knowledge plays a huge role in the provision of enteral nutrition (Hill, 2015; Kalaldeh & Shahein, 2014; Kuslapuu et al., 2015).

Providing optimal enteral nutrition was communicated to nurses in such a way as to promote meaningful changes in understanding and clinical practice. Evidence-based nutritional protocols with concise decision points have guided bedside clinicians and facilitated practice that reduces inappropriate feeding interruptions that diminish daily caloric intake which was needed to promote proper healing (Lakshmi & Vaidyanathan, 2012; Wang et al., 2017). These decision points included hemodynamic assessments, guidance for initiation and advancement to goal for enteral nutrition, and how to address instances of feeding intolerance (Orinovsky & Raizman, 2018).

Iatrogenic malnutrition has been studied to exist in a considerable number of critically ill patients (Corkins et al., 2014; Mauldin & O'Leary-Kelley, 2015). Despite advances in medicine and technology, iatrogenic malnutrition has remained a persistent problem within critical care units (Eglseer et al., 2018; Samadi et al., 2016). This project sought to confirm the efficacy of an evidence-based nutritional protocol to improve caloric intake of critically, ill mechanically ventilated patients with empirical data. The results associated with this project are intended to be added to the existing body of research to promote more evidence-based practices in other critical care units.

Rationale for Methodology

The clinical questions introduced variables that were used for analysis. The first clinical question asked whether the introduction of an enteral nutrition protocol (independent variable) would improve the three-day cumulative caloric intake (dependent variable) for adult critically ill, mechanically ventilated patients. The second clinical question asked whether the introduction of an enteral nutrition protocol (independent variable) would maintain or improve the serum albumin level (dependent variable) of critically ill, mechanically ventilated patients. These variables yielded valuable numerical results that underwent statistical analysis.

Due to a limited timeline of six weeks for the pre-intervention phase and a separate six weeks for the post-intervention phase, a convenience sampling was employed. Convenience sampling consisted of all adult critically ill, mechanically ventilated patients who were intubated for at least three days. Since there was no systematic means employed to obtain a representative sample, non-probability sampling was used on all patients in order to select those who met the criteria for inclusion and received the intervention (Shorten & Moorley, 2014). Also, convenience sampling was the most appropriate design due to the ease of use, and the principal investigator's access to the patient population, and the low overhead cost of assembling the sample (Elfil & Negida, 2017).

Nature of the Project Design

This project employed a quantitative, quasi-experimental approach to ascertain the efficacy of a specific nutritional protocol on the attainment of the daily goal for caloric intake for critically ill patients cumulatively over three days. Additionally, the study assessed the trend of the serum albumin of the patients from the day of intubation until three days after intubation. A quantitative approach was appropriate because the data collected was numerical in nature, and statistical analyses were employed to measure the relationship between the variables (Polit & Beck, 2012).

An experimental design required that patients be segregated into a control group and an experimental group (Polit & Beck, 2012). A quasi-experimental method has been deemed more suitable for this project because ethical constraints necessitated that critically ill patients are not denied the potential benefit of improved nutritional regimens in conjunction with this project (Fouka & Mantzorou, 2011). Additionally, a small sample size was anticipated which would have rendered an experimental design undoable.

A quasi-experimental design was used for this project to ascertain whether the enteral nutrition protocol would result in a higher three-day caloric intake of enteral nutrition among critically ill, mechanically ventilated patients. The use of an experimental design was dismissed out of the ethical consideration of depriving critically ill patients of higher-quality care. The sample consisted of data from patients intubated for at least three days who have an enteral nutrition order during the six-week periods encompassing the pre-intervention and post-intervention arms of the study.

Orinovsky and Raizman (2018) studied the effects of the enteral nutrition protocol that was used in the site selected for this protocol. The quality improvement project was conducted at a single site and the intervention was applied to all patients on mechanical ventilation for three days or more. The nursing staff participated in an in-service that provided brief, concise education on the evidence which supported the protocol and the protocol itself.

Providing education regarding evidence surrounding enteral nutrition practice afforded a foundation of understanding and compliance with regards to the enteral nutrition protocol. The in-services kick started the campaign to improve enteral nutrition practices within the intensive care unit. The current process of obtaining a physician order and consulting a registered dietitian for patient-specific prescriptions for enteral nutrition remained unchanged. The intervention was aimed at the bedside nurses who were administering enteral nutrition.

It was important to establish that this was not an education intervention. Nurses were not taught a new method of administering enteral nutrition. Instead, the quality improvement project introduced existing evidence in the form of an enteral nutrition protocol that standardized care practices among nurses. Introducing an evidence-based enteral nutrition protocol hopefully made nurses more conscientious about their practice and translated to better care for patients.

Definition of Terms

To promote understanding of the project and its scope, a list of the definitions of the terms used within the text is important. A list of terms germane to the project are included to ensure that reviewers had a clear understanding of the herein included content.

Acute Physiologic Assessment and Chronic Health Evaluation (APACHE II) score. The APACHE II is the second version of the Acute Physiological Assessment and Chronic Health Evaluation that was introduced in 1985 (Knaus, Draper, Wagner, & Zimmerman, 1985). It is a scoring system that grades the severity of patient illness (Merck, 2019). The scoring system is widely accepted as a means of predicting survival of critically ill patients (Merck, 2019). The point system is based on 12 physiological variables that include age, gender, and disease-related measurements (See Appendix G) (Knaus et al., 1985).

Dependent variable. The dependent variable is the presumed outcome of the study or variable that is impacted (Sylvia & Terhaar, 2014). The intention of the study is to improve the cumulative three-day caloric intake and serum albumin for critically ill, mechanically ventilated patients.

Electronic medical record. The electronic medical record (EMR) is a digitalized format for storage of health-related data of individual patients (Kutney-Lee, Sloane, Bowles, Burns, & Aikens, 2019). The data within the digitalized health record can be used to streamline workflows and improve the quality or safety of patient care (Kutney-Lee et al., 2019). Federal regulations govern the use, distribution, and security of electronic medical records (Health and Human Services, Office of the Secretary, Office for Civil Rights, 2013).

Enteral nutrition. The use of a tube to deliver a patient's daily nutrients into the gastrointestinal tract (American Society of Enteral and Parenteral Nutrition, n.d.). This method of feeding preserves the function of the gastrointestinal system and most closely mimics natural feeding (American Society of Enteral and Parenteral Nutrition, n.d.). Enteral nutrition is the preferred method of providing nutrition when a patient cannot take in oral nutrition independently (American Society of Enteral and Parenteral Nutrition, n.d.).

Gastric residual volume (GRV). The volume aspirated from within the stomach while receiving enteral nutrition (Metheny, Schallom, Oliver, & Clouse, 2008). Historically, providers and bedside caregivers felt that a high volume was indicative of feeding intolerance (Wiese et al., 2019). Current research has shown that the residual volumes of gastric contents during feeding can be due to a host of conditions that are not related to feeding tolerance (Wiese et al., 2019).

Iatrogenic malnutrition. This is a suboptimal nutrition state induced by a lack of adequate feedings while hospitalized (Iwuoha & Akwaowo, 2014). Patients who succumb to a severe illness that requires hospitalization may not receive nutritional intake that is appropriate to meet their needs (Iwuoha & Akwaowo, 2014). These patients can develop clinical malnutrition that can lead to poor outcomes if not treated in a timely fashion (Iwuoha & Akwaowo, 2014).

Independent variable.: The influential source upon the other variable or variables being studied (Sylvia & Terhaar, 2014). The use of an evidence-based algorithm was used to study its effect on the nutritional status of critically ill, mechanically ventilated patients.

Indirect calorimetry.: Method used to determine a patient's metabolic needs to determine the adequacy of nutritional prescriptions (Gupta, Ramachandran, Venkatesan, Anoop, Joseph, & Thomas, 2017). Metabolic needs are assessed through a device attached to a patient's ventilator that measures a patient's inhaled oxygen and expired carbon dioxide (Gupta et al., 2017). These numbers are entered into an equation to establish a patient's resting energy expenditure (REE) or metabolic needs (Gupta et al., 2017).

Intubation. Endotracheal intubation is a medical procedure performed by a trained provider in which a tube is placed into the windpipe (trachea) through the mouth or nose (Moll, 2018). The tube is then attached to a machine called a ventilator to aid in breathing (Moll, 2018). The purpose of intubation to provide a stable airway to support breathing through supplying oxygen and aiding in the removal of carbon dioxide (Moll, 2018).

Post-pyloric feeding. The use of a tube to deliver a patient's daily nutrients into the small bowel (Niv, Fireman, & Vaisman, 2009). This method is implemented for the patient who cannot tolerate feedings directly into the stomach. Post-pyloric feeding is the preferred method of feeding if patients cannot tolerate oral or stomach feedings.

Sequential Organ Failure Assessment (SOFA) score. The SOFA score is based on assessments of six different parameters that include respiratory, cardiovascular, neurological, renal, hematological assays, and hepatic function (Lambden, Laterre, Levy, & Francois, 2019). Each assessment parameter is given a point value of zero to four and the total score is used to indicate predicted mortality (Lambden et al., 2019). This score is usually calculated on admission to the critical care unit and updated daily (Lambden et al., 2019). Higher SOFA scores generally translate to higher mortality rates (See Appendix H) (Lambden et al., 2019).

Subjective Global Assessment (SGA) tool. The SGA is a tool used for nutritional assessments that is based on patient history, patient weight, dietary issues, functional capacity of the patient, and a subjective assessment of muscle mass (Gonzalez, Bielemann, Kruschardt, & Orlandi, 2019). The SGA can be used to identify malnutrition and prompt an intervention to address any nutritional deficiencies (Gonzalez et al., 2019). The SGA has been in existence for over 30 years and maintains a higher predictive validity that other tools that use subjective criteria (Gonzalez et al., 2019).

Assumptions, Limitations, and Delimitations

Conducting a quality improvement project to improve enteral nutrition practices had the potential to make a meaningful impact on patient care. It was important to acknowledge that some of the elements of the study could not be totally controlled, but nevertheless, were utterly needed within the project (Simon, 2011). Generally, researchers must acknowledge the presence of certain assumptions in order to convey to reviewers that such elements are expected to exist within the study (Leedy & Ormond, 2010). The assumptions related to the intervention outcomes were discussed within the following text.

The first assumption was that all critical care nurses and physicians were educated on the evidence in support of the protocol to encourage adherence to the protocol. Providing a basis for change rooted in evidence helped bedside nurses understand the need for altering practice; thus, fortifying the belief that all critical care nurses would follow the protocol in its entirety to improve patient care. Next, it was assumed that all critical care nurses documented accurate enteral intake and provided notations for interruptions or any reasons for discontinuation of enteral nutrition. The assumption aligned with expectations of practice within the critical care unit; therefore, it was expected that critical care nurses continued to document properly in the electronic medical record (EMR). The analysis of the intervention was heavily reliant upon complete, concise documentation from care providers.

The last assumption was that patients experienced more optimal enteral feedings as a result of the intervention. The use of an enteral nutrition protocol served to standardize practice and prevent unnecessary gaps in nutritional intake for critically ill patients. Ultimately, the intervention sought to ensure that critically ill, mechanically ventilated patients received optimal nutrition to support proper healing and metabolic functions.

In addition to the assumptions of the project, there were some limitations and delimitations that must be acknowledged. One limitation of the study was that a convenience sample was employed for the project. Convenience sampling did not allow for a representative sampling of the critically ill, mechanically ventilated patients within the ICU (Shorten & Moorley, 2014).

Another limitation that was present was the time frame of six-weeks for the pre-intervention and a separate six-weeks for post-intervention data analysis. A longer time frame would have allowed for the inclusion of more data sets and an opportunity to follow the patient's outcomes (Smith, 2011). Due to the use of convenience sampling and project timeframe constraints, generalizability would not possible or appropriate (Smith, 2011). Despite these limitations, this project was intended to impact clinical practice and improve the enteral nutrition intake of critically ill patients in the timeframe allotted.

A delimitation of this study was the choice of the site for the project. Patient populations can differ from one area of a city to another. The site chosen for this project was in one of the more affluent areas of town. Due to that fact, patients tended to present with different baseline nutritional statuses that patients in areas of more modest means.

Furthermore, the project was based on the theoretical foundations of Neuman (2011), Maslow (1943), and the Nutritional Care Process Model (Academy of Nutrition and Dietetics [Academy], 2003). Other theoretical frameworks may have been more advantageous to the project, such as theories that more attuned to organizational change. However, these theories and models chosen were deemed most appropriate to the study design and scope.

Finally, the intervention presented was one of many enteral nutrition protocols available for use in critical care units. The protocol chosen for this project encompassed the basic components of an evidence-based enteral nutrition protocol. This was a delimiting factor because other protocols existed that could have produced similar or better outcomes.

Summary and Organization of the Remainder of the Project

Despite the existence of substantial research touting ways and means to improve enteral nutrition for critically ill, mechanically ventilated patients (Li et al., 2017, Stewart, 2014; Stewart et al., 2017), the rates of iatrogenic malnutrition persisted in intensive care units in excess of 40% (Corkins et al, 2014; Mauldin & O'Leary-Kelley, 2015). The catabolic nature of severe illness can lead to significant debility, long-term ventilator dependency, and even death (Singer, 2019). It was prudent to introduce an enteral nutrition protocol that was simple to use and had clear clinical indicators for critical care nurses to follow (Li et al., 2017; Orinovsky & Raizman, 2018; Yeh et al., 2016).

Providing critical care nurses with a validated enteral nutrition protocol standardized practice and allowed patients to receive adequate enteral nutrition (Orinovsky & Raizman, 2018). Improving enteral nutrition practices has been dependent upon the translation of available evidence to support the best clinical practices and outcomes (Orinovsky & Raizman, 2018). Therefore, research into the effectiveness of specific enteral nutrition protocol added to the existing body of knowledge and could be applied to other intensive care units to improve care practices and patient outcomes (Morphet et al., 2016).

The intent of this DPI project was to ascertain how an enteral nutrition protocol influenced the three-day cumulative caloric intake of critically ill, mechanically ventilated patients in an ICU of an Arizonan community hospital. Additionally, the project observed whether the serum albumin level of critically ill patients was maintained or improved at day three of intubation with the use of the enteral nutrition protocol. The DPI project used a quasi-experimental, quantitative design to assess the relationship among the variables. Upon examination of the results, the project showed that the use of an enteral nutrition protocol increased enteral nutrition intake for critically ill, mechanically ventilated patients with statistically significant results that proved encouraging to future endeavors to improve practice.

Chapter One provided a background of the current problem and an introduction of a quality improvement project to improve enteral nutrition practices in the intensive care unit. Chapter Two provides a review of current literature on iatrogenic malnutrition along with enteral feeding practices and protocol elements germane to providing a foundation for a quality improvement project. Chapter Three provides a detailed discussion of project methodology to include research design, the rationale for the design chosen, and the data analysis procedures that were performed at the conclusion of the study. Lastly, Chapter Four and Chapter Five present the results of the quality improvement project and engage in an interpretive discussion of the finding of the project.

Chapter 2: Review of Literature

International studies have suggested that malnutrition rates have ranged from total of 40% to 60% of inpatient critically ill adults (Chakravarty et al., 2013; Mendes et al., 2017). Iatrogenic malnutrition in critically ill, mechanically ventilated patients correlated with increased complications and mortality (Vest et al., 2018). Since the days of Nightingale, there has been an assertion that proper healing cannot happen in the presence of inadequate nutrition (1859). Years later, Dr. Butterworth (1974) published an article to bring attention to the high number of patients who continued to develop iatrogenic malnutrition despite medical advances. Iatrogenic malnutrition has been avoidable through timely assessments of nutritional status upon admission, improving efforts to maintain nutrition throughout hospital stay, and educating bedside clinicians on the importance of diligence to adherence in implementing nutritional regimens (Butterworth, 1974). Unfortunately, efforts to eradicate iatrogenic malnutrition have failed and have remained a threat to patients' clinical outcomes (Souza, Sturion, & Faintuch, 2015).

Healthcare centers worldwide have been making efforts to improve the quality of nutritional care for critically ill patients (Berger et al., 2019; Elke et al., 2019). Existing literature has identified barriers to improving nutritional programs. Those barriers included ineffective or absent screening for nutritional deficits and improper nutritional tools to deliver valuable nutrients to vulnerable patients during times of high physical stress (Souza et al., 2015). These barriers served to sabotage patients' recovery and caused undue harm for those who entrusted their care and safety to hospitals (Butterworth, 1974; Souza et al., 2015). Therefore, it was important for critical care units to conduct timely, comprehensive nutritional assessment and initiate enteral nutrition promptly with the guidance of an evidence-based protocol to improve the quality of nutritional support (Kim & Chang, 2019). The purpose of the quality improvement project was to assess if a specific enteral nutrition protocol improved the cumulative nutritional intake for critically ill, mechanically ventilated patients.

The project began with a PICOT question that asked, "Did the introduction of an evidence-based enteral nutrition protocol improve enteral nutrition intake for adult, critically ill, mechanically ventilated patients within six weeks*?"* The university's online library provided a vehicle to explore available evidence pertaining to enteral nutrition for critically ill, mechanically ventilated adult patients. The platforms used within the university's online library included Medline (PubMed), the Cumulative Index of Nursing and Allied Health Literature (CINAHL), Science Direct, the Cochran Review, and a host of academic journals. The search terms used were *malnutrition, iatrogenic malnutrition, critical care, critically ill, adults, mechanical ventilation, nursing knowledge, enteral nutrition, enteral nutrition protocols, and clinical outcomes.* The resultant literature amassed was refined to include only those articles that were within five years of publication, written in English, and focused on an adult population in an intensive care unit. The main themes that emerged from the critical appraisal of the literature are *nutritional assessments, enteral nutrition protocols,* and *clinical outcomes*.

Chapter Two provides a contextual foundation for the project through the examination of theoretical foundations that supported the evidence-based project and the existing literature on enteral nutritional practices in adult critical care units. The project used theories and a conceptual model to help explain phenomena noted in healthcare and provided structure to further scientific inquiry. The remainder of Chapter Two provides a comprehensive review of literature that centered around three main themes. Each theme was expanded upon to reveal the three subthemes that examine the current gaps in knowledge and clinical practice in conjunction with the project. The chapter concludes with a summary of themes explored and relevant commentary regarding subsequent chapters.

Theoretical Foundations

The project aligned a quality improvement initiative with theoretical foundations that were known and accepted within the scientific community. The scientific underpinnings associated with theory served to underscore aspects of the human condition and guide nursing research on how to best construct practices to best meet the needs of patients. The theoretical foundations presented provided a platform to present evidence to support the implementation of an enteral nutrition protocol for critically ill, mechanically ventilated patients to enhance the quality of care and improve patient outcomes. This project was based on Maslow's (1974) hierarchy of need, Neuman's (1972) systems model (NSM), and the Nutrition Care Process Model (Academy of Nutrition and Dietetics [Academy], 2003).

Abraham Maslow's hierarchy of needs. Humans are sentient beings with basic needs essential to survival (Maslow, 1943). Maslow (1943) postulated that humans have a hierarchy of needs, whereas basic needs must be met in order to ascend to actualizations of higher order needs (See Appendix E). The need for nutrition and other sustenance formed the base for the needs pyramid signaling its significance to the human condition (Maslow, 1943). Critically ill, mechanically ventilated patients have been at the mercy of healthcare professionals to meet these basic human needs. Thus, it has been incumbent upon bedside clinicians to make use of all available evidence and medical advances to formulate plans that meet the nutritional needs of patients as part of a holistic plan to foster the best outcomes possible (Karnatonskaia, Gajic, Bienvenu, Stevenson, & Needham, 2015). In the interest of patient safety and wellbeing, it has been the duty of members of the patient care team to provide adequate nutrition to support the healing process.

Maslow's (1943) theory aligned with the project because the goal of providing enough nutrition has been critical to a patient's wellbeing and outcomes. Maslow's (1943) theory stressed the importance of meeting basic needs to help patients attain higher needs as part of a comprehensive, holistic plan of care (See Appendix E). Adequate nutrition forms the foundation for a comprehensive plan of care. The enteral nutrition protocol used in this project guided nurses in the provision of adequate nutrition to improve cumulative caloric intake which supported the metabolic processes and healing of critically ill patients. Maslow's (1943) theory provided a broad theoretical framework that aligns with this project.

Jackson et al. (2014) used Maslow's hierarchy of need to improve critical care practices through an expanded comprehension of holistic care. Jackson et al. (2014) posited that efforts to improve early mobility for critical care patients should focus on more than patient survival and improve the total patient experience. The framework for Maslow's hierarchy of needs helped to reshape the culture of a critical care units and encourage nursing staff to adopt patient-centered approaches (Jackson et al., 2014).

Betty Neuman's systems model. Neuman's (1972) system's model (NSM) was based on viewing the patient as an open system that is in constant interaction with the environment (See Appendix F). The NSM consists of a series of concentric circles with the person in the center surrounded by a series of outer circles that symbolize different levels of resistance that provide defense against stressors and maintain a state of wellness (Neuman & Young, 1972). Nurses have been instrumental in impacting the presence of stressors and mitigating patients' reactions to stressors that emanate from the environment (Neuman & Young, 1972). Nurses have provided comprehensive care for critically ill patients through prevention of illness, maintenance of wellness, movement of the system toward equilibrium (Neuman & Fawcett, 2002).

Within the NSM, primary prevention included strategies that maintain the system (patient) towards a state of wellness (Neuman & Young, 1972). Primary prevention for critically ill patients entailed reducing risks that threaten to derail patient progress. Malnutrition has been a stressor that weakens the lines of defense and makes the patient susceptible to a host of maladies. Critically ill, mechanically ventilated patients have a higher than normal metabolism that required timely intervention with a complete enteral nutritional program to reduce the risk of iatrogenic malnutrition (Kim et al., 2017). The NSM provided nursing with a framework to support critical thinking and decision-making skills that enhance clinical judgments necessary to generate best outcomes (Rosa et al., 2018).

The project introduced an evidence-based protocol that aligns with the NSM because the goal of the project is to prevent iatrogenic malnutrition through the improvement of cumulative enteral intake for critically ill patients. Preventing iatrogenic malnutrition allowed nurses and the healthcare team to identify other stressors and concentrate interventions on those as a means to strengthen the lines of defense. Strengthening the lines of defense for patients allowed the patient to move from a state of illness toward a state of wellness (Neuman & Young, 1972). Thus, NSM provided a strong theoretical basis for examining how an evidence-based enteral nutrition protocol could help to improve caloric intake for critically ill patients in the intensive care unit (ICU) of the project site.

The theoretical frameworks utilized to guide this DPI project have been used in other research projects. Ahmadi and Sadeghi (2017) sought to improve care practices for patient with multiple sclerosis using NSM. Assessment of intrapersonal, interpersonal stressors, and extra-personal stressor helped nursing staff to personalize care and prioritize interventions (Ahmadi & Sadeghi, 2017). The result of the study was an improvement in patient satisfaction with nursing care (Ahmadi & Sadeghi, 2017).

Nutrition Care Process Model. The Nutrition Care Process Model (NCPM) provided a clinical guide that began with a comprehensive assessment of the patient's needs then progresses to a nutritional prescription and its implementation (Academy, 2003). Proper nutrition support required trained and knowledgeable professionals to be invested in a collaborative effort to promote improved clinical outcomes and individualized needs assessments (Lachey & Pritchett, 2003; Swan et al., 2017). The NCPM had four steps that were integral to managing nutritional care and producing positive outcomes (Lachey & Pritchett, 2003). Those steps were as follows:

1. Nutritional assessment
2. Nutritional diagnosis
3. Nutritional intervention
4. Nutritional monitoring and evaluation

Nutritional assessments were systematic processes to gather information related to patient and the patient's condition to make decisions about the nutritional needs of patients (Academy of Nutrition and Dietetics [Academy], 2003). Next, the nutritional diagnosis determined the deficiencies that are present and provided a guide for the care team (Academy, 2003). The nutritional diagnosis led to the nutritional intervention. The nutritional intervention entailed enacting individualized nutrition plan that meet the needs of the patient (Academy, 2003). Finally, nutritional monitoring and evaluation was an ongoing assessment of how the patient responded to the nutritional program and determined if alterations are required (Academy, 2003).

The NCPM aligned with the project because its steps parallel the themes that were independently gathered for a literature review. The major themes for this project are *nutritional assessments, enteral nutrition protocols*, and *clinical outcomes.* The NCPM conceptualized the major themes for this project and underscored the need for collaborative practice between dietitians and the care team. The NCPM components helped to address the clinical questions of how an evidence-based enteral nutrition protocol impacted the cumulative caloric intake and albumin levels of critically ill, mechanically ventilated patients.

Finally, the NCPM was been implemented in healthcare centers around the world. Kim and Baek (2013) implemented the NCPM in Korean hospital to improve nutritional practices and identify barriers to adequate nutrition for at risk patients. Standardizing practices aided in an improvement in the assessment of patient needs and implementation of an appropriate nutritional plan for patients (Kim & Baek, 2013). Collectively, these theoretical frameworks addressed psychological, physiological, and practical aspects of improving nutrition care practices within the critical care setting as it related to the DPI project.

Review of Literature

The following section included a review of literature relevant to the project. The university database facilitated the location of studies germane to a care delivery quality improvement project. The studies reviewed for this chapter are organized by theme and provided a broad, balanced overview of the literature needed to conceptualize this project. First, this chapter discusses nutritional assessments. The discussion of nutritional assessments encompassed malnutrition assessments in critically ill patients, determining energy and protein requirements for critically ill patients, and the tools used to assess the nutritional needs of critically ill patients. Next, this section provides a review of evidence to support enteral nutrition protocols. Timely initiation, clinical decision support, and addressing the barriers to providing adequate nutrition was examined in relation to the use of enteral nutrition protocols. This section concluded with a literature review that discussed the correlation between nutritional support and clinical outcomes. The literature review integrated the themes into evidentiary support for a quality improvement project to enhance enteral nutritional practice.

Nutritional assessments. Comprehensive and accurate nutritional assessments have been critical to rendering timely and appropriate care to critically ill, mechanically ventilated patients facing a metabolic crisis (Cox & Rasmussen, 2014). Critically ill, mechanically ventilated patients have been reliant upon skilled clinicians to assess their metabolic needs, provide a nutritional prescription to meet those needs, and establish a route to deliver much needed nutrients (Stewart et al., 2017). Failure to address the needs of critically ill, mechanically ventilated patients during the hypermetabolic state of illness created an energy debt that complicated recovery and placed the patient in a precarious position (Kurlapuu, Jogela, Starkopf, & Blaser, 2015).

The complexity of assessing the metabolic needs for critically ill, mechanically ventilated patients as part of a comprehensive nutritional assessment required the skills and qualifications of trained dietitians (Dent, Wright, Hoogendijk, & Hubbard, 2018). Prompt consultation of a professional dietitian trained in performing nutritional assessments on critically ill, mechanically ventilated patients helped to lessen the time patients were without proper enteral nutrition (Hejazi, Mazloom, Zand, Rezaianzedah, & Amini, 2016). Timely nutritional assessments provided an enteral nutrition, caloric goal for bedside clinicians to allow patients who were in a hypermetabolic state to have the energy and nutrients required to sustain bodily functions (Yeh et al., 2016). Moreover, ongoing nutritional assessments were essential to capture variations in the metabolic needs of critically ill, mechanically ventilated patients with validated nutritional assessment tools to continually meet energy and protein requirements (Fetterplace et al., 2018; Raurich et al., 2015).

Improving the quality of enteral nutrition in the critical care unit started with a nutritional assessment that was based on evidence and validated assessment tools. The NCPM began with an individualized assessment of a patient’s nutritional needs to make a recommendation for an enteral formula to meet the patient’s caloric needs (Academy of Nutrition and Dietetics [Academy], 2003). Absence of a validated, evidence-based nutritional assessment could put patients at risk for an enteral nutrition regimen that did not meet their unique needs (Lachey & Pritchett, 2003). Thus, nutritional assessments provided a critical foundation for a quality improvement project to improve the cumulative caloric intake for critically ill, mechanically ventilated patients (Chelkeba, Mojtahedzadeh, & Mekonnen, 2017; Vallejo et al., 2017).

Iatrogenic malnutrition in critically ill patients. Existing data indicated that at least 40% of adult critically ill patients had some degree of malnourishment (Corkins et al., 2014, Mauldin & O’Leary-Kelley, 2015). Patients arrived at medical centers with some degree of malnutrition already present related to the onset of acute illness (Iwuoha & Akwaowo, 2014; Verghese, Mathai, Abraham, & Kaui, 2018). The nutritional status deteriorated further due to the progression of the illness and other mitigating factors such as comorbidities (Iwuoha & Akwaowo, 2014). Early assessments of nutritional status diagnosed deficits in nutrition and prompted implementation of a nutritional plan of care (Chelkeba et al., 2017; Iwuoha & Akwaowo, 2015).

For mechanically ventilated, critically ill patients, enteral nutrition provided much needed nutrients and supplements to support physiological functions (Iwuoha & Akwaowo, 2014).

Iatrogenic malnutrition has been shown to cause impairments of several physiological functions triggered multisystem organ failure and severe muscle wasting (Iwuoha & Akwaowo, 2014). Early and ongoing nutritional assessments helped clinicians implement enteral nutrition regimens that mitigate or eliminate the onset on iatrogenic malnutrition in critically ill patients (Iwuoha & Akwaowo, 2014).

Follow up nutritional assessments are needed to prevent iatrogenic malnutrition in critically ill patients due to overfeeding or underfeeding (Iwuoha & Akwaowo, 2014). Iatrogenic malnutrition could be further complicated by a response to medical treatments or drug reactions, as well as, inadequate enteral nutrition. (Iwuoha & Akwaowo, 2014). Thus, nutritional assessments were essential to providing patient-centered care that address metabolic needs to avoid unintentional hospital-acquired malnutrition (Kurlapuu et al., 2015).

Verghese et al. (2018) conducted a prospective, observational study that analyzed a year's worth of data collected in an adult medical ICU that sought to evaluate the nutritional assessments of patients on admission and the effect of patient-specific nutritional regimens. The researchers reviewed patient charts and used the data in statistical analysis to determine the nutritional status of the patients (Verghese et al., 2018). Using the subjective global assessment (SGA) tool, the study was able to show that patients presented to the critical care unit with some degree of pre-existing malnutrition (Verghese et al., 2018).

A total of 200 patients were included in the analysis which showed that 45% of patients were assessed to be mildly malnourished while almost 49% were assessed to have moderate levels of malnutrition (Verghese et al., 2018). To worsen matters, patients within the study did not consistently receive their allotted daily caloric which lead to worsening malnutrition and a higher mortality rate (Verghese et al., 2018). Those reasons for the shortfalls in nutritional intake were noted to be related to delayed initiation of feeding (18%) and feeding interruptions for procedures (16%) (Verghese et al., 2018).

The patients with a baseline level of malnutrition that was rated as moderate or above upon admission had higher mortality rates (p=0.001) than patients with mild indications of malnutrition (Verghese et al., 2018). Proper assessment and early initiation of enteral nutrition was deemed imperative for patients who were critically ill and showed early indications of malnutrition (Verghese et al., 2018). The study added to the existing evidence to support the judicious use of early nutritional assessments to implement timely interventions to prevent iatrogenic malnutrition.

Tools to properly assess the nutritional status of critically ill, mechanically ventilated adults have been in existence for some time (Stewart, 2014). The Verghese et al. (2018) used to SGA tool to assess the patients in the study. Use of a comprehensive assessment with a validated tool to guide individualized nutritional care practices has been a key strategy to support optimal nutrition in critical care units was the performance (Stewart, 2014). Avoiding malnutrition during an acute, critical illness provided patients with a foundation for a meaningful recovery in terms of an improved nutritional status, decreased debility, and optimized rehabilitation for the future (Singer, 2019).

Caloric intake for critically ill patients. Nutritional assessments provided valuable information about the enteral feeding needs of critically ill patients due to a higher than normal metabolic requirements (Kuslapuu et al., 2015; Stewart, 2014; Wang et al., 2017; Yeh et al., 2016). Researchers conducted a study that evaluated the cumulative nutritional intake of critically ill patients and assessed the clinical outcomes (Yeh et al., 2016). Researchers hypothesized that an inverse relationship existed between caloric intake and clinical outcomes (Yeh et al., 2016).

The study consisted of adult patients sampled from two surgical intensive care units (ICU) who received enteral nutrition for a minimum of three days (Yeh et al., 2016). A total of 94 patients were included for analysis (Yeh et al., 2016). The study reported that patients were subjected to an average caloric deficit of 6,000 during their stay in the ICU (Yeh et al., 2016). This correlated with longer stays in the intensive care unit ($p<0.001$), overall increase in hospital days ($p=0.007$), and increased incidences of complications ($p=0.007$) (Yeh et al., 2016). The nutritional deficits indicated that the patients included in the study were at risk for significant iatrogenic malnutrition and other associated complications (Yeh et al., 2016). Yeh et al. (2016) were able to state that a correlation exists between underfeeding critically ill patients and the exhibition of poor clinical outcomes (Yeh et al., 2016). Optimizing nutrition with the use of individualized prescriptions for caloric intake is an important step in improving patient outcomes (Yeh et al., 2016).

Wang et al. (2017) conducted a study to assess the efficacy of an enteral nutrition protocol with an emphasis on optimal energy delivery and its impact on clinical outcomes. The study centered around the premise that poor enteral intake leads to poor clinical outcomes in critically ill, mechanically ventilated patients (Wang et al., 2017). The retrospective, cross-sectional study enlisted 412 critically ill patients who were on the ventilator for a minimum of two days (Wang et al., 2017). The patients were split into two groups. One group of 214 patients acted as the control group and did not receive the intervention of the volume-based feeding protocol (Wang et al., 2017). The second group of 198 patients did receive the intervention of the volume-based enteral nutrition protocol (Wang et al., 2017).

Researchers analyzed the data related to how many patients received their daily energy and protein allowance and how many patients received inadequate enteral feedings during their stay in the ICU (Wang et al., 2017). Although there was no difference noted in mortality rates, researchers were able to show a strong correlation between those patients who received less than 65 % prescribed nutrition received by critically ill, mechanically ventilated patients, and overall clinical outcomes (odds ratio, 1.6, 95% confidence interval, 1.01-2.47) which included increased mortality, morbidity, and infection complications (Wang et al., 2017). The evidence supported the use of enteral nutrition programs that consider the energy and protein needs of critically ill, mechanically ventilated patients (Wang et al., 2017).

The determination of what constituted the optimal amount of caloric intake has been debated through multiple research studies. In one such study, researchers proposed that a high protein, low calorie enteral nutrition plan was better for patient outcomes (Rugeles, Rueda, Diaz, & Rosseli, 2013). Researchers hypothesized that a high protein, low calorie enteral nutrition plan would offset the catabolic nature of critical illness (Rugeles et al, 2013). The hypothesis led to the construction of a randomized, double-blind study (Rugeles et al., 2013).

The study incorporated 80 critically ill, mechanically ventilated patients who were placed into two groups for analysis (Rugeles et al., 2013). The control group received the standard enteral nutritional support, while the intervention group received a high protein, low calorie enteral nutrition formula (Rugeles et al., 2013). Patients in both groups were given the Sequential Organ Failure Assessment (SOFA) within 48 hours of their respective enteral nutrition regimens being initiated (Rugeles et al., 2013). Concurrent measurements of glucose levels, length of days in the ICU, time spent on the ventilator, and mortality rates were obtained to appraise clinical outcomes (Rugeles et al, 2013).

At the conclusion of the study, researchers noted that the group who received the high protein, low calorie enteral nutrition formula scored higher on the SOFA scale (7.5 ± *2.9* versus 6.7 ± *2.5*, p=0.17) and less incidences of hypoglycemia (1.0 ± *1.3* versus 1.7 ± *2.5*, p=0.017) in relation to this study (Rugeles et al., 2013). The SOFA score translated into a lower risk of organ failure and subsequent morbidity or mortality (Rugeles et al., 2013). The study employed a design that is considered strong but a sample size of only 94 patients. Still, this study offered an alternative viewpoint to other studies that support the use of higher caloric intake for critically ill patients (Rugeles et al., 2013).

To add more evidence to support improved enteral nutrition practices, Fetterplace et al. (2018) conducted the FEED trial to study the effects of enhanced protein supplementation in addition to an energy prescription on the overall clinical outcomes of critically ill, mechanically ventilated patients. The FEED trial was a randomized control trial (RCT) that sought to provide evidence to support recommendations to increase protein delivery to improve energy delivery for critically ill, mechanically ventilated patients (Fetterplace et al., 2018). Researchers hypothesized that higher protein delivery would improve morbidity and mortality rates in critically ill patients (Fetterplace et al., 2018).

The study included 60 critically ill patients that were randomized into two groups (Fetterplace et al., 2018). The control group received the standard enteral nutrition program, and the intervention group received an enteral nutrition regimen that was augmented with supplemental protein (Fetterplace et al., 2018). The intervention group was able to demonstrate a more appreciable improvement in energy delivery and nutritional status upon discharge from the ICU (Fetterplace et al., 2018). Researchers used the subjective global assessment (SGA) scale to gauge malnutrition in both groups and found that the intervention group had significantly lower rates of malnutrition than those of the control group (p=0.04) (Fetterplace et al., 2018). Thus, the FEED study outcomes add to the existing body of knowledge regarding the addition of protein supplementation to a comprehensive enteral nutrition program to improve patient outcomes (Fetterplace et al., 2018).

Nutritional assessment tools. The cornerstone of appropriately assessing the metabolic needs of critically ill, mechanically ventilated patients was using a validated assessment tool (Fetterplace et al., 2018; Fontes, Generoso, & Correia, 2014; Hejazi et al., 2016). There were many assessment tools used to assess the metabolic needs for critically ill, mechanically ventilated patients. Nutritional assessment tools varied from cost-effective, easy to read tables and charts to more highly sophisticated, costly medical equipment. The specific tool used has been reliant upon the resources and skill sets of respective healthcare facilities.

Subjective Global Assessment. The Subjective Global Assessment (SGA) tool has been widely used nutritional assessment tool that has been validated for use with critically ill, mechanically ventilated patients (Fontes et al., 2014; Hejazi et al, 2016). The SGA tool utilized a patient's height, weight, and laboratory metabolic profiles to perform an assessment of the patient's nutritional status to guide recommendations for an appropriate nutritional prescription (Detsky et al., 1987; Fontes et al., 2014; Hejazi et al., 2016). Independent studies at healthcare centers in Brazil and Iran validated the SGA tool through retrospective studies that compared the accuracy of the SGA tool against equations generally used by professional dietitians to determine resting energy expenditures such as the Harris-Benedict equation (Fontes et al., 2014; Hejazi et al., 2016, Picolo et al., 2016).

Fontes et al. (2014) applied the SGA tool to 185 patients and found that the tool accurately identified malnutrition with the critical care population. Those patients identified as malnourished had higher incidences of complications requiring readmission to critical care units (odds ratio 2.7, confidence interval 1.08-4.80) as well as higher mortality rates (odds ratio 8.12; confidence interval 2.94-22.42) (Fontes et al., 2014). The SGA tool allowed for a simplified way to determine the caloric needs of critically ill patients (Fontes et al., 2014; Hejazi et al., 2016). The predictive value of an accurate nutritional assessment tool has been shown to be effective in guiding nutritional practices (Fontes et al., 2014).

The SGA tool is an inexpensive instrument that has been used in healthcare settings with limited resources to provide comprehensive nutritional assessments for critically ill, mechanically ventilated patients (Detsky et al., 1987; Fontes et al., 2014; Hejazi et al., 2016). Despite the SGA tool being cost-effective and straightforward to use, there some limitations have been noted. The SGA tool lacked sensitivity related to the influence of confounding variables associated with comorbidities (Hejazi et al., 2016). Unintentional missteps in assessing the nutritional status of critically ill, mechanically ventilated adults negatively impacted clinical outcomes (Vest et al., 2018).

Controlling Nutritional Status Index. In addition to the SGA tool, other tools are in existence that estimated the caloric needs of critically ill patients. The Controlling Nutritional Status Index (CONUT) was employed as a validated tool to gauge the nutritional needs of critically ill patients (Kos et al., 2016; Stewart et al., 2017). The CONUT tool used a patient's hemoglobin and total cholesterol in an equation that determined nutritional status and inferred clinical outcomes based on the score derived (Ignacio de Ullibarri et al., 2005). The nutritional assessment tool was utilized to perform daily assessments with the assistance of laboratory data pulled from the electronic medical record to indicate the nutritional status of individual patients (Ignacio de Ullibarri et al., 2005).

Kos et al. (2016) validated this tool as an early detector of malnutrition to prompt clinicians to address the patient's undernutrition. In a study that included 225 patients, the CONUT tool was able identify malnutrition in critically ill patients (Kos et al., 2016). This allowed for prompt intervention which correlated with higher rates of survival to discharge (p=0.02) (Kos et al., 2016). CONUT was a prognostic tool that was highly advantageous in constructing an enteral nutritional prescription for critically ill, mechanically ventilated patients (Kos et al., 2016).

Indirect calorimetry. The SGA and CONUT tools provided estimations of a patient's caloric needs (Fontes et al., 2014; Hejazi et al., 2016; Ignacio de Ullibarri et al., 2005). However, the nutritional status of critically ill, mechanically ventilated patients varied related to the path of the disease process and other factors. Therefore, it was important to have validated assessment tools that captured those fluctuations in metabolic needs to better alter nutritional prescriptions and supplements (Raurich et al., 2015; Fetterplace et al., 2018). Indirect calorimetry quickly has become the benchmark for nutritional assessments in critically ill patients (Picolo et al., 2016; Rattanachaiwong & Singer, 2018).

Indirect calorimetry entailed a measurement of a patient's oxygen consumption and carbon dioxide production to attain a real time measurement of the resting energy expenditure (REE). A patient's REE had a direct correlation to the patient's metabolic needs. Rattanachaiwong and Singer (2018) caution that other traditional means of calculating the metabolic needs of patients were designed to predict the REE of healthy individuals. Indirect calorimetry allowed for clinicians to directly assess a patient's metabolic state under the existing effects of injury and illness (Rattanachaiwong & Singer, 2018).

The EAT-ICU trial noted that individualized, goal-directed enteral nutritional therapy with the use of indirect calorimetry was highly beneficial to the nutritional plan of care for critically ill, mechanically ventilated patients (Allingstrup et al., 2017). The EAT-ICU trial was a single-center, randomized, parallel group study that included 200 critical care patients (Allingstrup et al., 2017). Patients were randomly assigned to two groups in which one group received the standard of care and the other group received daily nutritional assessments with goal directed enteral nutrition prescriptions (Allingstrup et al., 2017). Although data analysis has being ongoing, the indirect calorimetry measurements showed a discrepancy between the nutritional assessments done with traditional methods such as SGA and CONUT (Allingstrup et al., 2017). The long-term outcomes are still being evaluated but look promising.

Summary of nutritional assessments. Comprehensive nutritional assessments have been the cornerstone of providing appropriate enteral nutrition prescriptions (Stewart et al., 2017). Incomplete assessments or assessments that are not conducted with validated nutritional assessment tools exposed patients to subpar feeding practices and a heightened risk for poor clinical outcomes (Saleh et al., 2017). Use of validated nutritional assessment tools and inclusion of current evidence was advantageous to promotion of best practices for enteral nutrition for critically ill, mechanically ventilated patients (Fontes et al., 2014).

Recent studies have employed a variety of quantitative research designs to show the relationship between providing nutritional assessments with validated tools and implementing enteral nutrition programs for critically ill, mechanically ventilated patients (Fetterplace et al., 2018; Verghese et al., 2018; Wang et al., 2017). Although the majority of studies agreed on the use of assessments to gauge that nutritional status of critically ill patients, there were variations on the assessment tools utilized and optimal enteral nutrition formulations that were employed within the studies (Fetterplace et al., 2018; Verghese et al., 2018; Wang et al., 2017). However, the main theme of early nutritional assessments remained constant throughout and underscored its importance as a prelude to the quality improvement measure for this DPI project.

As mentioned, a key factor in determining the appropriate enteral nutrition regimen for patients is to use a validated assessment tool to determine their individual needs (Cox & Rasmussen, 2014). The registered dietitians (RD) that assessed the patients included in the DPI project utilized the SGA tool to establish a caloric intake goal. The protocol that was used for this project maintained an assumption that the nutritional assessment was complete prior to initiation and considered the critical condition of the patient in an effort to prevent iatrogenic malnutrition. However, there are other tools that may be more effective in assessing the metabolic needs of critically ill, mechanically ventilated patients such as indirect calorimetry. Although this particular DPI project did not focus on the use of nutritional assessment tools, it is highly relevant to discuss the importance of accurate nutritional assessments with the use of validated assessment tools to optimize enteral nutrition in critically ill, mechanically ventilated patients.

Enteral nutrition protocols. Implementing a systematic means of assessing nutritional statuses and employing timely evidence-based nutritional prescriptions had profound effects on the outcomes of critically ill, mechanically ventilated patients (Stewart, 2014; Li et al., 2017; Orinovsky & Raizman, 2018). It was possible to modify the risks of developing caloric deficits through the use of an enteral nutrition protocol (Lo et al., 2016). Lo et al. (2016) conducted a quality improvement study that implemented an enteral nutrition protocol that was able to produce a 38% improvement in caloric intake within 14 months. Enteral nutrition protocols for critically ill, mechanically ventilated patients have been used to trigger prompt nutritional assessments, early initiation of enteral feeding, provided clinical decision support, and mitigated barriers to providing proper nutrients (Lo et al., 2016; Orinovsky & Raizman, 2018). The use of evidence to support the standardization of practices was associated with positive patient outcomes (Hill, 2015).

Early initiation of enteral nutrition for critically ill patients. The first few days of critical illness were characterized by high metabolic demands that exceeded an intrinsic means to meet those demands (Yin et al., 2015). Failure to act appropriately during this time had major repercussions for critically ill, mechanically ventilated patients (Yin et al., 2015). A study set out to determine the efficacy of early initiation of enteral feeding of patients who had suffered abdominal trauma (Yin et al., 2015). The researchers proposed the assumption of implementing early, goal directed nutrition support would counterbalance tendencies toward immunosuppression, catabolism, and poor clinical outcomes (Yin et al., 2015).

To that end, researchers performed a retrospective cohort study which included 88 patients who had suffered abdominal trauma (Yin et al., 2015). Study participants either received enteral nutrition within three days of admission (n=28) to the surgical ICU or enteral feeding was delayed (n=60) under standard practices (Yin et al., 2015). There was no significant statistical difference in rates of feeding intolerance (p=0.37) or mortality (p=0.55) (Yin et al., 2015). Of additional importance was the early enteral feeding group showed fewer infectious processes (p=0.04) and a shorter length of stay in the surgical ICU ($p < 0.01$) as compared to the standard of care group (Yin et al., 2015). Researchers concluded that early initiation of enteral nutrition was beneficial for patient clinical outcomes (Yin et al., 2015).

Wound infections in critically ill patients have complicated critical care treatment plans and have required clinicians to introduce enhanced nutritional support regimens to aid in healing and recovery (Haac, Henry, Diaz, Scalea, & Stein, 2017). Researchers at a medical center in Maryland speculated that initiating enteral nutrition within 48 hours of critical care admission improved clinical outcomes and reduced the incidences of hospital acquired complications for patients with complex wound issues (Haac et al., 2017). A retrospective review of 85 critically ill, mechanically ventilated adult patients with complex wound infections was included for analysis (Haac et al., 2017).

Data analysis revealed that patients who had enteral nutritional started within 48 hours of critical care admission had a decreased onset of hospital acquired infection, less time on the ventilator (mean 5 days versus 12 days), and fewer days were spent in the critical care unit (mean 18 days versus 40 days) (Haac et al., 2017). Hospital-acquired infection rates were lower in the early initiation of enteral nutrition group than the group who received the standard of care (p=0.04). Increased nutritional intake and decreased infections rates correlated with for improved wound healing and other clinical outcomes (Haac et al., 2017).

Clinicians must act quickly to introduce enteral nutrition in critically ill, mechanically ventilated patient to make use of the gastrointestinal (GI) tract before the increased metabolism caused harmful changes (Campos-Machado et al., 2015). Researchers in Ecuador conducted a study evaluating the efficacy of early enteral nutrition in septic, critically ill, mechanically ventilated patients in the ICU of a teaching hospital (Campos-Machado et al., 2015). The observational study included 53 critically ill, adult patients who received enteral nutrition during their stay in the critical care unit (Campos-Machado et al., 2015).

Data collection included the daily caloric intake, protein intake, rates of gastric intolerance, and clinical outcomes (Campos-Machado et al., 2015). Data showed an improvement in clinical outcomes such as a reduced length of stay in the critical care unit, less time on the mechanical ventilation (p=0.02), and decreased overall morbidity and mortality ($p < 0.01$) (Campos-Machado et al., 2015). Researchers also noted that the time to initiation of enteral feeding was as important as reaching the target daily caloric intake (Campos-Machado et al., 2015). The average start time for enteral nutrition was less than 24 hours and goal feeding rates were achieved in less than 48 hours (Campos-Machado et al., 2015). Ultimately, clinical prognosis was positively impacted by the early initiation of enteral feeding in septic patients (Campos-Machado et al., 2015).

Clinical decision support. Enteral nutrition protocols incorporate support for clinical decisions that is based on evidence to standardize practice and promote the best possible clinical outcomes (Li et al., 2017). Enteral nutrition protocols served to streamline available evidence-based guidelines and removed ambiguity that may exist due to varying levels of experience or a lack of knowledge with the provision of enteral nutrition in critical care (Compton, Bojarski, Seigmund, Van der Giet, 2014). The American Society for Enteral and Parenteral Nutrition (ASPEN) stressed that clinical decision support as part of an enteral nutrition protocol improves safety and efficacy of feeding practices (McClave et al., 2016). Hemodynamic status, feeding tolerance or intolerance, and clinical indications for modifying the route of enteral feeding were areas where support for clinical decision making was most advantageous in guiding clinicians toward appropriate, safe practice (McClave et al., 2016). Thus, it was important to examine the literature to find out what constituted best practice in terms of clinical decision support within an enteral nutrition protocol.

Hemodynamic status. Hemodynamic stability influenced the initiation and maintenance of an enteral nutrition regimen for critically ill patients (Flordelis-Lasierra, Perez-Vela, & Montejo-Gonzalez, 2015). Blood flow was shunted to preserve life-sustaining cerebral and coronary functions in times of hemodynamic compromise which was characterized by low blood pressure and decreased organ perfusion (Ceppa, Fuh, & Bulkley, 2003). Moderate to severe shunting resulted in reduced blood flow to the GI tract which compromised the functional abilities of the GI tract (Ceppa et al., 2003).

Flordelis-Lasierra et al. (2015) conducted a prospective observational study which found that enteral nutrition was safely administered in patients who maintained a mean arterial pressure (MAP) of at least 60 mmHg with the use of minimal to no vasopressor agents. Thus, critically ill patients forewent consequential interruptions in enteral nutrition if the hemodynamic status of the patient did not fall outside of set parameters (Flordelis-Lasierra et al., 2015). Integration of hemodynamic clinical triggers guided clinicians in the optimization of enteral nutrition in critically ill, mechanically ventilated patients to prevent iatrogenic malnutrition (Flordelis-Lasierra et al., 2015). Careful attention to changes in laboratory results, radiological readings, and physical assessments were required to alert clinicians to changes in enteral nutrition tolerance (Flordelis-Lasierra et al., 2015).

Feeding intolerance. The American Association of Critical Care Nurses (AACN, 2019) published practice advisories to provide recommendations for clinical decisions related to gastric intolerance. Gastric residual volumes (GRV) were measured through aspiration of gastric contents while receiving enteral feeding and were generally used to indicate gastric intolerance (Montejo et al., 2010). Wiese et al. (2019) studied the consequences of removing the measurement of GRV from the enteral nutrition program. The researchers conducted a quality improvement, pre-intervention versus post-intervention study in a 10-bed ICU at a single center to gauge the effects of removing the practice of GRV monitoring on clinical outcomes (Wiese et al., 2019).

The study spanned three years and included 181 adult critically ill, mechanically ventilated patients (Wiese et al., 2019). Bedside clinicians were instructed to maintain vigilance in performance of physical assessments and instituting the use of prokinetic agents when patients were noted to exhibit any abdominal distention (Wiese et al., 2019). At the conclusion of the study, researchers were able to show that the post intervention group of patients who did not have GRV monitoring were subject to fewer interruptions of their enteral feeding (Wiese et al., 2019). This translated to a 38% increase in caloric intake between the GRV monitored group and the group without GRV monitoring ($p<0.01$) (Wiese et al., 2019). Additionally, patients were able to more consistently reach optimal caloric and protein intake of at least 90% on a daily basis ($p<0.01$) (Wiese et al., 2019).

Researchers noted that incidences of vomiting did not differ significantly between the pre-intervention group and the post-intervention group ($p<0.01$) which led researchers to surmise that physical assessments were on par with GRV monitoring (Wiese et al., 2019). Wiese and associates (2019) established that GRV monitoring may be safely removed from clinical practice if bedside clinicians were astute in recognizing changes in the physical assessment of critically ill, mechanically ventilated adult patients.

Ozen et al. (2016) conducted a study with a similar premise but used a different study design. The study was conducted in two medical critical care units at two different hospitals in Turkey (Ozen et al. 2016). A total of 51 patients were randomized into two groups (Ozen et al. 2016). The control group was rendered the standard of care which included monitoring of the GRV every four hours with a threshold of 250 milliliters (mls) to be considered as acceptable to continue enteral feeding (Ozen et al. 2016). If the GRV was greater than 250 mls for the control group, then enteral feeding was suspended for four hours and resumed at the previous rate (Ozen et al. 2016).

The intervention group did not have GRV monitored during their time on enteral feeding (Ozen et al. 2016). For the intervention group, the presence of abdominal distention, vomiting, or diarrhea was used to indicate feeding intolerance (Ozen et al. 2016). At the conclusion of the study, researchers revealed that there was no statistical significance in the signs and symptom of feeding intolerance between the two groups (p>0.05) (Ozen et al. 2016). However, the intervention group received a higher percentage of their enteral nutrition prescription than the control group (p<0.05) (Ozen et al. 2016). The control group was reported to have a cumulative deficit of caloric and protein intake due to the constant interruptions of enteral nutrition (Ozen et al. 2016). Removal of GRV from the enteral nutrition program streamlined clinical decision support algorithms and reduced nursing workload associated with monitoring GRV (Ozen et al. 2016).

The studies of Flordelis-Lasierra et al. (2015) and Ozen et al. (2016) posed differing arguments for the use of GRV in enteral feeding practices. While both studies agree that it was the discretion of the providers within the facility to decide the appropriateness of inclusion of GRV in the enteral nutrition regimens, the studies from that altering the practices related to GRV could be safely implemented in the critical care setting (Flordelis-Lasierra et al., 2015; Ozen et al., 2016). The inclusion of clinical decision support related to the use GRV measurements served to direct clinical staff in facility-based guidelines to promoted standardized, best practices (AACN, 2019; McClave et al., 2016).

Small bowel feedings. There have been instances when clinical decision support needs to address gastric intolerance of enteral feeding when efforts to improve gastric motility were ineffective or gastric feedings were contraindicated (McClave et al., 2016). When feeding into the stomach was not feasible, small bowel or post pyloric feedings were implemented to maintain nutritional intake in critically ill, mechanically ventilated patients (Gokhale et al., 2016). Cooper (2018) performed a systematic review of research studies to assess the safety and effectiveness of small bowel feedings in critically ill patients. Findings were based on a Cochrane systematic review of 14 randomized control trials (RCT) that included a total of 1109 adult critically ill patients (Cooper, 2018).

The review indicated mid-quality evidence that patients who were fed in the small bowel as opposed to the stomach had fewer incidences of pneumonia (risk ratio 0.65; 95% confidence interval 0.51-0.84) (Cooper, 2018). The further review also indicated that patients fed in the small bowel received a higher number of total calories prescribed (mean difference 7.8%; 95% confidence interval 1.43-14.18) and that differences in time on the ventilator were unchanged (Cooper, 2018). While the placement of a small bowel feeding tube took some degree of skill, the review indicated that tube insertion was a safe, effective means to provide enteral nutrition to critically ill, mechanically ventilated (Cooper, 2018).

Barriers to adequate enteral nutrition practices. Critically ill, mechanically ventilated patients are dependent on bedside clinicians to provide valuable nutrients to support recovery. Enteral nutrition protocols provided guidance for clinical practice and reduced barriers to evidence-based enteral nutrition practices (Compton et al., 2014; Li et al., 2017; McClave et al., 2016). However, existing literature indicated that critically ill patients were underfed, which predisposed them to poor outcomes (Saleh et al., 2017; Stewart et al., 2017). Overcoming barriers to inadequate enteral feeding were critical to improving clinical practice and patient outcomes (Mooi & Mbatha, 2014).

Knowledge deficits among nurses. Kalaldeh & Shahein (2014) sought to understand the depth and breadth of nursing knowledge regarding enteral nutrition practices. Researchers created a questionnaire survey with 15 questions designed to gauge nursing knowledge and attitudes regarding enteral nutrition (Kalaldeh & Shahein, 2014). A total of 220 critical care nurses participated in the survey that was self-administered and returned via email (Kalaldeh & Shahein, 2014).

Respondents to the questionnaire felt that efforts to reduce aspiration risks were the priority for most bedside critical care nurses (Kalaldeh & Shahein, 2014). However, responses varied in the proper means to assuage the risks for aspiration (Kalaldeh & Shahein, 2014). Respondents who practiced in a facility with an enteral nutrition protocol with clinical decision support had a better understanding of nutritional standards for critically ill, mechanically ventilated patients (Kalaldeh & Shahein, 2014). The study concluded that evidence-based enteral nutrition protocols and ongoing nursing education provided the best foundation for promotion of appropriate clinical practices (Kalaldeh & Shahein, 2014).

Patient positioning. Existing evidence has stated that frequent repositioning of critically ill patients was important to reduce incidences of pressure related injuries and the development of pneumonia (Safdar et al., 2016; Yap et al., 2018). Standard practice in many critical care units has been to interrupt enteral nutrition for patient repositioning despite the lack of evidence to support this practice (DiLibero, Lavieri, O'Donoghue, DeSanto-Madeya, 2015). However, evidence does support findings that frequent interruptions in enteral feeding have led to undernourishment and iatrogenic malnutrition (DiLibero et al., 2015).

DiLibero et al. (2015) conducted a randomized control study to explore the feasibility of removing the practice of interrupting enteral nutrition for the repositioning of patients. The control group received the standard of care which was to interrupt enteral nutrition during repositioning (DiLibero et al., 2015). The intervention group had continuous enteral feeding infusion during repositioning (DiLibero et al., 2015). A total of 46 patients were included in this study.

Aspiration of contents from the subglottal area of 23 patients' throats was assessed for the presence of gastric contents on three separate occasions following repositioning (DiLibero et al., 2015). The study concluded that there was no increased risk of aspiration by leaving enteral nutrition infusing during repositioning ($p=0.88$) (DiLibero et al., 2015). Including the results of this study into an enteral nutrition protocol improved practice and bridged knowledge gaps of critical care nurses who practice withholding enteral feeding during repositioning of critically ill, mechanically ventilated patients (DiLibero et al., 2015).

Prone positioning of critically ill, mechanically ventilated patients posed a challenge to the provision of enteral nutrition (Linn, Beckett, & Foellinger, 2015). Literature has explored a comparison of enteral nutrition practices and outcomes in patients in the prone versus supine position (Linn et al., 2015). The review of existing evidence indicated that complications related to the prone position of a patient did not supersede those of patients in the supine position (Linn et al., 2015). Thus, prone positioning does not preclude a patient from receiving enteral nutrition (Linn et al., 2015). Educating critical care nurses on current, relevant evidence as part of an enteral nutrition protocol served to address clinical knowledge gaps and reduced barriers improve practice (Stewart, 2014).

Utilization of electronic resources. Electronic resources have revolutionized how practice has been implemented, documented, and critiqued (Bramo & Agago, 2016). The advent of the electronic medical record (EMR) improved efforts to standardize clinical practices and provide individualized patient practice alerts (Bouise, Van Blokland, & Van Zanten, 2016). The EMR calculated nutritional intake and correlated that data with available laboratory results (Bouise et al., 2016).

Researchers implemented an enteral nutrition protocol into the EMR to gauge the ability of the EMR to track and trend the adequacy of nutrition received by critically ill, mechanically ventilated patients (Bouise et al., 2016). The purpose of the study was to assess if imparting a guide for evidence-based clinical practice into the EMR regarding enteral nutrition would provide more timely and actionable feedback (Bouise et al., 2016). A pre-post retrospective study of 146 patients analyzed the data points and found that patients were more likely to receive their caloric and protein goals with the assistance of prompts from the EMR (p=0.03) (Bouise et al., 2016).

Registered dietitians made changes to enteral nutrition prescriptions due to the availability of more up to date information in the form of intake and output coupled with recent laboratory values (Bouise et al., 2016). Bedside clinicians improved clinical practice and maintained optimal clinical outcomes (Bouise et al., 2016). It was important for facilities with EMR capabilities to maximize their clinical potential through the introduction of evidence-based enteral nutrition protocols to guide clinical practice and offer real time feedback (Bouise et al., 2016).

Summary for enteral nutrition protocols. The use of enteral nutrition protocols improved the quality of care given to critically ill, mechanically ventilated patients (Lo et al., 2016). Multiple quantitative studies have validated the use of enteral nutrition protocols to support clinical decision making and overcome barriers to evidence-based practice (Compton et al., 2014; Li et al., 2017; McClave et al., 2016). The RCTs presented offer high level evidence

(Burns, Rohrich, & Chung, 2011), which substantiates the use of enteral nutrition protocols in critical care. Furthermore, electronic medical resources enhance the ability of healthcare facilities to provide guidance and feedback for clinicians to improve enteral nutrition practices (Bouise et al., 2016).

Marrying the themes of clinical decision support, reducing barriers to evidence-based practice, and incorporation of electric resources to enhance clinical practice are vital to the promotion best practice and positive clinical outcomes (McClave et al., 2016).

The purpose of this DPI project was to assess the efficacy of a particular enteral nutrition protocol to improve patient care through the standardization of nutritional care practices. The literature review provided offered insights into the effectiveness of various enteral nutrition protocols. The protocol used in this project had clinical decision points for hemodynamics, impaired gastric motility and absorption considerations, initiation and titration guidance, and a decision point of gastric residual volume monitoring (See Appendix C). Each of these clinical guides were deem important components needed for improving enteral nutrition intake in critical care settings following a review of existing literature.

Clinical outcomes. Enteral nutrition protocols aimed to foster positive outcomes in critically ill, mechanically ventilated patients (Li et al, 2017). Maintaining the metabolic integrity of critically ill patients helped to avoid poor clinical outcomes such as immunosuppression, organ dysfunction, and even death (Rugeles et al., 2013; Vest et al., 2018; Yang et al., 2017). Standardizing practices and implementing protocols ensured that critically ill, mechanically ventilated patients received adequate nutrition which played a fundamental role in improving clinical outcomes (Fetterplace et al., 2018).

Glycemic imbalances. Glycemic variability refers to the fluctuations in a patient's glucose levels. In critically ill patients, it has been deemed a side effect severe illness due to the bodily response to stress (Falciglia, Freyberg, Almenoff, D'Alessio, & Render, 2009). Frequent hyperglycemic and hypoglycemic episodes have been linked to increased morbidity and mortality in critically ill, mechanically ventilated patients (Falciglia et al., 2009).

Doola et al. (2019) conducted a prospective, parallel group, blinded, randomized feasibility study to evaluate the role of enteral nutrition in the mitigation of glycemic variations and other clinical outcomes in 759 patients. Doola et al. (2019) found that the use of an enteral nutrition regimen that used formulations with limited carbohydrate content were less likely to lead to poor clinical outcomes such as increased ventilator days and increased lengths of stay ($p<0.01$). The implementation of enteral nutrition early in a patient's critical care admission and limiting carbohydrate inclusion in the enteral regimen reduced the time spent on mechanical ventilation ($p< 0.01$) (Doola et al., 2019). The study also concluded that increased glycemic variability correlated with increased mortality rates ($p=0.03$) (Doola et al., 2019). Efforts to maintain glycemic stability with enteral nutrition were vital to improving clinical outcomes for critically ill, mechanically ventilated patients (Doola et al., 2019).

Refeeding syndrome and electrolyte disturbances. Iatrogenic malnutrition predisposed critically ill patients to the severe complications related to refeeding syndrome (Coskun, Gundogan, Baldane, Guven, & Sunger, 2014). Refeeding syndrome is the potentially dangerous shifts in fluid and electrolyte balances in patients found to be malnourished (Solomon & Kirby, 1990). With refeeding syndrome, the shifts in fluids and electrolytes could precipitate catastrophic multisystem organ failure and death (Solomon & Kirby, 1990). Clinicians must be attuned to the presence of iatrogenic malnutrition in order to implement the appropriate strategies to avoid disastrous electrolyte and glycemic imbalances (Coskun et al., 2014). Researchers in Turkey sought to understand the incidences and consequences of refeeding syndrome with enteral feeding (Coskun et al., 2014).

A total of 117 patients were included in a retrospective analysis in a critical care unit (Coskun et al., 2014). Of those 117 patients, 61 patients were noted to have low phosphate levels as a result of refeeding complications (Coskun et al., 2014). Low phosphate levels have the potential to exacerbate respiratory failure and general muscle weakness which could quickly progress to death (Miller & Slovis, 2000). Researchers noted that the presence of low phosphate levels that accompanied refeeding syndrome had a direct correlation with increased lengths of stay (p=0.03) and an increased mortality rate (p=0.04) (Coskun et al, 2014). Prevention of iatrogenic malnutrition was crucial to preventing patients from being susceptible to refeeding syndrome and its potentially catastrophic consequences (Coskun et al., 2014).

Older adults who fall critically ill were highly susceptible to developing malnutrition (Thomas, Zdrowski, & Wilson, 2002). The development of malnutrition in elderly critically ill patients resulted in detrimental metabolic dysfunction that led to electrolyte and glycemic imbalances (Avelino-Silva & Jaluul, 2017). Early initiation of enteral nutrition was recommended for elderly critically ill, mechanically ventilated patients to maintain the GI tract and meet the nutritional needs of this vulnerable population (Avelino-Silva & Jaluul, 2017). Iatrogenic malnutrition in elderly patients reached levels that caused refeeding complications and devastating consequences (Avelino-Silva & Jaluul, 2017). Early nutritional assessments and introduction of enteral nutrition care plans have had a positive effect on clinical outcomes (Avelino-Silva & Jaluul, 2017).

Decreased intensive care unit length of stay and mortality. Supporting the recoveries of critically ill, mechanically ventilated patients through the implementation of an evidence-based enteral nutrition program employed best practice to improve clinical outcomes (Stewart, 2014). European researchers set out to determine if implementing an enteral nutrition protocol to improve nutritional delivery improved clinical outcomes for critically ill, mechanically ventilated patients (Padar, Uusvel, Starkopf, Starkopf, & Blaser, 2017). The observational, before and after study was conducted in a critical care unit from 2011 through 2015 (Padar et al., 2017).

A total of 231 patients were included in the pre-intervention group and a total of 249 patients were included in the post-intervention group (Padar et al., 2017). At the mid-point of the study, researchers introduced an evidence-based enteral nutrition protocol to the staff of the critical care units and oversaw the integration of the protocol into bedside practice (Padar et al., 2017). Researchers compared rates of infection, length of stay in the ICU, and mortality rates for the pre-intervention and post-intervention group (Padar et al., 2017).

The patients who were treated with the enteral nutrition protocol had their nutritional needs met on a more consistent basis than the patients treated before the enteral nutritional protocol was introduced (p=0.05) (Padar et al., 2017). The study did not reach the level of producing statistically significant results in terms of decreased length of stay in the hospital overall (Padar et al., 2017). However, improving the nutritional intake with the use of an evidence-based enteral nutrition protocol for critically ill, mechanically ventilated patients had a corollary relationship with decreased time spent in the ICU (Orinovsky & Raizman, 2018; Padar et al., 2017).

The hypermetabolic state that accompanied severe illness required prompt intervention with a nutritional regimen that prevented catabolic consequences, iatrogenic malnutrition, and increased mortality (Ridley et al., 2018). A systematic review and meta-analysis of randomized control trials (RCT) was conducted to ascertain the amount of energy that should be included in an enteral nutrition regimen to affect mortality rates of critically ill, mechanically ventilated patients (Ridley et al., 2018). Researchers followed the PRISMA guidelines and consulted Medline, EMBASE, CINHAL, and the Cochrane Library in search of evidence for analysis (Ridley et al., 2018).

RCTs that evaluated the nutritional interventions used to support the metabolic needs of adult critically ill, mechanically ventilated were the focus of the analysis (Ridley et al., 2018). The RCTs were divided into two categories of patients who received their target nutrition and those who received at least 20% less than their target nutritional regimen (Ridley et al., 2018). Data collection netted a total of 10 trials with 3155 patients included for analysis (Ridley et al., 2018).

Researchers noted that statistically significant effects on mortality (p=0.89) were not shown in this analysis and attributed that finding to variations in protein delivery within this patient population (Ridley et al., 2018). The combination of protein and energy delivery as part of a comprehensive enteral nutrition program have been shown to reduce mortality in critically ill, mechanically ventilated patients (Chelkeba, Mojtahedzadeh, & Mekonnen, 2017). Some studies did show improved patient outcomes but lacked enough participants to achieve statistical significance (Ridley et al., 2018). Improving clinical practice for enteral nutrition to achieve consistency in practice was essential to attaining better clinical outcomes (Ridley et al., 2018).

The introduction of enteral nutrition protocols has had a positive impact on clinical outcomes in adult critically ill, mechanically ventilated patients (Li et al., 2017). This hypothesis was initially tested through a before and after, interventional study conducted on 10 hospitals with a total of 410 patients (Li et al., 2017). Patients were divided into two groups (Li et al., 2017). The control group consisted on 236 patients who received the standard of care and the intervention group consisted of 174 patients who received care guided by the enteral nutrition protocol (Li et al., 2017).

Researchers found that an enteral nutrition protocol helped patients receive a better proportion of enteral nutrition in the intervention group ($p<0.01$) (Li et al., 2017). Statistical analysis did not reveal a decrease in mortality at 28 days ($p=0.98$), but clinical significance was noted in the intervention group (Li et al., 2017). The limitation of no randomization and sample size was felt to contribute to lack of statistical significance (Li et al., 2017). Nevertheless, preventing malnutrition in critically ill, mechanically ventilated patients was seen to slightly decrease length of stay in the ICU ($p=0.07$) which was felt to be an improvement over the control group (Li et al., 2017).

Reduce healthcare costs. Iatrogenic malnutrition has proven costly to healthcare centers due to increased length of stay and increased morbidity (Correia et al., 2014). Thus, nutritional interventions were relevant to hospital expenditures and should be studied to evaluate best practices (Naberhuis, Hunt, Bell, Partridge, Goates, & Nuitjen, 2017). Researchers reviewed almost 6,000 pieces of literature and found 274 articles that discussed nutritional interventions in terms of hospital costs (Naberhuis et al., 2017).

Multiple studies have been performed to assess the link between malnutrition, clinical outcomes, and economic outcomes (Ruiz et al., 2019). Hospital costs included number of days in the hospital, readmissions due to complications, and mortality (Naberhuis et al., 2017). Researchers have found that improvements in nutrition related clinical practice have been implemented in hospitals and provided positive results in terms of outcomes and costs

(Naberhuis et al., 2017). Implementing cost-effective, enteral nutrition regimens helped to control costs associated with treating patient and improving clinical outcomes (Naberhuis et al., 2017).

Improving nutritional programs for critically ill, mechanically ventilated patient served to decrease iatrogenic malnutrition, healthcare costs, and poor outcomes (Ruiz et al., 2019). Ruiz et al. (2019) conducted a multicenter prospective observational cohort study that included 800 patients for analysis. All patients were assessed using the Malnutrition Screening Tool (MST) to look for indicators for malnutrition (Ruiz et al., 2019).

Nearly one-quarter of the patients exhibited signs of malnutrition (Ruiz et al., 2019). These patients had an average increase in hospital costs of 30% over that of patients who did not show any indications of malnutrition (Ruiz et al., 2019). The takeaway point from this study was the need for improved assessments and treatments for malnutrition in order to improve clinical outcomes and reduce healthcare costs (Ruiz et al., 2019).

Other researchers were also examining the relationship between hospital cost and the development of iatrogenic malnutrition. Curtis et al. (2017) conducted a study to determine the relationship between malnutrition and hospital costs at a Canadian healthcare center. A prospective cohort study used the Subjective Global Assessment (SGA) to study the link between the number of days spent in the hospital and the cost associated with the stay (Curtis et al., 2017).

Out of 956 patients, nearly 40% of the patients had clinical indication for moderate to severe malnutrition (Curtis et al., 2017). The group of patients had increased hospital stays (p=0.01) and medical complications (p<0.01) that translated to higher hospital costs (Curtis et al., 2017). Given this information, hospitals were incentivized to implement evidence-based nutritional programs that supported improved patient outcomes (Curtis et al., 2017).

Summary of clinical outcomes. Improving clinical practice aimed at fostering positive clinical outcomes has required an exhaustive appraisal of existing research (Al-Jundi & Sakka, 2017). Global efforts have been underway to improve enteral nutrition practices to raise the quality of care given to critically ill patients (McClave et al, 2016). The quantitative studies presented emphasized the detrimental effects of iatrogenic nutrition on critically ill patients and their outcomes (Avelino et al., 2017; Doola et al., 2019; Falciglia et al., 2009; Padar et al., 2017).

Incomplete or inappropriate enteral nutrition practices threatened clinical outcomes of critically ill, mechanically ventilated patients (Rugeles et al., 2013; Vest et al., 2018; Yang et al., 2017). The use of evidence-based enteral nutrition protocols improved enteral nutrition intake (Li et al., 2017; Orinovsky & Raizman, 2018) which correlated with improved morbidity and mortality. Additionally, evidence-based enteral nutrition protocols decreased incidences of hospital-acquired infections and lengths of stay (Avelino et al., 2017; Doola et al., 2019; Falciglia et al., 2009; Padar et al., 2017).

The review of literature included multiple studies that showed the importance of meeting the caloric needs of mechanically ventilated patients in critical care through a systematic process or protocol. The evidence-based enteral nutrition protocol used in conjunction with the DPI project sought to improve caloric intake for critically ill, mechanically ventilated patients within the first three days after intubation. The assumed implications of improving caloric intake for critically ill patients was that it would prevent iatrogenic malnutrition and the associated negative outcomes. Implementation of the protocol included brief in-services using the evidence gathered related to patient positioning, the consequences of iatrogenic malnutrition and refeeding syndrome, as well as, the effects nutrition on morbidity and mortality rates to provide a foundation for change. Ultimate, the goal of implementing an evidence-based enteral nutrition protocol was to positively impact patient care to contribute to improving patient outcomes through the translation of existing research.

Summary

Maslow's (1943) theory of human needs stated that nutrition was an essential part of the foundation of human existence and individual advancement. Yet, underfeeding critically ill patients has continued despite numerous advances in medical technologies (Souza et al., 2015). The incidences of iatrogenic malnutrition in critical care units has been estimated to surpass 40% of patients in some critical care units (Chakravarty et al., 2013; Mendes et al., 2017). An increased metabolism coupled with inadequate nutrition practices has placed patients at a significant and avoidable risk for developing malnutrition (Kuslapuu et al., 2015; Yeh et al., 2016; Yin et al., 2015).

Iatrogenic malnutrition has been linked to poor patient outcomes and increased healthcare expenditures (Correia et al., 2014; Naberhuis et al., 2017; Vest et al., 2018). Hence, enacting evidence-based practice encourages a higher quality of care that leads to optimal nutrition for critically ill, mechanically ventilated patients (McClave et al., 2016; Orinovsky & Raizman, 2018). The consensus among existing literature has supported implementing evidence-based enteral nutrition protocols to standardize clinical practice and offer guidance for clinical decisions for safe, effective enteral feeding (Li et al., 2017; Orinovsky & Raizman, 2018; Souza et al., 2015).

Introducing an evidence-based enteral nutrition protocol for critically ill, mechanically ventilated patients has provided patients with adequate, consistent nutrition necessary for healing

(Orinovsky & Raizman, 2018). Validated nutritional assessments have been considered to be a foundation for the establishment an individualized enteral nutrition prescription to provide nutrition to critically ill patients (Chelkba et al., 2017; Lachey & Pritchett, 2003; Yeh et al., 2016). Numerous healthcare entities have engaged in quantitative scientific inquiries to extend the amount of evidence available to support effective strategies aimed at improving enteral nutrition practices (Berger et al., 2019; Elke et al., 2019). Critical care units that introduced an enteral nutrition protocol were able to show with empirical data that critically ill patients received better caloric intake (Li et al., 2017; Orinovsky & Raizman, 2018). Offering critically ill patients the benefit of a comprehensive enteral nutrition protocol has been shown to reduce the chances for iatrogenic malnutrition and the collateral damage of immunosuppression and physical debility (Iwuoha & Akwaowo, 2015).

Under the auspices of Neuman's (1972) system model, a patient-centered effort was undertaken to reinforce the natural defenses of critically ill patients to induce an inclination toward health. The DPI project employed a quantitative methodology with a quasi-experimental design that assessed the efficacy of a specific enteral nutrition protocol to improve caloric intake for critically ill, mechanically ventilated patients. The overall intention of the quality improvement (QI), DPI project was threefold.

First, the QI project intended to improve the cumulative caloric intake for critically ill patients within an adult ICU. Second, the QI project intended to show that patients maintained or improved their serum albumin levels as an indication of nutritional health. Lastly, the QI project sought to validate the use a specific enteral nutrition protocol previously used in a before and after, retrospective study conducted at another facility. The results of the project may add to the existing body of knowledge and contribute to filling the existing gaps in available evidence.

Despite the growing amount of evidence to support improving enteral nutrition practices (Li et al., 2017), gaps have remained. There has yet to be a consensus published on the most effective protocol for enteral nutrition with critically ill patients. It is not known if a specific enteral nutrition protocol would improve the cumulative three-day caloric intake or the serum albumin of critically ill patients. Thus, understanding the effectiveness of an enteral nutrition protocol to improve feeding practices could benefit critically ill, mechanically ventilated patients.

The themes related to this DPI project were nutritional assessments, enteral nutrition protocols, and clinical outcomes. The specific enteral nutrition protocol that was implemented as part of the DPI project included a clinical decision point for hemodynamic assessments, consideration for any contraindications, initial starting rates and advancement guidance, along with a clinical decision point for monitoring GRV. The review of literature presented reflects each element of the protocol and the evidence to support its inclusion.

The literature reviewed in Chapter Two provided a review of theoretical frameworks and existing literature in order to provide a contextual foundation for the DPI project. Chapter Three continues with a discussion of the methodology, the problem statement, clinical questions, as well as, a discussion of the project design, the patient population that was the focus of this project, the data collection instrumentation, validity and reliability, data analysis, ethical consideration, and project limitations. Chapter Four provides the results of the project and graphics to illustrate the analysis that was performed. Chapter Five provides a summation of insights, recommendations, and ideas for directions of future projects and research to continue to mend gaps in existing knowledge.

Chapter 3: Methodology

Research has shown that approximately 40% of critically ill, mechanically ventilated patients are underfed and at risk for succumbing to adverse effects that result from iatrogenic malnutrition (Allard et al., 2016; Corkins et al., 2014; Curtis et al., 2017). Iatrogenic malnutrition has resulted in severe debility, increased hospital stays, and even death (Argarwal et al., 2013; Butterworth, 1974). Implementing an evidence-based enteral nutrition protocol with clinical decision points has been shown to help guide nursing practice in an effort to ensure that patients are receiving adequate nutrition (Orinovsky & Raizman, 2018).

The purpose of the direct practice improvement (DPI) project was to assess whether implementing an evidence-based enteral nutrition protocol improved the three-day cumulative enteral nutrition intake of critically ill, mechanically ventilated patients within an ICU of an Arizona community hospital. In addition to assessing the protocol's effect on cumulative enteral nutrition intake, the project assessed the serum albumin levels of patients of the day of intubation and three days later. This quantitative project employed a quasi-experimental design that compared the analysis of a pre-intervention group and a post-intervention group.

The goal of this chapter is to provide a concise detailing of the methodology that was used in conjunction with this quality improvement project. This chapter includes a description of the project's design, the population to be studied, how sampling was performed, the instrumentation that was utilized for data collection, and reliability. Chapter Three concludes with a description of the data that was collected and how it was analyzed, as well as, a discussion of the ethical considerations and project limitations that are included in this project.

Statement of the Problem

The quality improvement project addressed the inconsistency in enteral feeding practice. Bedside nurses have reported differing levels of knowledge when it comes to enteral feeding practices regarding hemodynamic instability, patient positioning issues, feeding intolerance, and other clinical presentations (Kim & Chang, 2019). Also, enteral feeding may be delayed due to the low prioritization of nutritional needs in favor of more immediate life-threatening demands or other distracting clinical issues (Orinovsky & Raizman, 2018). The discrepancies in knowledge and practice have had considerable, long-term consequences related to patient outcomes (Singer, 2019). Evidence supported the sensible use of a standardized, evidence-based enteral nutrition protocol for critically ill, mechanically ventilated patients to advance the best possible outcomes (Orinovsky & Raizman, 2018). To improve patient care and safeguard patients against underfeeding, an evidence-based nutritional support protocol was implemented in a 25-bed critical care unit within a non-trauma, community hospital in the metropolitan Phoenix area to improve the three-day cumulative caloric intake of critically ill, mechanically, ventilated patients.

Clinical Questions

As it was not known if a specific enteral nutrition protocol improved the enteral nutrition intake of critically ill, mechanically ventilated adult patients, the clinical questions that directed this project were as follows:

Q1. Was the three-day cumulative caloric intake of enteral nutrition improved in adult critically ill, mechanically ventilated patients following the implementation of an evidence-based enteral nutrition protocol over six-weeks?

Q2. Did implementing an evidence-based algorithm to enhance enteral nutrition practices maintain or improve serum albumin levels of critically ill, mechanically ventilated patients as compared to the current standard of care in six weeks?

From the clinical questions, a PICOT question was constructed that asked: Did the implementation of an enteral nutrition protocol result in patients receiving a higher percentage of their prescribed caloric intake compared to current standard practice with no protocol in the ICU of an Arizona community hospital in six-weeks?

The enteral nutrition protocol was an evidence-based practice (EBP) project that sought to improve enteral nutrition intake through the standardization of nursing practice (Li et al., 2017; Orinovsky & Raizman, 2018). The enteral nutrition protocol was the independent variable for the project. The primary dependent variable was the three-day cumulative enteral nutrition intake for critically ill, mechanically ventilated patients included in the project. The secondary dependent variable was the serum albumin level for critically ill, mechanically ventilated patients on the day of intubation and on the third day after intubation.

Patient data for a time period of six weeks from December 1, 2018 to January 11, 2019 were used for analysis related to caloric consumption and caloric prescription (pre-intervention). Patient data from a six-week time period of December 2, 2019 to January 12, 2020 were introduced was also used to examine the changes in the variables influenced by the intervention (post-intervention). The specific, mirrored time frames were chosen to mitigate differences in unit census and patient population that fluctuates seasonally in Arizona. Then, a comparison was made between the pre-intervention group and the post-intervention group to ascertain whether the introduction of an enteral nutrition protocol impacted nutritional intake.

The intervention began with a 20-minute in-service to provide the intensive care unit (ICU) nursing staff with a brief overview of the evidence that was available to support the institution of an enteral nutrition protocol and the six-week project timeline. The principal investigator provided an educational handout that illustrated the actual protocol to be used in the project, a listing of common misconceptions with regards to enteral nutrition practices, and references used for evidence used within the in-service (See Appendix D). Merci & Hensley (2010) posited that adults are more likely to conform to change if a logical rationale was afforded to clarify the need for change. Thus, nursing staff may have been more inclined to comply with the protocol after they were given the evidence that underscored a need to alter and standardize practice.

Data collection began with reviewing charts for all mechanically ventilated patients with an order for enteral nutrition. The data collection instrument was the patient data flowsheets, nutrition order set, and dietitian notes housed within the electronic medical record (EMR). The data collected included age, APACHE II score, and a daily caloric prescription from the dietitian notes, enteral nutrition intake volume from the intake and output flowsheet, and the serum albumin levels from the laboratory flowsheet. Patients were identified with an alphanumeric code to maintain anonymity.

The data analysis consisted of calculating the cumulative caloric intake for each patient and comparing that number to the prescribed caloric intake. The day of intubation served as the first day that caloric intake was recorded. The serum albumin levels for the day of intubation and the third day after intubation were compared for each patient as an assessment of nutritional status for the pre-intervention and the post-intervention groups. The results of that analysis were compared between the pre-intervention and post-intervention groups.

Multiple researchers have employed various designs to attempt showing a causal relationship between enteral nutrition and clinical outcomes (Avelino-Silva, 2017; Coskun et al., 2014; Doola et al., 2019; Padar et al., 2017). This DPI project intended to take a narrower scope and assess if an enteral nutrition protocol would result in critically ill patients receiving a higher degree of enteral nutrition as compared to the standard of care with no protocol. A quantitative methodology with a quasi-experimental design was chosen for this project since the data collected was numerical and subjected to statistical analysis to assess for a causal relationship.

To date, no studies have been able to show a definitive causal relationship between the amounts of enteral nutrition a critically ill patient received and clinical outcomes (Naberhuis et al., 2017; Ridley et al, 2018). The heterogony that existed between critically ill patients in terms of age, sex, diagnosis, and co-morbidities make establishing a causal relationship between enteral nutrition practices and clinical outcomes extremely difficult (Naberhuis et al., 2017; Ridley et al., 2018). However, several studies have shown statistically significant corollary relationships that provide clinical guidance for improving enteral nutrition practices (Naberhuis et al., 2017; Ridley et al., 2018). The quantitative methodology with a quasi-experimental design was most appropriate for this quality improvement (QI) project given the available evidence and the limitations of a single site, small patient population, no randomization of participants, and 12-week project timeframe.

Project Methodology

The quantitative methodology was chosen for this quality improvement project. Research studies could be quantitative, qualitative, or a combination of the two methodologies, which are mixed methods (Polit & Beck, 2012). A quantitative methodology was chosen due to the presence of numerical data being extrapolated to perform statistical analysis to determine the relationship between the variables. The independent variable for this project was an enteral nutrition protocol. The two dependent variables were the cumulative three-day caloric intake and serum albumin levels for critically ill, mechanically ventilated patients. The quality improvement (QI) project assessed the efficacy of an enteral nutrition protocol to improve cumulative caloric intake and serum albumin levels for critically ill, mechanically ventilated patients. A quantitative methodology was most appropriate method to assess the relationship of the nominal values that was used for statistical analysis.

A qualitative project would have generated thematic evidence aimed at understanding the experiences of participants through a narrative that is subjective in nature (Polit & Beck, 2012). A qualitative project would not have yielded the numerical data that the principal investigator required to explore the variables related to the clinical question as it is posed; therefore, a qualitative methodology was deemed inappropriate for the purpose of this project.

Some researchers have sought to maximize the outcome potential and reduce limitations with a multi-pronged approach, such as a mixed methodology (Polit & Beck, 2012). A mixed-methods approach would have combined elements of a quantitative and qualitative methodology (Polit & Beck, 2012). Mixed methods research has added a level of depth and scope that a solely quantitative or qualitative method cannot attain (Doorenbos, 2014). Qualitative data did not align with the clinical questions that were being asked, which form the foundation of this project. The lack of qualitative inquiry within this project left the principal investigator to determine that a quantitative method was the best fit.

Quantitative methods had the advantage of numerical data that can undergo statistical analysis and replication (Daniel, 2016). Consequently, quantitative methodology was given more credibility within the healthcare arena than qualitative or mixed methods research

(McCusker & Gunaydin, 2015). These were important considerations to examine when choosing a method to evaluate a practice problem. Thus, a quantitative methodology was thoughtfully chosen as the approach for this project.

Project Design

The project incorporated a quasi-experimental design. Other designs that could be utilized for quantitative research which include descriptive, correlational, and experimental (Polit & Beck, 2012). An experimental design was a controlled project where the researcher manipulates a randomly selected group of subjects to establish a causal effect (Polit & Beck, 2012). Experimental designs are considered the most reliable designs to produce evidence related to a cause and effect relationship between variables of a pre-intervention group and the experimental group (Polit & Beck, 2012).

Although the experimental design was ideal in the scientific world, it would be ethically inappropriate to apply randomization to critically ill patients and not provide a nutrition treatment to any group of critically ill patients that would be beneficial to outcomes. Also, the projected sample size was not thought to be appropriate for application of randomization. The project sought to improve the quality of care given in the intensive care unit (ICU) with an evidence-based intervention.

A correlational design for this project would have entailed determining if the variation of the enteral nutrition practices with an evidence-based protocol had an association or correlation with the patient outcomes. There were a multitude of conditions that contributed to patient outcomes which could not be regulated or quantified during the project within the clinical setting of the intensive care unit. Furthermore, a correlation design did not fit with the intentions of this project since the principal investigator was seeking to establish a causal relationship among the independent and dependent variables. Correlational designs produce less stringent outcomes and was deemed not appropriate given the context of the intended project outcomes (Polit & Beck, 2012). A correlation design would be most appropriate for future projects that support a more in-depth examination of patient outcomes with a longer project timeframe, larger sample, and inclusion of more clinical sites to obtain more generalizable results.

Descriptive research utilized the power of observation and explanation to document elements of the situation as it happens for the purposes of hypothesis creation (Polit & Beck, 2012). Descriptive research was considered non-experimental and thus, lacked the scientific rigor of experimental and quasi-experimental designs but was useful in some research studies (Rutberg & Bouikidis, 2018). A descriptive design was also not appropriate for this project because an intervention was introduced to assess a causal relationship between the variables. Therefore, a quasi-experimental design was the best design for this project.

Quasi-experimental designs divide subjects into groups but does not employ randomization to participants (Polit & Beck, 2012). The quasi-experimental design of this DPI project compared non-randomized group outcomes before and after an intervention was conducted to establish a cause and effect relationship (Polit & Beck, 2012). Although there was no division of patients into control and experimental groups, causal relationships could be inferred so long as the differences among participants were recognized to assess the impact on outcomes (Polit & Beck, 2012). The quasi-experimental design allowed for the assessment of variable relationships to improve nutrition for all critically ill patients through enhancing the existing body of knowledge.

For this quasi-experimental design, data was collected from the hospital’s electronic medical record (EMR) by the principal investigator. The hospital’s EMR was built on the

EPIC® platform and was used for documentation of all patient-related information. The EMR was reviewed to query all the patients who had an order for enteral nutrition and were mechanically ventilated for at least three days. Also, patient's charts were reviewed to obtain the age, APACHE II score, daily caloric intake recommended by the registered dietitian (RD). The daily volume of enteral nutrition intake recorded by the registered nurse for three days (RN), and the serum albumin level on the day of intubation and three days later were also obtained from the EMR.

The daily caloric prescription was ordered as kilocalories (kcal) to be delivered over 24 hours. The registered dietitian (RD) translated the caloric prescription to an enteral formula with a goal rate per hour that will provide the kcal ordered for the patients. For example, if a patient was ordered for 2400 kcal per 24 hours via an enteral nutrition formula rate of 100 milliliters (ml) per hour that translated to 100 ml per hour would deliver 100 kcal per hour. In other words, 1 milliliter of that particular enteral formula delivered 1 kilocalorie of nutrition. The recorded intake from the EMR was used to calculate the total caloric intake for critically ill, mechanically ventilated patients for three days. All the information was added to an Excel ® spreadsheet along with an alphanumeric code that was used as the patient identifier to maintain anonymity and confidentiality for the patient.

The dependent variables for this project were the cumulative caloric intake and the serum albumin level at day three after intubation. The pre-intervention sample was compared with the post-intervention sample to assess statistical differences in the two groups. The information derived from the electronic medical record (EMR) was used to assess for a causal relationship between the dependent variable and independent variables.

Population and Sample Selection

The site of the quality improvement (QI) project was an adult intensive care unit (ICU) that consisted of a mixture of medical and surgical patients and had a total bed capacity of 25. The hospital was in a metropolitan area but did not function as a trauma center. The ICU did not accept minor patients for medical or surgical treatment. The hospital had a separate pediatric intensive care unit (PICU) and neonatal intensive care unit (NICU) that were not included in this project. Also, the hospital had an obstetric unit on site however, none of those patients were admitted to the facility during the project period. If a pregnant patient had been admitted to the intensive care unit, that patient would have been excluded from the DPI project due to ethical concerns that would have required a full review and clearance from the Institutional Review Board (IRB) of both the facility and the university.

The project employed a non-probability convenience sampling of all adult ICU patients who were mechanically ventilated with an oral endotracheal tube for at least three days and had a physician order for enteral nutrition. The sampling process covered a six-week period exactly one year before the intervention was introduced to compensate for the season influences on illness and injuries that required hospitalization. A separate sampling process covered the six weeks after the intervention was also enacted.

Criteria for inclusion in the project was the patient had to be an adult over the age of 18, orally intubated, mechanically ventilated for at least three days, and had an order for enteral nutrition only. Patients with parenteral nutrition were excluded. Feedings were restricted to gastric tubes placed nasally or orally for the purposes of this DPI project. Patients with percutaneously placed feeding tubes were excluded as the project sought to explore feedings associated with acute conditions and percutaneous placed feeding tubes tended to denote chronic conditions. This project sought to specifically include patients who were acutely ill and required intubation. Patients with tracheostomies were excluded for the same reason. Also, any patients on mechanical ventilation for less than three days were excluded from the project.

Random sampling using statistical methodologies was impractical due to the high variability of clinical presentations and diagnoses of patients admitted to the ICU and the already small sample size that was expected. Therefore, non-probability sampling was the most appropriate approach to the project due to the short duration of the project in addition to the small pool of patients from which to choose appropriate candidates. Non-probability sampling was ideal since the principal investigator had easy access to the population, and data collection could be done in a cost-effective way (Rahi, 2017). Thus, non-probability convenience sampling was the most practical way to select patients for subsequent data collection for this project.

The project was conducted in a 25-bed ICU of a single site. A sample size calculator was used to determine the sample size needed to achieve statistical significance. An ideal target population for this project was a total of 384 participants evenly distributed in the pre-intervention and post-intervention groups (Creative Research Systems, n.d.). This estimate was calculated using a sample size calculator with a confidence level of 95% and a confidence interval of 5. Attaining nearly 400 subjects for this project was simply not possible. Hence, a non-probability convenience sample was used to obtain as many patients as possible that meet the criteria for inclusion for the pre-intervention and post-intervention analysis.

Since attaining nearly 400 patients for the project was not going to be possible given the single site use and limited timeline of six weeks, a statistician was consulted for assistance to come up with a more reasonable sample size target. A generalized linear model would have required at least 26 patient data sets for each of the pre-intervention and post-intervention groups. However, a more modest group of seven patients were obtained for the pre-intervention group and another five patients were obtained for the post-intervention group. It was a smaller than expected number for both groups; therefore, testing had to be changed to an appropriate statistical model for analysis.

Every adult patient that falls within the project timeline and met the criteria for inclusion was included in this project. The principal investigator did not require informed consent from patients since this was a quality improvement project and there was no interaction with patients. Additionally, ICU nurses did not have to provide formal consent because the project was a care-related policy change that standardized current practice and did not introduce a new practice. The principal investigator took all necessary and reasonable steps to maintain patient anonymity and confidentiality during the entire project period.

Instrumentation

The instrument for data collection was the hospital's electronic medical record (EMR) system. The EMR runs on the EPIC® software platform. The principal investigator was well versed in the use of EPIC® and was able to navigate the system proficiently. Data collection from the EMR had the advantage of being both convenient and cost-efficient as opposed to having to retrieve written health records (Hoover, 2016; Polit & Beck, 2012). The EMR saved inputted patient data in clearly defined areas according to the category of the data. Congregation of data allowed for the ease of recall of patient data that could be used for quality improvement projects (Hoover, 2016).

Electronic medical record. All of the information that was required for this DPI project was readily available within the EMR. The principal investigator provided the informatics team with a list of inclusion criteria to use as search terms. The health informatics team built a query tool to quickly identify the patients who met criteria for inclusion during the specified time frames. All records were further examined by the principal investigator to make sure that the patients selected met criteria for inclusion and for information relevant to the clinical questions.

Critically ill, mechanically ventilated patients with an order for enteral nutrition had their specific caloric intake recommendation from the registered dietitian (RD) recorded on an Excel® spreadsheet. The specific recommendation for the daily caloric intake was in the progress notes section and written by the registered dietitian (RD). Then, the principal investigator took the daily intake from the patient's electronic medical record (EMR) and converted to the cumulative caloric intake for three days after intubation for transcription onto the Excel® spreadsheet. In addition to this information, the patient's age and APACHE II score was extracted from the EMR and entered into the Excel® spreadsheet.

A separate, primary Excel® spreadsheet was constructed to house the information used to identify patients on the primary data collection spreadsheet. The primary spreadsheet contained the patient's initials for their first and last name plus the last six digits of the patient's hospital account number which will correspond with the alphanumeric code that was used in conjunction with that patient's nutritional data. The hospital account number was used in lieu of the medical record number since was it specific for that the current hospitalization. The information contained in this file never left the facility's grounds and remained stored on a password protected office computer. The principal investigator was the only person to have access to the files which had a unique password for controlled access.

The components of pre-intervention and post-intervention data collection were identical. The pre-intervention data collected from the electronic medical record (EMR) were added to an Excel® spreadsheet and labeled accordingly. The post-intervention data collected from the EMR were entered into an Excel® spreadsheet and labeled as the *post-intervention* group. Demographic data collection was limited to age and gender. The intervention was immediately preceded with an in-service aimed at providing background information to the bedside critical care nurses on the evidence to support the use of an evidence-based enteral nutrition protocol.

Validity

The validity of a project related to whether the methods used were measuring the concepts intended to measure (Polit & Beck, 2012). The validity of the project was limited due to the anticipated small sample size, conduction at a single site, and a short time period for data collection. These constraints were out of the control of the principal investigator. However, the data collected was assumed to maintain its validity because the data was collected from the electronic medical record (EMR) with standardized documentation and processed with the same SPSS v26 program for all sample subjects. The analyses were poised to offer results that were clinically significant and therefore, add to future evidence to highlight other opportunities to improve enteral nutrition practices for adult critically ill, mechanically ventilated patients.

Reliability

The reliability of the project related to whether the project outcomes were replicable using the same methods (Polit & Beck, 2012). Due to the lack of probability sampling and small sample size, it was difficult to apply the methods to another group of critically ill, mechanically ventilated patients. The variability of the patient population that was studied made the generalization to other adult intensive care unit (ICU) populations. It may have been possible to assess the test-retest reliability in another ICU of similar size and compare the results. Nonetheless, the results of such an endeavor would have been dependent upon many factors such as nurse engagement and involvement of dietitians within the facility.

Reliability was further ensured within elements of the data collection and data collection process. First, there was a team of two dietitians who rounded on patients within the critical care site. The dietitians used the Harris-Benedict equation to determine the caloric intake that patients would require during their stay in the critical care unit. The Harris-Benedict equation has been validated as a tool for assessing the nutritional needs of patients (Picolo et al., 2016). The standardization of a validated assessment tool ensured uniformity in determining nutritional prescriptions to meet patients' needs.

Second, the formulations used for enteral nutrition were pre-made, standardized formulas to deliver consistent caloric intake per bottle. The principal investigator was the only person collection data and performing calculations of caloric intake. By using the volume given and the caloric value of each milliliter, the principal investigator was able to determine the caloric intake of each patient included within the pre-intervention and post-intervention sampling. Thus, reliability was maintained through consistency of formulations and use of a single entity for caloric consumption calculations.

Lastly, the laboratory samples collected were processed on site. The laboratory performed quality control checks on laboratory instrumentation every 12 hours to ensure that the laboratory values reported were correct and reliable. Quality controls were also conducted whenever a new lot of reagents was introduced. The laboratory values were transmitted electronically from the laboratory instrumentation to the electronic medical record. As an extra measure for validation, laboratory technicians were responsible for certifying each data entry prior to publication of the laboratory values within the electronic medical record. Again, the principal investigator was the sole entity collecting and storing data. Therefore, the data collection process remained consistent in an effort to protect the reliability of the project's outcomes.

Data Collection Procedures

This section provides a detailed accounting of the data collection procedures that were performed for this quality improvement project:

Step 1: The project site employs the principal investigator. The principal investigator received consent to perform the project from the director of the intensive care unit (ICU). The facility's Institutional Review Board (IRB) approved the application before any forward movement with the project. Approvals were also obtained from the university's IRB prior to collection of any data (See Appendix A).

Data collection included patients who meet the criteria for inclusion. There was no randomization of eligible patients because to deny critically ill patients a potentially beneficially enteral nutrition plan was unethical. Consent was not required from patients or staff due to this being a quality improvement project, and there was no interaction between the principal investigator and the patients. Data collection also included patient age, sex, and APACHE II score in order to elicit values related to group characteristics.

Step 2: The principal investigator scheduled four 15-minute in-services for all bedside nurses and supervisors in the intensive care unit (ICU). The in-service provided a brief overview of the problem identified with current enteral nutrition practices and evidence for the use of an evidence-based enteral nutrition protocol. A poster with the components of the protocol was available for visualization and ongoing reference (See Appendix D). The in-service information was summarized in a one-page handout with a copy of the protocol on the back of the handout for continued reference during the project (See Appendix C).

Step 3: A separate, secondary Excel® spreadsheet was constructed to house the information that was used to identify patients on the primary data collection spreadsheet. The primary data collection sheet contained ten columns. The columns were labeled patient identifier, age, sex, APACHE II score, daily caloric prescription, caloric intake for day one, caloric intake for day two, caloric intake for day three, cumulative caloric intake for three days, serum albumin on day one, and serum albumin on day three.

The secondary spreadsheet contained two columns for the patient's initials of their first and last name plus the last six digits of the patient's hospital account number which corresponded with the alphanumeric code that was used in conjunction with that patient's nutritional data. The hospital account number was used in lieu of the medical record number since it was specific that the current hospitalization. The data in each Excel ® file was kept on the principal investigator's password protected laptop.

Step 4: The intervention phase began with the implementation of the enteral nutrition protocol. The protocol that was implemented has the following components:

1. Candidates for the protocol had a mean arterial pressure (MAP) greater than 65 mmHg. Norepinephrine infusions were less than 100 micrograms per kilogram per minute, or Dopamine infusions were less than three micrograms per kilogram per minute along with MAP parameters for the use of this protocol. Patients that did not meet these criteria were managed by a medical provider (Orinovsky & Raizman, 2018).
2. Patients with diagnosed digestive issues such as irritable bowel disease, refeeding syndrome, or require post-pyloric feeding started off with an enteral infusion rate of 10 ml per hour. Gastric residual volumes (GRV) were checked every six hours. The

feeding rate was increased by 10 milliliters until the patient reached the goal rates prescribed (Orinovsky & Raizman, 2018).

3. Patients with no diagnosed digestive issues started with an enteral nutrition rate of 25 milliliters per hour. The feeding rate was increased by 25 milliliters until the patient's goal rate was reached (Orinovsky & Raizman, 2018). Goal rate was determined by the prescription from the registered dietitian.
4. If the GRV greater than 250 milliliters, then the nurse consulted with the physician to obtain an order for a prokinetic agent or a change to post-pyloric feeding (Orinovsky & Raizman, 2018).

The standard care practices within the critical care unit for patients on an enteral feeding regimen continued unchanged. Critical care nurses continued to follow the prevention protocol for ventilator acquired pneumonia (VAP). Radiological studies continued to follow the placement of any feeding tubes. Also, critical care nurses continued to follow orders for holding feedings for procedures. However, nurses were presented with literature during the in-service stating interrupting enteral feeding for patient positioning was not evidence-based. Also, it was emphasized that if patients were showing signs and symptoms of gastric intolerance, a physician was notified and a discussion regarding prokinetic agents or a change from gastric to post-pyloric feedings took place.

Step 5: Data collection for the pre-intervention group began soon after completing the staff in-services. A non-probability, convenience sampling was employed. All adult, critically ill patients were sifted through to find patients that meet the criteria for inclusion. The inclusion criteria stipulated that were patients were orally intubated, have an order for enteral nutrition, and were mechanically ventilated for at least three continuous days.

This was a quality improvement project. The intent of the project was to improve practice with an evidence-based enteral nutrition protocol. The project did not introduce any new practice. Also, consent was not required from patients for this DPI project because the principal investigator did not interact with any the patients or their families.

The principal investigator (PI) queried the patient census from a six weeks period one calendar year (December 1, 2018 to January 11, 2019) before the intervention for patients who were mechanically ventilated for at least three days. Next, the PI reviewed the charts to obtain a sample of patients who had an enteral nutrition order entered. Patient's identifying information and names were changed to an alphanumeric code. The ages and APACHE II scores for each patient were recorded in the data spreadsheet.

A review of each patient's chart for dietitian recommendations and notes regarding enteral nutrition prescriptions for daily caloric intake was added to the data spreadsheet. Then, each patient's chart was reviewed to obtain the volume of enteral nutrition received over three days from the time of intubation and entered into the data collection spreadsheet. Lastly, the serum albumin level for the project patient was obtained for the day of intubation and three days later for entrance into the data spreadsheet. The data was recorded on a spreadsheet on the principal investigator's computer which is password protected.

The principal investigator (PI) ensured that the data was collected in an office that was not subject to foot traffic. Also, the PI was sure to log off of the computer and secure any loose documentation in a locked file folder. Neither the computer nor any documentation was left unattended or unsecured.

Step 6: At the end of the six-week intervention period, the same information was collected for the post-intervention group as the pre-intervention group and recorded on a separate data collection spreadsheet. The data on the Excel® spreadsheets was transferred to the SPSS software for analysis. The spreadsheets and the SPSS software are both on the principal investigator's password protected work computer.

All project data was kept in a locked file in the principle investigator's (PI) work office and stored electronically on the PI's computer which is password protected. Research records will be maintained for 3 years. At the conclusion of the required period, the records will be shredded or deleted per hospital protocol.

The goal of this project was to improve enteral feeding practices through the implementation of an evidence-based protocol. The data collected in conjunction with this project showed if a causal relationship existed between the independent variable of the enteral nutrition protocol and the dependent variables of cumulative caloric intake for three days and the serum albumin level on day three after intubation.

Data Analysis Procedures

The quality improvement project sought to address two clinical questions. The questions were as follows:

Q1. Was the three-day cumulative caloric intake of enteral nutrition improved in adult critically ill, mechanically ventilated patients following the implementation of an evidence-based enteral nutrition protocol over six-weeks?

Q2. Did implementing an evidence-based algorithm to enhance enteral nutrition practices maintain or improve serum albumin levels of critically ill, mechanically ventilated patients during the first three days as compared to the current standard of care in six weeks?

Existing literature indicated that patients who received at least 80 % of their prescribed caloric intake while critically ill were more likely to have positive outcomes (Dickerson et al., 2017). Thus, the clinical questions sought to further understand the relationship between an enteral nutrition protocol and improved nutritional intake. The variables associated with the clinical questions were an enteral nutrition protocol (dependent), the cumulative three-day caloric intake received by the patient (independent), the three-day cumulative caloric intake ordered by the provider, and the serum albumin of critically ill, mechanically ventilated patients at day three after intubation (independent). The implementation of an enteral nutrition protocol was intended to improve caloric intake for critically ill, mechanically ventilated patients.

Data collection consisted of two phases. The first phase was the pre-intervention phase, and the second phase was the post-intervention phase. The data from each phase underwent separate analysis and then underwent a comparative analysis of both data sets. All the project data was entered into an Excel® spreadsheet to streamline data for subsequent analysis. Table 3.1 illustrates how the pre-intervention data was organized, and Table 3.2 shows how the same type of data was collected for the post-intervention group. Once all the data fields are completed with the relevant data, the data was entered into the SPSS software for the appropriate analyses.

Table 3. 1

Pre-intervention Data Collection Spreadsheet

ID	Age	Sex	APACHE II score	Daily caloric prescription (kcal/day)	Caloric intake for day #1	Caloric intake for day #2	Caloric intake for day #3	Serum Albumin Day #1	Serum Albumin Day #3
A1									
A2									
A3									
A4									
A5									
A6									
A7									

Table 3. 2

Post-intervention Data Collection Spreadsheet

ID	Age	Sex	APACHE II score	Daily caloric prescription (kcal/day)	Caloric intake for day #1	Caloric intake for day #2	Caloric intake for day #3	Serum Albumin Day #1	Serum Albumin Day #3
B1									
B2									
B3									
B4									
B5									

Since the sampling consisted of convenience sampling, descriptive statistics were employed to elicit some of the characteristics of the pre-intervention and the post-intervention groups. It was important to understand the age distribution of each group and how the acuity, as measured by the APACHE II score, figured into each grouping. Patient sex was also included in descriptive analysis. Descriptive statistics offered valuable insights into the attributes of each group.

The principal investigator consulted the facility's statistician about the project and the appropriate data analyses. Initially, the project proposal indicated that a generalized linear model would be used in conjunction with descriptive analysis. However, the sample sizes that were obtained for the pre-intervention and post-intervention groups necessitated a change to a more appropriate statistical analysis. Since there was abnormal distribution of variables, a Mann-Whitney *U* test was utilized for analysis.

Descriptive statistics were employed to describe the characteristics of the population that was studied. The descriptive statistics incorporated data related to patient age, gender, and APACHE II score. The APACHE II score was related to the patient's acuity of the severity of illness. Statistical analysis indicated the differences between the pre-intervention group and the post-intervention group.

Additionally, summary statistics, including mean (standard deviation) and count (percentage) was provided for all demographic and baseline clinical variables, as well as all outcome variables, by group. Total calorie intake over three days was the criterion variable. Group membership was entered as a fixed factor. Calorie prescription (for three days) was entered as a covariate so the difference across groups may be interpreted as calorie intake minus calorie prescription. The main effect of group was evaluated.

Age, APACHE score, and sex were considered for use as covariates since the two groups are imbalanced at inception. A similar analysis was conducted to assess change in serum albumin. Final serum albumin was the criterion variable. Group membership was entered as a fixed factor. Initial serum albumin was entered as a covariate so differences across groups were interpreted as final albumin minus initial albumin. The main effect of group was evaluated and a *p*-value of less than 0.05 was considered to be statistically significant.

Ethical Considerations

Ethical considerations were an essential part of the project to ensure the safety and welfare of the patients. Following IRB approval, research was governed by the principles of the Belmont Report, which include beneficence, justice, and respect (Office for Human Research Protections [OHRP], 2018). The principal investigator intended to make sure that all the patients included in this project are treated with respect and dignity. A quasi-experimental design was deemed most appropriate to ensure that the principle of beneficence was applied to the project. All human beings need nutrition. Critically ill patients were dependent upon caregivers for nutrition. Withholding an enteral nutrition protocol that could improve the nutritional intake of critically ill patients is unethical; therefore, the enteral nutrition protocol was applied to all patients that are eligible for enteral nutrition.

Privacy and respect were maintained during the project and in any subsequent publication of project findings. Patients were given an alphanumeric code for identification and use with the data collected. Staff information was not collected as it was not needed for this project. The site's anonymity was maintained and regarded as an ICU in an Arizonan community hospital. Any information related to patients, staff, and project site remained confidential.

Organizational consent and unit management consent were obtained in writing and were added to the appendices. Hard copies of organizational and management consent were secured in a locked filing cabinet in the principal investigator's office on site. Consent from the patients and staff was not required for this project. The DPI project enhanced and standardized practice to improve enteral nutrition intake for critically ill, mechanically ventilated patients.

The principal investigator was the only person collecting data. Digital information consisted of alphanumeric identifiers for patients, their corresponding data, and SPSS v26 analyses. The digital information was kept on the principal investigator's password-protected work computer and an encrypted, password-protected thumb drive to maintain the security of the data. The university required that project data be kept for a minimum time period. After the waiting period, the project data will be destroyed in approved manner. The university has requirements related to the publication of project results as a condition of the pursuit of the Doctor of Nursing Practice.

The facility required that project data be kept in a locked file in the principal investigators office or stored electronically on the principal investigators work computer which is password protected. All project records will be maintained for three years and then disposed of per hospital policy. Those requirements will be implemented as instructed, and the facility will be privy to relevant project results.

Limitations

Despite attempts of mitigation, several limitations were present in this project. First, a quasi-experimental design was chosen for the project. A quasi-experimental design with non-probability convenience sampling did not capture the diversity that is inherent in the intensive care unit (ICU) population. The use of a single site for the project compounded the limitations of sample selection.

Additionally, the timetable for this project was set at six weeks for the pre-intervention and post-intervention arms of the project. The sample that was obtained is expected to be far smaller than the 384 participants generated from a power analysis. Generalizability to other intensive care units (ICU) was expected to be impaired due to these limitations. Moreover, the data collected was highly dependent on the quality and accuracy of documentation into the EMR. Missing or incomplete documentation impacted data collection and analyses.

Further limitations were not appreciated until the conclusion of the project. The specific facility where the principal investigator (PI) works had several projects that were ongoing and were expected to have confounding effects on this quality improvement project. Therefore, the PI moved the project to another critical care unit on another campus located across town. This meant that the PI would not visible to the staff to voice concerns or ask questions.

Lastly, the protocol was based on a European study. American standards differ slightly from those put forth in the protocol that was used in conjunction with this project. These differences were brought up after the conclusion of the project and were deemed as a post hoc limitation.

Summary

Chapter Three summarized the methods that were instituted in the quality improvement project to improve enteral nutrition for critically ill, mechanically ventilated patients. Chapter Three began with a review of the practice problem. Iatrogenic malnutrition was a significant issue among critical care patients (Corkins et al., 2014). Critically ill patients need to receive at least 80% of their daily caloric requirements in order to avoid nutrition related detriments to their clinical outcomes (Dickerson et al., 2017). Implementing an evidence-based protocol has been shown to improve enteral nutrition intake and foster better outcomes (Orinovsky & Raizman, 2018). The quality improvement project intended to improve the quality of enteral care in the critical care unit for mechanically ventilated patients with an evidence-based enteral nutrition protocol.

This chapter described the project's design, population, sampling procedures, instrumentation that was used, validity, and reliability. The quality improvement project employed a quantitative methodology with a quasi-experimental design to assess the relationship between an enteral nutrition protocol and the cumulative intake of enteral nutrition over three days. The project explored the effect that the enteral nutrition protocol had on the cumulative caloric intake and serum albumin levels of critically ill, mechanically ventilated patients.

The site of the project was a 25-bed adult ICU that a mix of medical and surgical patients. Sampling consisted of non-probability convenience selection of adult intensive care unit (ICU) patients that met the project inclusion criteria. The EMR was used as the data collection instrument. Although the principal investigator was the sole collector of data sets, it was difficult to state with certainty that the project results were not affected by a set of unknown, confounding variables.

The external validity of the project was limited due to the use of convenience sampling versus random sampling of a small population. Consequently, the ability to generalize results was limited. The reliability was influenced by the sampling procedures and may be difficult to confidently apply these methods to another population to elicit similar results. However, the essence of the project remained to improve clinical practice and add to existing knowledge.

The latter portion of the chapter detailed the data collection procedures, data analyses, ethical considerations, as well as project limitations. Data collection involved extracting patient data from the EMR and transcribing that data to an Excel® spreadsheet. Identifying patient information was converted to an alphanumeric code to maintain patient confidentiality and anonymity.

The data collected was uploaded to an SPSS v26 program for statistical and descriptive analysis. Ethical considerations included the security and future destruction of project materials. Informed consent was be required as the project was confined to quality improvement and patient interaction was not necessary. Despite the limitations of sample size and convenience sampling, this project was expected to improve enteral nutrition practices within the critical care unit. Chapter Four provides the results of the project with corresponding tables illustrate the project findings. Chapter Five includes cogent insights, recommendations, and suggestions for future research to continue to expand the current body of knowledge.

Chapter 4: Data Collection and Analyses

The Direct Practice Improvement (DPI) project addressed the lack of an evidence-based enteral nutrition protocol to standardize and guide clinical practice for critically ill, mechanically ventilated patients within the intensive care unit (ICU) of a metropolitan Phoenix community hospital. Existing literature indicated that a substantial number of critically ill patients were underfed to the point of developing iatrogenic malnutrition (Allard et al., 2016; Corkins et al., 2014; Curtis et al., 2017). Evidence-based enteral nutrition protocols have enhanced clinical practice and provided patients with a higher proportion of caloric intake, which has been shown to positively influence patient outcomes (Li et al., 2017; Orinovsky & Raizman, 2018; Stewart, 2014). The quality improvement project examined the efficacy of an evidence-based enteral nutrition protocol intervention and its impact on the caloric intake that critically ill patients received within the first few days of mechanical ventilation. Additionally, the project examined whether the serum albumin of critically ill, mechanically ventilated patients remained the same or increased after the intervention.

Since it was not known whether and to what extent the use of an evidence-based protocol would have improved the three-day cumulative intake of adult critically ill, mechanically ventilated patients in six weeks, two questions were formulated to evaluate the impact of a specific protocol as compared to the current standard of care. The questions were as follows:

1. Was the three-day cumulative caloric intake of enteral nutrition increased in adult critically ill, mechanically ventilated patients following the implementation of an evidence-based enteral nutrition protocol over a six-week period?

2. Did implementing an evidence-based algorithm to enhance enteral nutrition maintain or improve serum albumin levels of critically ill, mechanically ventilated patients as compared to the standard of care over six weeks?

Data related to the intervention were collected from a convenience sampling of all adult critical care patients who were orally intubated, on mechanical ventilation, had an order for enteral nutrition, and remained intubated for at least three days over a six-week period. The project employed a quasi-experimental design with one independent variable and two dependent variables. A quasi-experimental design was chosen to illustrate the relationship between an evidence-based enteral nutrition protocol and the number of calories critically ill, mechanically ventilated patients received over a three-day period. The independent variable was the enteral nutrition protocol. The dependent variables were the cumulative caloric intake for three days, and the change in serum albumin from day one to day three of enteral feeding.

Chapter Four reports and discusses the findings of the project. Result reporting begins with a discussion of descriptive data of the sample that will include age, sex, and APACHE II score. Next, an in-depth review of the data collection and analytic procedures was undertaken. Then, the results of the project were presented and organized in terms of the clinical questions that were portrayed in the previous text. Finally, the chapter concludes with a brief summary that will bring all the information together.

Descriptive Data

The facility's electronic medical database served as an instrument used to gather information for descriptive analysis. Descriptive data were obtained from the convenience sampling of patients who received treatment based on the intervention (post-intervention group) during a six-week period. An additional convenience sampling from a time period one-year prior to the intervention period that encompassed the same calendar dates as the post- underwent descriptive analysis to provide a basis for comparison. The choice of using these two specific timeframes separated by one year was intended to mitigate the seasonal differences in the unit census and patient population. The use of two groups allowed for a comparison between patients who represent the standard of care (pre-intervention group), and those in the experimental group who received the intervention.

A total of 102 patients were admitted to the critical care unit between December 1, 2018, and January 11, 2019, the time frame when the control group was selected. Of those, only seven patients met the criteria for inclusion in the quality improvement project. Table 4.1 shows the distribution of males and females for the convenience sampling of patients that met the criteria for inclusion into the pre-intervention group.

Table 4. 1

Descriptive Statistics of Pre- and Post-intervention Groups

	Pre-intervention group		Post-intervention group	
Gender	*n*	%	*n*	%
M=	5	71.4	3	60
F=	2	28.6	2	40
Total	7	100	5	100
	Mean *(SD)*		Mean *(SD)*	
Age	70.71 *(11.89)*		58.80 *(25.30)*	
AIIS	54.43 *(12.96)*		51.80 *(9.31)*	
DCP	1111.86 *(661.89)*		1594.20 *(454.58)*	

Note. M=male. F=female. *n*=number of patients. AIIS=APACHE II score. *SD*=standard deviation. DCP=daily caloric prescription in kilocalories. The table illustrates the different characteristics of the pre- and post-intervention groups. APACHE II score was used to demonstrate the acuities of the groups
*Serum albumin level

A total of 91 patients were admitted to the critical care unit between December 2, 2019, and January 14, 2020, the time frame when the experimental group was selected. Of those, only five patients met the criteria for inclusion and were subject to the use of the protocol as the intervention. Table 4.1 shows the distribution of males and females in the post-intervention group.

Table 4. 2

Summary IQR for the Pre- and Post-intervention Groups

	Pre-intervention group			Post-intervention group		
	Mean	Median	50th percentile	Mean	Median	50th percentile
Age	70.71	70.00	70.00	58.80	71.00	71.00
AIIS	54.43	57.00	57.00	51.80	53.00	53.00
DCP	1111.86	1320.00	1320.00	1594.20	1620.00	1620.00
TCI	599.14	60.00	60.00	2708.55	3240.00	3240.00
Albumin*						
D1	2.40	2.40	2.40	2.88	2.80	2.80
D3	2.13	2.20	2.20	2.52	2.30	2.30

Note. IQR=interquartile range. AIIS=APACHE II score. DCP=daily caloric prescription in kilocalories. TCI= Total caloric intake in kilocalories for three days. D1=day one. D3=day three. This table denotes an assessment of the midpoint values for the variable.
*Serum albumin level

Table 4.1 and Table 4.2 show the mean age of the pre-intervention group was 70.71 years, and the mean age of the post-intervention group was 58.80 years. The pre-intervention group ranged in age from 55 years to 90 years, while the post-intervention group ranged in age from 30 years to 83 years. The interquartile range (IQR) was calculated to estimate the midpoint or 50th percentile of the sample. Applying IQR to the sample narrowed the age range to 70 years for the pre-intervention group and 71 years for post-intervention group (See Table 4.2).

Table 4.1 shows the mean APACHE II score was 54.43 [12.960] for the pre-intervention group and 51.80 [9.311] for the post-intervention group. The relatively small difference in the APACHE II scores indicated that the acuities of the two samples were similar in acuity. The IQR was calculated and yielded values for an APACHE II score of 57 for pre-intervention and 53 for post-intervention group (See Table 4.2). The difference between the two samples is slightly greater using IQR.

Data Analysis

Summary statistics have been provided for all demographics and baseline clinical variables, as well as outcome variables for each group. Data were collected from the electronic medical records (EMR) for the patients who meet the criteria for inclusion in the pre-intervention and the post-intervention group. The primary investigator (PI) collected two sets of data. The use of the EMR for data collection will help to ensure the validity and reliability of the data sets.

The data collection aligned with the clinical questions posed for this project. Both sets included the caloric prescriptions, cumulative three-day caloric consumption, and serum albumin levels for day one of feeding initiation, and on day three after feeding initiation. The data was uploaded into SPSS v26 for statistical analysis. A generalized linear model had been proposed to evaluate the difference between caloric consumption of the pre-intervention group and the post-intervention group. Due to the small sample, it was determined that a normal distribution normalcy could not be assumed and more sophisticated statistical models using parametric testing could not be conducted.

Data analysis of both the pre-intervention and post-intervention groups consisted of descriptive analyses to obtain the means and standard deviations for gender, age, and APACHE II score. Descriptive analyses were also conducted on the pre-intervention and post-intervention groups to obtain the means and standard deviations of the total caloric intake for three days, the serum albumin on day one, as well as, the serum albumin for day three of intubation. Once group characteristics with regards to the average values for the criterion variables were established, a Mann-Whitney *U* analysis was conducted on the criterion variables of total caloric intake and the change in serum albumin from day one to day three for the pre-intervention group and the post-intervention groups to elicit any statistically significant findings. A *p*-value of less than 0.05 was considered statistically significant.

The veracity of the data collected depended heavily on whether the nursing staff was consistently and correctly inputting patient intake. If nurses did not provide complete and accurate data, data collection and the following analysis would have been flawed. There was one patient in the pre-intervention group that had no data entered related to enteral intake and therefore, the value was assumed to be zero enteral intake. The PI stressed the importance of accurate charting at the inception of the project. Unfortunately, the PI was not able to impact the charting practices for the pre-intervention group since that time period has already passed. Nevertheless, the primary investigator endeavored to ensure that nurses were encouraged to chart appropriately, as was an expected practice for the standard of care.

Results

The results for the Direct Practice Improvement (DPI) are discussed within the following text. The clinical questions served as a guide to organizing the findings relevant to this project. Descriptive statistics were applied to the data sets to obtain information related to group characteristics such as average age, number of males versus females, and average APACHE II scores. Other descriptive statistics such as average caloric intake for each group and serum albumin levels were obtained to appreciate other nuances between the pre-intervention and post-intervention groups. A nonparametric, Mann-Whitney *U* test was used due to the sample size not being conducive to any other more complex statistical analyses. A *p*-value of less than 0.05 was seen as achieving statistical significance.

Descriptive statistics yielded results for the mean total caloric intake for three days, serum albumin level on day one of intubation, and serum albumin on day three of intubation for both the pre-intervention and post-intervention group. The mean total caloric intake (TCI) for the pre-intervention group was 599.14 [1097.23] kilocalories (kcal) while the post-intervention group had a mean total caloric intake of 2708.55 [1027.96] kcal (See Table 4.3). The average serum albumin on day one (D1) of intubation for the pre-intervention group was 2.40 [0.25] grams per deciliter (g/dL) and 2.88 [0.52] g/dL for the post-intervention group (See Table 4.3). The average serum albumin for day three (D3) of intubation for the pre-intervention group was 2.13 [0.23] g/dL and 2.52 [0.54] g/dL for the post-intervention group (See Table 4.3). These results helped to identify surface differences between the pre-intervention and post-intervention groups.

Table 4. 3

Descriptive Statistics Related to Criterion Variables

	Pre-intervention group Mean (*SD*)	Post-intervention group Mean (*SD*)
TCI	599.14 *(1097.23)*	2708.55 *(1027.96)*
Albumin*		
D1	2.40 *(0.25)*	2.88 (*0.52*)
D3	2.13 *(0.23)*	2.52 (*0.54*)

Note: TCI=total caloric intake in kilocalories for three days. *SD*=standard deviation. D1=day one. D3=day three. The table illustrates the different characteristics of the pre- and post-intervention groups.
*Serum albumin level

Total caloric consumption for a three-day time period for pre-intervention group and post-intervention group was compared using IQR estimates (See Table 4.2). Total caloric consumption was 60 kilocalories (kcal) for the pre-intervention group compared to 3240 kilocalories (kcal) for post-intervention group. IQR statistics applied to the serum albumin levels of pre-intervention group and post-intervention group are shown in Table 4.2. On day one of pre-intervention group and post-intervention group, the IQR values for serum albumin were 2.4 grams per deciliter (g/dL) and 2.8 grams per deciliter (g/dL), respectively (See Table 4.2). On day three IQR values for pre-intervention group and post-intervention group were reported as 2.2 g/dL and 2.3 g/dL, respectively (See Table 4.2).

A Mann-Whitney *U* test was used to compare the differences between the two independent groups. The cumulative caloric intake for three days was the criterion variable, and group membership was input as a fixed factor. The caloric prescription for three days was added as a covariate, and the differences between the groups were cumulative caloric consumption minus the cumulative caloric prescription for the pre-intervention and post-intervention time periods.

A Mann-Whitney *U* test was also used to compare the changes in serum albumin in each group. The serum albumin level of the third day after intubation was the criterion variable and, group membership (i.e., pre-intervention group versus post-intervention group) was a fixed factor. The serum albumin level on the day of intubation was entered as a covariate, and the difference between the two groups was the final albumin level (day three) minus the initial serum albumin level (day one). The main effect of the differences between pre-intervention versus the post-intervention group was evaluated for statistical significance.

The information presented allowed the primary investigator to illuminate any commonalities or differences within and between the pre-intervention group and the post-intervention group. There is assumed to be an inherent heterogeny within the group related to the quasi-experimental design and convenience sampling methods that will be employed for this project. Consequently, the ability to generalize the findings will be extremely limited and only allow for a partial exploration of clinical insights.

The first clinical question examined whether the introduction of an evidence-based protocol would impact caloric intake and, if so, to what extent. Table 4.3 showed the average caloric intake for the pre-intervention group and the post-intervention group. Post-intervention group received much higher on average cumulative caloric intake than the pre-intervention group. Table 4.4 demonstrates a statistically significance in the caloric intake on day one (*U*=.00; *p*=0.03) and the cumulative caloric intake for three days (*U*=2.00; *p*=0.01).

Table 4. 4

Mann-Whitney U Analysis of Caloric Intake

Test Statistics[1]	D1	D2	D3	CI	ND
Mann-Whitney *U*	4.000	6.000	9.000	2.000	16.000
Wilcoxon W	32.000	34.000	37.000	30.000	44.000
Z	-2.273	-1.881	-1.405	-2.535	-0.244
Asymp. Sig. (2-tailed)	0.023	0.060	0.160	0.011	0.808
Exact Sig. [2*(1-tailed	.030*	.073^	.202	.010*	.876

Note. D1=day one. D2=day two. D3=day three. CI=cumulative intake. ND=net difference.
[1]This table shows a Mann-Whitney *U* test conducted on the two independent samples to identify any statistically significant differences in caloric intake.
^p < 0.10. *p < 0.05.

The second clinical question explored the effects of an enteral nutrition protocol on the serum albumin levels on the third day after the initiation of enteral feeding. Table 4.3 shows that the average serum albumin levels for both groups decreased from day one to day three. However, there was no statistically significant difference between the changes in albumin for the pre-intervention group and the post-intervention group (*U*=7.50; *p*=0.177) (See Table 4.5).

Table 4. 5

Mann-Whitney U Analysis of the Serum Albumin Levels

Test statistics[2]	D1	D3
Mann-Whitney *U*	7.000	7.500
Wilcoxon W	35.000	28.500
Z	-1.717	-1.388
Asymp. Sig. (2-tailed)	0.086	0.165
Exact Sig. [2*(1-tailed	.106	.177

Note. D1=day one. D3=day three
[2]This table shows a Mann-Whitney *U* test conducted on the two independent samples to identify any statistically significant differences in serum albumin level changes. A *p*-value of less than 0.05 was deemed statistically significant for this project.

Summary

The project examined the impact of an enteral nutrition protocol on the caloric intake and serum albumin levels of critically ill, mechanically ventilated patients in an intensive care unit within a non-trauma, community hospital in the metropolitan Phoenix area. The goal was to have 26 patients in the post-intervention group and an additional 26 patients to in the pre-intervention group. However, a smaller sample size was obtained which necessitated an alternative approach to data analysis than initially planned.

Data analysis of the two groups yielded information relevant to the two clinical questions that are guiding this project. The first clinical question that raised the question of impacting the caloric intake of critically ill patients with an evidence-based enteral nutrition protocol did yield some statistically significant results ($p<0.05$). Caloric intake for day one yielded statistically significant results ($U=4.00$; $p=0.03$). Also, total caloric intake produced a statistically significant results ($U=2.00$; $p=0.01$). While a statistically significant difference was found between the pre-intervention group and post-intervention group in day one caloric intake and cumulative caloric intake for three days, those results must be interpreted with caution because of the small sample size.

Meanwhile, the analysis of data related to the second clinical question regarding the influence of an evidence-based enteral nutrition protocol on serum albumin levels did not yield any statistically significant results (U=7.00; p=0.18). In light of the statistical significance of the caloric intake for day one and the cumulative caloric intake for three days, this was puzzling. A review of the literature was able to shed light on this finding.

Serum albumin levels have a corollary relationship with nutritional status (Marcason, 2017; Valtuille, Casos, Fernandez, Guinsburg, & Marelli, 2015). However, it has been determined in existing literature that serum albumin is not accurate as a prognosticator of nutritional status or patient outcome (Marcason, 2017; Valtuille et al., 2015). Albumin fluctuates slowly over 30 or more days; therefore, it can only be useful as a trending agent or as part of a set of laboratory values and clinical assessment (McClave et al., 2016). No single value can be used to predict or identify nutritional deficits (McClave et al., 2016). Nonetheless, the serum albumin remains a useful tool in aiding with the assessment of nutritional status and its relationship to patient outcomes when used with other variables to evaluate such as prealbumin, electrolyte studies, and glycemic trends (McClave et al., 2016).

Chapter 5: Summary, Conclusions, and Recommendations

Patients who succumb to iatrogenic malnutrition in the presence of critical illness have a much harder road to recovery than those patients who receive at least 80% of their daily caloric intake (Yeh et al., 2016). Iatrogenic malnutrition affects nearly half of the hospitalized critically ill patients around the globe (Corkins et al., 2014; Mauldin & O'Leary-Kelley, 2015) and is associated with increased morbidity, mortality, and hospital lengths of stays (Allard et al., 2016; Argarwal et al., 2013; Curtis et al., 2017). Underfeeding of critically ill, mechanically ventilated patients has consistently been identified as the biggest contributor to hospital-acquired, or iatrogenic, malnutrition (Chakravarty et al., 2013). Despite several current and former research studies aimed at improving enteral nutrition practices, there remains a large proportion of critically ill patients are not receiving adequate daily caloric intake (Orinovsky & Raizman, 2018).

Nursing practice and culture in critical care areas can vary from unit to unit, in terms of skill mix, staff engagement, and resources available to impact clinical practice. Therefore, it is important to introduce practice standardization that optimizes patient care and supports positive outcomes. The identification of an evidence-based enteral nutrition protocol with clearly defined steps to guide clinical practice is an important step to addressing the persistent issue of iatrogenic malnutrition in critical care settings.

A large body of research suggests, targeted interventions can improve enteral nutrition consumption in critical care units (Orinovsky & Raizman, 2018). There are numerous enteral nutrition protocols in existence that require varying degrees of resources to implement. The problem of inadequate feeding practices in a specific critical care unit was addressed as part of a quality improvement project with the implementation of a simple, evidence-based, evidence-based protocol. The implementation of this protocol was intended to aid in the understanding of the effects of using an enteral nutrition protocol on the caloric intake and serum albumin levels of critically ill, mechanically ventilated patients.

The purpose of the quantitative, quasi-experimental project was to determine whether an evidence-based enteral nutritional protocol could positively impact the three-day cumulative caloric intake and serum albumin levels of critically ill, mechanically ventilated patients in the intensive care unit (ICU) of a non-trauma, community hospital in the metropolitan Phoenix area. The data gleaned from the project was used to determine the efficacy of the enteral nutrition protocol that was implemented in the ICU. This chapter will provide a summary of the project, a discussion of the project findings, and a closing statement from the principal investigator (PI). Also, this chapter will include a discussion of theoretical and practical perspectives, as well as the future implications for research that will be gleaned from the findings of this project. This chapter will close with proposed recommendations for future quality improvement projects and evidence-based practice.

Summary of the Project

There was little known about how a specific protocol could improve caloric intake and serum albumin levels in critically ill, mechanically ventilated patients. The quality improvement project employed a quasi-experimental design that included data from the interventional group and the data from a group of patients from a time period one year before the intervention that will serve as a pre-intervention group, representing the standard of care. The relationship between the implementation of an enteral nutritional protocol and caloric intake was explored through the data collected for a six-week period after the intervention and a six-week period from a year prior to the intervention. The data for the pre-intervention group (standard of care) included the same information as the post-intervention group and was extracted from the hospital's electronic database (EPIC) by the PI. This DPI contributed to the body of knowledge by demonstrating that an evidence-based protocol may positively impact caloric intake.

Chapter Five will include a summary of project findings and the conclusions related to the clinical questions posed in Chapter One. The chapter will then discuss the theoretical, practical, and future implications of this quality improvement project. Chapter Five will conclude with a discussion of recommendations for future practice and other evidence-based projects.

Summary of Findings and Conclusion

The project originally planned to have at least 26 patients for each group but was only able to obtain a modest number of seven patients in the standard of care, pre-intervention group, and five patients for the post-intervention group. At the conclusion of the Direct Practice Improvement (DPI) project, the principal investigator (PI) determined the cumulative three-day caloric intake of the pre-intervention group versus the post-intervention group. Additionally, the PI determined the level of change with regards to the serum albumin level on the day of intubation and the third day of intubation. Both analyses served to address the clinical questions that were posed at the inception of the DPI project.

The first clinical question of this project was to examine whether the three-day cumulative caloric intake of enteral nutrition can be increased in critically ill, mechanically ventilated patients following the implementation of an evidence-based enteral nutrition protocol over a six-week period. With the assistance of the facility's statistician, relevant statistical analyses were undertaken to assess for any statistical significance related to the first clinical question.

The small sample sizes for the pre-intervention group and post-intervention group underscored that a normal distribution of variables could not be assumed, and therefore, the statistical models that were indicated in Chapter Three were no longer appropriate for analyses. Instead, a Mann-Whitney *U* test was used to test the means of the two independent samples. The Mann-Whitney *U* test was able to indicate that there was a statistically significant difference in caloric intake on day one of initiation of enteral nutrition with a *p*-value of 0.03 and the overall caloric intake over three days after initiation of enteral feeding with a *p*-value of 0.01. Reaching statistical significance with the total caloric intake is a positive indication that the intervention was able to influence enteral nutrition practices within the critical care unit.

The second clinical question of this project examined if implementing an evidence-based algorithm to enhance enteral nutrition practices maintained or increased the serum albumin levels of critically ill, mechanically ventilated patients as compared to the standard of care over a six-week period. With the assistance of the facility's statistician, relevant statistical analyses were undertaken to assess for any statistical significance related to the second clinical question.

As mentioned in relation to the first clinical question, the sample sizes of the pre-intervention group and the post-intervention group did not lend themselves to analysis with more sophisticated statistical models. Therefore, a Mann-Whitney *U* test was used to explore the relationship between the implementation of the enteral nutrition protocol and the serum albumin levels of the two groups. Analysis of the serum albumin levels of the two independent groups indicated that there were no statistically discernible differences that could be appreciated. The results of this analysis are neutral.

The reason that the results do not constitute a negative or positive outcome lies in the stance put forth by the Academy of Nutrition and Dietetics (Academy) that states that albumin levels do not change solely based on nutritional intake (2009). Serum albumin levels are more of a prognosticator for morbidity and mortality in critically ill or chronically ill patients when viewed over a period of time such as 30 days or more (Marcason, 2017). For the purposes of this project, serum albumin levels cannot be used to indicate the nutritional status or completeness of an enteral nutrition regimen. In fact, there has been no one laboratory value that has been found to be an accurate indicator or predictor of nutritional status (Valtuille et al., 2015). Laboratory values must be taken in context of the patient's clinical condition, as well as, other factors over a period of time in order to be translated correctly (Marcason, 2017; Valtuille et al., 2015).

Implications

In addition to potentially improving clinical practice at the project site, this had several important implications for both theory and practice, as well as implications for future research. The implications served to add depth and understanding to existing knowledge. Also, the implications served to guide others in future pursuits to improve clinical practice.

Theoretical implications. The quality improvement project was based on the theoretical frameworks of Maslow's (1943) hierarchy of needs, Neuman's (1972) systems model (NSM), and the Nutritional Care Process Model (Academy of Nutrition and Dietetics [Academy], 2003). Together, these frameworks established a cohesive foundation for this project. Maslow's (1943) hierarchy of needs included nutrition as one of the basic needs that all humans must attain before achieving any higher-level needs. In terms of nutrition for critically ill, mechanically ventilated patients, the need for adequate nutrition must be met by external interventions. The nurses, physicians, and dietitians of the project facility understand the importance of nutrition to the promotion of health and wellbeing. Maslow (1943) underscores the need for prompt action to meet the basic human needs of patients so they can attain higher-level needs, such as safety and security.

Next, Neuman's (1972) systems model expands the concept of the patient as an open system with multiple lines of defense that must be supported to guard the health and wellbeing of the patient. Nursing staff are instrumental in helping to maintain the integrity of those lines of defense in critically ill patients to move them toward a state of wellness (Neuman & Young, 1972). Implementing a protocol to ensure best nutritional practices for critically ill patients reinforces the importance of patient-centered care. In terms of Neuman's systems model, nutritional status is a line of defense that if broken puts a patient at risk for detrimental consequences such as malnutrition and other poor outcomes. Thus, Neuman's (1972) systems model was used to guide nurses toward best practice as evidenced by a statistically significant increase in the cumulative caloric intake of critically ill patients.

The Nutritional Care Process Model (NCPM) breaks down nutritional assessment and support into four steps that can be used with all critically ill patients (AND, 2003). The four steps of the NCPM include (a) performing a comprehensive nutritional assessment, (b) assigning a nutritional diagnosis, (c) formulating a nutritional intervention specific to the patient's needs, and (d) continuous monitoring and evaluation of the patient's response to treatment (AND, 2003). The registered dietitians were responsible for the performance of a nutritional assessment. The attending physician translated the nutrition recommendation into an actionable order. However, the implementation of enteral nutrition was an area that fell on the purview of nursing.

This framework aligned with the project because it supported a comprehensive nutritional regimen to improve enteral feeding practices in this patient population within the implementation phase of the NCPM. Adding this aspect of patient-centered care helped to improve cumulative three-day caloric intake for critically ill patients (*p*=0.01). The last step of monitoring/evaluation within the NCPM was realized with this statistic and helped to strengthen practice.

Practical implications. Iatrogenic malnutrition is a clear and ever-present issue affecting scores of critically ill, mechanically ventilated patients (Blaser et al., 2017; Li et al., 2017; Stewart, 2014). While the quantitative results of this project were intriguing, some qualitative feedback provided additional perspective and depth to the project findings.

The PI met with a clinical dietitian prior to starting the project to review the components of the enteral nutrition protocol and the study on which it was based. At the time, the clinical dietitian acknowledged an understanding of the project's purpose and the enteral nutrition protocol that would be implemented. At the conclusion of the project, the principal investigator (PI) was approached by a different clinical dietitian with questions regarding the components of the protocol.

The study used as the basis for this project was conducted in Europe. European standards differ from the standards of the American Society of Parenteral and Enteral Nutrition (ASPEN). For example, the protocol set a threshold of 250 milliliters (mls) for gastric residual volume (GRV) as a decision point to consult the critical care physician for potential intervention. ASPEN sets the threshold at 500 milliliters (mls). In addition, the parameters for hemodynamics in the European study differed from the standards set forth by ASPEN. The discrepancy led to a few questions regarding the protocol.

The main four questions that were asked by the clinical educator on behalf of the staff at the conclusion of the project were as follows:

1. Why were we using a mean arterial pressure (MAP) of 65 instead of the unit and ASPEN standard of 60?
2. Why did the start point of feeding differ in the protocol than the unit's and ASPEN's standards? (The unit standard was to start at 20 milliliters per hour and the protocol stated to at 25 milliliters per hour or 10 milliliters per hour.)
3. Why did the protocol call for gastric residual volume (GRV) checks every four or six hours depending on whether the patient had eaten within the previous 96 hours? (the unit standard for GRV monitoring was six hours for everyone.)
4. Why was the threshold of GRV 250 milliliters for the protocol to trigger an intervention? (Unit, ASPEN, and American Association of Critical Care Nurses set the threshold at 500 milliters.)

The concerns voiced by the dietitian were echoed by the critical physicians at the conclusion of the project. Despite meeting with the stakeholders individually prior to the start of the project, there were important questions that arose that were not communicated to the PI prior to or during the project. The PI was not able to make any changes to the project design retrospectively. With the benefit of hindsight, the PI should have found a protocol based on the standards set forth by ASPEN in order to reconcile the differences that became apparent between American and European standards.

Further compounding the issues that were identified was the fact that the PI does not work at the specific project site. The PI worked at a different facility within the hospital network. Low visibility of the PI may have been a factor in stakeholders not bringing concerns and questions to the forefront during the project. Future projects will take this anecdotal feedback into consideration to address during the project design phase. Also, since this information was not conveyed to the PI during the project period, it is not possible to say whether or how much the implementation of the protocol was influenced by stakeholders who questioned some elements of the protocol.

Future implications. Several studies have investigated iatrogenic malnutrition and enteral nutrition practices, but there is still a gap between knowledge and practice. While this project produced some statistically significant results, the subsequent anecdotal feedback was equally compelling in terms of future implications. Use of the protocol was suspended until further clarifications could be made regarding the clinical decision points of the algorithm.

Nevertheless, the staffed reported being more cognizant of the pitfalls of iatrogenic malnutrition and made improved efforts to initiate enteral nutrition in a timely manner, minimize interruptions, and improve collaborative practice with clinical dietitians. Taking steps to introduce an enteral nutrition protocol and offer evidence of best practice sparked an interest in improving practice for critically ill, mechanically ventilated patients. The overall takeaway from this project is that more research should be done to find a simple, cost-effective protocol that can be used to improve enteral nutrition practices in critical care areas while offering invaluable education to improve understanding of best practices.

Recommendations

The project served to impact the health and welfare of the patients of the critical care unit used in conjunction with this project. Additionally, it is intended that the information gleaned from this project be used to promote an increase in knowledge and understanding of evidence-based enteral nutrition protocols. Several recommendations for future projects and practices were identified at the conclusion of the project. A brief summary of those recommendations will be presented.

Recommendations for future projects. Progress in the area of enteral nutrition for critically ill, mechanically ventilated patients can be made with more projects that address aspects of enteral nutrition. According to the NCPM, the first step in recommending the correct enteral nutritional formulation and caloric prescription is employing a valid and reliable assessment tool that provides an accurate determination of an individual's energy expenditure and caloric needs. Current methods for this assessment include the use of antiquated calculations that cannot account for nuances that can exist in the critically ill population. Future projects should focus on the use of modern, sophisticated technologies like indirect calorimetry, which produce a more precise assessment of individual needs. Use of modern technology to assist with patient assessments promote standardization and facilitate the development of cost-effective tools to improve care.

Another recommendation for future projects would be to conduct studies to look at ensuring that critically ill, mechanically ventilated patients are receiving their daily caloric allowance when procedures and other planned interventions cause interruptions. Concentrating on patients obtaining their overall daily volume of calories instead of an hourly infusion of enteral nutrition may help to alleviate the caloric shortfalls that some patients experience while in the critical care unit. For example, bolus or nocturnal feedings may be appropriate for some patients who will be engaging in various daytime procedures. Future projects should be able to evaluate the efficacy of enteral feeding practices that best meet the needs of critically ill patients.

Nurse-driven enteral nutrition protocols in some institutions have improved feeding practices by shortening the time from admission to feeding. More research into the feasibility of enacting a nurse-driven program for enteral nutrition can help to improve patient outcomes and re-prioritize nutrition as part of a comprehensive care plan. Future projects can gather valuable evidence needed to persuade stakeholders that it is within the nurse's scope of practice to collaborate with clinical dietitians to implement enteral nutrition in a timely, safe manner.

A final recommendation would be to conduct a larger study or project using the information and valuable lessons gleaned from this project. First, an initial meeting with all stakeholders together might have helped to identify and address any potential issues. When stakeholders met as a group, concerns and questions about the protocol and project were raised. Those issues did not surface when the PI met individually with stakeholders at the outset.

Next, it is clear that understanding the differences between studies from other countries and the ASPEN guidelines are critical when applying evidence to any projects involving nutrition. Evidence is continually being gathered and changing our understanding of phenomena and care practices. It is essential that practice is informed by the best available evidence and that practices that are contradictory be reconciled.

Visibility is key to promote staff engagement and identify any knowledge gaps that need to be addressed. In order to parlay this project into a larger study that looks at long term outcomes, it is paramount that the principal investigator (PI) be present and highly visible. Fortunately, the questions that arose after the project sparked a dialogue in support of repeating the project. The PI recommends that the facility leverage this interest to conduct a future project on a larger scale that will deepen our understanding of meeting nutritional needs of critically ill patients and, ultimately, improve patient care and clinical outcomes.

Recommendations for future practice. Evidence to support moving away from the routine checks of gastric residual volumes (GRV) is mounting. Wang et al. (2019) conducted a meta-analysis and found that adverse events related to enteral nutrition did not increase in the absence of routine checks for GRV. Astute assessment skills and vigilance were deemed a more reliable indicator of gastric feeding intolerance than routinely aspirating stomach contents of patients receiving enteral nutrition (Wiese et al., 2019). Wiese et al. (2019) found that patients received a higher percentage of their prescribed caloric intake when foregoing routine GRV checks. Recommendations for future practice includes exploring available evidence regarding the efficacy of routine GRV checks and modifying practice accordingly.

In addition to removing routine GRV monitoring from current practice, it is a recommendation that critical care nurses receive more education related to evidence-based enteral nutrition practices. Based on anecdotal evidence compiled over the course of this project, it seems clear that many staff nurses are not up to date on current evidence-based enteral nutrition practices, and that puts patients at risk for being underfed. Al-Jalil et al. (2019) found education on current evidence and practice were lacking in many critical care nurses. Gaps in current knowledge can lead to incomplete or incorrect feeding practices in critically ill patients (Al-Jalil, Gray, Rasouli, Hoseini-Azizi & Hejazi, 2019). Best outcomes require healthcare practitioners to keep pace with current knowledge and evidence in order to deliver best care.

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Appendix A

University IRB Exemption Letter

GRAND CANYON
UNIVERSITY™

3300 West Camelback Road, Phoenix Arizona 85017 602.639.7500 Toll Free 800.800.9776 www.gcu.edu

DATE:	December 02, 2019
TO:	Andrea McCray
FROM:	Grand Canyon University Institutional Review Board
STUDY TITLE:	Improving Enteral Nutrition Practices in Critical Care
IRB REFERENCE #:	IRB-2019-1782
SUBMISSION TYPE:	Submission Response for Initial Review Submission Packet
ACTION:	Determination of Exempt Status
DECISION DATE:	December 02, 2019

REVIEW CATEGORY:Category 4

Thank you for submitting your study materials. This submission has received Exempt approval from [redacted] Review Board.

Grand Canyon University Institutional Review Board has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations. You now have GCU IRB approval to collect data.

If applicable, please use the approved recruitment script and informed consent(s) that are included in your published documents.

We will put a copy of this correspondence on file in our office.

If you have any questions, please contact the IRB office at irb@gcu.edu or 602-639-7804. Please include your study title and reference number in all correspondence with this office.

Dr. Cynthia Bainbridge
Assistant Dean, Research and Dissertations

Appendix B

Permission to Cite Tool

From: רייזמן אלה - RAIIZMAN ELA
Sent: Monday, July 15, 2019 10:12 AM
To: Andrea McCray
Subject: Re: Permission to cite

Dear Ms McCray,

I'm honored to know you intend to base your project on our protocol. Of course I give you a permission. If you have any questions please don't hesitate to contact me. Good luck!

Ela

On 15 Jul 2019, at 8:13, Andrea McCray <[redacted] wrote:

> Greetings Ms. Raizman;
>
> I am a doctoral student who is looking to implement an enteral nutrition protocol in the critical care units of a hospital in Phoenix, Arizona, United States. I came across the article in *Critical Care Nurse* entitled "Improvement of nutritional intake in intensive care patients via a nurse-led enteral nutrition feeding protocol" that I would like to use as the basis for an evidence-based, practice improvement project. I am seeking permission to utilize the algorithm and cite it within my project. I thank you in advance for your consideration.
>
> Best regards,
>
> Andrea C. McCray MSN-L, RN, CCRN
> Grand Canyon University
> [redacted]

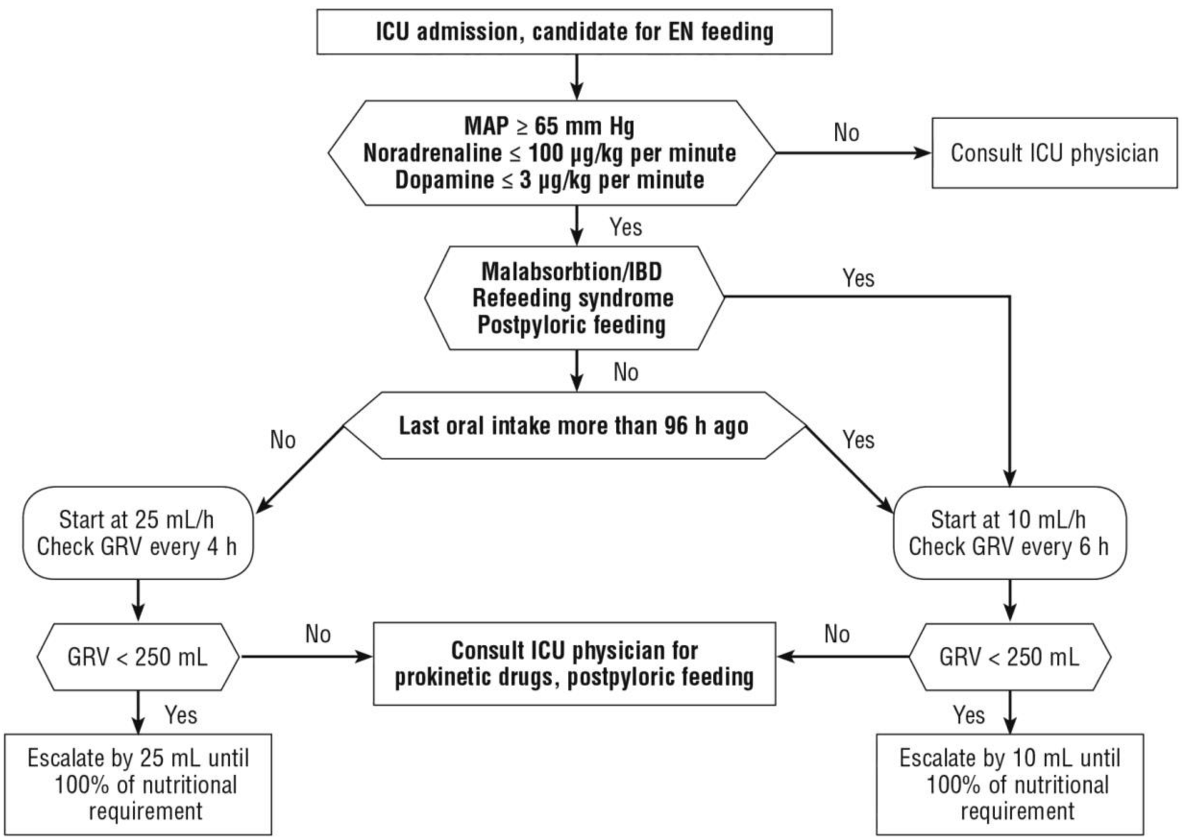
This Message confirms that this email message has been scanned by Hadassah for the presence of malicious code, vandals & computer viruses.

WARNING - CONFIDENTIAL INFORMATION

The information contained in the email may contain confidential or privileged information. If you are not the intended recipient please contact the sender.

Appendix C

Enteral Nutrition Protocol



- Check blood glucose level every 4 hours
- After nutritional requirement achieved, check GRV every 8 hours as needed with signs of intolerance
- Daily radiological confirmation of NGT placement
- VAP prevention: head elevated 30°, oral hygiene every 8 hours
- Hold feeding 6 hours before procedure; resume at final rate 1 hour after procedure
- If constipation, consider stool softeners
- If diarrhea, consider *Clostridium difficile*, antibiotics side effect, pseudomembranous colitis, prior EN cessation

Abbreviations: EN, enteral nutition; GRV, gastric residual volume; IBD, inflammatory bowel disease; ICU, intensive care unit; MAP, mean arterial pressure; NGT, nasogastric tube; VAP, ventilator-associated pneumonia.

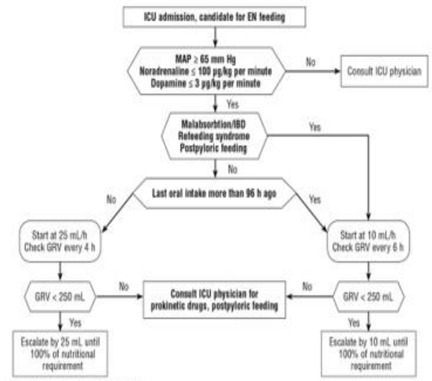
Note: Adapted from "Improvement of nutritional intake in intensive care unit patients via a nurse-led enteral nutrition feeding protocol," by I. Orinovsky and E. Raizman, 2018, *Critical Care*, *38*(3), 38-44.

Appendix D

Educational Handout for Bedside Nurses

Did you know…

1. Nearly 40% of all critically ill patients have been assessed to be malnourished.
2. The source of malnourishment has been linked to inadequate enteral feeding practices.
3. There is no evidence to support pausing or turning off tube feedings during repositioning.
4. There is no evidence to support withholding tube feedings for patients who are in the prone or supine position.
5. Gastric residual volume measurements are not a definitive way to gauge feeding intolerance.
6. Enteral nutrition protocols have been shown to improve practice and increase the caloric intake for patients
7. Poor enteral intake correlates with increased ICU length of stay, higher mortality and morbidity, increased ventilator days, and increased infection rates.



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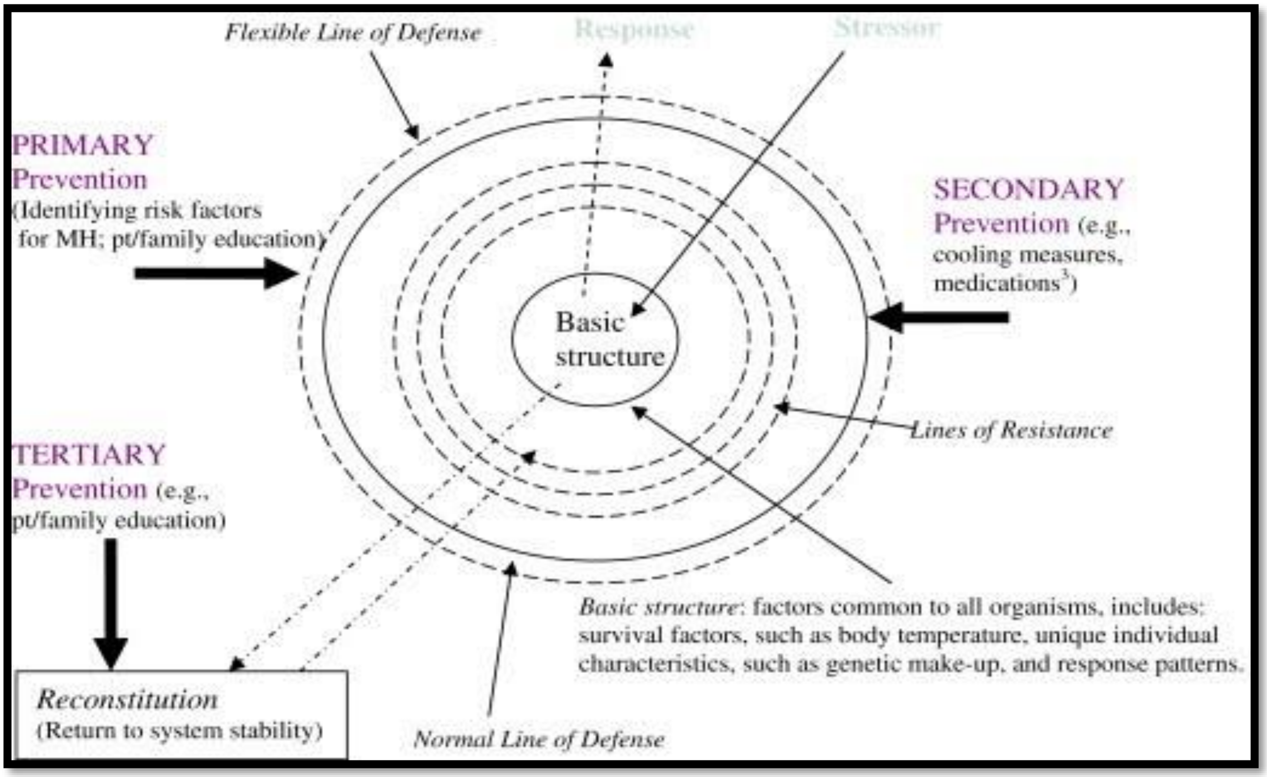
Appendix E

Maslow's Hierarchy of Needs

https://www.coachilla.co/blog/the-new-hierarchy-of-needs

Appendix F

The Neuman Systems Model



http://www.sciencedirect.com/science/article/pii/S1089947208003444

Appendix G

APACHE II Scoring System and Relative Mortality Rate

Appendix 1: Acute Physiology and Chronic Health Evaluation II scoring system

Physiologic variable	High abnormal range					Low abnormal range				
	+4	+3	+2	+1	0	+1	+2	+3	+4	Points
Temperature-rectal (°C)	≥41	39-40.9		38.5-38.9	36-38.4	34-35.9	32-33.9	30-31.9	≤29.9	
Mean arterial pressure (mmHg)	≥160	130-159	110-129		70-109		50-69		≤49	
Heart rate (ventricular response)	≥180	140-179	110-139		70-109		55-69	40-54	≤39	
Respiratory rate (nonventilated or ventilated)	≥50	35-49		25-34	12-24	10-11	6-9		≤5	
Oxygenation: A-aDO_2 or PaO_2 (mmHg) a. FIO_2≥0.5 record A-aDO_2 b. FIO_2<0.5 record PaO_2	≥500	350-499	200-349		<200 PO_2>70	PO_2 61-70		PO_2 55-60	PO_2<55	
Arterial pH (preferred)	≥7.7	7.6-7.69		7.5-7.59	7.33-7.49		7.25-7.32	7.15-7.24	<7.15	
Serum sodium (mEq/L)	≥180	160-169	155-159	150-154	130-149		120-129	111-119	≤110	
Serum potassium (mEq/L)	≥7	6-6.9		5.5-5.9	3.5-5.4	3-3.4	2.5-2.9		<2.5	
Serum creatinine (mg/dL)	≥3.5	2-3.4	1.5-1.9		0.6-1.4		<0.6			
Hematocrit (%)	≥60		50-59.9	46-49.9	30-45.9		20-29.9		<20	
White blood count (total/mm^3) (1000 s)	≥40		20-39.9	15-19.9	3-14.9		1-2.9		<1	
GCS score - 15 minus actual GCS										
A. Total acute physiology score (sum of 12 above points)										
B. Age points (years) <44=0, 45-54=2, 55-64=3, 65-74=5, ≥75=6										
C. Chronic health points										
Total APACHE II score										

APACHE=Acute Physiology and Chronic Health Evaluation II, GCS=Glasgow Coma Score

APACHE II

Score	Interpretation
0-4	~4% death rate
5-9	~8% death rate
10-14	~15% death rate
15-19	~25% death rate
20-24	~40% death rate
25-29	~55% death rate
30-34	~75% death rate
over 34	~85% death rate

Retrieved from http://www.aeronline.org/article.asp?issn=0259-1162;year=2018;volume=12;issue=1;spage=149;epage=154;aulast=Sethi

Appendix H

Sequential Organ Failure Assessment (SOFA) Score

THE SEQUENTIAL ORGAN FAILURE ASSESSMENT (SOFA) SCORE

SYSTEM	0	1	2	3	4
Respiration PaO2/FIO2 mm Hg (kPa)	≥400 (53.3)	<400 (53.3)	<300 (40)	<200 (26.7) with respiratory support	<100 (13.3) with respiratory support
Coagulation Platelets ×10³/uL	≥150	<150	<100	<50	<20
Liver Bilirubin mg/dL (umol/L)	<1.2 (20)	1.2-1.9 (20-32)	2.0-5.9 (33-101)	6.0-11.9 (102-204)	>12.0 (204)
Cardiovascular	MAP ≥70mmHg	MAP <70mmHg	Dopamine <5 or Dobutamine (any dose)	Dopamine 5.1 - 15 or Epinephrine ≤ 0.1 or Norepinephrine ≤ 0.1	Dopamine >15 or Epinephrine >0.1 or Norepi-nephrine >0.1
CNS GCS Score	15	13-14	10-12	6-9	<6
Renal Creatinine, mg/dl (umol/L) Urine Output, ml/d	<1.2 (110)	1.2 -1.9 (110-170)	2.0 - 3.4 (171-299)	3.5 - 4.9 (300 -440) <500	> 5.0 (440) <200

Catecholamine Doses = ug/kg/min for at least 1hr

Retrieved from: https://epmonthly.com/article/sepsis-gets-an-upgrade/