THE EFFECT OF EARLY ENTERAL NUTRITION ON THE
NUMBER OF MECHANICAL VENTILATION DAYS AND LENGTH OF STAY IN
THE CORONARY INTENSIVE CARE UNIT

A Thesis
Presented to
The Graduate Faculty of the University of Akron

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

Elizabeth Pash Penniman
May, 2008
THE EFFECT OF EARLY ENTERAL NUTRITION ON THE
NUMBER OF MECHANICAL VENTILATION DAYS AND LENGTH OF STAY IN
THE CORONARY INTENSIVE CARE UNIT

Elizabeth Pash Penniman
Thesis

Approved:
Advisor
Dr. Sandra Hudak

Accepted:
Dean of the College
Dr. James Lynn

Committee Member
Dr. Richard Steiner

Dean of the Graduate School
Dr. George Newkome

Committee Member
Mrs. Cinda Chima

School Director
Dr. Richard Glotzer
ABSTRACT

Enteral nutrition is the preferred route of feeding critically ill patients with a functioning gastrointestinal tract. Student’s t-test’s were used to analyze hypotheses that mechanically ventilated Coronary Intensive Care Unit (CICU) patients who receive early enteral nutrition, will have decreased days on ventilator and decreased length of stay in the CICU when compared to those who do not receive early enteral nutrition. Results include 35 patients, 19 patients (54%) received tube feeding within 72 hours of intubation and 16 (46%) patients received tube feeding after 72 hours of intubation. The average days on mechanical ventilation for patients enterally fed within 72 hours of intubation were 5.3 days, and 9.9 days for patients enterally fed after 72 hours of intubation. The average length of stay in the CICU for patients enterally fed within 72 hours of intubation was 9.6 days, and 16.4 days for patients enterally fed after 72 hours of intubation. In summary, patient’s fed after 72 hours of intubation averaged 4.6 days longer on mechanical ventilation and 6.7 days longer stay in the CICU compared to patients who received early enteral nutrition within 72 hours of intubation. Results indicated a significant difference between initiation of early enteral nutrition compared to patients who did not receive early enteral nutrition in mechanical ventilation days (p=0.04) and length of CICU stay (p=0.01). Early enteral nutrition contributes to reduced ventilator days and length of stay in CICU. Results encourage dietitians to become engaged in institutional nutrition protocols to favorably influence patient outcomes.
DEDICATION

Dedicated in memory of my late father, Joseph M. Pash.
AKNOWLEDGEMENTS

I wish to thank my thesis advisor, Dr. Sandra Hudak, for her knowledge and guidance of this research, and for her confidence in my abilities. I would also like to thank Mrs. Cinda Chima for being a member of my thesis committee and providing her clinical and editorial expertise. Thank you to Dr. Richard Steiner for being a member of my thesis committee, as well as your patience, time, and statistical expertise. Also I would like to thank the staff of the Coronary Intensive Care Unit at The Cleveland Clinic for all their help and support while conducting my research. Thanks to all the amazing nurses I work with, and for your inspiration into my valuable research. Lastly, thank you to my family for your love, tolerance and understanding while pursuing my goal.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>LIST OF TABLES</th>
<th>ix</th>
</tr>
</thead>
</table>

## CHAPTER

### I. INTRODUCTION

- Statement of the Problem ................................................................. 3
- Purpose of the Study ........................................................................... 4
- Significance of the Study ................................................................. 5
- Hypotheses ......................................................................................... 5
- Summary ......................................................................................... 6

### II. REVIEW OF THE LITERATURE

- History .............................................................................................. 8
- Trauma and Injury ........................................................................... 9
- The Gastrointestinal Tract ............................................................... 10
- Cardiology ....................................................................................... 11
- Surgery ......................................................................................... 12
- Pneumonia ..................................................................................... 14
- Malnutrition ................................................................................... 15
- Length of Stay ............................................................................... 16
- ICU Protocols ................................................................................. 17
APPENDIX B. HUMAN SUBJECTS APPROVAL..........................................................45
APPENDIX C. RESEARCH SUBJECTS........................................................................46
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Mean days on vent and length of stay of patients</td>
<td>29</td>
</tr>
<tr>
<td>4.2 Analysis of total vent days by tube feeding (TF) initiation</td>
<td>30</td>
</tr>
<tr>
<td>4.3 Analysis of total ICU days by tube feeding (TF) initiation</td>
<td>31</td>
</tr>
</tbody>
</table>
CHAPTER I
INTRODUCTION

The early initiation of enteral nutrition is accepted as the preferred route of feeding in critically ill patients with a functioning gastrointestinal (GI) tract (1). The intent of this thesis is to evaluate the benefits of early enteral nutrition in the critically ill population of the coronary intensive care unit (CICU). Outcome variables include, amount of time on mechanical ventilation and length of stay in the intensive care unit. The American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.) 2002 standards state that enteral nutrition (EN) should be used in preference to parenteral nutrition (PN) to the greatest extent possible (2). Parenteral nutrition should be used when the gastrointestinal tract is not functional, cannot be accessed, or the patient’s nutrient needs are greater than those that can be met through the gastrointestinal tract (2).

It is particularly important to establish early enteral nutrition in mechanically ventilated patients because of the metabolic demands associated with mechanical ventilation. Nutrition is an integral component of medical disease prevention, treatment and recovery. It can have a direct impact on a patient’s health and medical condition. Providing optimal care to each individual patient is the goal of all clinical practice in dietetics. As professionals, registered dietitians are obligated to understand the quality of care component of patient’s nutritional status and the relationship regarding the
improvement for the benefit of critically ill patients in the clinical setting. The benefits of nutrition support are improved nutritional status, reduced morbidity and mortality, decreased length of stay, and decreased costs to patients and facilities (1).

When caloric intake is zero, the average daily weight loss is about one pound, consisting of 60% muscle tissue and 40% fat tissue (1). After three to four days of starvation, the body begins to conserve sodium and water, which can lead to edema. Glycogen stores and muscle protein contribute to the pool in late starvation; consequences of starvation in the critically ill patient may result in death, generally from infection. When nutrition is delayed starvation can result and have detrimental effects on the critically ill patient.

Failure of the respiratory muscles, secondary to severe muscle wasting, leads to the inability of the lungs to clear infectious secretions and often results in pneumonia, therefore, requiring mechanical ventilation (1). Certain body systems show changes during starvation and injury; those changes in the cardiovascular system include, decreased heart function, decreased cardiac output, decreased ability to handle fluid overload, bradycardia, hypotension and diminished venous return (1). When complicated disease process or trauma precludes the oral route as in mechanically ventilated patients, alternative nutrition methods must be considered (2).

Specialized nutrition support describes a variety of techniques that are available for use when a patient is unable to meet his or her nutrient needs by normal ingestion of food (2). The term *enteral* means, within or by way of the gastrointestinal tract. In common clinical practice, the terms enteral feeding and tube feeding are used interchangeably. In critical illness, the catabolic response by the body is mediated by
neurohormonal events that activate the sympathetic nervous system and release catecholamines, stimulation of glucocorticosteroids, growth hormone, and cytokines. These events characterize the stress response, tachycardia, hyperglycemia, mobilization of body fat and net breakdown of skeletal muscle protein (3). Aggressive nutritional support during catabolic illness will reduce the loss of body protein, while optimizing the response to illness.

Statement of the Problem

A concerning issue encountered in the intensive care unit, is delayed feeding of mechanically ventilated or intubated patients mechanically ventilated also referred to as intubated patients. Patients, who have delayed feeding secondary to nothing by mouth (NPO) status for prolonged periods, can have increased metabolic needs due to stress, illness, and injury. Lack of nutrition support has negative consequences in the critically ill patient. Part of the role of the dietitian in the CICU is to make recommendations for nutritional treatment or interventions with the medical team.

Coronary heart disease (CHD), also known as coronary artery disease (CAD), is the most deadly cardiovascular disease (3). As a result of CHD, lack of blood flow to blood vessels surrounding the heart and serving the myocardium occurs. The major underlying cause of CHD is atherosclerosis, which involves structural and compositional changes in the innermost layer of the large arteries (3). When occlusion of the arteries is significant, acute clinical events such as myocardial infarctions (MI) can occur. In some cases, MI’s cause cardiac arrest or respiratory failure requiring patients to be maintained on mechanical ventilation in the coronary intensive care unit. Other cardiac related events requiring mechanical ventilation and a stay in the CICU include: endocarditis,
congestive heart failure, and coronary artery disease (CAD). Those aforementioned cardiac events in addition to patients who require intra aortic balloon pump support, pulmonary artery catheter monitoring, temporary heart pacing, pressure support and constant monitoring are admission criteria for the CICU.

When particular cardiac events occur, respiratory distress, or cardiac arrest may result, requiring the patient to be intubated, and to be placed on mechanical ventilation. Mechanical ventilation maintains the blood volume of oxygen that meets tissues needs. Adequate oxygenation on a ventilator, also known as a respirator, is accomplished by manipulation of the concentration of inspired oxygen (FiO2) and, in some cases, use of positive end-expiratory pressure (PEEP). PEEP prevents alveolar collapse and enables lower FiO2 to be used (3). Nutrition support is essential for mechanically ventilated patients to meet their energy requirement and to maintain or to enhance their muscle strength for facilitating ventilator weaning.

Purpose of the Study

The purpose of this study was to determine if mechanically ventilated patients admitted to the coronary intensive care unit have decreased length of stay in the CICU and shorter duration on the ventilator when enteral nutrition is initiated within 72 hours of intubation. Nutrition support in critically ill patients provides the body with nutrients for protein synthesis, immune system response, energy needs, and reduction of protein catabolism. Early enteral nutrition preserves intestinal integrity and functions, while reducing hepatic protein response and reducing the rate of infectious complications. Current practice standards in nutrition support emphasize using the GI tract if at all
possible (1, 2, 3, 4). The goal of this research is to determine the difference in time spent on mechanical ventilation and length of stay in CICU between patients enterally fed within 72 hours of intubation and those fed after 72 hours of intubation.

Significance of the Study

The benefits of early enteral nutrition include decreased weight loss, increased nitrogen intake and balance, decreased catabolic hormones, improved wound healing, decreased bacterial infections, and decreased length of intensive care and hospital stay, all resulting in decreased cost (1). Results of this study will provide dietitians and other care providers in the intensive care unit, in particular the coronary intensive care unit, with information regarding the association of early enteral nutrition and length of mechanical ventilation and ICU stay. No study to date has looked at this issue in the CICU population.

Hypotheses

There is some evidence that early and appropriate enteral nutrition support is associated with favorable outcomes. A review of the literature generated the following hypothesis; early enteral nutrition within 72 hours of mechanical ventilation in CICU patients admitted with, including myocardial infarctions, cardiac arrest, endocarditis, congestive heart failure, and/or respiratory failure, will have decreased length of ICU stay, and decreased days on the ventilator, when compared to patients fed after 72 hours of mechanical ventilation, or patients not fed at all. Among mechanically vented CICU patients admitted with a primary cardiac diagnosis, but not limited to myocardial infarctions, cardiac arrest, endocarditis, congestive heart failure, or respiratory failure, who receive early enteral nutrition (within 72 hours of intubation), will have decreased
days on the ventilator, when compared to those who do not receive early enteral nutrition (after 72 hours of intubation).

1. Among mechanically vented CICU patients admitted with a primary cardiac diagnosis, including myocardial infarctions, cardiac arrest, endocarditis, congestive heart failure, or respiratory failure, who receive early enteral nutrition (within 72 hours of intubation), will have decreased days on the ventilator when compared to those who do not receive early enteral nutrition (after 72 hours of intubation).

2. Among mechanically vented CICU patients admitted with a primary cardiac diagnosis, including myocardial infarctions, cardiac arrest, endocarditis, congestive heart failure, or respiratory failure, who receive early enteral nutrition (within 72 hours of intubation), will have decreased length of stay in the CICU, when compared to those who do not receive early enteral nutrition (after 72 hours of intubation).

Summary

It is important to treat each patient as an individual. Nutrition assessment takes time to develop the nutrition support plan to meet the needs of the patient. This data suggests recommendations on why early enteral nutrition should be encouraged in the ICU patient. Well trained clinicians should be in charge of gathering and documenting the appropriate data to yield the best possible therapeutic outcome. Soon after surgery or trauma, such as myocardial infarction, which often results in cardiopulmonary resuscitation, defibrillator shock, cardiac catheterization, and mechanical ventilation, changes in the body’s metabolism occur. The risk for complications are high at this time, therefore multifaceted management including nutritional and immunological control appears to be necessary. Early enteral feeding is considered the accepted method of nutrition support in critically ill patients.
CHAPTER II
REVIEW OF THE LITERATURE

There is evidence that initiation of enteral nutrition within three days of intensive care unit admission in mechanically ventilated patients reduces duration of mechanical ventilation (4). Zeman and Ney, report that 86% of ventilator-dependent patients who had received some degree of nutritional support could be weaned early, compared to 22% of those patients who received only 5% dextrose intravenous solutions (3). Malnutrition or starvation in patients on mechanical ventilators further compromised respiratory insufficiency, especially in ventilator-dependent patients (3). Without adequate nutrition, the diaphragmatic, intercostals, and accessory breathing muscles were catabolized for energy, resulting in a decrease in inspiratory capacity, possibly lengthening the time on the ventilator. A decrease in protein intake may led to a decrease in serum albumin levels, leading to a decrease in oncotic pressure, resulting in pulmonary edema. These factors suggested that adequate nutritional support is especially important to maintain normal pulmonary function in anticipation of being extubated (being removed from the mechanical ventilation) (3).

The major goal of nutrition therapy is the maintenance of body cell mass and the provision of adequate nitrogen and fuel to heal tissues, meet metabolic needs and support
the immune system. During stress, intestinal blood flow tends to decrease as blood is shunted to support metabolic processes needed for tissue repair. This can lead to mucosal damage and loss of intestinal barrier function, which in turn leads to alterations in the gastrointestinal tract’s permeability to bacteria or toxins (1). Evidence from the literature review showed that preventing villous atrophy by continuously stimulating the small bowel with feeding may prevent translocation of bacteria through the epithelial mucosa to the portal and lymphatic circulation (1,3). Bacterial translocation is associated with sepsis and multi system organ failure which lengthens time spent required on the mechanical ventilator, and a prolonged intensive care unit stay (4). Nutrients have been shown to increase intestinal blood flow. The GI tract can usually be used immediately after trauma or surgery. The literature review revealed that early enteral nutrition will enhance the GI barrier function, prevent microbial translocation, reduce the hypermetabolic response to injury and improve clinical outcomes.

History

Early initiation of enteral nutrition has proven to be beneficial, with positive effects on septic complications, multi-system organ failure, trauma, and injury. Enteral nutrition also known as tube feeding has improved with regard to techniques, materials, and composition. Weissman notes use of enteral nutrition has resulted in lower cost and lower rate of complications compared with parenteral nutrition (4). Inadequate nutrition has negative implications for recovery from illness, surgery, or trauma. An inability to consume adequate nutrition predisposes patients in the intensive care unit to nutrition risk. The goal of nutrition therapy is to meet energy requirements while preserving body lean mass, which may be difficult to accomplish in critically ill populations (5). In a state
of health and disease, the body requires a constant supply of energy to be used in human metabolism that is derived from nutrient intake in the form of food or artificial nutrition support, when oral food and nutrition cannot be consumed (6). Wounds from surgery or trauma require increased blood supply, which result in increased cardiac output to expand and maintain blood flow to the injured or traumatized region (7).

Trauma and Injury

After an injury or trauma, metabolic response occurs in two phases, ebb and flow. The ebb phase lasts 24-48 hours after initial shock or injury, where metabolism is reduced, after which the body is in hyper-metabolism during the flow phase. This phase consists of catabolism of stored protein, lipid and carbohydrate to maintain organ function, usually peaking at 3 days (6, 7). Nutrition intervention should be initiated early in the flow phase to preserve lean body mass, as a critical component in critically ill patients based on a study by Campbell (7). Energy through nutrition support can be considered a component of the clinical outcome of the patient.

Acute stress from an accident, surgery, sepsis, or serious illness, like myocardial infarction, can result in an increase in counter-regulatory hormones, cytokines and lymphokines. Weissman indicated that increases in counter-regulatory hormones, can lead to catabolism and hyper-metabolism (4). Various stresses, including myocardial infarctions and congestive heart failure cause alteration in lipid metabolism, which increases activity of the triglycerides to cause hyper-metabolism during stress (4). Lack of enteral intake among postoperative and critically ill patients is associated with villus atrophy (7, 8). In the stressed patient, there is chance that the proliferating gastrointestinal tissues may have an inadequate supply of nutrition. Hernandez et al.
found that within a short period of fasting, significant duodenal mucosal atrophy and abnormal gut permeability in critically ill patients can occur (8).

The Gastrointestinal Tract

The intestinal epithelium represents a critical barrier against systemic absorption of microbes. Disruption of this barrier may result in translocation or passage of bacteria and their toxic products in the bloodstream (4, 8, 12). The GI tract abnormalities can be noticed as soon as four days without nutrition. In a study by Hernandez et al., 15 critically ill patients that fasted for at least four days, experienced a significant atrophy of the duodenal mucosa, demonstrated by a decrease in villus height, and increase in crypt depth which occurred after 7.8 days of fasting (8). Atrophy in some patients occurred in as little as three days without nutrition. A study by Binnekade et al. of 403 patients identified several factors impeding successful nutrition such as using the feeding tube to deliver contrast, need for prokinetic drugs, and other interfering factors (9).

Some studies demonstrated cost savings by reducing parenteral nutrition, in favor of early enteral nutrition. A study by Blanc et al. reviewed 555 ICU patients, in whom an early enteral protocol was implemented. Early enteral nutrition resulted in a 31% decrease in cost while using the GI tract function (10). The studies by Hernandez et al., Binnekade et al., and Blanc et al. suggest the implementation of protocols for feeding in the ICU setting (8,9,10).

Early enteral nutrition may be increasing in units, due to the increased availability of soft, small bore feeding tubes, which simplified the administration and maintenance of tube feeding. According to Popovich, enteral nutrition has now been accepted as the most desirable method of repletion, largely because of evidence suggesting that enteral
feeding is associated with reduced morbidity, complications, and costs when compared to parenteral nutrition (11). Enteral nutrition is considered desirable in acutely ill patients for a variety of metabolic reasons.

Cardiology

A majority of admissions to intensive care units are due to cardiovascular disease. The most common cardiovascular diagnoses prompting admissions to the intensive care unit include myocardial infarctions, cardiac surgery, and cardiomyopathies. The vast majority of cardiac surgery patients do not require artificial nutrition support, as they generally have a brief stay in ICU, and are able to resume oral feeding 1-2 days post-operatively according to Berger et al. (12). Berger et al studied cardiac surgery patients that suffered complicated clinical courses requiring pharmacological and mechanical cardiac support with prolonged mechanical ventilation. Berger demonstrated that the GI tract appeared functional in such patients and that enteral nutrition support is maintained, even in severe hemodynamic failure, when started after 24-48 hours (12). Berger’s study concluded that enteral nutrition is possible after 24 hours post-op in cardiac related intensive care. The potential hazards associated with enteral feeding require careful monitoring during nutrition repletion. Restoration of an anabolic state may improve myocardial infarction; however this has not been proven according to Quinn and Askanazi (13).

Early enteral nutrition has been shown to lower stress hormone concentrations, reduce infection rates, shorten hospital stays and increase survival of critically ill patients according to Weissman (4). Multiple organ failure studies have led to the recommendation that enteral nutrition be started as soon as possible after surgery or in
non-surgical patients after admission to the intensive care unit (4). Typically when insult to the body from injury or surgery is overwhelming, the physiological and immunological reserves are already impaired and multiple organ dysfunctions may occur (14). Lungs are normally the first to be affected by a decrease in compliance and failure of gas exchange. The cardiovascular system follows with myocardial depression and reduced peripheral vascular resistance, which may require inotropic and vasopressor support. Often the kidneys shut down requiring hemodiafiltration, then liver failure, soon followed by GI tract failure, and unconsciousness (14). Organ support is then required in patients with multi-system organ failure, such as artificial ventilation, and artificial nutrition until the precipitating cause is treated and recovery occurs, or death supervenes (14).

Surgery

Surgery involves invasion of the body, in which, rapid changes in metabolism occur and the risk for complications is high. A Japanese study by Nakamura et al. evaluated whether the preoperative nutritional state influenced the postoperative inflammatory reaction and immunity (15). This study grouped postoperative patients on total parental nutrition (TPN) into two groups. Group one, consisted of the good nutritional state group. Patients with protein-calorie malnutrition were in group two based on their pre-operative rapid turnover protein rate (15). Nutritional markers such as albumin and C-reactive protein (an inflammatory response marker) were measured in both groups. Both groups showed a decrease in the nutritional markers after surgery, but group one recovered to almost preoperative levels by postoperative day seven (15). After postoperative day seven, group two had significantly lower albumin levels (p<0.05) than those in group one (15). C-reactive protein was also higher in group two. Nakamura et
al. concluded that evaluation of the preoperative nutritional state appears to be very important for the prediction of postoperative complications. Nakamura’s study can be summarized that the preoperative nutritional state greatly affects the postoperative nutrition state and inflammatory process. Evaluation of preoperative nutrition status is important, in the coronary intensive care unit, where patients are typically preparing for an emergent cardiac surgery once stable and off mechanical ventilation. The nutritional state of patients is important for deciding on the application of surgery and predictions of postoperative outcomes.

Enteral feeding has been shown to prevent GI mucosal atrophy associated with prolonged NPO status and required TPN. It is theorized that enteral nutrition may reduce the frequency of endotoxemia and bactremia as a result of GI bacterial translocation (4, 7, 8, 12, 16). Nutrition support has been proven to be an important part of intensive care therapy. Enteral feeding is the preferred route for nutrition support to preserve GI function and integrity (4, 7, 8, 12, 16). A functional GI tract allows the most effective route of administering nutritional support.

A prospective trial that divided patients into two groups was conducted by Suchner et al. It compared the efficacy of early postoperative enteral nutrition in a group of 17 patients and total parenteral nutrition (TPN) in the other group of 17 patients with head injuries requiring neurosurgery (16). Early enteral nutrition was started on day one, and by the fifth postoperative day all patients were at the goal rate of adequate nutrition (16). Early parenteral nutrition was started on day zero, the day of surgery, with 50-100mg dextrose solutions, by day three all patients were at goal rate of adequate nutrition (16). Nutrition measurements were made of resting energy expenditure, urea production
rate, visceral proteins, and gastrointestinal absorption. Results revealed that the nutritional measurements improved after early enteral nutrition (p<0.05) where it remained unchanged in TPN patients (16). It was concluded that early enteral nutrition following neurosurgical procedures is associated with an accelerated normalization of nutritional status (16). Accelerated normalization during early enteral nutrition improved protein synthesis as well as carbohydrate homeostasis.

Pneumonia

A study conducted by Kesek et al. evaluated the effect of 73 patients eligible for enteral nutrition in the cardiothoracic intensive care unit. They were observed until discharge from the ICU. The patients had surgery for valvular disease, coronary artery bypass grafting, thoracic or thoracoabdominal aortic aneurysms (17). All patients were on ventilators and enteral nutrition was started on the first postoperative day or when it was obvious that he patient would remain on artificial ventilation for several days (17). Aspiration pneumonia was defined as a rise in temperature and typical findings in routine radiographs as evaluated by radiologists occurred in 7 patients (17). Kesek et al. concluded that in the cardiothoracic ICI, early enteral nutrition is feasible with few problems.

A Slovenian study by Kompan et al., looked at the post-trauma risk for pneumonia in early enterally fed patients on the ventilator. Two groups of patients were randomized to receive immediate intragastric enteral nutrition or delayed intragastric enteral nutrition started after 24 hour of admission (18). Thirty three percent of the early group and 64% of the delayed group met criteria for pneumonia (p=0.050). The patients who had pneumonia were on average older and more severely injured requiring longer
ventilation days and a longer ICU stay (18). Kompan et al. concluded that in patients with properly administered early enteral nutrition the incidence of pneumonia in patients with injuries can be decreased (18).

Malnutrition

Nutrition support plays a vital role in the prevention and treatment of nutritional deficiencies in at risk critically ill ICU patients. Malnutrition is an alteration of body composition in which deficiencies of macronutrients and micronutrients result in reduced body cell mass, abnormal serum chemistry values and organ dysfunction (19). The route of feeding is determined by the presence or absence of a functioning intestine and hemodynamic status of the patient (4, 7, 8, 12, 16, 19). An article in Chest, by Chan et al., addressed nutrition management in the ICU and the importance of early nutrition intervention in critical patients. Malnutrition in critically ill patients in this article was defined as recent involuntary weight loss of 5% in 1 month or 10% over 6 months (19). Malnutrition also was defined in patients with signs of micronutrient deficiency such as anemia, glossitis, or skin rash. The goals of nutrition support in the ICU patient were based on consensus form the American College of Chest Physicians, as follows:

1. To provide nutrition support consistent with the patient’s medical condition and the available route of nutrient administration.
2. To prevent and treat macronutrient and micronutrient deficiencies.
3. To provide doses of nutrients compatible with the existing metabolism.
4. To avoid complications related to the technique of dietary delivery.
5. To improve patient outcomes such as those affecting resource utilization, medical morbidities and mortalities, and subsequent patient performance.

Nasogastric feeding requires adequate gastric motility and emptying (19). High residual volumes are a relative contraindication to gastric feeding as the risk of aspiration
may be higher. Small-bowel feeding is then appropriate (19). Post pyloric feeding is often effective in the ICU patient population to decrease incidence of aspiration.

A Swiss study by Villet et al., evaluated 48 critically ill patients with complications frequently involving hyper-metabolism, catabolism, and underfeeding. The prospective observational study assessed the relationship between energy balance and outcome in surgical ICU patients staying greater than five days (20). Mechanical ventilation lasted 11 +/- 8 days, ICU stay 15 +/- 9 days and time to feeding initiation was 3.1 +/- 2.2 days (20). Mean energy delivery was 1090 +/- 930 kilocalories. Villet et al. study results revealed that mean energy balance that was negative, increased the number of complications (20). Delaying nutrition support initiation exposes the patients to energy deficits that cannot be compensated later on, with risk of malnutrition.

Length of Stay

To evaluate the effect of early enteral nutrition on critically ill patients, Marik and Zaloga conducted a systemic review of the literature (21). They looked at randomized, controlled studies that compared early enteral nutrition with delayed enteral nutrition in hospitalized patients (21). The patients in the review were postoperative, or had a head injury, burns, or trauma. Fifteen studies that had 753 patients were used to extract data on infections, length of stay and mortality. The meta-analysis was performed using the random effects model (21). The review showed early enteral nutrition was associated with a significantly lower incidence of infections with a 95% confidence interval, 0.30-0.66; p=.00006 (21). A reduced length of hospital stay of 2.2 days, 95% confidence interval, 0.81-3.3 days; p=.004 (21) was also shown (21). The results of the systemic review support the data to demonstrate the benefit of early initiation of enteral nutrition.
A smaller study from Slovenia by Kompan, Kremzar, Gadzijev, and Prosek revealed no influence of early enteral nutrition on the length of ICU stay or time of mechanical ventilation in a surgical intensive care unit (22). Their study was a prospective randomized trial consisting of 28 patients with multiple injuries admitted in shock. The patients were randomly assigned into two groups: group A had enteral nutrition started not later than 6 hours after ICU admission and group B, had enteral nutrition started after 24 hours after admission (22).

In another study, implementation of a nutritional protocol in the ICU, by Barr and associates resulted in no significant difference in hospital or ICU length of stay (23). Barr et al compared critically ill patients who received early enteral nutrition and those who received enteral nutrition after 48 hours of ICU admission. Their study focused on a nutrition protocol in the ICU to increase the number of patients enterally fed sooner. The mean duration of mechanical ventilation was 17.9+/− 31.3 days in the pre-ental nutrition protocol group, and 11.2+/−19.5 days in the post-ental nutritional protocol group (p=0.11). The mean ICU length of stay was 14.9+/− 18.0 days in the pre-ental implementation group and 14.1+/−18.8 days in the post-ental implementation group (23). The objective of the above study was to determine implementation of a nutrition protocol in ICU for improved clinical outcomes in patients.

ICU Protocols

Frequently, critically ill patients do not receive adequate nutrition support during their ICU stay. This is often due to the difficulty of estimating nutrient needs and/or the delay in the initiation of nutrition support. Nutrition support in the ICU initiated within 48-72 hours of admission is associated with improved outcomes and reduced length of
stay based on a study by Barr et al. (23). A prospective study of critically ill patients before and after the introduction of evidence based guidelines for providing nutritional support in the ICU was conducted at the Department of Veteran’s Affairs Palo Alto Health Care Systems (23). Their study was conducted to determine if a nutritional protocol in the ICU leads to increased use of enteral nutrition, earlier feeding, and improved clinical outcomes. The study had 200 medical surgical ICU patients who remained nothing by mouth (NPO) >48 hours after admission to ICU. One hundred patients were evaluated prior to implementation and the other 100 patients were in the post-implementation group (23). Barr et al. measured time to initiate nutrition support, duration of mechanical ventilation, ICU and hospital length of stay.

The protocol instructed physicians to evaluate the need for nutritional support in each patient on admission to the ICU (23). The physicians were encouraged to feed patients within 24 hours of admission via feeding tubes unless they had contraindications to enteral nutrition as defined by the American Society of Parenteral and Enteral Nutrition guidelines (23). The enteral feeding to be used for each patient was determined by the ICU physician in conjunction with the ICU dietitian (23). The student’s t-test was used to statistically analyze the comparisons between the groups. The mean time to feeding in the pre-implementation group was 3.2+/− 2.0 days and 2.9+/−1.7 days in the post-implementation group (p=0.26) (23). The mean duration of mechanical ventilation was 17.9+/−31.3 days in the pre-implementation group, and 11.2+/−19.5 days in the post-implementation group (p=0.11) (23). The mean ICU length of stay was 14.9+/−18.0 days in the pre-implementation group and 14.1+/−18.8 days in the post-implementation group (23). Results showed that those in the post-implementation group were mechanically
ventilated for 9.5 fewer days than the patients in the pre-implementation group (p=0.03) (23). The study by Barr et al. concluded that the use of enteral nutrition support within 48 to 72 hours of ICU admission improve clinical outcomes in critically ill patients (23). Despite the benefits of early enteral nutrition, not all ICU patients receive early enteral nutrition support, or if they do it may not be adequate. It is often delayed or inadequate due to delayed orders, delayed tube placement, and the underestimation of caloric requirements. The delivery of enteral nutrition in the ICU setting can be delayed or inadequate.

A Canadian study by Mackenzie et al. determined that the development and use of an evidence-based nutrition support protocol improved the proportion of enterally fed ICU patients meeting their calculated nutrient requirements (24). A protocol was developed with input from dietitians, ICU physicians, surgeons, nurses, and pharmacists that led to a 20% increase in 123 patients receiving their estimated energy requirements (24).

Numerous factors impede delivery of enteral nutrition to ICU patients. Woien and Bjork from Norway tested a feeding algorithm designed to improve nutritional support of ICU patients (25). Data on 21 patients were collected from the first 72 hours of admission. Data collected included onset of delivery of enteral nutrition, amount of calories received versus prescribed, and enteral versus parenteral nutrition (25). The results indicated that a nutritional support algorithm improved delivery of nutrients, and a more rapid increase in the delivery of enteral nutrition administered by nurses based on improved physician orders form the algorithm (25). Woien and Bjork’s study concluded that it is possible to improve the delivery of enteral nutrition in the ICU population.
Providing enteral nutrition to mechanically vented patients varies from hospital to hospital. Four intensive care units in a tertiary-care referral hospital at Vanderbilt were studied. Those patients that were mechanically vented for 48 hours and received enteral nutrition were studied by Rice et al. (26). Patients in the medical intensive care unit, where a nutritional protocol was in place, had received enteral nutrition earlier in the ventilator course than those in non-protocol units (p=0.004) (26). Feeding rates were advanced faster (p=0.043) than the other non-protocol units as well (26). The results of the study by Rice et al. indicated that a protocol enhances early enteral nutrition.

McClave et al. conducted a prospective study of 44 patients in medical and coronary intensive care units at two university hospitals to evaluate factors that impact the delivery of enteral feeding (27). Advantages of early enteral nutrition in critically ill patients led to the preferred route of enteral nutrition rather than parenteral nutrition. Data from the study suggest that enteral nutrition may preserve GI tract integrity and prevent bacterial translocation, which has been implicated in the development of multiple organ failure (4, 7, 8, 12, 16, 19, 27). Other factors hinder efforts to deliver enteral nutrition, such as GI dysfunction, diagnostic tests and other procedure that require a fasting patient (27). The objective of McClave’s study was to determine what percentage of impeding factors of tube feeding delivery were potentially avoidable.

McClave et al. had registered dietitians determine tube feeding goal rates in his study. The dietitians used 25 to 35 kilocalories per kilogram per day as the caloric requirement (27). The infusion goal rate was ordered by the physician and strict intake and output was recorded by the nurse (27). Results indicated cessation of enteral nutrition occurred in 83.7% of the patients for a mean 19.6% of the infusion time (27).
Factors that accounted for the cessation included, surgical or endoscopic procedures, high residuals, tube displacement, diagnostic imaging studies, routine nursing care and other causes of patient intolerance (27). Cessation was deemed avoidable 66% of the time (27). McClave et al. believed that lack of enthusiasm, personal bias, and individual practices on part of the intensive care physician with regard to early enteral nutrition may be key factors effecting success (27). It can be concluded form the results of McCalve’s study that nutrition protocols and education of the healthcare professionals and intensive care specialists may be required to maximize delivery of tube feeding in the critical care setting.

Throughout the review of the literature, early enteral nutrition has demonstrated to be an effective method of providing nourishment to patients admitted to the intensive care unit. Accelerated catabolism may be deleterious in critically ill patients and advantages of enteral nutrition over parenteral nutrition are evident since the use of substrates via the gastrointestinal tract improves the local and systemic immune response while maintaining the barrier function of the gut (4, 9, 27, 28). For early enteral nutrition to be effective, a protocol should be implemented to include, uprising the bed headrest, a transpyloric approach when placing the tube, and timing of initiation (26, 27, 28).

Doig and Simpson conducted a methodological review on nutrition support of the critically ill to find the benefits of early enteral nutrition. Recommendations were based on reasonable evidence, but only 50% of eligible patients actually received enteral nutrition within 48 hours of admission to the intensive care unit (29). Doig and Simpson conducted the review as they felt there is a need for high quality definitive evidence to convince more clinicians that their patients will benefit from early enteral nutrition.
Methodological Review

A recent methodological review of 330 primary feeding intervention trials to support development of Australian and New Zealand evidence-based guidelines failed to find studies that the U.S. Food and Drug Administration (FDA) would consider equivalent to a phase III definitive licensing trial known as level I evidence according to Doig et al. (29). The authors of the review also state that many of the level II trials were found to have methodological flaws. Despite the findings, it is certain that malnutrition is associated with a worse outcome and therefore patients would benefit from early enteral nutrition (29). Many level II type trials support the benefits of early enteral nutrition. The benefits include preservation of muscle mass, maintenance of gastrointestinal barrier and immune function resulting in reduced translocation of bacteria and subsequent infections, thus reducing multiple organ dysfunctions (4, 6, 9, 12, 16, 19, 20, 27, 29).

Evidence based recommendation for early enteral nutrition was evaluated in 14 hospital Algorithms for Critical-Care Enteral and Parenteral Therapy (ACCEPT) resulted in a 10% reduction in hospital discharge mortality (p=0.058) (29). This evidence based guideline resulted in a reduced hospital length of stay by 10 days (p=0.003). In other trials comparing early versus late enteral nutrition initiation, an 8% reduction in mortality was noticed and it was recommended that enteral nutrition be initiated within 48 hours of ICU admission (29). However the evidence to support the early enteral nutrition recommendations is considered grade B+. The addition of level I evidence could increase this recommendation to grade A, which would lead to consistent delivery of early enteral nutrition (29).
Summary

Early enteral nutrition is supported by meta-analysis of level II trials. Results from a level I trail are needed to convince more clinicians to deliver early enteral nutrition. A level I trial would provide the opportunity to validate measures of nutritional status through mid-arm circumference, biochemical markers, handgrip and strength against patient oriented outcomes like quality of life, activities of daily living, and duration of survival (29). Upon validation of the above measures, clinicians will be able to make clinical decisions with more confidence. Higher levels of evidence would demonstrate a benefit to patient outcomes which would result in a change in practice.

There is an accumulating body of evidence in the literature that demonstrates beneficial effects of early enteral nutrition on wound healing, gastrointestinal mucosal integrity, and reduction of infectious complications (7, 8, 11, 29). Unfortunately interpretation of the findings relative to specific patient populations, statistical methods, and publication bias makes it difficult to ascertain the relevance for particular populations (11). Until such studies are performed and analyzed, nutritional support should continue to be viewed as an important adjunctive therapy (4). Nutrition support should be used in a manner that maximizes positive effects and minimizes negative impact.
CHAPTER III
RESEARCH DESIGN AND METHODS

The purpose of this study will be to determine if mechanically ventilated patients admitted to the coronary intensive care unit, have decreased length of stay in the CICU and shorter duration on the ventilator when enteral nutrition is initiated within 72 hours of intubation. The study will evaluate the days in the CICU and days on ventilator when tube feeding was initiated the first 72 hours of intubation compared to patients who received enteral nutrition after 72 hours of intubation. Chapter three describes the sample population, study design, process of collection, data analysis and limitations of the study.

Sample Population and Study Design

This was a retrospective study that employed data acquired from patient medical records. Data collection commenced after the approval from the Institutional Review Boards of the medical center and a Midwest university (Appendices A and B). Coronary Intensive Care Unit lists for the department of nutrition therapy were used to identify mechanically ventilated patients with cardiac diagnosis who had nutrition consults ordered. All patients 18 years of age or older admitted to CICU between January 2007 through October 2007 who met study criteria were considered for inclusion in the study.
The criteria were CICU patients with the primary diagnosis including myocardial infarction (MI), endocarditis, congestive heart failure (CHF), or respiratory failure/distress. Any patients with diagnoses other than above were excluded. Medical records were not reviewed if the patients had a gastrointestinal bleed (GI bleed), ileus, pancreatitis, or bowel obstruction. Those patients with GI bleeds, ileus, or bowel obstructions were excluded from the study, as enteral nutrition is sometimes contraindicated in these subjects (2, 4). Subjects who were admitted to the unit already receiving enteral nutrition were also excluded.

Data Collection

Medical records reviewed from January 2007 through October 2007 were provided by the department of medical records at the medical center. Data were collected from 50 patient medical records meeting study criteria as previously described. Data were gathered in a confidential manner, meeting HIPPA requirements and made available only to the researcher. Data were obtained from all parts of the medical record, including nursing flow sheets and respiratory therapy documentation flow sheets. The review process of patient charts included documentation on diagnosis, initiation time of the tube feeding, and vent status, admission and discharge dates. A codebook was created and used to guide data entry into an Excel spreadsheet.

Data Analysis and Testing Instruments

Inferential statistics were used to analyze the data in this study to make predictions based on a sample obtained from the CICU population. For all statistical tests, p<.05 was used to indicate statistical significance. Two dependent variables were examined in this study, days on a ventilator and length of stay in the CICU. Hypothesis
one states that among mechanically vented CICU patients admitted with a primary cardiac diagnosis, including myocardial infarctions, cardiac arrest, endocarditis, congestive heart failure, or respiratory failure, who receive early enteral nutrition (within 72 hours of intubation), will have decreased days on the ventilator, when compared to those who do not receive early enteral nutrition (after 72 hours of intubation). Statistical analyses by two-sample Student’s t-test were done to determine whether there was a statistically significant difference in the mean number of days on the ventilator between the two groups.

The second hypothesis states that mechanically vented CICU patients admitted with a primary cardiac diagnosis, including myocardial infarctions, cardiac arrest, endocarditis, congestive heart failure, or respiratory failure, who receive early enteral nutrition (within 72 hours of intubation), will have decreased length of stay in the ICU, when compared to those who do not receive early enteral nutrition (after 72 hours of intubation). Statistical analyses by two-sample Student’s t-test were done to determine whether there was a statistically significant difference in the mean number of days during the length of stay in the CICU between the two groups.

Limitations of the Study

Patients’ past medical history were not accounted for in the study, as all patients in the study had multiple co-morbidities. A majority of the admitted CICU patients are transferred in to the medical center from other hospitals for second opinions regarding their cardiac conditions, and therefore not all of the patients’ histories were known at time of admission. Those with lung disease or related illness may have an effect on length of time on the ventilator, which could also affect length of stay in the CICU.
Some patients in the study were septic and some were not, this was not noted for patients in the study, and could affect the study results. Other variables that may effect the time on ventilator and length of stay include, history of smoking, recreational drug use, weight of patient, age, renal replacement therapy, use of pulmonary artery catheters, and intra aortic balloon pumps, were not included in this study. Other variables were not included as some may not have been known upon, during or after CICU admission. Patient’s co-morbidities such as diabetes, hypertension, history of heart disease, and other past medical histories were not addressed. Controlling for co-morbidities was not possible, making it difficult to establish a direct cause-effect. Therefore, the results of this study may not represent the CICU population as a whole.

Summary

The intent of this study was to understand the effect of nutrition intervention on patient care and patient outcomes. This study used statistical methods to elucidate the relationship between controllable patient care factors and outcomes based on early enteral nutrition in the CICU. This research hopes to facilitate clinical guideline developments in the coronary intensive care unit. Understanding the impact of quality nutrition care upon patient outcomes is difficult because it is one of a complex of various therapies affecting patient outcomes.
CHAPTER IV
RESULTS AND DISCUSSION

The purpose of this study was to determine if early enteral nutrition provided within 72 hours of intubation would be associated with decreased time duration on the ventilator and decreased the intensive care unit stay. This chapter includes results of the study. It begins with a review of the subjects’ demographics and pertinent data. Statistical analysis of each hypothesis is presented.

Subjects

Data on fifty subjects were collected for the study. Results on 35 patients out of 50 were included in the study sample. Fifteen of the 50 subjects did not met study criteria. Of those 50 subjects, five patients were not mechanically ventilated longer than 72 hours, seven patients expired prior to extubation and/or discharge from the CICU, and three patients transferred to other hospitals. Subjects were over 18 years old, any race, sex, or ethnic origin. Subjects were admitted to the CICU of the medical center, January 1, 2007 through October 1, 2007.

All subjects were admitted to the CICU with cardiac related diagnoses. Most subjects were admitted with myocardial infarction. Thirteen subjects were admitted with other cardiac diagnoses such as coronary artery disease, aortic stenosis and cardiomyopathy. Seven had congestive heart failure (CHF), six had cardiac arrest, five had respiratory failure due to cardiac event, and three had endocarditis. (Appendix C)
Data Analysis

Statistical analysis consisted of two-sample Student’s t-tests. The data were analyzed to determine if statistically significant differences existed between early enteral nutrition initiation within 72 hours of intubation and enteral nutrition initiation after 72 hours of intubation. Appendix C illustrates the study participants diagnosis, ventilator days, intensive care (ICU) days, and study completion results.

Results of the 35 patients that completed the study include 19 patients (54%) that received tube feeding within 72 hours of intubation and 16 (46%) patients that received tube feeding after 72 hours of intubation. The average days on mechanical ventilation for patients enterally fed within 72 hours of intubation were 5.3 days, and 9.9 days for patients enterally fed after 72 hours of intubation. The average length of stay in the CICU for patients enterally fed within 72 hours of intubation was 9.6 days, and 16.4 days for patients enterally fed after 72 hours of intubation (Table 1).

Table 1. Mean days on vent and length of stay of patients

<table>
<thead>
<tr>
<th></th>
<th>Tube Feeding within 72 hours of intubation</th>
<th>Tube Feeding after 72 hours of intubation</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>19</td>
<td>16</td>
</tr>
<tr>
<td>Mean Days on Vent</td>
<td>5.3</td>
<td>9.9</td>
</tr>
<tr>
<td>P value=0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Length of Stay</td>
<td>9.6</td>
<td>16.4</td>
</tr>
<tr>
<td>P value=0.01</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hypothesis one states that among mechanically vented CICU patients admitted with a primary cardiac diagnosis, but not limited to myocardial infarctions, cardiac arrest, endocarditis, congestive heart failure, or respiratory failure, who receive early enteral
nutrition (within 72 hours of intubation), will have decreased days on the ventilator, when compared to those who do not receive early enteral nutrition (after 72 hours of intubation). (Table 2.) illustrates the 35 patients that completed the study, a significant difference between those who received early enteral nutrition within 72 hours of intubation group “a” compared to those who received enteral nutrition after 72 hours of intubation group “b” (p=0.04). A p value of 0.05 was used to indicate statistical significance. Group “a” ranged from four to seven days on mechanical ventilation and group “b” ranged from six to fourteen days on mechanical ventilation

Table 2. Analysis of total vent days by tube feeding (TF) initiation

Hypothesis two states that among mechanically vented CICU patients admitted with a primary cardiac diagnosis, but not limited to myocardial infarctions, cardiac arrest, endocarditis, congestive heart failure, or respiratory failure, who receive early enteral nutrition (within 72 hours of intubation), will have decreased length of stay in the ICU, when compared to those who did not receive early enteral nutrition (after 72 hours of intubation). Hypothesis two is supported as there was a significant difference between
patients who received enteral nutrition within 72 hours of intubation compared to patients who received enteral nutrition after 72 hours of intubation (p=0.01). A p value of 0.05 was used to indicate statistical significance.

There are two outliers on Table 3 indicating longer than average stay in the ICU. One patient had an intubation period of 35 days, on day 14 of mechanical ventilation the patient had a tracheotomy with intentions to wean from the ventilator but failed. The patient remained on the ventilator via their tracheostomy. Another patient had the same problem, requiring a tracheotomy and prolonged mechanical ventilation. Table 3 depicts the “a” group as the early enteral nutrition group tube fed within 72 hours of intubation. The “b” group as the patients fed after 72 hours of intubation. The average ICU stay for group “a” were 7 to 12 days, and the average ICU stay for group “b” were 12 to 21 days. In summary patient’s fed after 72 hours of intubation averaged 6.7 days longer stay in the ICU.

Table 3. Analysis of total ICU days by tube feeding (TF) initiation

![Total ICU days by TF Initiation](image)

When the two outlier patients are removed, and data is analyzed on 33 patients the average length of stay in the ICU decreases from 9.6 days to 8.6 days in group “a” the
early enteral nutrition group. The mean length of stay in the ICU also decreases from 16.4 days in group “b” the late enteral nutrition group to 15.0 days. The mean ICU stay for group “a” was 7 to 10 days, (95% confidence interval) and the mean ICU stay for group “b” was 11 to 19 days (95% confidence interval). In summary when the two outlier patient’s are removed, patient’s fed after 72 hours of intubation averaged 6.3 more days in the ICU. With the outliers, the average stay was 6.7 more days in the ICU, a difference of 0.4 days.

Summary

A major finding of this study indicates that early enteral nutrition initiation within 72 hours of intubation in CICU patients can significantly reduce the amount of time spent on mechanical ventilation and length of stay in the CICU. Nutrition support in CICU patients minimizes the nutrient loss in the high risk ventilator dependent patient, thus decreasing the time spent on the ventilator and length of stay in the CICU.
CHAPTER V
SUMMARY

Statement of the Problem

Prolonged mechanical ventilation has a negative impact on an ICU stay possibly leading to a longer stay in the ICU. Lack of nutrition support may result in prolonged time on the ventilator, thus prolonged time in the ICU. Patients who have delayed feeding secondary to nothing by mouth (NPO) status for prolonged periods can have increased metabolic needs due to stress, illness, and injury. Lack of nutrition support has negative consequences in the critically ill. Such consequences may include, increased time spent on mechanical ventilator and prolonged length of stay in the intensive care unit. Those consequences may lengthen time for the patient's ability to heal and improve their condition.

Summary of the Hypotheses

Hypothesis one states, among mechanically vented CICU patients admitted with a primary cardiac diagnosis, including myocardial infarctions, cardiac arrest, endocarditis, congestive heart failure, or respiratory failure, who receive early enteral nutrition (within 72 hours of intubation), will have decreased days on the ventilator, when compared to those who do not receive early enteral nutrition (after 72 hours of intubation). For statistical analysis, Student’s t-test was used to determine the significance between
patients who received tube feeding within 72 hours of intubation and patients who received tube feeding after 72 hours of intubation. Results of the hypothesis are statistically significant (p=0.04). According to study findings, early enteral nutrition in the critically ill population is beneficial to the patient by decreasing the length of mechanical ventilation.

Unfortunately, there are no definitive large multi-center studies that have examined whether nutritional support improves patient outcomes, and specifically if enteral nutrition reduces time on mechanical ventilation and duration of intensive care stay. Adequate nutritional support is especially important to maintain normal pulmonary function in hopes of being extubated, or removal from the mechanical ventilation (3). In Weissman’s study, *Health Benchmarks 1998*, claimed that starting enteral nutrition within 72 hours of intensive care unit admission reduced duration of mechanical ventilation (4). Length of mechanical ventilation in a surgical ICU with patient’s post cardiovascular surgery was shorter for those patients who received early enteral nutrition within two to three days postoperatively (12). Overall the average days on vent on enterally feed patients in Berger’s study was 5+/-5days (p<0.001), it indicated that post operative cardiac patients can be extubated and that early enteral nutrition in this population is beneficial (12). In a study by Kompan et al. two groups of patients randomized to early enteral nutrition or delayed enteral nutrition, showed that 64% of the delayed patient group met criteria for pneumonia (p=0.050.) and required more ventilator days (18). Another study by Kompan involving multiple system organ failure and early enteral nutrition did not indicate any influence on time of mechanical ventilation (22).
Barr’s study looked at implementation of a nutrition protocol in the ICU which included early enteral nutrition initiation. Results indicated that those patients enrolled in the post protocol implementation group (the group that did initiate early enteral nutrition) had a shorter duration on mechanically ventilation (17.9 days versus 19.5 days, p=0.03) (23). Barr’s study indicated that an evidenced based nutritional protocol involving early initiation of enteral feeding shortened the duration of mechanical ventilation. The practice of enterally feeding mechanically ventilated ICU patients varies widely; more studies are needed to prove that early enteral nutrition will shorten the duration of mechanical ventilation. Based on this study’s research findings, initiation of enteral nutrition within 72 hours of intubation appears to shorten duration on mechanical ventilation.

Hypothesis two states that mechanically vented CICU patients admitted with a primary cardiac diagnosis, including myocardial infarctions, cardiac arrest, endocarditis, congestive heart failure, or respiratory failure, who receive early enteral nutrition (within 72 hours of intubation), will have decreased length of stay in the ICU, when compared to those who do not receive early enteral nutrition (after 72 hours of intubation). Statistical analysis that used Student’s t-test was used to determine the significance between patients who received tube feeding within 72 hours of intubation and patients who received tube feeding after 72 hours of intubation. Results of the second hypothesis are statistically significant (p=0.01). A review of literature reveals study findings, that early enteral nutrition in the critically ill population may decrease the length of stay in the ICU.

There were similar results in Berger’s study with a length of surgical ICU stay of 10 +/- 7 days (p=0.09 more severely ill and p=0.0001 less severely ill) when enteral
nutrition was initiated within 48 to 72 hours if intubation (12). In a study by Kesek, Akerlind, and Karlsson, patients in whom a prolonged ventilator treatment period was anticipated on the first cardiac postoperative day were started on enteral nutrition within 72 hours (17). The study concluded that early enteral nutrition is feasible with few problems in over 50% of the 62 patients observed in the study (17). Kompan researched the relationship between early enteral nutrition and pneumonia, 64% of the delayed enteral feeding patients had longer stay in the ICU (p=0.050) and concluded that early enteral nutrition can decrease pneumonia and length of ICU stay (18).

Marik and Zaloga evaluated fifteen studies with 753 subjects to evaluate the effect of early enteral nutrition on the outcome of critically ill patients including length of stay. The study showed a significantly reduced length of hospital stay (mean reduction of 2.2 days; 95% confidence interval, 0.81-3.63 days; p=0.004) (27). Barr’s study of nutritional protocols for ICU feeding showed that patients who received early enteral nutrition patients in the protocol group had slightly shorter ICU stay. The mean ICU stay was 14.1 days +/- 18.0 days in the protocol early enteral nutrition group compared to the mean ICU stay of 14.9 days +/- 18.0 days in the group with no early enteral protocol (p=0.78). However, this difference did not achieve statistical difference at p value of 0.78 (23). Ultimately the development of enteral protocols may maximize the delivery of enteral nutrition and decreasing the length of ICU stay. Peters et al. meta-analysis, evaluated over 30 trials assessing early enteral nutrition versus parenteral nutrition found that complication rates, hospital and ICU length of stay was reduced compared to parenteral nutrition (30). A review by Doig et al. revealed that evidence based guidelines for
implementing early enteral nutrition in the ICU resulted in a significant reduction in hospital length of stay by 10 days (p=0.003) (29).

The American Dietetic Association’s Evidence Analysis has concluded that adequately powered studies have not been done to evaluate the impact of early enteral nutrition versus late enteral nutrition on mortality (32). A majority of the findings in study results reviewed in this thesis indicated a decrease in length of ICU stay in patients who were mechanically ventilated and received enteral nutrition within 72 hours of intubation. Although the optimal timing of enteral nutrition in the critically ill patient has not been clearly elucidated, current evidence presented in this study suggest that early enteral nutrition is associated with improved clinical outcomes postoperatively or following injury.

The purpose of this study was to determine if mechanically ventilated patients admitted to the coronary intensive care unit, have decreased length of stay in the CICU and shorter duration on the ventilator when enteral nutrition is initiated within 72 hours of intubation. It can be concluded from this study that early enteral nutrition is associated with positive patient outcomes by reducing duration on the ventilator and decreasing the length of stay in the CICU.

Implications

This research addressed the effectiveness of medical nutrition therapy on patient outcomes experienced at the medical center used in this study. In the coronary intensive care unit in this study, most patients are critically ill and requiring cardiac surgery when stable and extubated. The preoperative state greatly affects the postoperative nutritional state but the immunity and inflammatory response as well (15). Understanding the CICU
patient population nutritional need timing appears to be important for the predication of mechanical ventilation duration, length of CICU stay and prediction of postoperative outcomes.

Dietetics professionals can contribute to institutional protocols for nutrition and medical care which favorably influence patient outcomes such as mechanical ventilation duration and length of stay. Medical professionals can improve nutritional status which ultimately will help with reducing the length of stay, thus reducing the rates of morbidity and mortality. Finally, results of this study can be used to effectively assist with the development of policies and procedures to identify ways to efficiently feed mechanically ventilated patients to improve their outcomes. Based on the findings of this study, an algorithm can be developed and used by medical professionals in the CICU to determine enteral nutrition regimens within 72 hours of intubation.

In summary it is important to treat each patient as an individual case. An accurate assessment of the patient guides the decision making for many other treatments including artificial nutrition support. Decisions regarding the patient’s treatment can possibly impact a patient’s time on mechanical ventilation and length of stay as illustrated here. Therefore clinicians should be in charge of gathering and documenting the appropriate data to yield the best possible therapeutic outcome.

Possibilities for Future Research

Nutritional support has become a routine part of the care of the critically ill patient. It is often used as an adjunctive therapy to benefit the patient. There is a need to acquire more information through large multi-center studies on the benefits of early enteral nutrition in intensive care units, especially coronary intensive care units. According to the American
Dietetic Association’s Evidence Analysis Library, most trials on early enteral nutrition are poorly designed and new trials are needed (32). Even if similar studies could not be done, follow up studies would be useful in determining if early enteral nutrition in coronary intensive care units is successful at decreasing time spent on mechanical ventilation and duration of ICU stay. There is also a need to conduct large, multi-center, prospective randomized trials, to acquire knowledge of the cost-benefit and cost effectiveness of nutritional support in the critically ill population. Larger studies might have populations more heterogeneous in age, co-morbidities, and diagnosis. The impact of early enteral nutrition initiation in the coronary intensive care unit might be influenced by these factors. Medical nutrition therapy is an integral part of the patient’s medical management, and is beneficial when early enteral nutrition is implemented within seventy two hours of intubation.
REFERENCES


APPENDICES
January 12, 2007

TO: Elizabeth Pass Perrinman, RD, LD / G90

RE: Exempt Research: 07-019: EXEMPT: Early enteral nutrition of mechanically ventilated patients in the coronary intensive care unit (CICU) decreases days on vent, decreases length of stay in CICU, and increases albumin levels.

Dear Ms. Pass Perrinman,

Your new study application received on 12/20/2006 has been reviewed and qualifies as exempt from further IRB review under the federal exemption category #4. Research involving the collection or study of existing data is exempt if the information is recorded by the investigator in such a manner that subjects cannot be identified.

You are free to conduct your study without further reporting to the IRB.

Thank you for keeping the board informed of your activities.

Sincerely,

[Signature]

Daniel Beyer, M.S., MHA, CIP
Executive Director
Institutional Review Board

[Stamp]
APPENDIX B. HUMAN SUBJECTS APPROVAL

Elizabeth Pash Penniman
504 Andover Cnr.
Broadview Heights, Ohio 44147

Ms. Pash Penniman:

Your request for exemption for the protocol entitled "Early Enteral Nutrition of Mechanically Ventilated Patients in the Coronary Intensive Care Unit (CICU) Decreases Days on Vent and Length of Stay in CICU" was approved on November 19, 2007. The IRB application number assigned to this project is 20071120. The protocol represents minimal risk to subjects and matches the following federal category for exemption:

☐ Exemption 1 - Research conducted in established or commonly accepted educational settings, involving normal educational practices.

☐ Exemption 2 - Research involving the use of educational tests, survey procedures, interview procedures, or observation of public behavior.

☐ Exemption 3 - Research involving the use of educational tests, survey procedures, interview procedures, or observation of public behavior not exempt under category 1, but subjects are elected or appointed public officials or candidates for public office.

☐ Exemption 4 - Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens.

☐ Exemption 5 - Research and demonstration projects conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine public programs or benefits.

☐ Exemption 4 - Taste and food quality evaluation and consumer acceptance studies.

Annual continuation applications are not required for exempt projects. If you make changes to the study's design or procedures that increase the risk to subjects or include activities that do not fall within the approved exemption category, please contact the IRB to discuss whether or not a new application must be submitted. Any such changes or modifications must be reviewed and approved by the IRB prior to implementation.

Please retain this letter for your files. If the research is being conducted for a master's thesis or doctoral dissertation, the student must file a copy of this letter with the thesis or dissertation.

Sincerely,

Sharon McWhorter
Associate Director

Cc: Sandra Hudak, Advisor
Rustie Hall, IRB Chair

Office of Research Services and Sponsored Programs
Akron, OH 44325-3102
330-972-1998 • 330-972-6281 Fax
The University of Akron is an Equal Opportunity, Affirmative Action Institution.
## APPENDIX C. RESEARCH SUBJECTS

<table>
<thead>
<tr>
<th>Assigned Non-Identifiable #</th>
<th>TF Initiation</th>
<th>Diagnosis</th>
<th>Total Vent Days</th>
<th>Total ICU Days</th>
<th>Study Criteria Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>TF w/in 72h</td>
<td>Resp. Fail</td>
<td>4</td>
<td>5</td>
<td>Completed</td>
</tr>
<tr>
<td>002</td>
<td>TF after 72h</td>
<td>MI</td>
<td>35</td>
<td>37</td>
<td>Completed</td>
</tr>
<tr>
<td>003</td>
<td>TF after 72h</td>
<td>CHF</td>
<td>12</td>
<td>16</td>
<td>Completed</td>
</tr>
<tr>
<td>004</td>
<td>No tube feed</td>
<td>Other</td>
<td>7</td>
<td>12</td>
<td>Completed</td>
</tr>
<tr>
<td>005</td>
<td>No tube feed</td>
<td>CHF</td>
<td>4</td>
<td>8</td>
<td>Completed</td>
</tr>
<tr>
<td>006</td>
<td>TF after 72h</td>
<td>Other</td>
<td>8</td>
<td>27</td>
<td>Completed</td>
</tr>
<tr>
<td>007</td>
<td>TF after 72h</td>
<td>Other</td>
<td>9</td>
<td>15</td>
<td>Completed</td>
</tr>
<tr>
<td>008</td>
<td>TF after 72h</td>
<td>Other</td>
<td>9</td>
<td>25</td>
<td>Completed</td>
</tr>
<tr>
<td>009</td>
<td>No tube feed</td>
<td>Resp. Fail</td>
<td>5</td>
<td>9</td>
<td>Completed</td>
</tr>
<tr>
<td>010</td>
<td>TF w/in 72h</td>
<td>Endocard.</td>
<td>8</td>
<td>14</td>
<td>Completed</td>
</tr>
<tr>
<td>011</td>
<td>TF w/in 72h</td>
<td>Other</td>
<td>3</td>
<td>4</td>
<td>Completed</td>
</tr>
<tr>
<td>012</td>
<td>TF w/in 72h</td>
<td>Other</td>
<td>10</td>
<td>13</td>
<td>Completed</td>
</tr>
<tr>
<td>013</td>
<td>TF w/in 72h</td>
<td>CHF</td>
<td>2</td>
<td>27</td>
<td>Completed</td>
</tr>
<tr>
<td>014</td>
<td>TF after 72h</td>
<td>Other</td>
<td>5</td>
<td>10</td>
<td>Completed</td>
</tr>
<tr>
<td>015</td>
<td>TF w/in 72h</td>
<td>CHF</td>
<td>10</td>
<td>12</td>
<td>Completed</td>
</tr>
<tr>
<td>016</td>
<td>TF after 72h</td>
<td>Endocard.</td>
<td>7</td>
<td>7</td>
<td>Completed</td>
</tr>
<tr>
<td>017</td>
<td>TF w/in 72h</td>
<td>Endocard.</td>
<td>5</td>
<td>11</td>
<td>Completed</td>
</tr>
<tr>
<td>018</td>
<td>TF w/in 72h</td>
<td>Other</td>
<td>9</td>
<td>13</td>
<td>Completed</td>
</tr>
<tr>
<td>019</td>
<td>TF after 72h</td>
<td>MI</td>
<td>21</td>
<td>26</td>
<td>Completed</td>
</tr>
<tr>
<td>020</td>
<td>TF w/in 72h</td>
<td>C. Arrest</td>
<td>3</td>
<td>4</td>
<td>Completed</td>
</tr>
<tr>
<td>021</td>
<td>TF w/in 72h</td>
<td>Other</td>
<td>6</td>
<td>8</td>
<td>Completed</td>
</tr>
<tr>
<td>022</td>
<td>No tube feed</td>
<td>CHF</td>
<td>3</td>
<td>20</td>
<td>Extubated w/o TF</td>
</tr>
<tr>
<td>023</td>
<td>TF after 72h</td>
<td>Resp. Fail</td>
<td>4</td>
<td>14</td>
<td>Completed</td>
</tr>
<tr>
<td>024</td>
<td>TF after 72h</td>
<td>CHF</td>
<td>10</td>
<td>14</td>
<td>Completed</td>
</tr>
<tr>
<td>025</td>
<td>TF after 72h</td>
<td>CHF</td>
<td>10</td>
<td>11</td>
<td>Completed</td>
</tr>
<tr>
<td>026</td>
<td>TF w/in 72h</td>
<td>MI</td>
<td>5</td>
<td>6</td>
<td>Completed</td>
</tr>
<tr>
<td>027</td>
<td>TF after 72h</td>
<td>C. Arrest</td>
<td>9</td>
<td>11</td>
<td>Completed</td>
</tr>
<tr>
<td>028</td>
<td>TF w/in 72h</td>
<td>MI</td>
<td>6</td>
<td>11</td>
<td>Completed</td>
</tr>
<tr>
<td>029</td>
<td>TF w/in 72h</td>
<td>MI</td>
<td>7</td>
<td>9</td>
<td>Completed</td>
</tr>
<tr>
<td>030</td>
<td>TF w/in 72h</td>
<td>MI</td>
<td>4</td>
<td>11</td>
<td>Completed</td>
</tr>
<tr>
<td>031</td>
<td>TF w/in 72h</td>
<td>MI</td>
<td>5</td>
<td>8</td>
<td>Completed</td>
</tr>
<tr>
<td>032</td>
<td>TF w/in 72h</td>
<td>MI</td>
<td>2</td>
<td>9</td>
<td>Completed</td>
</tr>
<tr>
<td>033</td>
<td>TF w/in 72h</td>
<td>Other</td>
<td>7</td>
<td>8</td>
<td>Completed</td>
</tr>
<tr>
<td>034</td>
<td>TF w/in 72h</td>
<td>MI</td>
<td>3</td>
<td>3</td>
<td>Completed</td>
</tr>
<tr>
<td>035</td>
<td>TF w/in 72h</td>
<td>Resp. Fail</td>
<td>2</td>
<td>7</td>
<td>Completed</td>
</tr>
<tr>
<td>036</td>
<td>TF w/in 72h</td>
<td>C. Arrest</td>
<td>12</td>
<td>38</td>
<td>Expired</td>
</tr>
<tr>
<td>037</td>
<td>TF w/in 72h</td>
<td>MI</td>
<td>7</td>
<td>10</td>
<td>Expired</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Hours</td>
<td>Days</td>
<td>Status</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------</td>
<td>-------</td>
<td>------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td>038</td>
<td>TF after 72h</td>
<td>Other</td>
<td>20</td>
<td>21 Expired</td>
<td></td>
</tr>
<tr>
<td>039</td>
<td>TF after 72h</td>
<td>Other</td>
<td>18</td>
<td>18 LTAC Transfer</td>
<td></td>
</tr>
<tr>
<td>040</td>
<td>TF after 72h</td>
<td>MI</td>
<td>34</td>
<td>34 LTAC Transfer</td>
<td></td>
</tr>
<tr>
<td>041</td>
<td>TF w/in 72h</td>
<td>Other</td>
<td>4</td>
<td>4 Expired</td>
<td></td>
</tr>
<tr>
<td>042</td>
<td>No tube feed</td>
<td>C.Arrest</td>
<td>4</td>
<td>4 Expired</td>
<td></td>
</tr>
<tr>
<td>043</td>
<td>TF after 72h</td>
<td>MI</td>
<td>8</td>
<td>8 Expired</td>
<td></td>
</tr>
<tr>
<td>044</td>
<td>No tube feed</td>
<td>MI</td>
<td>6</td>
<td>6 Expired</td>
<td></td>
</tr>
<tr>
<td>045</td>
<td>TF after 72h</td>
<td>C.Arrest</td>
<td>17</td>
<td>17 LTAC Transfer</td>
<td></td>
</tr>
<tr>
<td>046</td>
<td>No tube feed</td>
<td>MI</td>
<td>60 hours</td>
<td>6 Extubated w/o TF</td>
<td></td>
</tr>
<tr>
<td>047</td>
<td>No tube feed</td>
<td>C.Arrest</td>
<td>57 hours</td>
<td>6 TF, Expired</td>
<td></td>
</tr>
<tr>
<td>048</td>
<td>No tube feed</td>
<td>MI</td>
<td>48 hours</td>
<td>4 Extubated w/o TF</td>
<td></td>
</tr>
<tr>
<td>049</td>
<td>No tube feed</td>
<td>MI</td>
<td>48 hours</td>
<td>6 Extubated w/o TF</td>
<td></td>
</tr>
<tr>
<td>050</td>
<td>No tube feed</td>
<td>Resp. Fail</td>
<td>48 hours</td>
<td>4 Extubated w/o TF</td>
<td></td>
</tr>
</tbody>
</table>