# Effectiveness of Using an Electromagnetic Tube Placement Device for Placement of Bedside Small Bowel Feeding Tubes in a Regional Burn Center

by

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ABSTRACT

Early and adequate nutritional support is crucial in the care of burn patients. There have been described in literature many different methods for and technology to aid in the placement of small bowel feeding tubes that are used to provide the needed enteral nutrition. The purpose of this study was to determine if using an electromagnetic tube placement device (ETPD) was an effective way to place blind (without aid of fluoroscopy and endoscopy) bedside small bowel feeding tubes in a regional burn center. After IRB approval, quality improvement (QI) data that had been collected on burn patients who required small bowel feeding tube placement at a regional burn center before (control) and after (trial) the implementation of using an ETPD device for placement of small bowel feeding tubes, July-December 2006 and all of 2007, were reviewed.

There were 55 patients with 148 feeding tube placements in the study, 36 feeding tube placements were in the pre-ETPD (control) group and 112 feeding tube placements were in the post-ETPD (trial) group. The age of the patients ranged from 20-78, the BMI's ranged from 15.82-51.96, and 16 patients had an inhalation injury. In the pre-ETPD (control group) there were 25 blind placements with a success rate of 24%. The 11 fluoroscopy placements with a success rate of 81.8% were significantly more successful ($p=0.002$) then the blind placement. In the post-ETPD (trial) group there were 40 blind placements with a success rate 22.5%. In the post-ETPD (trial) group the18 fluoroscopy placements with a success rate of 77.8% and 54 placements with the ETPD with a success rate of 85.2% were both significantly more successful than the blind placement method ($p=\leq 0.001$). Based on the results of this study, the use of an ETPD device was effective in aiding in the placement of bedside small bowel feeding tubes and can also help prevent the complication of lung misplacement.

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# Chapter I: Introduction

Clinical dietitians can attest to the direct impact of nutrition on patient health, both for the good and bad. Nutrition can have profound effects upon many medical conditions. Research has shown the importance of medical nutritional therapy in the care and treatment of patients with burns. A noticeable hypermetabolic response, hypercatabolism, and severe loss of lean body mass are all characteristics of a severe burn injury (Mochizuki et al., 1984). There is also impaired survival secondary to the ongoing deterioration of host defenses. Patients with burns must have adequate nutritional support, to meet the large nutritional needs necessary for wound healing and to mediate the enormous metabolic and stress responses associated with burn injury (Lee, Benjamin, & Herndon, 2005). Adequate nutritional support is also necessary to prevent weight and lean body mass losses, as these effects are associated with negative outcomes in patients with burns. Medical nutritional support therapy has been reported to have very favorable results and has been considered a crucial part of post burn treatment (Mochizuki et al., 1984).

Providing adequate nutritional support is essential in the care of patients with burns; however, there exists a debate of whether that nutritional support should be provided enterally or parenterally. There was a time when parenteral nutrition (PN) administered by way of the subclavian vein (Appendix A) was used more frequently than EN to provide nutritional support to burn patients. The more recent body of evidence suggests the use of enteral nutrition (EN) to provide nutritional support after burn injury. According to McDonald, Sharp, and Deitch (1991), in terms of safety, convenience, and cost, EN is preferred over PN after burn injury. PN may actually improve the patient's ability to manage a septic challenge and to avoid bacterial translocation by preserving the intestinal barrier function. Some of the other proposed benefits of EN are prevention of mucosal deterioration, better use of nutritional substrates, weakening of

the hypermetabolic response, and less glucose intolerance (Todd, Kozar, & Moore, 2006). It seems then, that EN may not only improve patient outcomes by providing needed nutritional support, but also has many other natural advantages over PN (McDonald et al., 1991). Enteral nutrition then appears to be preferable to PN and in circumstances where either EN or PN can be administered; EN should be started as it is a way of delivering nutritional support that is both safe and successful. The only time then EN would not be used and PN would need to be used instead, would be "if there was a significant contraindication to EN, such as an ileus, Ogilvie's syndrome, bowel obstruction, or ischemic enterocolitis" (Lee et al., 2005, p. 326).

Along with the body of evidence suggesting the use of EN vs. PN for the nutritional support of patients with burns, evidence also supports feeding patients with burns into the small intestine (Appendix B) rather than into the stomach (Appendix C) although the best route of feeding is still a manner of discussion. According to Mochizuki et al. (1984), there is dysfunction of the stomach and colon, but not the small bowel after traumatic injury and in the very early period after surgery. However, reports show unharmed motility and absorptive function of the small bowel. As cited by Mochizuki et al. (1984), McArdle and associates avoided enteral delivery into the stomach by using a feeding tube placed into the duodenum and fed patients an elemental formula beginning 48 hrs after the burn injury. These patients did not develop any symptoms of vomiting or gastric dilation. The patients with a feeding tube in the duodenum tolerated feedings at rates of 125-150 mL/hr and also had superior survival rates and exceptional nutritional preservation (Mochizuki et al., 1984). Therefore, placing a feeding tube in the duodenum avoids the gastric dysmotility that can be common after traumatic burn injuries. In these patients a small bowel feeding tube is more effective than a gastric placement because enteral nutritional support can be delivered earlier and at a higher volume.

It can be very challenging to place a blind bedside feeding tube successfully into the small bowel, especially past the duodenum and into the jejunum and do so in a way as to prevent any adverse complications and early enough to decrease the hypermetabolic response of burn injury. Placement of a blind bedside feeding tube is not a benign procedure. Blind placement into the lung can cause injury and complications. "Hydrothorax, mediastinitis, pleural effusion, empyema, pneumothorax, actelectasis, and pneumonia" are all disastrous complications that are associated with an improperly placed feeding tube into the lung (Roberts, Echeverria, & Gabriel, 2007, p. 412). Patients with decreased consciousness or cough reflex and those that are unhelpful during placement are at more risk of misplacement of a feeding tube during blind bedside feeding tube placement (Roberts et. al., 2007). The knowledge of healthcare personnel that are placing the feeding tubes can contribute greatly to the possibility of successful placement and the prevention of misplacements (Roberts et al., 2007).

Fluoroscopy and endoscopy are techniques that can be employed to place small bowel feeding tubes. These techniques can prevent misplacement into the lung and can help successfully place feeding tubes as medical personnel are able to visualize the tube as it passes into the small bowel. These techniques however require the transport of critically ill patients unless there is portable equipment available and specially trained physicians which might not be available at every healthcare institution (Cresci, 2002; Vanek, 2002). Fluoroscopy and endoscopy are also associated with variable results, from 85-95% success in small feeding tube placement (Cresci, 2002). There are also other techniques that can be used at the bedside to aid in the blind placement of small feeding tubes including ultrasound, and electromyogram and continuous stomach electrocardiogram both with erythromycin delivery (Cresi & Mellinger, 2006). These also have resulted in variable success in placement and require both specialized

equipment along with trained personnel. In addition to the above mentioned techniques, there are also various other techniques and devices that have been used to aide in the insertion of blind bedside feeding tube placement to help determine the location of the feeding tube tip and enhance the safety of blind bedside feeding tube placement (Roberts et. al., 2007). Many of these techniques and devices will be discussed further in the literature review.

This present study looked at the effectiveness of using an electromagnetic tube placement device (ETPD) for the placement of bedside small bowel feeding tubes in a regional burn center. There are methods to place small bowel feeding tubes that can help prevent the complications associated with lung placement such as fluoroscopy or endoscopy. These often require the transport of critically ill patients and the need for specially trained physicians. However, it is not always possible to transport critical burn patients, and initiation of enteral feeds is delayed. As a result, the present study sought a method to place blind bedside small bowel feeding tubes for the early delivery of enteral nutrition to patients in our regional burn center. The limited studies that have been done on use of an ETPD have been promising, showing increased success rates at placement compared to blind bedside small bowel feeding tubes, and the ETPD prevented tube misplacement into the lung (Roberts et al., 2007).

*Statement of the Problem*

The need for adequate nutritional support is critical in the care of burn patients. Research has shown that enteral nutrition is preferable to parenteral nutrition in providing needed nutritional support. Delivery of the enteral nutrition support into the small bowel avoids the gastric dysmotility that is common after burn injury. In order for a burn patient to receive enteral nutrition into the intestinal small bowel, access is needed to the small bowel with a feeding tube. It is difficult to place feeding tubes into the small bowel. Blind bedside placement (without aid of

an imaging technique) has varying degrees of success and can be associated with potential complications. Other techniques traditionally used for small bowel feeding tube placement have been evaluated for successful placement. However, fluoroscopy and other imaging techniques often require the transport of critically ill patients to distant areas of the hospital and have an increased cost associated with them for both the patient and the healthcare institution. If there was a device available that would allow easier access to the small bowel while avoiding the potential complications associated with blind bedside small bowel feeding tube placement and transport of critically ill patients, it would ultimately improve patient care, minimize complications, and decrease costs for both the patient and the medical facility.

*Purpose of the Study*

The purpose of this study was to determine the effectiveness of using an electromagnetic tube placement device (ETPD) to place blind bedside small bowel feeding tubes in a regional Burn Center. After IRB approval from both UW-Stout and the regional burn center, quality improvement (QI) data were collected on patients with burns who required small bowel feeding tube placement at a regional Burn Center. The data collected before (control) and after (trial) the implementation of using an ETPD device for placement of small bowel feeding tubes, July-December, 2006 and all of 2007, were compiled. The QI data were reviewed for rate of success of placements, number of x-rays to confirm placement, and trips to fluoroscopy as well as any potential complications associated with the blind bedside small bowel feeding tube placement. Hospital charts for burn patients that had feeding tube placements during this time were also reviewed for age, BMI, inhalation injury, and type of burn injury.

*Research Questions*

The five research questions this study attempted to answer were:

1. Will there be any associations between success of blind bedside small bowel feeding tube placement (both trail and control together) and BMI, age, and inhalation injury?

2. Will use of an electromagnetic tube placement device decrease complications associated with blind bedside small bowel feeding tube placement in a regional burn center?

3. Will use of an electromagnetic tube placement device decrease number of x-rays to confirm small bowel feeding tube placement in a regional burn center?

4. Will use of an electromagnetic tube placement device decrease transports to fluoroscopy for small bowel feeding tube placement in a regional burn center?

5. Will use of an electromagnetic tube placement device increase the number of successful blind bedside small bowel feeding tube placements in patients with burns in a regional burn center?

*Definition of Terms*

There are multiple terms that need to be defined for clarity of understanding. These are:

*Acalculous cholecystitis*. "Inflammation of the gallbladder that is not affected with, caused by, or associated with gallstones" (Merriam-Webster online dictionary, 2009).

*Aspiration pneumonia*. A pneumonia characterized by inflammation caused by aspirated food material, aspirated foreign body, or gastric contents in the lower respiratory tract or pulmonary aspiration of fluid" (Merriam-Webster online dictionary, 2009).

*Atelectasis*. "Collapse of the expanded lung" (Merriam-Webster online dictionary, 2009).

*Blind feeding tube placement*. The technique of placing a feeding tube at bedside without the use of any devices or technology to aid in the placement.

*Bowel obstruction*. "A condition when the bowel becomes clogged or blocked" (Merriam-Webster online dictionary, 2009).

*Burn*. "Injury or damage resulting from exposure to fire, caustics, electricity, or certain radiations" (Merriam-Webster online dictionary, 2009).

*Burn with explosion*. "Injury or damage resulting from exposure to fire, caustics, or certain radiations where there is also an explosion or a rapid or nuclear reaction with the production of noise, heat, and violent explosion of gases" (Merriam-Webster online dictionary, 2009).

*Electromagnetic tube placement device*. A device that allows tracking of the approximate location of a feeding tube during actual blind placement by viewing the tip of the feeding on a computer screen.

*Empyema*. "The presence of pus in a bodily cavity" (Merriam-Webster online dictionary, 2009).

*Endoscopy*. "An illuminated usually fiber-optic flexible or rigid tubular instrument for visualizing the interior of a hollow organ and part (as the bladder or esophagus) for diagnostic or therapeutic purposes that typically has one or more channels to enable passage" (Merriam-Webster online dictionary, 2009).

*Enteral feeding*. "Method of provision of nutrients into the gastrointestinal (GI) tract through a tube" (Shils et al., 2006, p. 1554).

*Fluoroscopy*. Fluoroscopy can be defined as

An instrument used chiefly in industry and in medical diagnosis for observing the internal structure of opaque objects (as the living body) by means of the shadow cast by the object examined upon a fluorescent screen when placed between the screen and a source of x-rays (Merriam-Webster online dictionary, 2009).

*Hypercatabolism.* "An excess of degradative metabolism involving the release of energy and resulting in the breakdown of complex materials (as proteins and lipids) within an organism" (Merriam-Webster online dictionary, 2009).

*Hypermetabolic response.* A condition where there is alteration in the cytokines and counterregulatory hormones that can occur after injury or infection that increases the metabolic rate and protein and fat breakdown (Shils et al., 2006).

*Hydrothorax.* "An excess of serous fluid in the pleural cavity" (Merriam-Webster online dictionary, 2009).

*Ileus.* "A condition that is commonly marked by a painful distended abdomen, vomiting of dark or fecal matter, toxemia, and dehydration and results when there is obstruction of the bowel when the intestinal contents back up because peristalsis fails although the lumen is not occluded" (Merriam-Webster online dictionary, 2009).

*Ischemic enterocolitis.* "Enteritis affecting both the large and small intestine that is caused by a deficient supply of blood to the intestine that is due to obstruction of the inflow of arterial blood" (Merriam-Webster online dictionary, 2009).

*Mediastinitis.* "Inflammation of the tissues of the mediastinum" (Merriam-Webster online dictionary, 2009).

*Necrotizing fasciitis.* "A severe soft tissue infection by bacteria (as Group A Streptococci) that is marked by edema and necrosis of subcutaneous tissues with involvement of

adjacent fascia and by painful red swollen skin over affected areas" (Merriam-Webster online dictionary, 2009).

*Ogilvie's syndrome.* "Distension of the colon that is similar to that occurring as a consequence of bowel obstruction, but in which no physical obstruction exists and that occurs especially in seriously ill individuals and as a complications of abdominal surgery" (Merriam-Webster online dictionary, 2009).

*Parenteral feeding.* Feeding nutrients directly into the bloodstream.

*Pleural effusion.* "An exudation of fluid from the blood or lymph into the pleural cavity" (Merriam-Webster online dictionary, 2009).

*Pneumothorax.* "A condition in which air or other gas present in the pleural cavity and which occurs spontaneously as a result of disease or injury of lung tissue, rupture of air-filled pulmonary cysts, or puncture of the chest wall or is induced as a therapeutic measure to collapse the lung" (Merriam-Webster online dictionary, 2009).

*Small bowel feeding tube.* A feeding tube that has been passed through the stomach and pylorus into the small intestine, either the duodenum or jejunum.

*Steven Johnson syndrome and toxic epidermal necrolysis (TENS)* "A skin disorder characterized by widespread erythema and the formation of flaccid bullae and later skin that is scalded in appearance and separates from the body in large sheets." It is typically called Steven Johnson Syndrome if less of the body is affected and TENS if a greater percentage of the body is affected (Merriam-Webster online dictionary, 2009).

*Systemic inflammatory response syndrome.* Systemic inflammatory response syndrome can be defined as

"A severe systemic response to a condition (as trauma, an infection, or a burn) that provokes an acute inflammatory reaction indicated by the presence of two or more of a group of symptoms including abnormally increased or decreased body temperature, heart rate greater than 90 beats/minute, respiratory rate greater than 20 breaths per minute or a reduced concentration of carbon dioxide in the arterial blood, and the white blood cell count greatly decreased or increased or consisting of more than ten percent immature neutrophils" ( Merriam-Webster online dictionary, 2009).

*Total body surface area.* Is an assessment measure of the total area of skin affected by burns.

*Xiphoid process.* "The third and lowest segment of the human sternum" (Merriam-Webster online dictionary, 2009).

*Assumptions and Limitations*

It was assumed that all the QI data were accurate. Accuracy will be discussed further in Chapter 3. Because the QI data were collected over a significant amount of time and by more than one health care professional, differences and inaccuracies in the data could have occurred. It was also assumed that all patients had the same ability for successful placement, meaning that no patients have altered GI anatomy or injury that would make it difficult to place a blind bedside feeding tube. As this information is unknown before and after the blind placement of a small bowel feeding tube, it also could be a limitation to the study. Finally, it was assumed that health care professionals trained to place the bedside feeding tubes both blind and using the electromagnetic tube placement device had the same ability to place feeding tubes. If there was a

difference in the ability to place bedside small bowel feeding tubes, these individual different abilities also could be a limitation to the study.

# Chapter II: Literature Review

## *Introduction*

Chapter 1 discussed topics that lead to the purpose of this study which was to investigate the effectiveness of using an electromagnetic tube placement device for bedside small bowel feeding tube placement in a regional burn center. This chapter will provide the background information that lead to this research and will discuss these topics in depth. Specifically this chapter will discuss a) the importance of nutrition in burn patients, b) enteral nutrition (EN) vs. parenteral nutrition (PN) in burn patients, c) gastric vs. small bowel enteral feedings in burn and intensive care patients, d) difficulties and complications of blind bedside small bowel feeding tube placement, e) different techniques and technologies to aid in bedside small feeding tube placement, and g) the use of an electromagnetic tube placement device for bedside small bowel feeding tube placement.

## *The Importance of Nutrition in Burn Patients*

The stress response to serious illness or severe injury is comparable to that of a burn injury. It is distinctive though, in that the severity of the injury can be much worse and that the healing can be more extended after a burn injury (Lee, Benjamin & Herndon, 2005). A positive systemic inflammatory response syndrome (SIRS) occurs after any traumatic injury (Todd, Kozar, &Moore, 2006). In injuries with overwhelming SIRS, like burn, immune system impairment and protein malnutrition result from the subsequent hypercatabolism. Muscle volume and visceral proteins are decreased if appropriate nutrition is not provided to burn patients (Gudaviciene, Rimdeika, & Adamonis, 2004). Subsequently, the patient with burns is unable to conserve the use of energy and unable to adjust to the existing condition.

According to Gudaviciene et al. (2004), the greatest disorder of body metabolism is caused by burn injury more so than all other traumas. "Energy expenditure can increase to almost twice normal as burn size exceeds 50% total body surface area (TBSA)" (Mochizuki, et al., 1984, p. 302). This noticeable hypermetabolic response is common in severely burned patients. Slowed wound healing, visceral protein loss, and weakened immune function can then result if there is a failure to meet these metabolic needs (McDonald et al., 1991). This could lead to multiple organ failure according to Lee et al. (2005). Even after the burn wound is closed or covered, there continues to be hypermetabolism and muscle protein catabolism (Lee et al., 2005).

> "For 6-9 months after a severe burn injury, protein breakdown continues and for 2 years after a severe burn injury there is almost a complete lack of bone growth. This not only results in long-term osteopenia in burn children, but also a linear growth delay for years after injury in severely burned children with a burn size of greater than 80%" (Lee et al. 2005, p. 325)

Thus, it is imperative to meet the nutritional needs of burn patients during the acute injury, but also during their post acute or rehabilitation time to avoid adverse consequences described below (Lee et al., 2005).

As reported by Lee et al. (2005), loss of lean body mass is inversely associated with survival rate in seriously ill patients. Weakened immune reaction and an increase in infection rate are also linked with protein energy insufficiency. According to Chiarelli et al. (1990), inhibition of the burn induced increase of catecholamine and glugagon secretions can lead to a better clinical course and helps to manage the hypercatabolic state. Management of the hypermetabolic state includes early enteral administration of nutrients to patients with burns.

Early enteral nutrition decreases hospitalization and complications and increases the survival likelihood (Gudaviciene, Rimdeika, & Adamonis, 2004).

*Enteral versus Parenteral Nutrition in Burn Patients*

Initially, it was perceived that EN was less costly, more convenient, and safer, thus EN was favored over PN in the early 1970's (Todd et al., 2006). However, EN was often not started early as it was thought that the gut did not function initially after traumatic insult. During this time it was also thought that in the first week after burn injury that the hemodynamic and cardiopulmonary features of burn care took precedence over attaining nutritional equilibrium (McDonald et al., 1991). In the late 1970's, in the intensive care units (ICU) central venous catheterization became a common procedure. Also because it had become more extensively available and safer, PN then became the standard of nutritional support (Todd et al., 2006). PN was then typically started after burn injury and EN delayed until gastrointestinal function was thought to be returned to normal or following the acute fluid recovery stage (McDonald et al., 1991). However, PN is not without its problems in comparison to EN. Some of the advantages of EN are detailed below.

In terms of cost, gut mucosal preservation, immune and metabolic function, and complications, EN is actually favored to PN based on latest evidence (Shikora & Ogawa, 1996). According to McDonald et al. (1991), parenterally fed animals have reductions in mucosal height, weight, enzymatic action, and mucosal protein and DNA of the intestines, thus making EN better in preserving gastrointestinal mass and function. PN does not appear to support the trophic outcome on intestinal function and morphology in comparison to enterally provided nutrients. The presence of exact intraluminal nutrients appears to be needed for the maintenance of mucosal integrity and mass, which explains why EN is more effective in preservation of gut

function. Mochizuki et al. (1984) maintains that there is reduction of mucosal integrity when there is absence of oral or enteral feeding. When EN is provided after burn injury the reduction in the intestinal mucosal integrity may be prevented. The improvement in mucosal integrity may also help with the prevention of translocation of gastrointestinal bacteria to blood and other organs, which has been shown to happen after severe burn injury.

According to Chiarelli et al. (1991), there is an improved medical course and management of the hypercatabolic condition for burned patients when there is early enteral administration of nutrients as the burn induced increase of catecholomine and glucagon secretions is avoided. Increased pancreatic stimulation and better gallbladder contraction leading to a decrease in the probability of gallstone formation and acalculous cholecystitis has been reported when EN is provided after burn injury (Shikora & Ogawa, 1996). It appears that EN should be used for providing nutritional support to burn patients, and that PN should only be used if there "is significant contraindication to EN, such as an ileus, Ogilvie's syndrome, bowel obstruction, or ischemic entercolits" (Lee et al., 2005, p. 326). However, the manner of providing EN could affect patient outcomes and is discussed below.

*Gastric versus Small Bowel Feedings*

Although the body of data supports the use of EN support over PN support in burn injury, there is still some controversy over the most optimal site for enteral delivery. The discussion revolves around whether to feed burn and trauma patients via their stomach or via their small intestine. According to Todd et al. (2006), during critical illness, after major trauma, and after surgery the stomach frequently develops an ileus unlike the small intestine. An initial gastric ileus can be caused by the inhibitory neuroendocrine reflexes and ischemia reperfusion injuries from the distressing event itself. The initial gastric ileus can progress further into an ongoing

ileus when other intensive care treatments are added like H2 antagonist, narcotics, and broad spectrum antibiotics which promote further gut dysfunction. According to the Canadian Critical Care Clinical Practice Guidelines Committee (cited in Todd et al., 2006), there was quick and successful delivery of nutrition in those patients fed via the small intestine, in 11 level two studies that compared EN via the small intestine with gastric EN. The committee also found that there was an important decrease in infectious complications when the patients were fed via the small intestine; however, there was no difference between the groups in mortality (Todd et al., 2006).

There is also a larger risk for bacterial colonization of the stomach and aspiration pneumonia related with early gastric feedings because of the more common elevated gastric residual volumes (Guidroz & Chaudhary, 2004). These increased gastric residual volumes can place patients at increased risk for gastroesophageal reflux which can lead to mucosal damage including erosions, ulcers, and erosive esophagitis. These complications associated with high gastric residual volumes common in gastrically fed critically ill patients, according to researchers can then ultimately lead to poor enteral nutrition support delivery and thus increased ICU complications and death or longer ICU stays (Tynan & Reed, 2008). Finally, it is advocated that high risk patients be fed through a small bowel placed feeding tube to lessen the risk for aspiration according to the consensus statement from the North American Summit on Aspiration in the Critically Ill Patient as cited in (Jimenez & Ramage, 2004). Some additional research to support feeding by the small bowl is discussed below.

McDonald et al. (1991) reported that most patients in their study were able to tolerate early gastric feedings; however, there were 13 patients that were unable to tolerate gastric feedings and those patients had larger burns and higher actual and predicted mortality. This data

indicated that those patients with larger burns who are in greater need of nutritional support may need small bowel enteral feeds as they are unable to tolerate gastric feeds to meet their large metabolic needs for wound healing. According to Lee et al. (2005), there can be a post burn ileus, but this ileus typically spares the small intestine and mainly influences the stomach. As early as 6 hours after burn injury enteral tube feeds can be delivered if given into the small intestine. Enteral tubes that are passed past the pylorus sphincter of stomach and even farther past the ligament of treitz of intestine allow start of enteral nutrition before total stomach function returns. Because of the above reasons it is argued that post pyloric or small bowel feeding tubes should be used for the delivery of nutritional support for burn patients to ensure early delivery and tolerance of enteral feeds and to ensure adequate nutritional support.

*Difficulties and Complications with Blind Bedside Feeding Tube Placement*

As mentioned in the introduction, fluoroscopy and endoscopy are both techniques that can be used to place small bowel feeding tubes. Fluoroscopy and endoscopy allow the visualization of the feeding tube as it passes through the body which can aide in successful small bowel placement and avoid misplacement into the lung. However, fluoroscopy and endoscopy carry with them an 85-95% success rate in obtaining postpyloric feeding tube placement, and if there is lack of portable equipment these methods require the transport of critically ill patients to the instruments (Cresci, 2002). Other methods and technologies that can be used to aid in the placement of bedside small bowel feeding tubes will be discussed later, however many of these methods do not avoid the complications that may arise as a result of blind bedside feeding tube placement. Some of the difficulties and challenges in blind bedside feeding tube placement are discussed below.

One difficulty that has become a factor with placing bedside small bowel feeding tubes is a matter of skill of personnel. Traditionally, trained registered nurses (RNs) frequently place the blind bedside feeding tubes. However, RN's can have enormous patient care accountabilities and challenging time constraints which may not allow the necessary time for proper bedside feeding tube placement. Nursing turnover and shortages can lead to RN's with less experience placing blind feeding tubes with less success (Tynan & Reed, 2008). As mentioned earlier it can be very time consuming and is not always successful to pass a feeding tube past the pylorus into the jejunum. Training and experience is a critical factor related to successful manual passage of a feeding tube into the small bowel (Guidroz & Chaudhary, 2004). For that reason, there has been a change in practice in some institutions to train the nutrition support dietitians to place the blind bedside small bowel feeding tubes or dedicate a team trained specifically for placement. Dietitians may have more time to devote to the placement and with practice may be more successful at blind bedside small bowel feeding tube placement. According to Jimenez and Ramage (2004), there was an 84% success rate for blind bedside placement of small bowel feeding tubes placed by a nutrition support dietitian. This success rate avoids inappropriate placement and the serious consequences of inappropriately placed tubes that are described below.

When wrongly positioned, small bore feeding tubes can cause little or no warning signs (Metheny & Meert, 2004). There can be potentially deadly consequences because of intrapulmonary aspiration when a feeding tube is wrongly placed into the trachea or bronchi. A decreased gag reflux or impaired swallowing as a result of injury increases the risk an endobronchial placement of a feeding tube (Pearce & Duncan, 2002). "Ventilated patients and those with changed level of consciousness or with neuromuscular irregularities are at increased

risk for tube misplacement which can cause pneumothorax, intrapleural infusion of enteral feedings, or esophageal perforation" (Pearce & Duncan, 2002, p. 202). According to Valentine and Turner (cited in Baskin, 2006), in a 28-month period in one hospital there were five cases of inadvertent transbronchial insertion of a feeding tube. Complications that arose from these misplacements included tension pneumothorax, pleural effusion, and pneumonia with pulmonary abscess. Also reported by McWey et al. (cited in Baskin, 2006), in 1100 patients in an 18 month period there were 14 feeding tube misplacements which resulted in complications such as pneumothorax, hydrothorax, empyema, mediastinitis, and esophageal perforation. Although these complications are uncommon, they can be potentially life threatening. Prompt removal of the feeding tube and implementation of measures to minimize those complications are crucial (Baskin, 2006). Various techniques used for blind bedside placement of feeding tubes and likelihood of incorrect placement are discussed below.

*Different Techniques and Technologies Used for Blind Bedside Placement*

Previous research indicates small bowel enteral feedings can best meet the increased nutritional needs of burn patients; however, placement of small bowel enteral tubes at the bedside can be technically difficult and may cause complications. The ultimate goals for placement of these small bowel feeding tubes are to do so with the least amount of morbidity or complications, quickly, effectively, and with the least amount of expense to both the patient and the healthcare facility (Cresci & Mellinger, 2006). To determine between lung, esophageal, gastric, or small bowel placement of blindly placed feeding tubes, there has been no certain nonradiographic technique (Metheny & Meert, 2004). The literature describes many different methods with variable success rates to help in placement of small bowel feeding tubes as well as different techniques to help determine the exact location of blindly placed feeding tubes.

Successful placement is beneficial in that unnecessary x-rays can be eliminated, which is especially important in critically ill patients (Metheny & Meert, 2004). The following is a review of these nonradiographic techniques.

*Signs of Respiratory Distress*. This a method used to determine between lung and gastric placement. The personnel placing the feeding tube looks for any signs of respiratory distress such as coughing that could alert them to misplacement of the feeding tube into the lung. This technique can be unreliable as it often fails to determine if a feeding tube has actually inadvertently been placed into the lung, especially in debilitated and unconscious patients (Methany & Meert, 2004).

*Measuring of pH*. This method is used to determine between both lung and gastric and between gastric and small bowl feeding tube placement. In this technique secretions or residuals are taken from the feeding tube and then pH levels are determined. The different areas in the gastrointestinal tract all have different pH levels thus allowing the determination of where the tip of the feeding tube is located (Metheny & Meert, 2004). This technique seems to be more useful in determining between gastric and small bowel feeding tube placement as gastric secretions typically have a much lower pH then small bowel secretions even with the use of H2 antagonists medication. It does not seem to be as effective in determining between gastric and respiratory placement as although it can be done, it can be difficult to get secretions from an actual lung placement to test pH. Esophageal placement can not be determined by pH testing.

*Carbon Dioxide ($CO_2$)*. Carbon dioxide is used to determine between gastric and lung placement. Once the $CO_2$ device is placed at the proximal end of a feeding tube, exposure of the membrane to $CO_2$ causes the device to change to yellow from purple indicating tracheal placement (Roberts, Echeverria, & Gabriel, 2007). Research has shown the effectiveness of

using the $CO_2$ device to determine between lung and gastric placement. The $CO_2$ detector is similar to capnography which when $CO_2$ is detected during the respiration cycle, it produces a waveform that is displayed on a screen (Robert et al, 2007). The $CO_2$ technique and capnography does not help to determine between gastric and small bowel feeding tube placement.

*Appearance of Fluid Withdrawn.* Appearance of fluid withdrawn is a method used to determine between both lung and gastric and between gastric and small bowel feeding tube placement. In this technique secretions or residuals are withdrawn from the feeding tube and the appearance and color is evaluated to determine the expected location of the feeding tube tip (Metheny & Meert, 2004). This method seems to work better when determining between gastric and small bowel feeding tube placement. Typically there is a range from light to dark yellow or brownish green for small bowel aspirates so they can be more easily differentiated from the clear, grassy green, light yellow or brown aspirates of the stomach. Again, it can be difficult to aspirate from a lung or esophageal placement and these secretions can resemble more closely gastric secretions making it more difficult to determine between gastric and respiratory placement. All the above can vary greatly depending on the expertise of the person determining the aspirate color (Metheny & Meert, 2004).

*Negative Pressure.* Negative pressure is a method used to determine between gastric and small bowel feeding tube placement. This method works on the premise that at least 40 mL of air can be aspirated when a tube is in the stomach and very little air, less than 10 mL can be aspirated when a feeding tube is in the small bowel (Metheny & Meert, 2004). There have been variable results when using this method and this method would not prevent the misplacement of the feeding tube initially into the lung.

*Spontaneous Migration.* Spontaneous migration is a method in which a feeding tube is passed into the stomach and allowed to spontaneously pass through the pylorus into the small bowel on its own without further manipulation of the feeding tube (Cresci & Mellinger, 2006). There have been adjuncts to this method to help the tube spontaneously pass into the small bowel including administration of a prokinetic agent and use of a weighted or non-weighted feeding tube tips. The results of this method alone or with the use of the weighted/non-weighted tubes or prokinetic agents have been quite variable in successful placement of feeding tubes into the small bowel. This method does not prevent the misplacement of a feeding tube into the lung and any of the associated complications with lung placement. X-ray confirmation of the feeding tube tip is necessary.

*Air-Insufflation and Auscultation.* In air-insufflation and auscultation post-pyloric placement is determined when auscultation is heard pre-dominantly in the right upper quadrant. The tube, which is initially confirmed via auscultation in the stomach after a large bolus of air is delivered, is advanced in small increments with air being delivered after each advancement (Cresci & Mellinger, 2006). There is continued auscultation of the abdomen throughout the procedure to follow the advancement of the tube. In the corkscrew method the same is true; however, after gastric placement is confirmed, the tube is advanced in a corkscrew-type turning motion advancing approximately 5 cm every 5 minutes (Jimenez & Ramage, 2004) . Water and air are administered after each advancement until the tube is thought to be in the small bowel. There was an 83% success rate using the air and auscultation method in the study done by Ugo, Mohler, and Wilson (cited in Cresci & Mellinger, 2006). Auscultation alone as well as observing for bubbles when the end of tube is held underwater do not seem to be reliable methods for determining feeding tube tip location (Metheny & Meert, 2004). It is especially important to be

very careful when using this method as the sounds can easily mimic gastric placement especially in pulmonary edema and pneumonia when the feeding tube is really in the left lower lobe of the lung (Pearce & Duncan, 2002). Again, this method does not prevent the misplacement of a feeding tube into the lung and any of the associated complications and placement of feeding tip must be confirmed by x-ray.

*Bending the Feeding Tube Stylet.* In this technique the feeding tube is initially passed into the stomach and placement is confirmed by auscultation, determining the pH, or direct vision of the tube passing into the esophagus (Zaloga, 1991). The wire stylet is taken out after the feeding tube is withdrawn to 30 cm. Then 3 cm from the distal tip, a 30 degree bend is placed in the wire stylet. A 60 mL syringe is attached at the end of the feeding tube after the now bent stylet is rethreaded into the feeding tube. Then the syringe is slowly rotated while the feeding tube is advanced slowly with the goal to pass the feeding tube past the pylorus. Zaloga (1991), had a 92% success rate for small bowel placement using this method. This method does not prevent the misplacement of a feeding tube into the lung and any of the associated complications with that, and x-ray confirmation of the feeding tube tip is required.

*Magnetic Guidance.* This insertion technique is used to guide the feeding tube from the stomach into the small bowel. There is a magnet field sensor and the feeding tube has a small magnet at its distal end (Roberts et al., 2007). At the tube's proximal end there is a light indicator that is connected to the sensor. Then using a handheld magnet the tube is guided and maneuvered from the stomach into the small bowel. The range of success using magnetic guidance for small bowel feeding tube placement is 60-88% (Roberts et al., 2007). However, if this technique is used, medical personnel are unable to use the medical procedure of magnetic resonance imaging (MRI) because the magnet on the feeding tube remains (Robert et al., 2007). Use of magnetic

guidance in patients with a Greenfield inferior vena cava filter placed in the preceding 2 weeks or on patients that have an implanted automatic defibrillator is contraindicated. The magnetic device can momentarily stop a pacemaker if the magnet is placed directly near the pacemaker. Again, this method does not prevent the misplacement of a feeding tube into the lung and any of the associated complications of lung placement and placement must be confirmed by x-ray. Thus, each of these nonradiographic techniques carries certain risks. A technique that allows a degree of visualization of placement will now be discussed.

*Use of an Electromagnetic Tube Placement Device for Small Bowel Feeding Tube Placement*

An electromagnetic tube placement device (ETPD) is a device that uses electro-magnetic technology to help prevent misplacement of a feeding tube into the lung as well as aid in the successful insertion of small bowel feeding tubes (Roberts et al., 2007) . The ETPD device consists of a feeding tube that has an electromagnetic transmitter at the stylet tip. A receiver is placed at the patient's xiphoid process that detects the signal from the stylet. The advancement of the feeding tube as it passes through the gastrointestinal tract is then presented on a computer monitor. When placing feeding tubes at bedside, there is an added protection factor when using the ETPD as personnel have the capability to watch the location of the feeding tube tip in actual time (Roberts et al., 2007). The clinician can immediately take corrective actions if the path strays from normal, because there is a predictable path that shows on the computer screen. The ETPD allows the image of the feeding tube through the pylorus into the small bowel via a path that shows on the computer screen, but the device does not supply a means to actually influence the tube through the pylorus.

Gray et al. (2007), had a 63% success rate in their control or blind group and 78% success rate at small bowel feeding tube placement using the ETPD in the study (trial) group,

which was not significant. Unlike the rest of the studies using the ETPD for feeding tube placement that are only found in literature in an abstract form, the Gray et al. study was published. Gray et al. looked at placement of small bowel feeding tubes using the ETPD in conjunction with registered dietitian/registered nurse teams in ICUs (Gray et al., 2007). Evaluation of the safety of placing feeding tubes in the ICU at bedside using an ETPD was the primary objective. Timeliness of feeding initiation, cost, and success rate were the secondary outcomes. These researchers found more timely initiation of enteral feeds and lower x-ray costs using the ETPD compared to blind placement.

According to Ackerman, Mick, Bianchi, Chiodo, and Yeager (2004), who studied the use of the ETPD in 25 critically ill patients requiring feeding tube placement, four patients appeared to have lung placement according to the ETPD monitor. Ackerman et al. (2004) found 100% success rate in avoiding lung placements as these four tubes were removed and reinserted, thus improving patient safety. Phang and colleagues demonstrated a 100% accuracy of the ETPD indicating feeding tube location in 25 critically ill patients (Phang, Marsh, & Prager, 2006). Stockdale and colleagues reviewed 483 feeding tube insertions that took place over an 11 month period prospectively using the ETPD (Stockdale, Nordbeck, Kadro, & Hale, 2007). They had an 89% success rate for small bowel placement and 4 bronchial placements that were aborted. They also found cost savings and a 66% reduction in overall time to place feeding tubes using the ETPD compared with blind placement (Stockdale et al., 2007). Finally, Kearns and Donna (2001) reported a 90% success in determining feeding tube tip location in their study where they compared 4 different techniques to confirm feeding tip location. The above mentioned studies are the only studies in full or abstract evaluating the use of an ETPD for feeding tube placement.

# Chapter III: Methodology

*Introduction*

Adequate enteral nutritional support is an important component in the medical treatment of burn patients. Although still being researched, it seems that enteral nutrition provided into the small bowel is better tolerated then gastric feedings, especially in patients with large burns. However placing small bowel feeding tubes blindly at the bedside is difficult and not without complications. If there was a device available that would allow easier access to the small bowel while avoiding the potential complications associated with bedside small bowel feeding tube placement and transport of critically ill patients as in fluoroscopy, this device would ultimately improve patient care, minimize complications, and decrease costs for both the patient and the institution. This chapter will review how the trial sample was selected, as well as a description of the sample and the instrument that was used to collect the data. In addition, data collection and data analysis procedures will be reviewed. This chapter will conclude with the methodological limitations of the study.

*Subject Selection and Description*

Initially our institution implemented the use of an electromagnetic tube placement device (ETPD) for assistance in small bowel feeding tube (SBFT) placement in the surgical intensive care unit. The use of the ETPD in the surgical unit showed much greater success in the placement of SBFT's. The decision was made that the institution would implement the use of the ETPD in the burn center and would determine the effectiveness of using this device to aide in bedside SBFT placements in patients with burns. The subjects for this study were all the patients in this regional burn center that had bedside SBFT's placed between July 2006 and December 2007. Quality improvement (QI) data had been collected on all burn patients that required SBFT

placement at this regional Burn Center before (control) and after the implementation of using an ETPD device for placement of SBFTs during this time period. After approval from the IRB board from both University of Wisconsin-Stout (Appendix D) and that of the institution, the QI data was reviewed for success of placement into the small bowel, number of x-rays to confirm feeding tube placement, number of trips to fluoroscopy for feeding tube placement, and if there were any complications associated with the feeding tube placement. Burn patients' charts that had feeding tube placements during this time were also reviewed for age, BMI, inhalation injury, and type of burn injury. Of note there continued to be blind bedside small bowel feeding tube placements after the use of the ETPD at times when the ETPD machine was being used elsewhere and when staff trained on the ETPD were not available.

*Instrumentation*

An original data abstraction tool was created to collect information from the quality improvement (QI) data and the medical charts. The tool used no patient identifiers and included BMI, inhalation injury, type of burn injury, if placement were blind without ETPD, utilized fluoroscopy, or blind with the ETPD, if placement was successful or unsuccessful, number of x-rays to confirm placement, and if there were any complications associated with the feeding tube placement. A copy of this data abstraction tool is located in Appendix E. As this was an original data abstraction tool, there was no reliability or validity associated with the tool.

*Data Collection Procedures*

After IRB approval from both UW-Stout and the healthcare institution, the QI data that had been collected was reviewed for the type of placement (blind with no ETPD, utilized fluoroscopy, or blind with the ETPD), if the feeding tube was placed successfully into the small bowel or not, the number of x-rays to confirm placement, and if there were any complications

associated with feeding tube placement. The patient's charts were then also reviewed for age, BMI, type of burn injury, and if there was inhalation injury. All data were entered into the data abstraction tool without any patient identifiers. There was very careful attention to ensure that there was no documentation of any patient identifiers through out this process. The completed data abstraction tool was reviewed to see that the tool was without any errors and without any patient identifiers. Then the data were sent to the healthcare institution's Statistical Services Department who completed the statistical analysis described below.

*Data Analysis*

Data analysis was completed by the healthcare institution's Statistical Service Department. The descriptive analysis of variables included the use of frequency distributions, computed means, standard deviations, and proportions. Bivariate associations were assessed with contingency tables, Pearson's chi-square test, and Fisher's exact test. All statistical tests were 2-sided and hypotheses were evaluated at the 5% significance level. Alpha levels were not adjusted for testing of multiple dependent variables. Each placement was treated as an independent event. Analyses were conducted with SAS version 9.1 (SAS Institute Inc., Cary, North Carolina).

*Limitations*

A limitation of the study was that the data extraction instrument had no measure of validity or reliability. Another limitation to the study in regards to the data collection and analysis was that the QI data had been collected over a significant amount of time and by different people. This made it difficult to collect all the necessary data. Placements for which data were missing were not included in the study. Chart reviews for specific information can be tedious; similarly finding all the necessary information for the QI data was often difficult.

Because all the original data had been collected at different times and by different persons, there could be discrepancies in how the QI data were recorded or interpreted for original data entry.

# Chapter IV: Results

*Introduction*

The purpose of this study was to determine the effectiveness of an electromagnetic tube placement device (ETPD) to place blind bedside small bowel feeding tubes in a regional burn center. After IRB approval, quality improvement (QI) data that had been collected on burn patients who required small bowel feeding tube placement at a regional burn center before (control) and after (trial) the implementation of using an ETPD device for placement of small bowel feeding tubes, July-December 2006 and all of 2007, were reviewed. The QI data were reviewed for rate of success of placements, number of x-rays to confirm placement, trips to fluoroscopy, and any potential complications associated with the blind bedside small bowel feeding tube placements. Hospital charts for burn patients that had feeding tube placements during this time were also reviewed for age, BMI, inhalation injury, and type of burn injury. This chapter will present the results of this study that includes age at time of placement, BMI at time of placement, types of burn injury, number of inhalation injuries, and total placements. The chapter will conclude with the research questions under investigation.

*Item Analysis from the Data Abstraction Tool*

Data from 55 patients with 148 feeding tube placements were included in the study. The age of the patients in the study ranged from 20 to 78 years of age. The ages most frequently needing a feeding tube placement were 26, 49, 50, 61, and 63 years, with 11, 10, 9, 8, and 8 tube placements, respectively. Table 1 presents the frequencies of the ages. Fifty seven percent of the total placements were in patients 50 years of age or younger.

Table 1

*Ages of the Patients at time of Feeding Tube Placement*

| Age | Frequency | Percent | Frequency | Percent |
|---|---|---|---|---|
| 20 | 5 | 3.38 | 5 | 3.38 |
| 22 | 2 | 1.35 | 7 | 4.73 |
| 23 | 6 | 4.05 | 13 | 8.78 |
| 24 | 3 | 2.03 | 16 | 10.81 |
| 25 | 5 | 3.38 | 21 | 14.19 |
| 26 | 11 | 7.43 | 32 | 21.62 |
| 27 | 7 | 4.73 | 39 | 26.35 |
| 29 | 2 | 1.35 | 41 | 27.70 |
| 31 | 3 | 2.03 | 44 | 29.73 |
| 36 | 2 | 1.35 | 46 | 31.08 |
| 37 | 1 | 0.68 | 47 | 31.76 |
| 38 | 3 | 2.03 | 50 | 33.78 |
| 42 | 6 | 4.05 | 56 | 37.84 |
| 45 | 7 | 4.73 | 63 | 42.57 |
| 47 | 3 | 2.03 | 66 | 44.59 |
| 49 | 10 | 6.76 | 76 | 51.35 |
| 50 | 9 | 6.08 | 85 | 57.43 |
| 53 | 6 | 4.05 | 91 | 61.49 |
| 54 | 5 | 3.38 | 96 | 64.86 |
| 56 | 1 | 0.68 | 97 | 65.54 |
| 57 | 3 | 2.03 | 100 | 67.57 |
| 58 | 2 | 1.35 | 102 | 68.92 |
| 60 | 7 | 4.73 | 109 | 73.65 |
| 61 | 8 | 5.41 | 117 | 79.05 |
| 62 | 1 | 0.68 | 118 | 79.73 |
| 63 | 8 | 5.41 | 126 | 85.14 |
| 66 | 3 | 2.03 | 129 | 87.16 |
| 68 | 3 | 2.03 | 132 | 89.19 |
| 70 | 7 | 4.73 | 139 | 93.92 |
| 71 | 2 | 1.35 | 141 | 95.27 |
| 73 | 4 | 2.70 | 145 | 97.97 |
| 75 | 1 | 0.68 | 146 | 98.65 |
| 78 | 2 | 1.35 | 148 | 100.00 |

The BMI of the patients in the study ranged from 15.82-51.96 kg/m$^2$. See Figure 1. Sixty percent of patients had a BMI of less then 28 kg/m$^2$. The number of patients with BMI of 15-

19.9, 20-24.9, 25-29.9, 30-34.9, 35-39.9, 40-44.9, and 45 kg/m$^2$ and over were 4, 13, 19, 10, 3, 5 and 1, respectively.

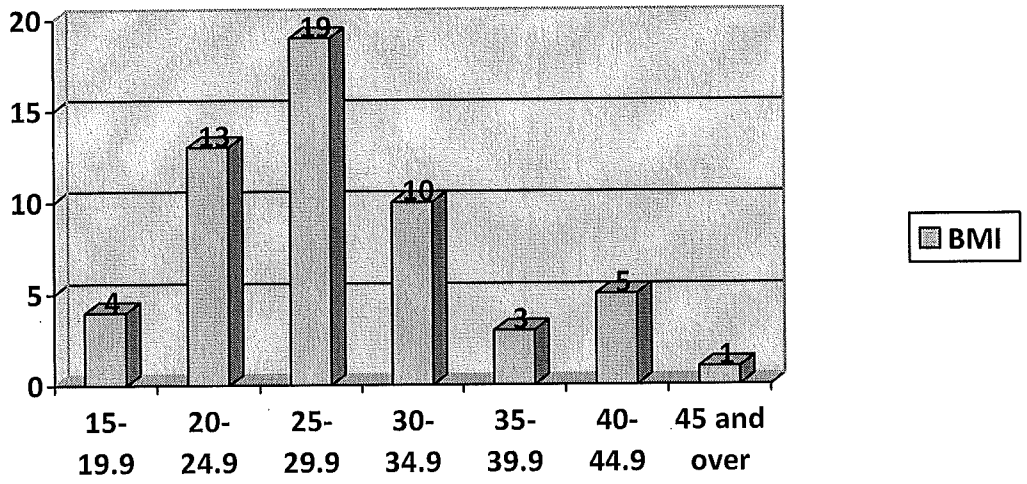


Figure 1: BMI of patients in the study at time of feeding tube placement

There were 5 types of injury that were documented in this study. They were Burn = B, Burn with Explosion = B/E, Frostbite = FB, Necrotizing Fasciitis = NF, and Steven Johnson Syndrome and TENS (SJ/TE). See Figure 2. Some 69% of the patients in the study had a burn injury (B). Of the 55 patients in the study, the numbers associated with each type of injury were 38, 2, 1, 8, and 6 for burn, burn explosion, frostbite, necrotizing fasciitis, and Steven Johnson Syndrome/TENS, respectively. Figure 2 shows percentage of patients with each type of injury.

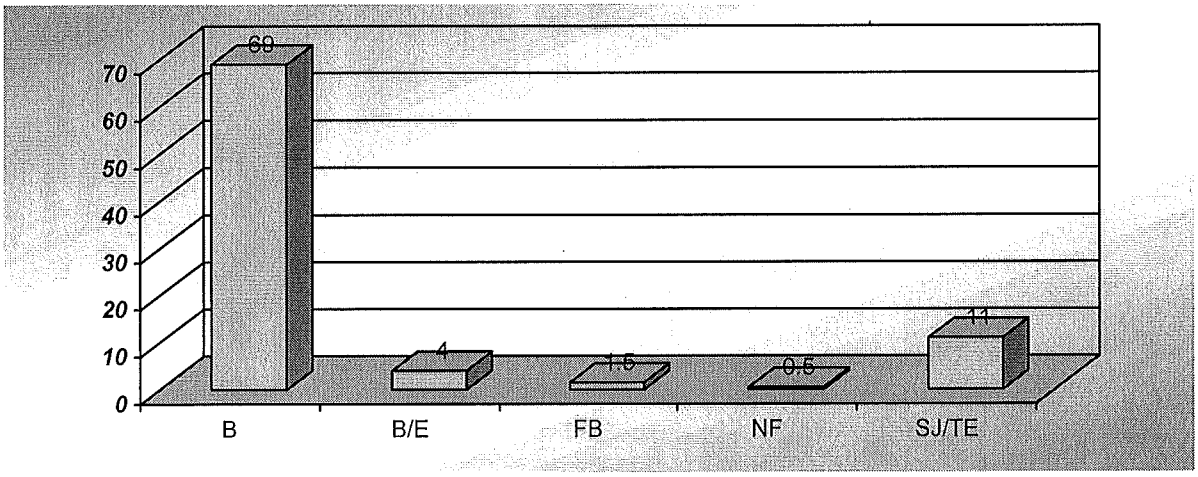


Figure 2: Type of burn injury in percent

There were 16 patients in the study that had an inhalation injury. See Table 2. Feeding tubes placed in patients with inhalation injury represented 31% of the total sample, thus 69% of the feeding tubes were placed in patients in the study that did not have an inhalation injury.

Table 2

*Frequency of Inhalation Injury in Patients in the Study*

| Injury | Frequency | Percent | Cumulative Frequency | Cumulative Percent |
|---|---|---|---|---|
| Inhalation | 46 | 31.08 | 148 | 100.00 |
| Non-inhalation | 102 | 68.92 | 102 | 68.92 |

There were 36 total feeding tube placements in the Control Group. Of those 25 (69%) were blind without use of ETPD and 11 (31%) were placed in fluoroscopy. See Table 3. During the study period although the ETPD was implemented for use, RN's also still placed small bowel feeding tubes without use of the ETPD as they were not trained or the ETPD was unavailable for use. So in the trial group there were 112 total placements. Of those, 40 (36%) were blind without the use of ETPD, 54 (48%) were with the use of the ETPD, and 18 (16%) were placed by fluoroscopy.

Table 3

*Total Placements of Small Bowel Feeding Tubes Using Three Methods in Control and Trial Groups*

| | Blind | ETPD | Fluoroscopy | Total |
|---|---|---|---|---|
| Control | 25 (69.44%) | 0 (0%) | 11 (30.56%) | 36 |
| Trial | 40 (35.71%) | 54 (48.21%) | 18 (16.07%) | 112 |
| Total | 65 (43.92%) | 54 (36.49%) | 29 (19.59%) | 148 |

*Research Questions*

*Research Question #1: Will there be associations between success of blind beside small bowel feeding tube placement (both trial and control together) and BMI, age, and inhalation injury?*

For analysis patient BMIs were divided into BMIs less than 28 $kg/m^2$ and BMIs greater than 28 $kg/m^2$. BMI did not have a significant association with success of placement of small bowel feeding tube as analyzed by Chi-squared (p=0.47). See Table 4.

Table 4

*BMI and Success Rates for Bedside Small Bowel Feeding Tube Placement*

| BMI | Unsuccessful Placements | Successful Placements | Total | p=0.47 |
|---|---|---|---|---|
| <28 | 32 (40.5%) | 47 (59.5%) | 79 | |
| >28 | 32 (46.4%) | 37 (53.6%) | 69 | |
| Total | 64 | 84 | 148 | |

Age had a significant association with success as analyzed by Mantel-Haenszel Chi-squared (p=.035). See Table 5. Patients in the age bracket of 20-40 had a much greater success of bedside small bowel placement compared to those in the 41-60 and 61-78 age brackets.

Table 5

*Age and Success Rates for Bedside Small Bowel Feeding Tube Placement*

| Ages | Unsuccessful Placement | Successful Placements | Total | p=0.035 |
|---|---|---|---|---|
| 20-40 | 16 (32%) | 34 (68%) | 50 | |
| 41-60 | 27 (45.8%) | 32 (54.2%) | 59 | |
| 61-78 | 21 (53.9%) | 18 (46.2%) | 39 | |
| Total | 64 | 84 | 148 | |

In addition to age, inhalation injury also had a significant association with success as analyzed Chi-squared (p=0.03). See Table 6. There was greater success of placement of feeding tube at the bedside of patients with inhalation injury than in patients who had no inhalation injury.

Table 6

*Inhalation Injury and Success Rates for Small Bowel Feeding Tube Placement*

| Inhalation Injury | Unsuccessful Placement | Successful Placement | Total | p=0.03 |
|---|---|---|---|---|
| Non-Inhalation Injury | 50 (49.0%) | 52 (51.0%) | 102 | |
| Inhalation Injury | 14 (30.4%) | 32 (69.6%) | 46 | |
| Total | 64 | 84 | 148 | |

*Research Question #2: Will use of an electromagnetic tube placement device decrease complications associated with blind bedside small bowel feeding tube placement in a regional burn center?* There were no reported complications documented in either the control or the trial groups.

*Research Question #3: Will use of an electromagnetic tube placement device decrease number of x-rays to confirm small bowel feeding tube placement in a regional burn center?*

The mean number of x-rays for the control group was 0.92. See Table 7. There were a total of 36 x-rays in the blind and fluoroscopy (control) groups. The mean number of x-rays for the trial group for non-ETPD was 0.98 and for ETPD was 1.09. See Table 8. The mean number of x-rays for the trial group, No-ETPD vs ETPD was analyzed for significance and it was found that the differences were not statistically significant by any parametric test (t-test-p=0.35), non-parametric test (Wilcoxon rank sum test-p=0.23), or by Poisson regression (p=0.37).

Table 7

*Mean Number of X-rays for Control Group*

| Variable | N | Mean | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Blind & Fluoroscopy | 36 | 0.91 | 0.7319 | 0 | 2.00 |

Note that in the control group (blind and fluoroscopy), placements which have no or zero x-rays attached to them were included in the analysis, which lowered the mean number of x-rays .

Table 8

*Mean number of X-rays for Trial Group Separated into Non-ETPD and ETPD*

| Variable | N | Mean | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| No-ETPD (Blind & Fluoroscopy) | 58 | 0.98 | 0.826 | 0 | 3.00 |
| ETPD | 54 | 0.29 | 0.2925 | 1.00 | 2.00 |

Note that in the trial group-no-ETPD (Blind and Fluoroscopy) and ETPD, placements which have no or zero x-rays attached to them were included in the analysis, which lowered the mean number of x-rays for these groups.

*Research Question #4: Will use of an electromagnetic tube placement device decrease trips to fluoroscopy for small bowel feeding tube placement in a regional burn center?*

There were 11(30.6%) fluoroscopy placements in the control group out of 36 total placements and 18 (16.1%) fluoroscopy placements in the trial group out of 112 total placements. See Table 9 and Figure 3. The less number of trips to fluoroscopy tended to be significantly lower for the trial group as compared to the control group (p=0.0568) as analyzed by Chi-squared.

Table 9

*Trips to Fluoroscopy for Trial and Control Group*

| | No Fluoroscopy | Fluoroscopy | Total | p=0.0568 |
|---|---|---|---|---|
| Control Group | 25 (69.4%) | 11 (30.6%) | 36 | |
| Trial Group | 94 (83.9%) | 18 (16.1%) | 112 | |
| Total | 119 | 29 | 148 | |

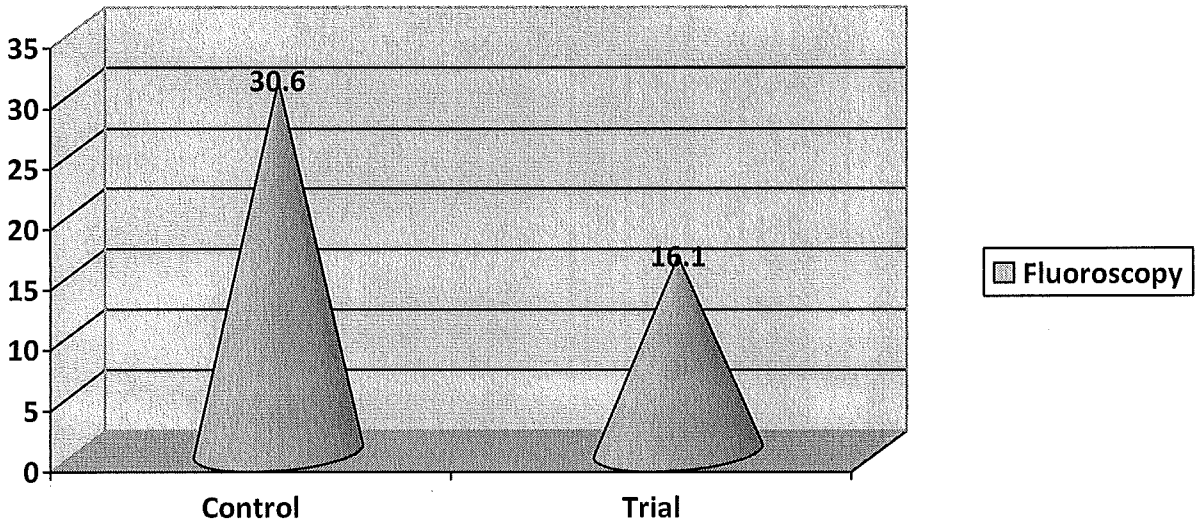


Figure 3: Percentage of trips to fluoroscopy for control and trial groups (n = 36 and 112)

*Research Question #5: Will use of an electromagnetic tube placement device increase the number of successful blind bedside small bowel feeding tube placements in a regional burn center?*

In the control group there were 36 total small bowel feeding tube placements. Twenty-five were blind placements with out use of ETPD; of these six (24%) were successful and 19 were unsuccessful. Of the 11 small bowel feeding tube placements in fluoroscopy, nine (81.8%) were successful and two were unsuccessful. See Table 10. Two-sided probability analysis indicates a significance (p=0.002), in that the fluoroscopy placement method showed a higher number of successful placements than the blind method.

Table 10

*Success Rates for Feeding Tube Placement in Control Group for the Two Methods*

| Type of Placement | Unsuccessful | Successful | Total Placements | p=0.0024 |
|---|---|---|---|---|
| Blind | 19 (76%) | 6 (24%) | 25 | |
| Fluoroscopy | 2 (18.2%) | 9 (81.8%) | 11 | |
| Total | 21 | 15 | 36 | |

In the trial group there were 112 total placements. As explained earlier, although there was implementation of the ETPD in the trial group, there continued to be blind placements with out the use of the ETPD. Forty were blind placements with out the use of the ETPD. See Table 11. Nine (22.5%) of these blind small bowel feeding tube placements were successful and 31 (77.5%) of the blind placements were unsuccessful. Fifty-four feeding tubes were placed with the ETPD device; 46 (85.2%) were successful small bowel feeding tube placements and eight were unsuccessful. Eighteen were placed in fluoroscopy. There were 14 (77.8%) successful fluoroscopy small bowel feeding tube placements and four were unsuccessful. Chi squared analysis indicates a significance ($p=<0.0001$) in that ETPD placement method and fluoroscopy method showed a higher number of successful placements than the blind method. If the blind group were excluded from the analysis, there was no significant difference in success rates for ETPD and fluoroscopy ($p=.48$). Figure 4 reviews the success rates for the different methods of feeding tube placement in both the control (Blind no ETPD and Fluoroscopy) and trial groups (Blind no ETPD, Fluoroscopy, and with ETPD). The significance of these findings will be discussed in Chapter 5.

Table 11

*Success Rates for Feeding Tube Placement in Trial Group for the Three Methods*

| Type of Placement | Unsuccessful | Successful | Total Placements | p=<0.001 |
|---|---|---|---|---|
| Blind | 31 (77.5%) | 9 (22.5%) | 40 | |
| With ETPD | 8 (14.8%) | 46 (85.2%) | 54 | |
| Fluoroscopy | 4 (22.2%) | 14 (77.8%) | 18 | |
| Total | 43 | 69 | 112 | |

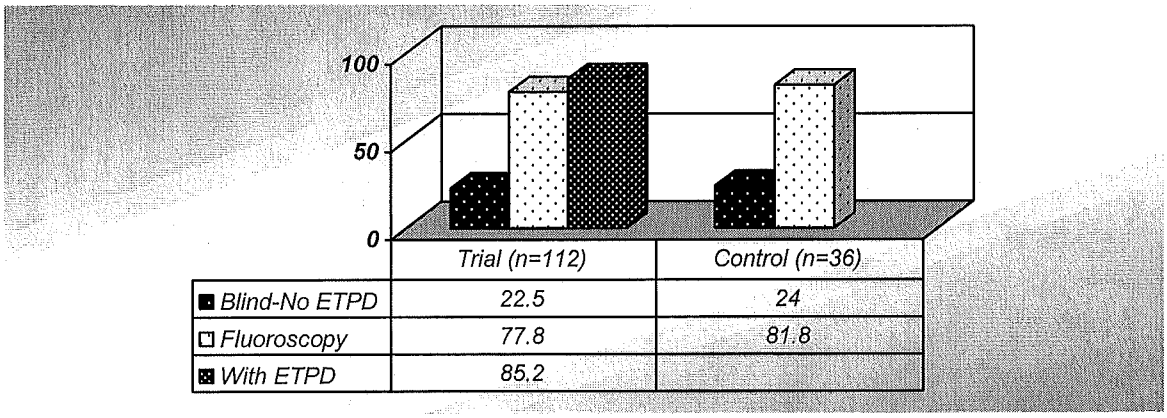


Figure 4: Percentage of success rates for feeding tube placement for the different methods in both the trial and control groups

# Chapter V: Discussion

*Introduction*

The body of this thesis has reviewed the following: the importance of nutritional support in the care of burn patients, the benefits of enteral vs parenteral nutrition support as well as small bowel feeding versus gastric feeding, the difficulties and complications associated with blind bedside small bowel feeding tube placement, the different techniques to aid in blind bedside small bowel feeding tube placement, and the use of an electromagnetic tube placement device in placement of blind bedside small bowel feeding tube placement.

The purpose of this study was to determine the effectiveness of an electromagnetic tube placement device (ETPD) to place blind bedside small bowel feeding tubes in a regional burn center. After IRB approval, quality improvement (QI) data that had been collected on burn patients who required small bowel feeding tube placement at a regional burn center before (control) and after (trial) the implementation of using an ETPD device for placement of small bowel feeding tubes, July-December 2006 and all of 2007, were reviewed. The QI data were reviewed for rate of success of placements, number of x-rays to confirm placement, trips to fluoroscopy, and any potential complications associated with the blind bedside small bowel feeding tube placement. Hospital charts for burn patients that had feeding tube placements during this time were also reviewed for age, BMI, inhalation injury, and type of burn injury. This chapter will include a discussion that will compare the trial results of this study to the control and to evidence from literature. The chapter will also include conclusions of the study and recommendations for further study.

*Discussion*

Nutritional support is a crucial component in the care of burn center patients. There tends to be agreement that enteral nutritional support is preferable to parenteral nutritional support and although there remains discussion, small bowel enteral delivery seems to be preferable to gastric feedings if small bowel feeding tube placement can be completed successfully, especially in the case of large burns. Blind bedside small bowel feeding tube placement can be difficult and if misplacement of the feeding tube occurs there can be harmful complications. Because of this, there have been many different techniques and different technologies created to aid in the placement of bedside small bowel feeding tubes. Many of these different techniques and technologies were reviewed in Chapter 2. These methods all have different success rates for small bowel feeding tube placement and at preventing associated complications that can occur during blind bedside feeding tube placement. The goal of our regional burn center was to determine if there was technology available that could help to increase the success rate of blind bedside small bowel feeding tube placements, so we could avoid transport of critically ill burn patients to fluoroscopy. In addition would the technology also help the regional burn center to avoid any complications associated with blind bedside small bowel feeding tube placement. Some of the techniques that were described in Chapter 2 had been employed at the burn center in the past with variable success.

Although there was limited study data available on the use of an electromagnetic tube placement device for feeding tube placement, what was available showed good success for bedside small bowel feeding tube placement and at preventing misplacement of the feeding tube during placement, thus decreasing the chance for complications. To compare our study findings with the studies documented in Chapter 2 our success rate for blind bedside small bowel

placement without the use of the electromagnetic tube placement device should be examined. Chapter 2 discussed how success for small bowel placement blindly can be very difficult. The results of our study showed a 24% success rate for blind placement without ETPD in the control group and a 22.5% success rate for blind placement with out ETPD in the trial group. This would then show at least at our institution that blind placement into the small bowel with out the aid of this device is very difficult to achieve with success.

Gray et al. (2007), had a 63% success rate for blind bedside small bowel placement without use of an ETPD. Although the Gray success rate was low, our burn unit success rate with the blind placement was lower (24% control and 22.5% trial). The present study showed very good results for small bowel feeding tube placement using the ETPD with an 85.2% success rate. This was slightly higher than results from Gray et al. (2007) who had a 78% success rate for small bowel feeding tube placement using the ETPD device and similar to Stockdale et al. (2007) who had a 89% success rate for small bowel feeding tube placement using the ETPD. Gray et al. (2007) showed decreased x-rays and thus decreased cost in the ETPD group. However, this present study did not show a difference in x-rays between the blind group without ETPD and the ETPD groups as x-rays were limited in all groups. Finally, many of the studies cited in Chapter 2 showed that the ETPD was able to prevent misplacement of the feeding tube into the lung. There was no complications documented in either group in the present study. However, our records did not indicate that there had been placements in the ETPD group where the tube was shown to go into the lung and then was removed which would have indicated that the lungs had been avoided because of visualization of the tube using the ETPD.

*Conclusions*

Based on the results of the study, the use of an electromagnetic tube placement device was effective in the placement of bedside small bowel feeding tubes in our regional burn center. There was a much greater success rate in small bowel feeding tube placement using the ETPD (85.2%) compared with blind placement in both the control (24%) and the trial (22.5%) groups. ETPD placement also proved to have a better success when compared to fluoroscopy in both in the control group (81.8%) and the trial group (77.8%). Using the ETPD device did not show a difference in the number of x-rays needed to confirm placement. However, although not statistically significant, there was less usage of fluoroscopy in the trial group (16%) compared to the control group (33%). This decrease in fluoroscopy would also be associated with a decreased cost to the healthcare institution as fluoroscopy placement is more costly when compared to blind placement. There were no complications documented in either of the groups, however, there was no record of any adverted lung placements in the ETPD group. The success rate of ETPD placements was higher in (20-40 year olds). Although an ETPD device is costly, because ETPD has proved to greatly improve success for small bowel feeding tube placement and prevents misplacement of feeding tubes, it is the center's opinion that it is worth the cost for the improvement in patient care. Also, the cost of the ETPD device could be recouped quickly if the ETPD method replaced the fluoroscopy currently being used for feeding tube placement, as fluoroscopy is quite costly. Thus a reduction in fluoroscopy cost could greatly reduce total costs.

*Recommendations*

Although there has been studies done looking at use of the ETPD for small bowel feeding tube placement, many have only been published in abstract form. In order for the profession to reliably prove that the ETPD can significantly improve the success of small bowel feeding tube

placement and avoid complications associated with misplacement of feeding tubes there has to be published research demonstrating these results. If this study were repeated, in addition to including this same data, additional data could be collected on why patients had to go to fluoroscopy as well as determining the number of lung placements that were adverted using the ETPD. Another recommendation is that one person would be designated to collect the data to avoid any inaccuracies. An additional recommendation would be to be insure that the ETPD instruments were available for all placements and that there were enough trained personnel so no blind placement without the ETPD occurred in the study group. Finally, documenting any gastrointestinal anatomy difficulties that would make the small bowel feeding tube placement unsuccessful would be useful. However, because we have used the ETPD and proved the success at our institution, it would be unethical to discontinue the ETPD for placement. Therefore other healthcare institutions that employ other methods for feeding tube placement would have to complete further studies.

Recommendations for other healthcare institutions currently utilizing other methods for blind bedside small bowel feeding tube placement would be to evaluate the use of the ETPD device to aid in bedside small bowel feeding tube placement. Past research has shown increased success of small bowel feeding tube placement with ETPD compared to both blind and fluoroscopy placement as well as adverted possible misplacement of the feeding tube into the lung. Conducting studies using this device would be more helpful to the profession if the data were collected for publication and for conference presentation so as to continue to show the reliability of using the ETPD device in a variety of facilities for bedside small bowel feeding tube placement.

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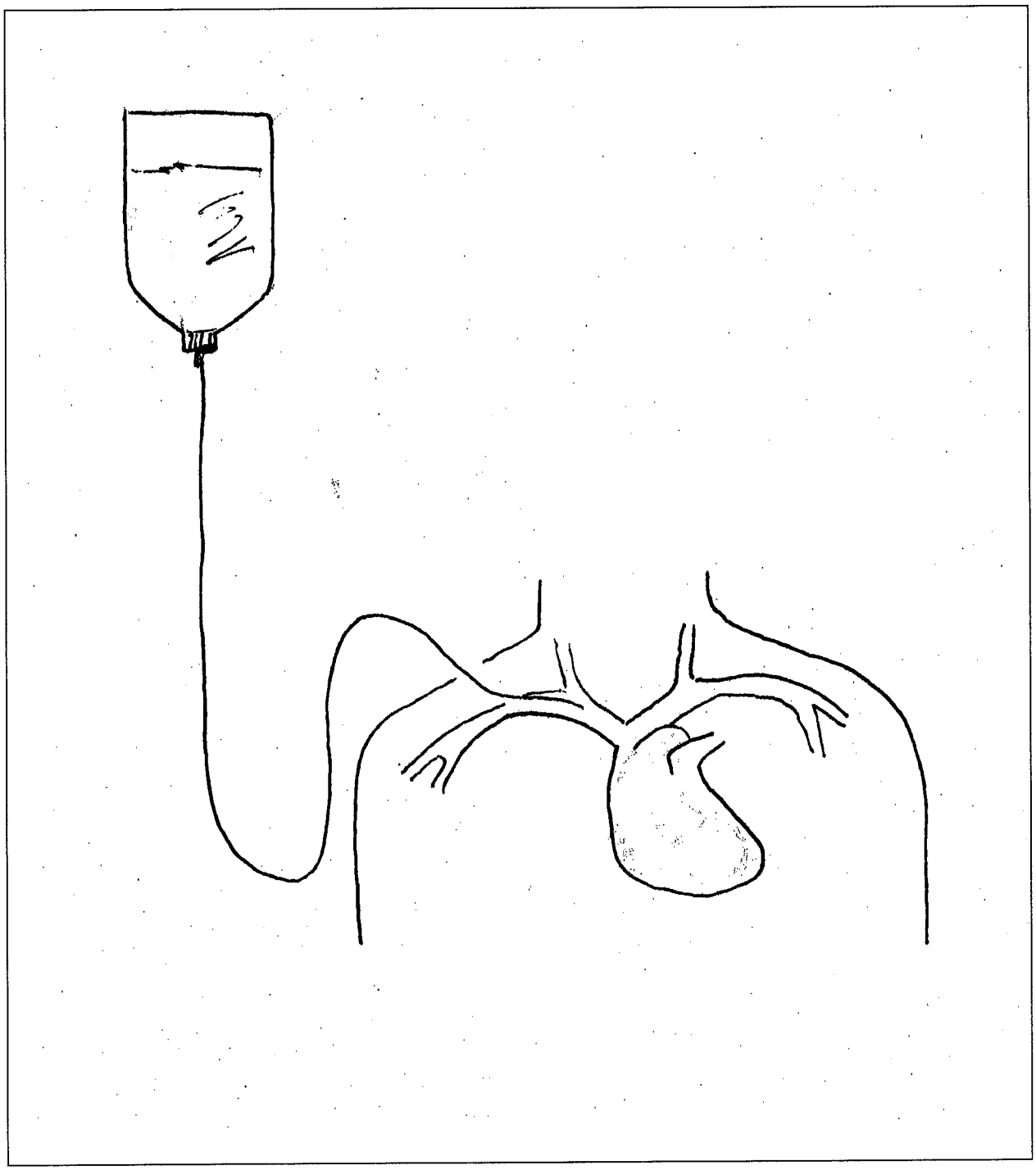
# APPENDIX A

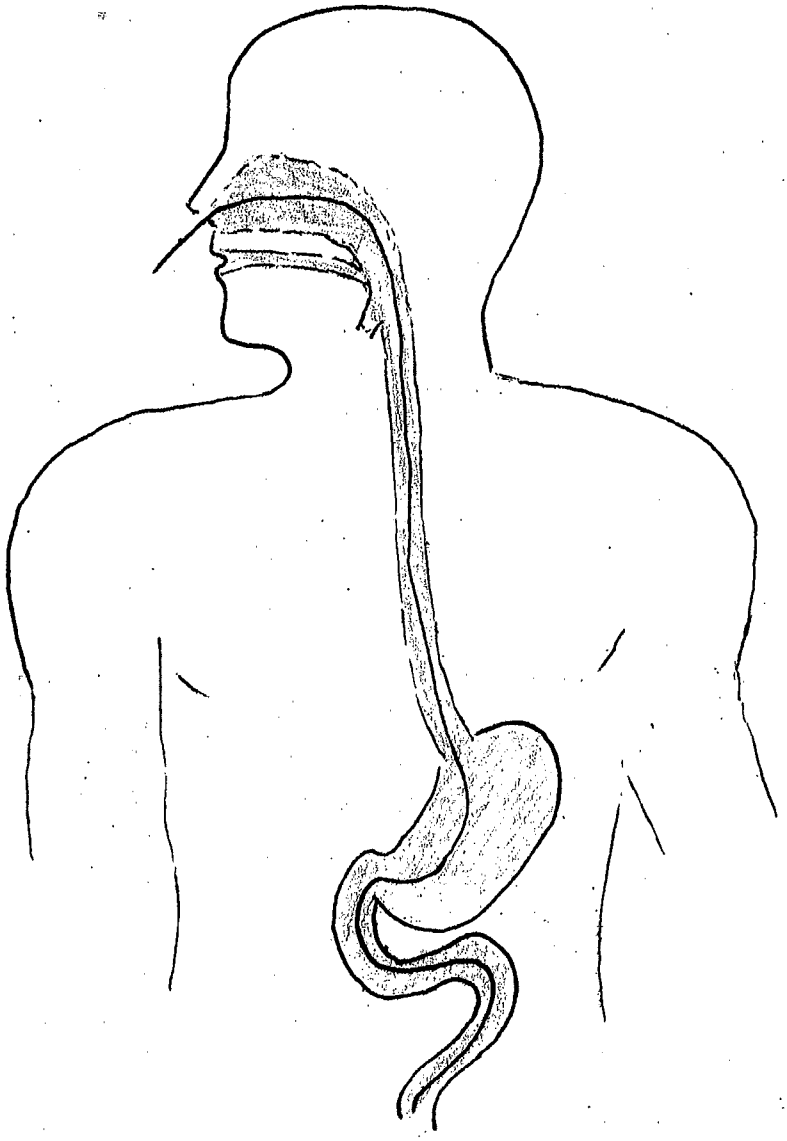
## Total Parenteral Nutrition Diagram



Drawing shows TPN solution and tubing into the subclavian vein. (Permission for using original drawing obtained from Carol Seaborn, May 11, 2009).

# Appendix B

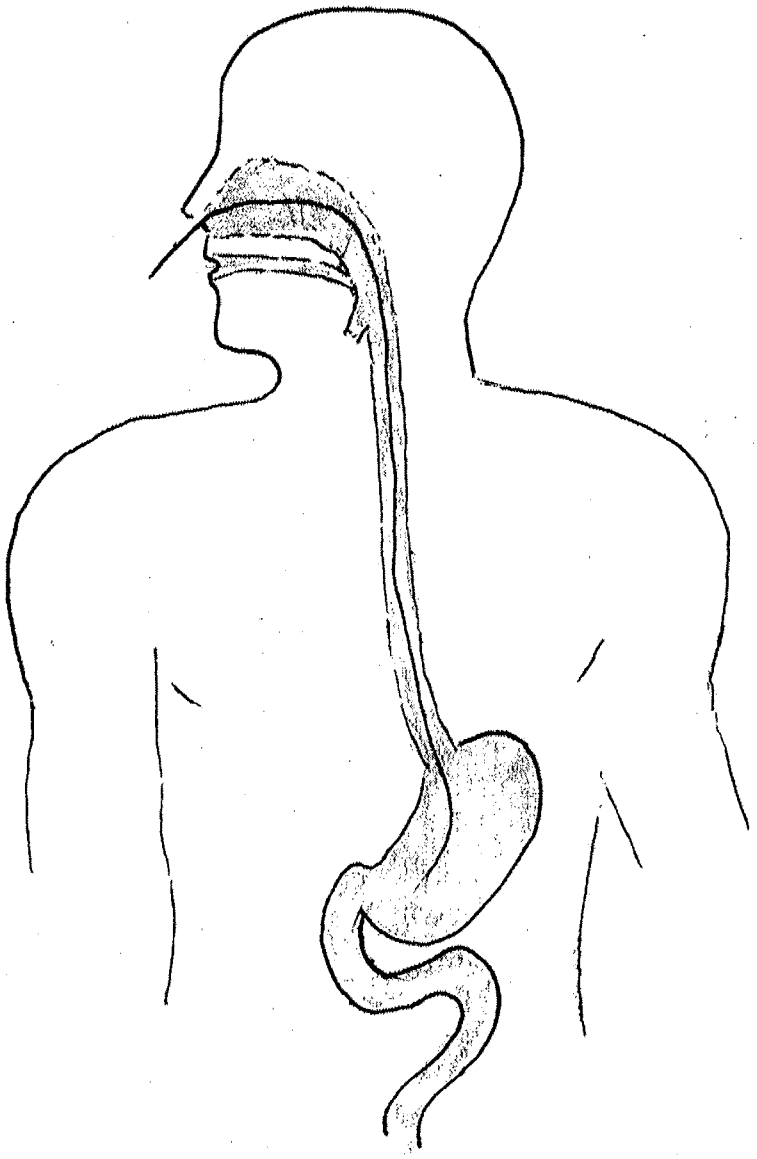
## Small Bowel Feeding Tube Diagram



Drawing shows nasalgastric feeding tube in nasal cavity, esophagus, stomach and ending in small bowel. (Permission for using original drawing obtained from Carol Seaborn, May 11, 2009).

# APPENDIX C

## Nasogastric Feeding Tube Diagram



Drawing shows feeding tube from nasal cavity through esophagus and ending in stomach.

(Permission for using original drawing obtained from Carol Seaborn, May 11, 2009).

# APPENDIX D

## UW-Stout IRB Approval Form

STOUT
UNIVERSITY OF WISCONSIN

Research Services
152 Voc Rehab Building

University of Wisconsin-Stout
P.O. Box 790
Menomonie, WI 54751-0790

715/232-1126
715/232-1749 (fax)
http://www.uwstout.edu/rs/

**Date:** December 3, 2009

**To:** Stacey Nelson
William Mohr
Kamrun Jenabzadeh

**Cc:** Dr. Carol Seaborn

**From:** Sue Foxwell, Research Administrator and Human Protections Administrator, UW-Stout Institutional Review Board for the Protection of Human Subjects in Research (IRB)

**Subject:** **Protection of Human Subjects in Research**

Your project, "*Effectiveness of Using a Non-Invasive Electromagnetic Tube Placement Device for Placement of Small Bowel Feeding Tubes in a Burn Center*" is **Exempt** from review by the Institutional Review Board for the Protection of Human Subjects. The project is exempt under Category 4 of the Federal Exempt Guidelines and holds for 5 years.

Please copy and paste the following message to the top of your survey form before dissemination:

> This project has been reviewed by the UW-Stout IRB as required by the Code of Federal Regulations Title 45 Part 46

Please contact the IRB if the plan of your research changes. Thank you for your cooperation with the IRB and best wishes with your project.

***NOTE: This is the only notice you will receive – no paper copy will be sent.**

SF:ds

# APPENDIX E

## Data Abstraction Tool

| | Age | BMI | Inhalation Injury | Type of Injury | Blind | Placed By Fluro | Cortrak Used | Success-ful | Un-success-ful | # of X-rays | Complications |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Patient #1 | | | | | | | | | | | |
| Patient #2 | | | | | | | | | | | |
| Patient #3 | | | | | | | | | | | |
| Patient #4 | | | | | | | | | | | |
| Patient #5 | | | | | | | | | | | |
| Patient #6 | | | | | | | | | | | |
| Patient #7 | | | | | | | | | | | |
| Patient #8 | | | | | | | | | | | |
| Patient #9 | | | | | | | | | | | |
| Patient #10 | | | | | | | | | | | |