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Effect of an external visual cue on delivery of enteral nutrition in a university trauma/surgical/burn intensive care unit

Paula West

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**EFFECT OF AN EXTERNAL VISUAL CUE ON DELIVERY OF ENTERAL
NUTRITION IN A UNIVERSITY TRAUMA/SURGICAL/BURN
INTENSIVE CARE UNIT**

By

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B.A., Economics, University of New Mexico, 1986
B.S., Nutrition, University of New Mexico, 2008

THESIS

Submitted in Partial Fulfillment of the
Requirements for the Degree of

**Master of Science
Nutrition**

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Dedication

To Nicholas and Stepho for patiently giving me time and space to complete my work. You are magnificent young men with maturity and understanding beyond your years. We can finally use the dining room table for meals again ...

To James for believing I can do anything, for having the patience to standby while I try, and for sharing life's journey. My life is infinitely richer with you by my side. Now we can finally sit on that porch for a while ...

And to my parents, Dorothy and Ante, for sharing their unending thirst for knowledge, teaching me how to think, and giving me access to the finest educational beginnings. Thank you for giving me a life outside the box. I am eternally grateful for your gifts.

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ABSTRACT

Background: Enteral nutrition in the critically ill patient is interrupted for myriad reasons some of which include withholding for operations, diagnostic tests, high residuals, feeding tube displacements and routine care. We sought to determine if use of an external visual cue by nursing increases delivery of goal enteral nutrition (EN) from baseline during the first 7 days of ICU admission.

Methods: After achieving IRB approval we retrospectively evaluated all trauma/surgical/burn intensive care unit (TSBICU) records from May 2012 through March 2013 for patients with more than 7 days in the TSBICU who received EN as their primary means of nutrition support. In the initial arm, we identified goal EN and determined the percentage EN delivered, calculated average Braden score during the first 7 days of admission as well as average ICU length of stay (LOS), and then compared those data to the post intervention group. Intervention consisted of a nursing-placed placard that cued staff to initiate or resume EN. Data were analyzed utilizing Shapiro-Wilk W test, standard t-test, Fisher's exact test, and Wilcoxon rank sum test. Data were further stratified to test differences between burn patients and remaining ICU patients.

Results: Compared to all TSBICU patients in the pre-intervention group (n = 50), those in the post-intervention group (N = 31) did not receive significantly more EN (47.3% vs. 39.5%; p = 0.10), did not experience a difference in ICU LOS (14.5 vs. 13 days; p = 0.94), and did not see changes in average Braden scores (12.4 vs. 13; p = 0.14). However, parceling out the burn patients (N = 11) vs. remaining ICU patients (N = 70) showed burn patients received significantly higher delivery of EN (58.8% vs. 42%; p = 0.011) and experienced longer ICU LOS (21 vs. 13 days; p = 0.044). There was no difference in average Braden scores between the two groups.

Conclusion: This retrospective review failed to demonstrate statistical significance for the application of a nursing- placed placard to cue resumption or initiation of EN. Burn patients received significantly more EN and had longer ICU LOS compared to trauma/surgical ICU patients.

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Chapter 1: Introduction

The Academy of Nutrition and Dietetics (Academy) along with the American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.) have made addressing malnutrition in hospitalized patients in the United States one of their top priorities. One in three hospitalized patients is malnourished, and many others are becoming malnourished while hospitalized¹. Malnutrition not only increases healthcare costs, but also contributes to increased morbidity and mortality, decreased quality of life, and increased hospital admissions and length of stay.²

Acute malnutrition in the intensive care unit (ICU) differs vastly from chronic ambulatory malnutrition in that chronically malnourished patients have lower resting energy expenditures in order to conserve energy and use fat as their primary fuel source, whereas those with acutely malnourished patients rely on glucose as the preferred fuel, have high resting energy expenditures, and high mobilization of proteins for use in gluconeogenesis.³

Trauma patients experience a systemic inflammatory process which alters the body's use of macronutrients.⁴ Following insult or injury the body releases proinflammatory cytokines that cause the release of catabolic hormones glucagon, cortisol, and catecholamines. In order to mobilize glucose these hormones, in turn, stimulate glycogenolysis and gluconeogenesis. Patients in the critical phase will have high circulating blood glucose for this reason. This increase in circulating blood glucose is accompanied by decreased glucose uptake and insulin resistance. As such, glycogen stores are depleted within a matter of hours and endogenous protein and lipid stores become the primary fuel source.

Amino acid supplies come from accelerated protein breakdown in skeletal muscle, connective tissue, and the unstimulated gastrointestinal tract. This breakdown is accompanied by decreased muscle uptake of amino acids in order to divert them to the liver to be used in gluconeogenesis. Provision of adequate exogenous amino acids via nutrition support can maintain production of hepatic acute-phase proteins but cannot keep up with the overall rate of protein catabolism.

An unfed, stressed patient will lose up to 250g (0.55 pounds) of lean body mass per day.⁴

The body also relies on lipid stores for oxidative fuel during the stressed stage. However, transport mechanisms are disrupted leading to impaired free fatty acid utilization and impaired ketogenesis resulting in hyperlipidemia, in addition to the hyperglycemia, and hyperlactatemia.

Given this catabolic cascade, provision of early and adequate enteral nutrition (EN) support in the intensive care unit is critical to optimal patient outcomes. It has been shown to decrease disease severity, decrease morbidity and length of stay (LOS), and increase favorable outcomes.⁵ The Society of Critical Care Medicine (SCCM) and A.S.P.E.N. Critical Care Guidelines recommend starting EN within the first 24-48 hours following admission to the ICU with advancement to goal rate over the following 48-72 hours given hemodynamic stability.⁶ Early EN maintains structural and functional integrity of the gut mucosal barrier, increases visceral blood flow, and enhances immune response.⁷ As such, clinical benefits of early EN include reducing infections and hospital LOS.

In September, 2012 an internal nursing quality assurance (QA) survey was administered at the University of New Mexico Hospitals (UNMH) to better understand inconsistencies with starting and/or resuming EN on the Trauma/Surgical/Burn ICU (TSBICU). In line with the American Society of Anesthesiologists Guidelines, patients are routinely made nil per os (NPO = nothing by mouth) preoperatively due to concerns for pulmonary aspiration of gastric contents either after the administration of general anesthesia, during a procedure, or in the immediate post-operative period.⁸ These Guidelines were written for patients in whom upper airway protective reflexes might be impaired and does not address management of intubated patients whose airways are inherently protected. Therefore, this leaves an area of controversy regarding making patients with protected airways NPO prior to surgical procedures.

Despite existing TSBICU guidelines to help minimize the amount of time patients are left NPO, QA survey results showed inconsistencies in NPO status

before procedures or surgical interventions. Furthermore, there were even greater inconsistencies with resuming EN when patients on the OR add-on list were bumped from day to day without being seen. (Being on the add-on list means patients are taken to the operating room (OR) *only* if all scheduled patients have received their procedures.) There also appeared to be provider variability with resumption of EN or NPO status depending on the resident MD on service, or the service team itself. (Details of this survey provided in the next section.)

In an attempt to improve delivery of optimal EN at UNMH TSBICU, the purpose of this study was to examine whether use of a visual cue would prompt nursing to better meet goal EN prescriptions. Since nurses are the primary contact point in patient care it can be important to have them be the primary patient advocate when it comes to meeting goal EN needs. Martin et al have shown that nurse-directed feeding protocols or algorithms increase the amount of EN delivered daily.⁹ A review of the literature (PubMed, CINAHL, and Google Scholar) revealed no existing research on the use of a visual cue to specifically improve delivery of EN. As such, this study could provide new information towards improving delivery of EN support and playing a key role in optimizing patient outcomes on the trauma/surgical/burn ICU.

Discussion of Existing Literature

Because malnutrition in the hospitalized patient is such a chronic problem, the Academy and A.S.P.E.N. published a Consensus Statement in 2012 making recommendations for the identification and documentation of adult malnutrition.¹⁰ Prevalence of adult malnutrition ranges from 15-60% depending both on the patient population as well as diagnostic criteria. Therefore standardization of diagnosis is vital, according to the Consensus authors, to properly capture malnourished patients and appropriately code malnutrition for insurance billing purposes.

In this document, they propose the identification of two or more of the following criteria in order to diagnose malnutrition:

- Insufficient energy intake
- Weight loss

- Loss of muscle mass
- Loss of subcutaneous fat
- Localized or generalized fluid accumulation that may sometimes mask weight loss
- Diminished functional status as measured by handgrip strength

Given these diagnostic criteria, it is easy to see that most, if not all trauma, surgical and burn patients would be classified as malnourished simply using “insufficient energy intake” and “fluid accumulation” as indicators.

Existing scientific literature supports early and adequate EN in the critically ill patient to reduce disease severity, decrease morbidity and LOS, and increase favorable outcomes.^{11,12,13} EN in the critically ill patient is interrupted for myriad reasons some of which include MD holds for OR and/or diagnostic tests, and nursing holds for residuals, feeding tube displacements, and routine care.

The experience in our facility is that patients with planned trips to the OR can often go days with their EN either not started, or started and placed on hold. The reason often cited by nursing is that the patients get bumped from the OR schedule from day to day thereby requiring them to remain NPO in anticipation of the next scheduled trip. However, the primary team’s physicians will not order EN to be started/restarted once the patient is confirmed not to be going to the OR (which is most often in the late afternoon/early evening) because feeds will need to be held once again that midnight for OR the following day, often in patients with a secure airway.

The literature addresses both the importance of early EN as well as adequacy of goal EN support provision. SCCM/A.S.P.E.N. Critical Care Guidelines recommend starting EN within the first 24-48 hours following admission with advancement to goal rate over the following 48-72 hours.¹³ The guidelines further recommend that EN should not be initiated until the patient has been properly resuscitated to minimize the risk of nonocclusive mesenteric ischemia.^{11,13} Once resuscitated, early EN maintains structural and functional integrity of the gut mucosal

barrier, increases visceral blood flow, and enhances immune response helping to reduce infections and hospital LOS.

Of note, these same SCCM/A.S.P.E.N. Guidelines also recommend permissive underfeeding or hypocaloric feeding of critically ill, obese patients (BMI > 30). This recommendation should not be confused with the unintentional underfeeding discussed for investigation here. Heyland et al recently demonstrated that critically ill patients who receive more than two thirds of their EN caloric prescription are much less likely to die than those receiving less than one third of their prescription.¹²

While we did not find any research directly examining effects of the placement of a visual cue on EN delivery, there is a fair amount of research related to hand hygiene and signage. For example, in 2011 researchers tested whether placement of signs in public settings would increase hand hygiene during the 2009-2010 H1N1 epidemic.¹⁴ Results showed that use of signs was associated with greater sanitizer use, particularly those signs that were gain-framed (i.e., signs giving positive consequences of the behavior (hand hygiene)). In 2012 another study looked at the effects of visual cues on visitor hand hygiene in a private university hospital.¹⁵ Again, hand hygiene improved with the use of visual cues, most significantly when the sign was placed together with the sanitizer dispenser.

Visual cues are used for multiple purposes in the TSBICU. For example, there is signage reminding individuals to use hand gel when entering/exiting rooms and for hand washing while in the room; there is a patient turning schedule posted in each room to mitigate skin breakdown and the development of pressure ulcers; above each sharps container there is signage to remind staff of appropriate trash disposal (sharps/garbage/biohazard); Latex allergies are displayed prominently on patients' doors; and some patients have reminders affixed to their doors to check blood sugars every morning at 0600 hours.

Various international guidelines have been published with respect to nutrition in the critically ill population suggesting this area of research is equally important

beyond our shores. Americans, Canadians, and Europeans all agree that EN should be started within 24-48 hours of ICU admission.

In 2009 SCCM and A.S.P.E.N. issued guidelines for the provision and assessment of nutrition support in the adult critically ill patient.¹³ These were written to address the needs of the adult medical and surgical critically ill patient expected to be in the ICU for more than 2-3 days. Each guideline is given a grade depending on the level of evidence supporting it; the grading system is explained in the referenced guidelines. Per SCCM/A.S.P.E.N. recommendations, EN is the preferred route of feeding over parenteral nutrition (PN) for critically ill patients who require nutrition support therapy (Grade B evidence), and target goal EN should be clearly defined when starting EN (Grade C). At the UNMH TSBICU patients are assessed by a Registered Dietitian (RD) who is a Certified Nutrition Support Clinician (CNSC) for EN support as soon as they are hemodynamically stable as determined by the primary medical team. Assessment includes estimating total calorie and protein needs, micronutrient needs, determining the need for supplemental immunonutrition, enteral formula selection, and goal tube feed rate calculation. Patients are continually monitored by the RD, and nutrition needs are reassessed as clinical conditions change. There is currently no EN protocol in the TSBICU so EN advancement and holds are often subjectively determined by the registered nurse (RN) caring for the patient. Reasons for holds include subjective high residuals, procedures, diagnostic tests, routine nursing care, feeding tube displacements, and so on. According to McClave et al in the aforementioned Critical Care guidelines, “cessation of feeding occurs in >85% of patients for an average of 20% of the infusion time (the reasons for which are avoidable in >65% of occasions).”¹³

EN should be started within 24-48 hours of admission (Grade C) and advanced to goal over the next 48-72 hours (Grade E). Early initiation and advancement to goal is associated with decreased intestinal permeability, and decreased activation and release of inflammatory cytokines. Further, in order to achieve the clinical benefit of EN efforts should be made to provide >50-65% goal calories over the first 7 days of admission (Grade C).

Canadian Clinical Practice Guidelines¹⁶ were first published in 2003 and most recently updated in 2013.¹⁷ Like the SCCM/A.S.P.E.N. Guidelines, the Canadians recommend early EN within 24-48 hours of ICU admission in critically ill patients. In order to help achieve target EN the following received a “should be considered” rating: Starting EN at goal rate, setting a higher threshold for gastric residuals (250mL–500mL), use of prokinetics, and the use of small bowel feedings. Heyland et al conducted further research in 2010 to test a new protocol for maximizing nutrition delivery that includes starting EN at goal rate, use of 24-hour volume based EN goal rates instead of hourly rates, starting prokinetics and modular protein supplements at the start of EN, increasing the gastric residual volume threshold, and the option to use trickle (trophic) feeds.¹⁸ Results showed those patients who received volume-based feeds received almost 90% of their prescribed protein and calories. Equally important for its success, this PEPuP protocol (The Enhanced Protein-Energy Provision via the Enteral Route in Critically Ill Patients) was shown to be safe and acceptable to critical care RN's.

In 2006 the European Society for Parenteral and Enteral Nutrition (ESPEN) published their own guidelines recommending EN within the first 24 hours of ICU admission.¹⁹ Like the other organizations, ESPEN promotes the use of EN over PN. However, ESPEN uses a slightly different approach when making recommendations to meet goal EN by differentiating between the acute vs. flow phases of critical illness. During the acute phase, efforts should be made to provide 20-25 kcals/kg; during the anabolic flow phase, this should be increased to 25-30 kcals/kg. ESPEN does not comment on the use of feeding protocols but does recommend the use of prokinetics with intolerance to gastric feeds.

UNMH TSBICU uses the American Society of Anesthesiologists Guidelines regarding pre-operative NPO status⁸. These guidelines recommend a 2-hour fast for patients receiving a clear liquid diet, a 6-hour fast following a light meal (toast, milk, and clear liquids), and an 8-hour fast for those having eaten a heavy meal (to include fried and fatty foods). However, the guidelines are written for healthy patients undergoing elective procedures, and specifically exclude patients receiving

EN. Furthermore, these recommendations are made for procedures “in which upper airway protective reflexes may be impaired,”⁸ which does not address the management of NPO status in patients who are intubated and with secure airways. It is common practice on the TSBICU to make patients NPO after midnight (and sometimes, subjectively, after 0400 hours) thereby decreasing delivery of maximum nutrition.

In theory and partly in practice, there is a mechanism in place to monitor patient nutrition status. During daily ICU rounds, providers follow the FASTHUG mnemonic in order to identify and monitor key aspects in the general care of critically ill patients.²⁰ The first letter in FASTHUG stands for Feeding. “Can the patient be fed orally, if not enterally? If not, should we start parenteral feeding?” The remaining letters stand for Analgesia, Sedation, Thromboembolic prevention, Head of bed elevated, Stress Ulcer prophylaxis, and Glucose control. The idea of using this mnemonic is to provide a checklist to minimize oversights in the overall care of the critically ill patient. While intended to be used primarily by unit intensivists, it is also designed for use by each member of the interdisciplinary team to ensure comprehensive patient care. It is hoped that use of this checklist will increase delivery of much-needed nutrition.

Placing the financial responsibility on hospitals, effective October 1, 2008 the Centers for Medicare and Medicaid Services (CMS) ceased paying for adverse events they deemed the hospital’s fault.²¹ Included in the list of non-reimbursable “hospital-acquired conditions” are stage III and IV pressure ulcers. Further punctuating the importance of pressure ulcer prevention, The Joint Commission’s National Patient Safety Goals effective January 1, 2013 lists as its Goal #14: Prevent health care-associated pressure ulcers (decubitus ulcers).²² Their stated rationale is, “Pressure ulcers (decubiti) continue to be problematic in all health care settings. Most pressure ulcers can be prevented, and deterioration at Stage I can be halted. The use of clinical practice guidelines can effectively identify residents and define early intervention for prevention of pressure ulcers.”

In 2009 the National Pressure Ulcer Advisory Panel (NPUAP) estimated the prevalence of pressure ulcers in acute care settings to be 10-18% with an incidence of 0.4-38%.²³ Prevalence is defined as “a proportion of persons who have a pressure ulcer at a specific point in time,” and incidence as “the number of new cases of pressure ulcers appearing in a pressure ulcer-free population over a period of time.”

The financial burden on the healthcare system of treating pressure ulcers is staggering. The NPUAP, citing statistics from CMS, estimates the cost of treating a pressure ulcer as a secondary diagnosis in an acute care setting to be \$43,180 per hospital stay. A 2006 Agency for Healthcare Research and Quality report found that more than 90% of pressure ulcer-related adult hospitalizations noted pressure ulcers as a *secondary* diagnosis with an average daily cost of \$1,600; \$400/day higher than for patients with pressure ulcers as a primary diagnosis and \$800/day more than other, non-pressure ulcer diagnoses.²⁴ As such, the cost savings of mitigating the development of pressure ulcers in hospitalized patients can be stunning.

In 2010 Banks et al published a study in which they designed a statistical model to predict the cost of pressure ulcers attributable to malnutrition in public hospitals in Queensland, Australia, between 2002-2003.²⁵ Using the cost of “bed days,” i.e, LOS measured as opportunity cost, their model estimated that about one-third of pressure ulcers were attributable to malnutrition at a mean cost of €7 million (approximately \$9 million using exchange rates on 7/27/13).

In 2013 the same group of researchers extended their 2010 study to estimate the financial impact of providing intensive nutrition support to patients at high risk for developing pressure ulcers.²⁶ Intensive nutrition support was defined as the provision of additional food and commercial supplements to standard hospital food, as well as additional staffing resources to provide assistance, encouragement, and monitoring in the case of malnourished patients. Where patients were receiving EN these costs were assumed to replace the cost of standard hospital fare and were not included in the analysis. Their statistical analysis predicted a 95% chance that implementing an intensive nutrition support program would result in cost savings

while also reducing the incidence of pressure ulcers and LOS. Their model predicted a cost savings of approximately €2.9 million (approximately \$3.8 million using exchange rates on 7/27/13) if an intensive nutrition support intervention had been implemented in Queensland public hospitals in 2002-2003.

Materials and Methods

Study design and setting. This retrospective study examined the effectiveness of posting an external visual cue designed to improve delivery of EN to critically ill patients in a 24-bed Trauma/Surgical/Burn Intensive Care Unit (TSBICU) at the University of New Mexico Hospitals. Secondary outcomes under investigation included changes in pressure ulcer incidence as measured by Braden Scores ≤ 16 , and ICU LOS. The study was approved by the University of New Mexico Human Research Protections Office on March 18, 2013. Informed consent was waived since the research did not involve more than minimal risk, and the intervention did not change routine care of patients.

Participants. Eligible participants included all adult patients age 18 and over on the TSBICU who were hemodynamically stable, had a functional gastrointestinal tract, and who were unable to meet nutrition needs via the oral route. Inclusion criteria included patients with ≥ 7 -day TSBICU LOS. Patients were excluded if they were receiving nutrition support via parenteral nutrition (either as a sole source of nutrition or in combination with EN), those under the age of 18, prisoners, and the mentally ill/disabled.

Development of intervention. This study was designed to observe a nursing-led, unit-based quality assurance program. In September, 2012 a survey was developed on TSBICU to determine current nursing practices with respect to EN and NPO status. Subsequently, a PDSA (plan, do, study, act) was developed to create consistency within the unit in order to ensure that all patients could meet their goal nutrition goals. Resulting from this PDSA, a visual cue was developed to prompt RN's to start/resume EN.

Existing unit guidelines (this is not hospital-wide) specify that those patients who are at increased risk for aspiration should be made NPO prior to elective

surgery. Identified at-risk patients include non-intubated patients, patients requiring intra-abdominal or intra-thoracic procedures, patients requiring tracheostomies, as well as procedures requiring patients be in the prone, lateral, or lithotomy positions.

Identified patients considered *not* to be at increased risk for aspiration who would benefit from continued tube feeding pre-operatively up to the time of scheduled surgery include intubated patients scheduled for superficial and extremity surgery in the supine position, intubated patients scheduled for craniotomies, and non-facial burn procedures. These patients should have a gastric tube in place to facilitate decompression of the stomach, and stomach contents should be aspirated prior to transfer to the operating room (OR).²⁷

In order to understand the genesis of the visual cue, following are the three questions asked in the survey with subsequent results. Included, here, are current unit guidelines for reference:

- (1) What is the standard timeframe for NPO status if a patient is scheduled for an OR procedure?

Guideline: Adults should be made NPO 6-8 hours before surgery or NPO after midnight; patients may also be placed on an abbreviated NPO status if previously on a clear liquid diet.

- (2) If an ICU patient has a Dobhoff tube and/or Salem Sump/nasogastric tube, what is the time interval needed for NPO status?

Guideline: Patients who have confirmed placement of bridled, nasal-duodenal feeding tubes can receive nutrition up to the time of conscious sedation. This does not, however, apply to deep sedation.

- (3) Do you observe inconsistencies in NPO status from the Burn Center and the TSICU?

Survey results are graphically illustrated in Tables 1-3 and show variable time intervals across TSICU for NPO status prior to OR. Following is feedback provided by bedside RN's participating in the survey:

- Some reported continuing EN until the time of OR if a gastric tube was in place and contents could be aspirated prior to transport, per unit guidelines.
- Some reported that patients who were on the OR add-on list did not have their EN orders resumed by the appropriate providers resulting in prolonged NPO status.
- RN's stated MD orders were not clear in defining NPO status. For example, it was unclear whether a patient was to be strict NPO or only NPO except for medications.
- Finally, resumption of EN or NPO status was reportedly varied depending on the resident MD and/or service team.
- The Burn Center's NPO practice was noted to be more consistent and RN's believed EN was restarted sooner after surgical interventions on the burn pod.

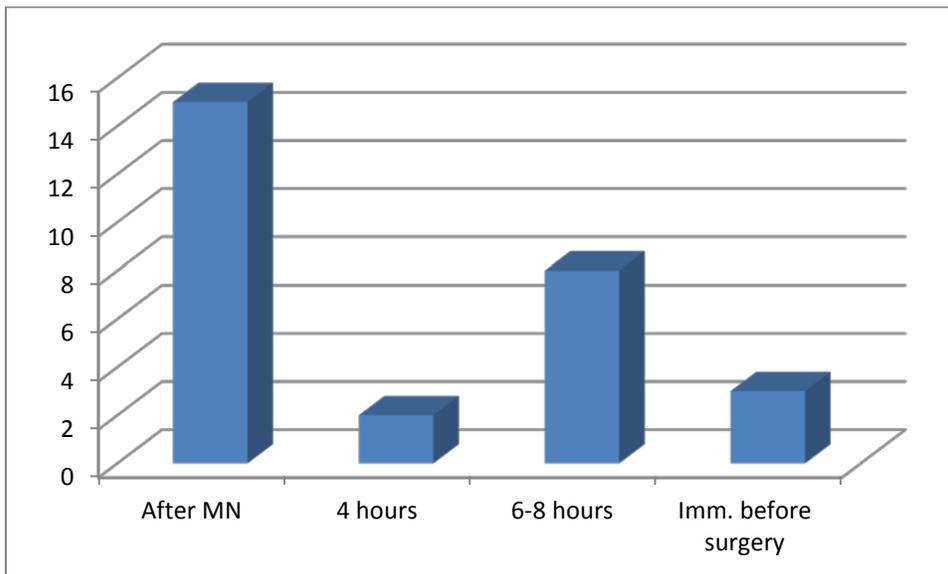


Figure 1: What is the standard timeframe for NPO status if a patient is scheduled for an OR procedure? (n = 28) MN = midnight; Imm = immediately.

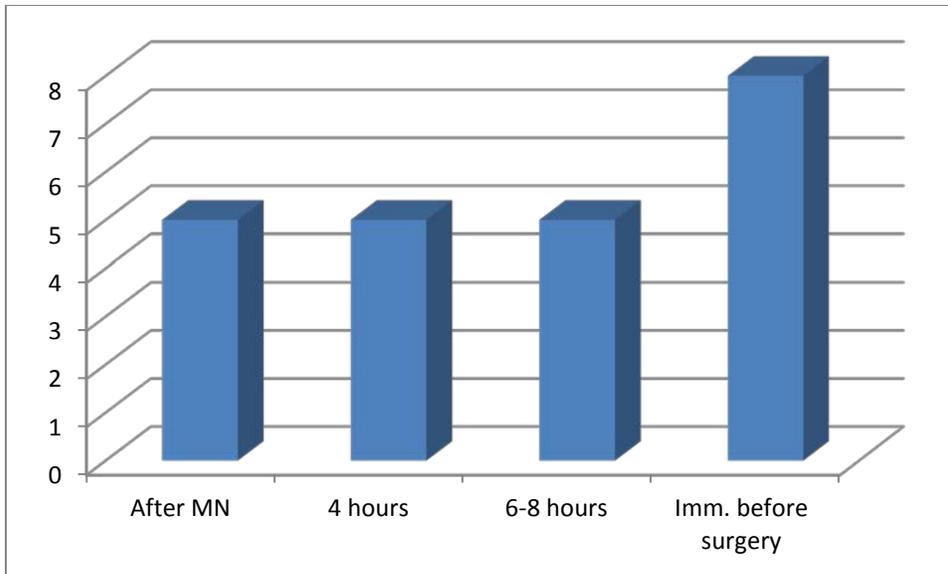


Figure 2: If an ICU patient has a DHT and/or a Salem Sump/NGT, what is the time interval needed for NPO status? (n = 23) MN = midnight; Imm = immediately.

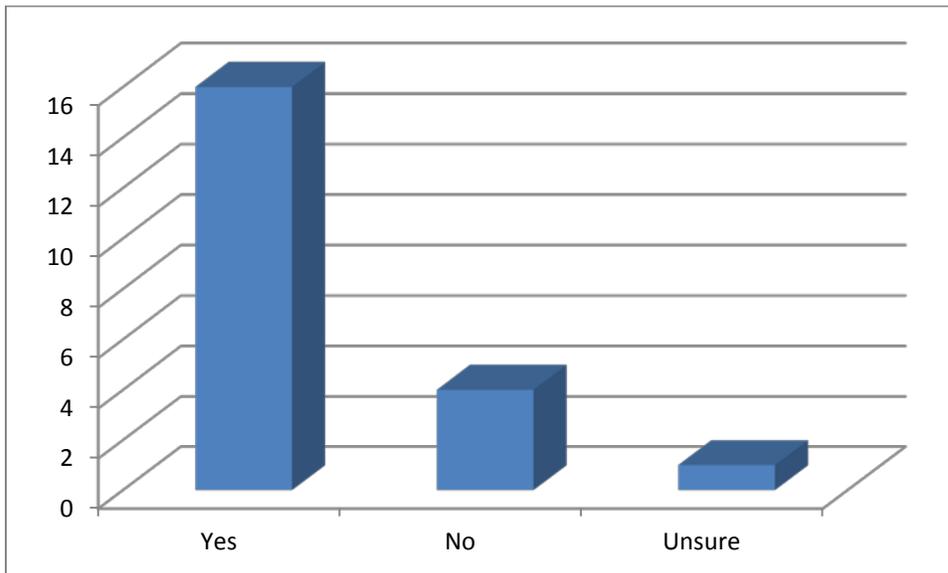


Figure 3: Do you observe inconsistencies in NPO status from the Burn Center and the TSICU? (n = 21)

The survey produced the following NPO Nursing Responsibilities/Take Home Points:

- RN's were to remind resident MD's or the primary service to restart EN as soon as the RN was aware that OR add-on patients would not be making a trip to the OR.
- RN's were reminded of the fact that poor nutrition equates with poor wound healing and prolonged hospital stay. Long hospital stays place patients at risk for hospital-acquired pneumonia (HAP), and antibiotics coverage may not be reimbursed by Medicare if poor wound healing or infection is proven to be hospital-related.²⁸

On January 2, 2013, following the preliminary survey, a visual reminder was affixed on each ICU door to prompt nursing to start and/or restart EN. RN's were educated by nurse educators on completing the form and asked to circle the appropriate answers daily with a dry erase marker.

TSBICU/BURN UNIT NUTRITIONAL MAINTENANCE CHECKLIST	
DATE	
1. NPO?	
YES	NO
2. O.R.?	
SCHEDULED?	ADD-ON?
YES/NO	YES/NO
3. RESUME TF?	
YES	NO

Figure 4: Visual cue on display.

Data collection. The TSBICU log book, which catalogs each patient admitted to the unit, was reviewed to identify eligible participants. Fifty patients identified as TSBICU residents prior to posting of the visual cue, and 31 patients identified as residents after posting of the visual cue, were selected by searching the book for ICU LOS \geq 7 days and then reviewing each individual’s electronic medical record. Each identified patient receiving EN had been assessed by the unit RD who determined daily calorie and protein needs, recommended the appropriate enteral formula plus any modular supplements, and the EN delivery rate expressed in milliliters/hour (mL/hour). Data collected included total mL/hour delivered during the first seven days of ICU admission expressed as a percentage of goal EN prescribed by the unit RD and ordered by the MD. As secondary outcomes, daily Braden scores during the same time period and ICU LOS were collected.

Braden scores are used as a means to predict pressure ulcer risk by rating the following six different risk factors on a scale of 6-23 where a total score ≤ 9 represents severe risk, 10-12 high risk, 13-14 moderate risk, and 15-18 mild risk.

- sensory perception
- moisture
- activity
- mobility
- nutrition
- friction and shear

Per TSBICU protocol, a Braden score ≤ 16 represents considerable risk of developing pressure ulcers and is the cutoff value for RN's to initiate a checklist to mitigate further skin breakdown. This checklist includes the following elements with the acronym SKIN:

- (i) **Surface:** head of bed $\leq 30^\circ$, float heels off all surfaces, and specialty mattress if Braden score ≤ 18 ;
- (ii) **Keep Moving:** turn patient every 2 hours, reposition every 30 minutes while in chair or chair mode, and ambulate;
- (iii) **Increased Moisture:** change linens as needed, check for wetness every 2 hours, and apply skin barrier products as needed;
- (iv) **Nutrition:** order nutrition consult, notify MD if patient NPO or on clear liquids ≥ 3 days, assist with feeds and encourage oral intake, and check prealbumin and C-reactive protein.

Daily Braden scores were collected in order to compare the number of patients at risk before and after the intervention using ≤ 16 as the cutoff. Scores were averaged pre- and post-intervention. ICU LOS was also recorded pre-and post-intervention to determine whether there was a change.

Statistical methods. The investigators of this study estimated that the majority of patients on TSBICU receive, on average, ~40% goal EN daily. Per SCCM/A.S.P.E.N. Critical Care Guidelines previously referenced, efforts should be made to provide 50-65% goal EN during the first 7 days of ICU stay. Therefore, the

desired outcome in this study was to see an improvement of 30% of current EN delivery (40%) to bring patients into the goal range of 50-65%.

It was estimated that the sample size needed to produce an improvement of EN delivery from 40 to 52% by setting a clinically-relevant threshold at 12% would be 12 patients in each intervention group in order to achieve 80% power with $\alpha = 0.05$. Using the actual sample sizes of 50 patients pre-intervention and 31 patients post-intervention gave the study a power of greater than 99%.

Results were analyzed using JMP version 9.0.0 (SAS Institute, Inc., Cary, NC, 2010). Descriptive statistics were calculated for data collected.

The Shapiro-Wilk W test was used to test the assumption of normality for age, ICU LOS and percentage EN delivered.

Enrollments by sex were compared with Fisher's Exact test. Fisher's Exact test is used when analyzing two nominal variables (2x2 tables) such as sex (male/female) + pre-/post-intervention, and is more accurate to test independence than chi-squared test when the expected numbers are small.²⁹

Age and percent EN delivered were analyzed using a standard t-test with equal variances assumed as data are normally distributed.

Differences between groups for ICU LOS and Braden scores were tested using Wilcoxon's rank sum test (equivalent to Mann-Whitney U), chosen to analyze data that are not normally distributed.³⁰

The threshold of statistical significance for all tests was set at $\alpha = 0.05$.

Chapter 2: Results

Table 1: Age and sex of participants in pre- and post-intervention groups in all TSBICU patients.

	Pre-intervention	Post-intervention	p
Age: mean (SD)	54.0 (16.7)	58.5 (18.9)	0.26
Sex: Female/Male	11/39	10/21	0.31

Age was normally distributed with similar variances between groups, and the difference between group's mean ages was not significant ($p = 0.26$). Sex distributions also showed no statistically significant gender difference between groups ($p = 0.31$).

Table 2: Percent EN delivered, ICU LOS, and median Braden score pre- and post-intervention in all TSBICU patients.

	Pre-intervention	Post-intervention	p
N	50	31	--
% EN delivered: mean (SD)	47.3 (21.5)	39.5 (18.7)	0.10
ICU LOS: median (IQR)	14.5 (10.8, 18.3)	13 (10, 21)	0.94
Avg Braden: median (IQR)	12.4 (11.5, 13.8)	13 (12, 13.9)	0.14

Percent EN delivered was normally distributed with similar variances between groups. However, ICU LOS was not normally distributed, and average Braden was normal in the "post" group only. Therefore, ICU LOS and average Braden were analyzed using Wilcoxon's rank sum test for ICU LOS, while percent EN delivered was analyzed using a standard t-test.

Analysis show no statistically significant change from pre- to post-intervention in mean percent EN delivered, median ICU LOS, and median Braden score as shown in Table 2 and Figures 5, 6, and 7. In addition, it is noted that all patients included in this study had an average Braden score ≤ 16 putting them at high risk for the development of pressure ulcers.

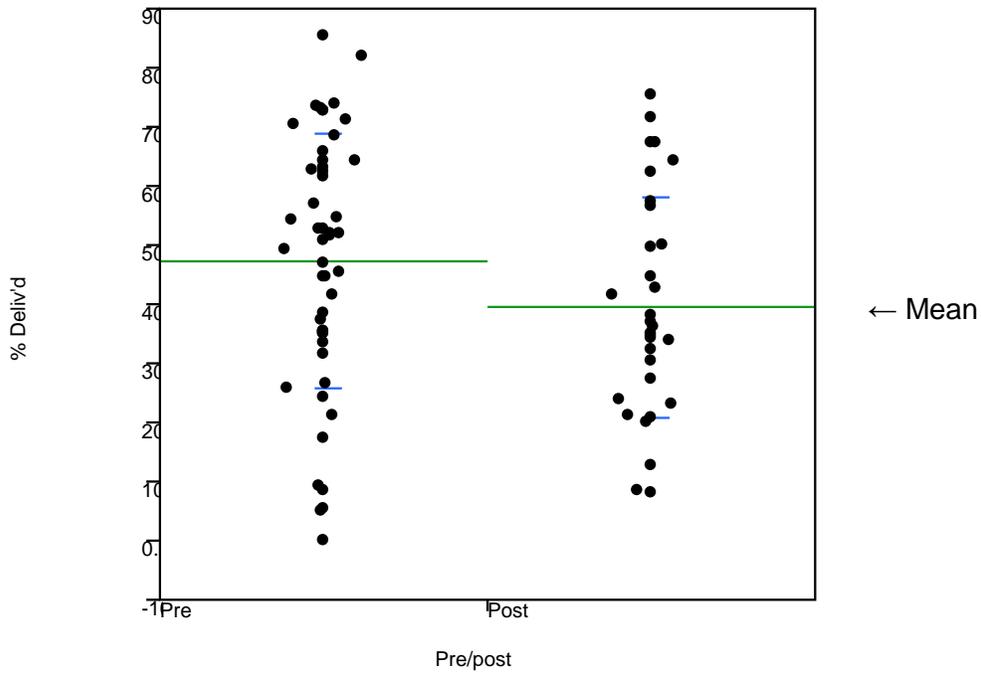


Figure 5: Mean percent EN delivered pre- vs. post-intervention in all TSBICU patients.

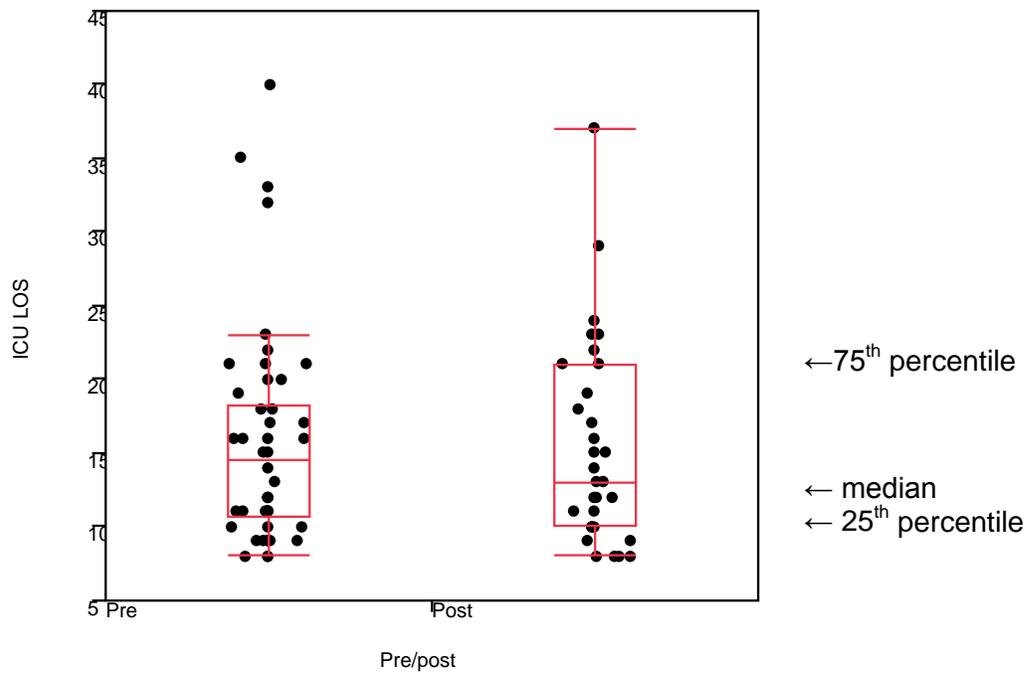


Figure 6: Median ICU LOS pre- vs. post-intervention in all TSBICU patients.

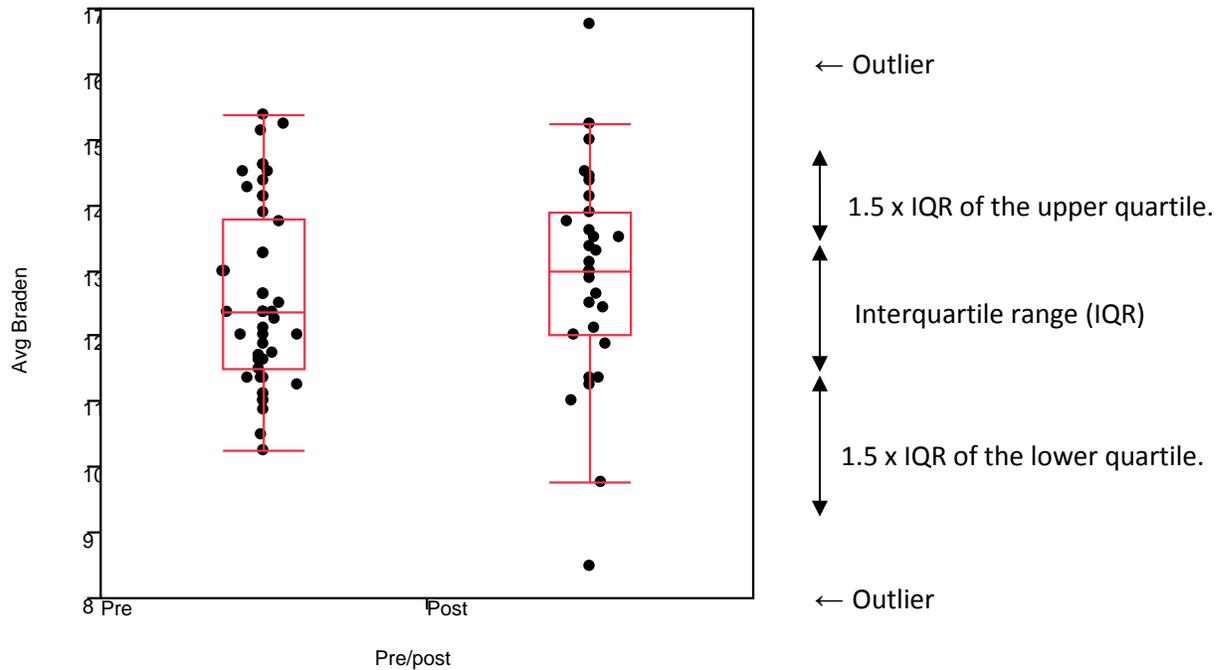


Figure 7: Median Braden score pre- vs. post-intervention in all TSBICU patients.

Because there was no significant change pre- and post-intervention, we parceled out the burn patients vs. the general Trauma/Surgical ICU patients to determine whether, in fact, there was better experience with the burn population with restarting EN as initially opined by the nursing staff in their baseline QA survey.

Table 3: Comparison between burn patients and all other patients in percent EN delivered, ICU LOS, and average Braden score post-intervention

	Burn	Other	p (two-tailed)
N	11	70	--
% EN delivered: mean (SD)	58.8% (21.2)	42% (19.8)	0.011
ICU LOS: median (interquartile range)	21 (11, 29)	13 (10, 18)	0.044
Avg Braden: median (IQR)	12 (11, 14)	13 (12, 14)	0.394

Percent EN delivered is normally distributed with equal variances between Burn and Other groups. ICU LOS and average Braden score are not normally

distributed. As shown in Table 3, and illustrated in Figures 8, 9, and 10, burn patients tended to receive significantly higher percentages of target nutrition, and stayed in the ICU longer than their non-burn counterparts. Average Braden score did not differ between these groups.

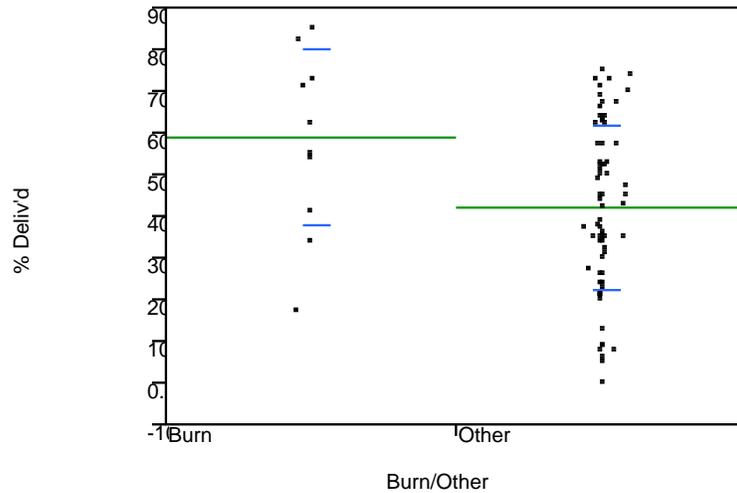


Figure 8: Mean percent EN delivered post-intervention in Burn vs. Trauma/Surgical ICU patients.

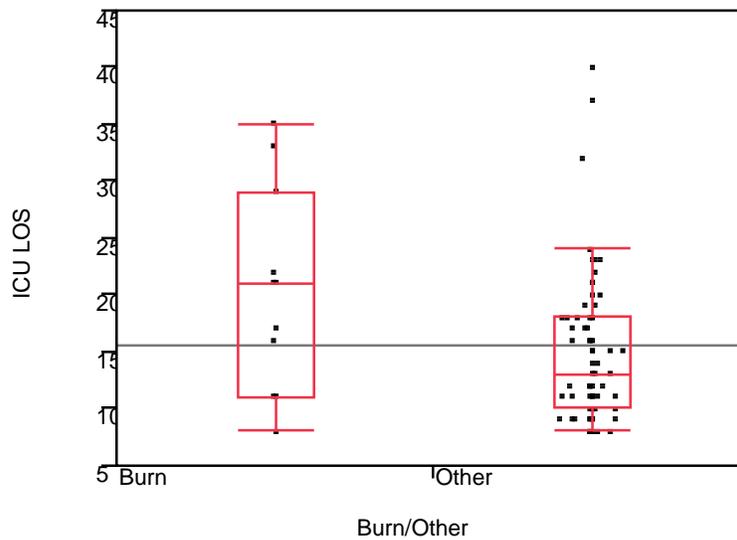


Figure 9: Median ICU LOS post-intervention in Burn vs. Trauma/Surgical ICU patients.

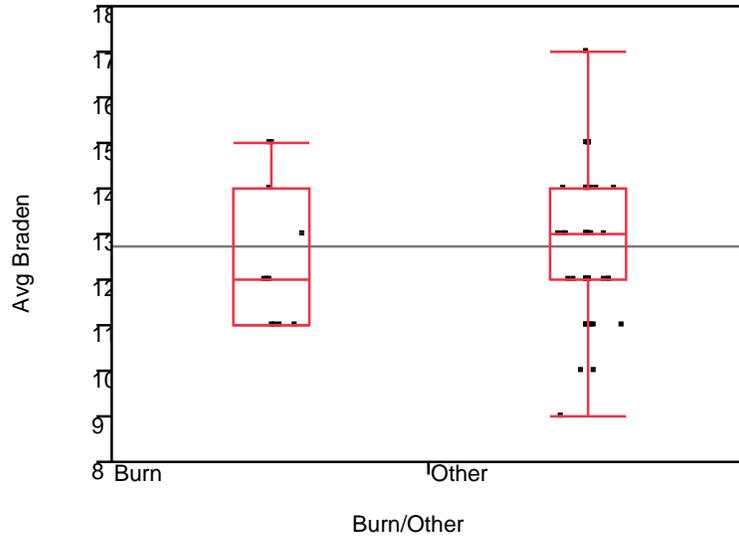


Figure 10: Median Braden scores post-intervention in Burn vs. Trauma/Surgical ICU patients.

Chapter 3: Discussion

The most important finding of our study was that burn patients tended to receive significantly higher percentages of target nutrition and stayed in the ICU longer than their non-burn counterparts. These results corroborate pilot survey results in which RN's believed EN was restarted sooner after surgical interventions in the burn unit, and that the Burn Center's NPO practice was more consistent than the rest of the ICU.

Increased LOS is consistent with the nature of this patient, often requiring repeated skin harvesting with concurrent grafting and, many times, daily wound care. The patient is often required to heal between surgeries, therefore requiring more time. More time in the ICU, however, puts the patient at higher risk for comorbidities and, at times, the team has to manage other developing complications such as infection and sepsis delaying primary burn care and making it even more important that patients be fed adequately.

It cannot be overlooked, however, that increased LOS is also due to the fact the our hospital has a dedicated Burn Unit, meaning that not all patients admitted to the burn portion of the ICU are as critically ill as those admitted to the trauma/surgical portion of the ICU. Patients with smaller total body surface area burns are admitted as frequently to the Burn Unit as are those with large burns and trauma, and burn patients are usually discharged directly from the TSBICU rather than being transferred to a floor first for a lower level of care. Our study did not differentiate between burn severity when comparing burn patients to the remaining ICU patients.

We did not find any literature directly comparing the delivery of EN in burn patients vs. other ICU patients. However, we found studies in which burn patients were teased out from the remaining ICU population due to recognized differences in both patient population and the importance of nutrition support.

For example, in a 2006 study by Berger et al analyzing whether computerized information systems (CIS) would improve the quality of nutrition support in ICU's, data were separately analyzed for burn patients, "because nutritional support is a

priority in burn units and the presence of burn patients in the case mix might have influenced nutritional support and biased the results ... toward better support.”³¹

While this study did not compare the burn patients directly to the surgical patients as did our study, it did provide inferences that other facilities experience different results between the two hospital populations, as well.

In a 2008 study by Soguel et al examining the effect of enteral glutamine and antioxidant administration in critically ill burn and trauma patients, researchers analyzed the burn patients separately from the trauma patients because they recognized that the former have, “ different metabolic, nutritional, and infectious risk factors and different lengths of ICU stay.”³² They, too, did not compare the two groups to one another as we did in our study.

Increased EN delivery on our burn unit could be due to several factors:

- The Burn Center has a dedicated attending MD, resident MD, and physician’s assistant (PA) who exclusively care for burn patients. In comparison, the remaining trauma/surgical ICU has a weekly rotating attending MD, and resident MD’s who rotate through the ICU for variable time periods depending on their specialty. Nurse practitioners (NP’s) are also part of their team but not on service daily.
- The burn team holds weekly interdisciplinary rounds where nutrition is routinely addressed. The group includes the director of the Burn Center who is also the chief surgeon, the plastic surgeon, the medical resident, the burn PA, as well as members of the nutrition, nursing, wound care, social work, discharge planning, psychiatry, speech therapy, physical therapy, and occupational therapy teams. If nutrition delivery is suboptimal the entire team is aware and able to act.
- Feeding tubes are often placed post-pyloric in burn patients such that feeds do not need to be held as long prior to procedures and/or sedation per unit guidelines.
- Protocols are in place when starting EN in the Burn Center in patients who do not have contraindications such as GI injury: EN is started at

20mL/hour and the rate doubled every two hours to goal as tolerated.

This is in contrast to the rest of the ICU where EN is started at 20mL/hour and advanced by 20mL/hour every 4 hours to goal as tolerated. As such, goal EN is reached far sooner in burn patients.

- Let us assume a patient has an EN goal rate of 100mL/hour. If he is a burn patient his EN will reach goal in 6 hours. If he is a trauma/surgical patient he will reach his goal rate in 20 hours.
- Burn Center culture is one where nutrition is a priority of the burn team and, as such, RN's are more aware of the importance of starting, restarting, and continuing EN.

Since this was an RN-lead QA, RN education about the intervention proved effective since it was provided by their own educators. One of the biggest challenges in getting nursing on board is being able to have them see the importance of, and agree to participate in, the intervention. Our prior experience is that this is not always well received when presented by non-nursing professionals.

Our study results beg the question, why was there no change in outcome? We observed that as time passed the visual cue faded into the background of the many tasks ICU RN's must perform on a daily basis. Many described it as "just one more thing to do," a sentiment reflected in the data showing no significant change in behavior pre- and post-intervention.

Since there are several other visual cues already competing with ours maybe future studies call for a different reminder modality. Given the heavy reliance on electronic charting perhaps we could schedule automatic electronic reminders at fixed time intervals (every 2-4 hours?) anytime a patient is ordered to be NPO. Some sort of manual action/dismissal could be required to complete the reminder task at each interval to act as a working prompt.

Perhaps RD's should be given more responsibility to start/restart EN including placement and management of feeding tubes. Recent literature points to the effectiveness and cost savings associated with RD placement of feeding tubes.^{33,34} In a 2004 study, postpyloric feeding tubes placed by RD's showed no EN

interruptions compared to 56% in the gastric-tube control group thereby increasing delivery of goal EN.³⁵ In a study as recent as August, 2013 research showed that blind bedside placement of postpyloric feeding tubes by RD's were completed in less than four hours after the order was written and resulted in 73% success; when gastric feeding tube placement deemed appropriate for use was included, success rates jumped to nearly 90%. In addition, a 66% reduction in patient charges was associated with bedside feeding tube insertion. Therefore, patients received more timely initiation of EN with a marked reduction in cost.³³

Finally, maybe it is time for our Level 1 Trauma Center with three, 24-bed ICU's – Trauma/Surgical/Burn ICU, Neurosciences ICU, and Medical ICU – to adopt an EN protocol that could provide clear pathways to delivering optimal nutrition support. The PEPuP protocol previously mentioned is an example of a novel approach to thinking outside the box to push the boundaries of conventional thinking surrounding initiation and delivery of EN.¹⁸

Significant differences in outcomes between the burn unit and the rest of the ICU warrant further investigation. It would be interesting to examine the pure differences between EN delivery in the Burn Unit vs. the remaining trauma/surgical ICU population making sure to adjust for injury severity. It would further contribute to our existing knowledge base to determine which practices permitted increased delivery of EN on our burn pod such that they could be implemented more broadly across the TSBICU.

Using information we learned from the PEPuP protocol, we have recently started implementing 24-hour volume feeding in the Burn Unit to allow nursing greater flexibility to make up EN volume when patients are made NPO. A follow-up study to determine the effectiveness of this protocol would further contribute to answering the question of how we can improve EN delivery in the critically ill patient.

Chapter 4: Conclusion

Use of a visual cue to increase delivery of EN was ineffective on the TSBICU. It did not improve nutrition status, nor improve Braden scores or LOS. Burn patients, however, received significantly higher percentages of their target nutrition compared to the rest of the ICU population and tended to have longer LOS. Further research is warranted to uncover successful strategies to meet goal EN in critically ill patients.

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