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REVIEW, APPROVAL AND ACCEPTANCE

The document mentioned above has been reviewed and accepted by the student's advisor, on behalf of the advisory committee, and by the Assistant Dean for MSN and DNP Studies, on behalf of the program; we verify that this is the final, approved version of the student's DNP Project including all changes required by the advisory committee. The undersigned agree to abide by the statements above.

Lisa J. Fryman, Student

Dr. Karen Stefaniak, Advisor

Final DNP Project Report

A Trauma Resuscitation Team Program Evaluation

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University of Kentucky

College of Nursing

Fall 2014

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Capstone Overview

Working in a Level 1 Trauma Center offers ample opportunity to engage in processes to improve the trauma care delivery system for all trauma patients through a system approach. The purpose of this capstone project was to evaluate a newly implemented Trauma Intensive Care Unit (TICU) charge-nurse led trauma resuscitation team focusing on patient throughput efficiency, clinical and financial outcomes.

Trauma management is one of the major challenges in the care continuum starting with the emergency department (ED) through to the rehabilitation phase. The critically injured trauma patient is unique and complex, requiring a high level of specialized trauma care. In order to provide definitive trauma care the patient must arrive to the TICU in a timely manner. The first manuscript provides background data that details the significant constraints that emergency departments deal with daily due to overcrowding. A review of the literature provides data that support the finding that early mobilization of trauma patients to the TICU improves clinical outcomes. These data support the development and implementation of the TICU charge-nurse led trauma resuscitation team.

The second manuscript details the development and implementation of the charge nurse role in the TICU. A group of experienced charge nurses developed the role as a part of the trauma resuscitation team. Improved communication, collaboration, and handoffs among the TICU charge nurse and house-wide staff were realized along with the expected outcome of more efficient care for the critically injured trauma patient. The addition of the Trauma Service Line charge nurse as a clinical leader resulted in sustained throughput efficiency resulting in a 50% decrease in ED length of stay.

The third manuscript is a retrospective analysis of the clinical and financial data following the implementation of the TICU charge-nurse led trauma resuscitation team. Overall positive outcomes were shown for ED, intensive care, and hospital length of stay. While staffing was shown to increase during the pilot study, the decrease in the length of stay outweighed the staffing increase cost for an institutional cost savings.

The American College of Surgeons Committee on Trauma has made every effort to create a nationwide system that continually evaluates trauma care for needed improvements. To develop state of the art trauma care, one must look at the history of trauma care as well as new developments in trauma care. This capstone project demonstrated an innovative method to combine evidence-based clinical practice with hospital bed management which creates cost efficient trauma care without adversely affecting clinical outcomes.

Review of Trauma Patient Outcomes and ED Length of Stay

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Abstract

Purpose: Emergency Department (ED) data have long suggested that an increase in length of stay (LOS) has a negative impact on overall patient outcomes and satisfaction. Few studies exist on ED LOS and outcomes for trauma patients. The purpose of this literature review is to evaluate the association between ED LOS and trauma patient clinical quality outcomes.

Method: A search of MedLine and CINAHL databases for relevant nursing and medical journals was completed for the years 2002-2014. Search terms included trauma patient, outcomes, mortality and morbidity, ED length of stay, ED crowding, and trauma activation. Articles were reviewed if they addressed (a) ED length of stay and/or crowding; (b) contained quantitative and observational data; (c) trauma patient management; (d) patient outcome information; and (e) expedited transfer to a trauma intensive care unit (TICU).

Results: A total of 439 articles were identified of which 11 met the inclusion criteria. Three of the articles identified were systematic reviews, four addressed trauma specific patient outcomes, and four examined all ED patient outcomes. ED crowding and length of stay are associated with an increased risk for negative patient outcomes. Trauma specific data showed an increased risk in mortality, longer hospital and intensive care LOS, and higher pneumonia rates.

Conclusions: It has been suggested that ED LOS has an adverse effect on patient outcomes. Studies are now available that support increased ED LOS's negative impact on all patient outcomes with a small group related to trauma.

Clinical Relevance: The literature provides support that ED LOS has a negative effect on all patient outcomes with a small number specifically impacting trauma. Measures should be implemented to develop guidelines to address trauma patient outcomes impacted by ED crowding and extended ED LOS.

Review of Trauma Patient Outcomes and ED Length of Stay

Introduction

Trauma care and trauma patient outcomes are impacted by overburdened emergency departments. The 2006 Institute of Medicine (IOM) Future of Emergency Care report provided a comprehensive review of the history and future of hospital emergency care (Institute of Medicine, 2006). The IOM workgroup reported that hospital-based emergency care is overburdened, underfunded, and highly fragmented. As a result systems are ill prepared to handle any type of patient volume surge (Institute of Medicine, 2006). Olshaker (2009) reported that the American Hospital Association, the Centers for Disease Control, the National Hospital Ambulatory Medical Care Survey, and the National Center for Health Statistics data showed a 40% decrease in hospital inpatient beds and a 10% decrease in ED beds between 1981 and 2006. During this same time frame, there was a 32% increase in ED visits. While ED visits were on the rise, bed availability was decreasing. The Joint Commission and the General Accounting Office (GAO) have since acknowledged ED crowding as a system problem, and have further identified the failure to move admitted patients out of the ED to inpatient beds as the most significant factor in ED crowding (Olshaker, 2009).

Emergency department crowding leading to increased ED LOS has been recognized as a significant problem associated with negative patient outcomes. ED crowding is defined as any time inadequate resources are available to meet patient care demands leading to a reduction in the quality of care (American Academy of Emergency Medicine, 2006). Two components that contribute to ED crowding are patients using the ED as their primary care provider, and critically ill and injured patients who are admitted remaining in the ED due to inappropriate hospital beds or lack of available appropriate staffing on the inpatient units. As a discipline trauma is

unplanned and can create surge events at any time for emergency departments. Emergency Department data have long suggested that an increase in ED LOS has a negative impact on overall patient outcomes and satisfaction (Olshaker, 2009). The purpose of this literature review is to evaluate the association between trauma patient quality outcomes and ED length of stay.

Methods

Electronic databases MedLine and CINAHL were searched for relevant nursing and medical journals for the years 2002-2014. Search terms included trauma patient, outcomes, mortality and morbidity, ED length of stay, ED crowding, and trauma activation. Articles were reviewed if they (a) contained quantitative and observational data, and/or if they addressed (b) ED length of stay and/or crowding; (c) trauma patient management; (d) patient outcome information; and (e) expedited transfer to a trauma intensive care unit (TICU). These criteria were chosen to focus the search on ED LOS and its relationship with trauma patient outcomes. This initial search yielded only four studies. The search was expanded to include all patient outcomes and their association with ED LOS, allowing for a more robust pool of studies.

The more inclusive search produced 439 articles. Further in-depth reviews narrowed the list to 268 articles that were in English and included research from peer reviewed journals. Eleven articles met the inclusion criteria for this review. Excluded were studies that addressed modalities to fix ED crowding, causes of crowding, and care processes. The studies reviewed are organized into Table 1 using the categories of: (a) Reference; (b) Type of Study; (c) Purpose; (d) Sample; (e) Key findings; and (f) Level of Evidence. All studies were graded according to the American Association of Critical Care Nurses (AACN) Levels of Evidence (Armola et al., 2009). The AACN grading system uses grades A to E and M as categories; with A being the strongest and M reported as 'Manufactures' recommendation only' (Armola et al., 2009).

Results

Carter, Pouch, and Larson (2014) completed a systematic review of the literature to determine the relationship between ED LOS and patient outcomes. Two of the manuscripts reviewed were literature reviews evaluating patient outcomes and ED LOS (Bernstein et al., 2009; Johnson & Winkelman, 2011). These three reviews combined identified outcomes as; (a) delays in treatment, (b) morbidities, (c) hospital and intensive care unit (ICU) LOS, and (d) mortality (Bernstein et al., 2009; Johnson & Winkelman, 2011; & Carter et al., 2014). Four articles examined all ED patients and the association with ED LOS and patient outcomes (Richardson, 2006; Chalfin, Trzeciak, Likourezos, Baumann, & Dillinger, 2007; Singer, Thorde, Viccellio, & Pines, 2011; & (De Araujo, Khraiche, & Tukan, 2013) and four studies specifically examined trauma patient outcomes (Carr et al., 2007; Richardson et al., 2009; Mowery et al., 2010; & Bhakta et al., 2013). All studies used retrospective analysis of cohort studies, cross-sectional studies, cross-sectional analytical studies, and stratified cross-sectional studies. Several studies in the three literature review articles used pooled data from multiple EDs (Bernstein et al., 2009; Johnson & Winkelman, 2011; & Carter et al., 2014). None of these studies was a randomized controlled trial. The strength of the data was modest with all studies graded at Level C (Armola et al., 2009). A synthesis of the review highlighted mortality, complications, inpatient LOS, and ED specific outcomes as the factors most strongly correlated with trauma care and ED LOS.

Mortality

An increased risk of mortality and an increased overall hospital LOS were noted in five of the studies when patients remained in the ED compared to patients who did not experience an extended ED LOS of an average time of 2 to 6 hours (Richardson, 2006; Bernstein, et al, 2008;

Johnson & Winkelman, 2011; Mowery 2011; Carter, Pouch, & Larson, 2014). The review findings were then stratified into non-trauma and trauma patients to further examine the mortality data. The three literature reviews found the 7, 10, and 30 day mortality to be affected at an increased rate of 34% and hazard ratio of 1.26; mortality increased with ED LOS > 6 hours by 17.4%; patient's had an increased risk of mortality at 10-days inpatient stay with an odds ratio (OR) of 1.34; and mortality was inversely related to ED LOS (Bernstein et al., 2009; Johnson & Winkelman, 2011; Carter et al., 2014). Chalfin and colleagues (2007) compared critically ill patients' hospital and ICU mortality rates with an ED LOS of less than or greater than six hours. Chalfin's (2007) group found that patients with an ED LOS of greater than six hours had an increased ICU mortality rate of 10.7% (delayed) vs 8.4% (nondelayed) $p < 0.01$ and an in-house mortality rate of 17.4% (delayed) vs 12.9% (nondelayed) $p < 0.001$, as compared to those with an ED LOS of less than six hours. Both groups, greater than six hours and less than six hours were corrected for age, gender, injury severity score, and do not resuscitate (DNR) status. Singer, Thorde, Viccellio, & Pines (2011) compared an ED LOS of greater than or less than two hours, and found adjusting for age, case mix, time of day of ED admission, and gender, mortality was shown to be affected by an increase of 2% $p < 0.001$ with an ED LOS of over two hours. Richardson (2006) specifically showed that mortality increased from 0.31% to 0.42% ($p = 0.025$) with admissions during the time the ED was overcrowded.

Trauma-specific data were evaluated for mortality outcomes. Mowery's (2011) study showed an increased ED LOS to be an independent predictor (OR 1.003) of hospital mortality in critically injured patients that required trauma activation. Adjusting for injury severity and age, ED LOS greater than two hours had a higher mortality rate of 13.2% compared to 5.7% for ED LOS less than two hours, with an ED LOS between four and five hours mortality increased by

8.3%, and cause of death was most often attributed to late complications (Mowery, et al, 2011). Richardson and colleagues (2009) found that mortality did not increase with increased ED LOS at one institution. Richardson's team grouped their patients with ED LOS less than 6 hours and greater than 6 hours and showed the group with a shorter ED LOS had a higher mortality of 18% vs 2.3% $p = 0.00001$ (Richardson et al., 2009). The authors attributed this to the group possibly having more severe head trauma as they had a higher incident of positive head CT scans (58% vs. 41%) however, when the groups were stratified they showed no difference in mortality rates (Richardson et al., 2009). Richardson and group did support that critically injured patients should be triaged more rapidly to the ICU for specialized care (Richardson et al., 2009). Bhakta (2012) showed overall mortality unchanged in their study when a bed was available 24/7 in trauma ICU (TICU) at 9% vs. 8% pre and post implementation. A trend toward improved mortality was identified after protocol implementation in patients with injury severity scores (ISS) greater than 24 at 13% vs 30% ($p = .07$), and a head abbreviated injury score (AIS) greater than 2 at 6% vs. 12% ($p = .01$) (Bhakta et al., 2013).

Complications

Pulmonary complications such as pneumonia and ventilator associated pneumonia (VAP) have been found to be associated with extended ED LOS. Carr (2007) reported ED LOS to be a major risk factor for pneumonia in trauma patients. Each additional ED boarding hour added a 20% risk of pneumonia with an OR 1.21, ($p < .05$, 95% CI = 1.04 – 1.39). Pneumonia at one trauma center was associated with longer ICU LOS; 16.3 days compared to 5.1 days for patients without pneumonia and a longer hospital stay of 25.2 days compared to 11.2 days (Carr et al., 2007). Carr (2007) also reported that an increased injury severity score (ISS) did not affect pneumonia rates; but age greater than 50 years did affect pneumonia rates at an OR of 1.3, CI =

1.00-1.06. Patients with chest injuries with low AIS less than 3 appeared to be more likely to develop pneumonia as a function of ED LOS by OR 1.3 compared to OR = 0.9 for the group with lower ED LOS (Carr et al., 2007). In general, intubated blunt chest trauma patients are also at higher risk of developing a VAP by 3.5% (Carr et al., 2007). Patients with VAPs have an overall increased LOS, with VAPs adding an estimated \$40,000 to the total cost of hospitalization (Rello et al, 2002). The use of a VAP bundle has been found to decrease the risk of acquiring a VAP by 44.5% (Rello et al, 2002). The Institute of Healthcare Improvement (IHI) developed a central line bundle that included clinical evidence for best practice. The bundle included five major elements: 1) hand hygiene; 2) maximum barrier precautions; 3) chlorhexidine gluconate antiseptic; 4) optimal catheter site selection with avoidance of femoral vein use in adults; and 5) daily review of line necessity (Institute of Healthcare Improvement [IHI], 2011). The VAP bundle is considered the standard of care in the ICU and yet is not always initiated in ED (Carr et al, 2007).

Hospital and ICU Length of Stay

Hospital and ICU LOS were shown to be affected by increasing ED LOS in both categories of patients, all patients and trauma patients. Emergency department LOS ranging from two to greater than six hours increased hospital and ICU LOS by 1 to 3 days (Chalfin, Trzeciak, Likourezos, Baumann, & Dillinger, 2007; Mowery et al., 2010). Singer's (2011) study provided support that ICU admissions were more frequent with increased ED LOS. Bhakta (2012) showed that ICU readmissions rates were unchanged with implementation of their 24/7 trauma bed, which did decrease their ED LOS from 4.2 hours to 3.2 hours. Richardson (2009) demonstrated at their trauma center the group with longer ED LOS had a shorter hospital and ICU LOS by 2 to 4 days with ($p < .001$).

Emergency Department Specific Outcomes

Emergency department specific outcomes for left without being seen (LWBS), wait times (WT), treatment modalities, and quality of care were evaluated by several studies. These ED specific outcomes did not include any trauma patient data. Their findings were increased WT led to increased LWBS (OR from 1.01 – 1.12) and delay in treatments from 31% to 72% of critical procedures of door to needle time for myocardial infarction (MI) patients, time to antibiotic dosing for septic patients, and general medication administration (Bernstein et al., 2009; Johnson & Winkelman, 2011; Carter et al., 2014). Two studies specifically examined the effect of a lower socioeconomic population on ED outcomes of LWBS and WTs and found them to be higher in hospitals located in poorer neighborhoods (Bernstein et al., 2009; De Araujo et al., 2013). These facilities are used as ‘safety-net’ hospitals and have a disproportionately high number of uninsured persons (Bernstein et al., 2009). These results are important “given that uninsured patients do not typically have access to health services other than emergency rooms and typically experience preventable health outcomes that can be addressed with timely attention” (De Araujo et al., 2013, p. 5).

Conclusion

The purpose of this review was to evaluate the association between ED LOS and trauma patient outcomes. The search produced only four studies that were trauma specific, and the expanded search yielded an additional seven studies that met inclusion criteria. Two recent literature reviews and one systematic review (Bernstein et al., 2009; Johnson & Winkelman, 2011; Carter et al., 2014) found many studies that reported ED LOS had a significant influence on patient treatment modalities, ED specific WT and LWBS outcomes, and mortality rates. Seven single center studies showed that ED LOS had a negative impact on all patient outcomes,

including trauma outcomes and increased hospital and ICU LOS (Richardson, 2006; Carr et al., 2007; Chalfin et al., 2007; Mowery et al., 2010; Singer et al., 2011; De Araujo et al., 2013; Bhakta et al., 2013). Richardson and colleagues (2009) instead found at one trauma center the more critically injured were triaged more rapidly to their TICU, but had a higher hospital and ICU LOS and a higher mortality rate. They attributed this difference to the higher acuity of the nondelayed group of patients that were transferred to the TICU at that trauma center (Richardson et al., 2009).

Currently, the majority of early resuscitation of critically ill and injured patients occurs in the ED setting. The critically ill and injured patient is unique and complex, requiring a higher level of specialized trauma and critical care. ED staff must contend with a constant influx of patients requiring immediate triage, and this results in multiple episodes of interrupted and fragmented care. There is a growing body of literature that highlights the association of ED LOS with worse outcomes for all patients and now there is increasing evidence illustrating the same phenomenon in trauma specific patients. The effects of ED crowding are multifactorial; add the unplanned consequences of trauma events and emergency departments can be placed into a crisis at any time. Trauma Services should make rapid mobilization to the appropriate level of inpatient care a priority, as this will improve trauma patient outcomes and secondarily reduce ED LOS.

Table 1: Review of Literature Trauma Patient Outcomes and ED Length of Stay

Reference	Type of Study	Purpose	Sample	Key Findings	Level of Evidence
<p>Carter, E.J., Pouch, S.M., & Larson, E.L. (2014). The relationship between emergency department crowding and patient outcomes; A systematic review. <i>J Nurs Scholarship</i>, 46(2), 106-115.</p>	<p>Systematic Review</p>	<p>To assess the relationship between ED crowding and patient outcomes.</p>	<p>11 articles – all studies used measured ED crowding or measured a proxy of ED crowding (ED LOS, ED volume, ED capacity) & measured at least one outcome of morbidity and/or mortality. Excluded were studies related to interventions to alleviate crowding, care processes, tools to forecast or measure crowding. Study designs were retrospective cross-sectional, observational, stratified cohort; case-crossover; correlational; prospective cross-sectional, observational studies.</p>	<ul style="list-style-type: none"> • Findings are clinically important as ED plays a significant role in health care & the safety net for the US. • Increased ED LOS associated with adverse cardiovascular outcomes • LWBS increased by OR of 1.96 to 2.0 with increased LOS • 7, 10, & 30 day inpatient mortality increased with increased ED LOS of 34% & hazard ratio of 1.26 • Increased WR time is a predictor of care compromise in nurses and doctors by OR = 1.05 for additional 10min wait time. • Press-Ganey survey scores were inversely related to ED crowding 	<p>C</p>

Reference	Type of Study	Purpose	Sample	Key Findings	Level of Evidence
<p>Johnson, K.D., & Winkelman, C. (2011). The effect of emergency department crowding on patients outcomes. <i>Adv Em Nurs J</i>, 33(1), 39-54.</p>	<p>Literature Review</p>	<p>To summarize the findings of published reports that investigates quality patient outcomes and emergency department crowding.</p>	<p>23 articles – grouped in 3 categories of delay in treatment, decreased satisfaction, and increased mortality. Delays in intervention and mortality used retrospective, cohort, observational, & cross-sectional studies. Satisfaction studies used retrospective, cross-sectional, prospective (descriptive & survey), & secondary observational studies.</p>	<ul style="list-style-type: none"> • Quality care is impacted during crowding, resulting in delayed treatment & medication administration, decreased patient satisfaction, & increased mortality. • Delay in treatment – increased ED LOS resulted in increased time to treatment by 31 to 72%; ED LOS inversely associated with treatment; increased door to needle time for heart cath; increased time to pain meds. • Mortality – increased ED LOS > 6 hours to admit = 17.4% increase in mortality; Ambulance diversion did not show association with increased mortality; Risk of mortality at 10 days was 1.34 with increase ED LOS; hazard ratio at 2, 7, 30 days increased to 1.3, 1.3, 1.2 with ED crowding. • Patient Satisfaction – increased ED LOS = LWBS & time in WR increased (OR from 1.01 – 1.12), waiting time for inpatient beds & increased number of hallway beds. Greater patient dissatisfaction related to overcrowding by OR = .48. 	<p>C</p>

Reference	Type of Study	Purpose	Sample	Key Findings	Level of Evidence
Bernstein, S.L., et al. (2009). The effect of emergency department crowding on clinically oriented outcomes. <i>Acad Em Med</i> , 16(1), 1-10.	Literature Review	Review the medical literature addressing the effects of ED crowding on clinically oriented outcomes.	41 articles – studies were categorized in IOM quality domains of safety & effectiveness, timeliness, patient-centeredness, efficiency, equitability. Studies were cohort studies (prospective or retrospective) or clinical trials with quantitative data. Clinical endpoints included mortality, morbidity, treatment delays, patient satisfaction, and process measures of LWBS, LOS, and ambulance diversion.	<ul style="list-style-type: none"> • Mortality increased with ED LOS by 1.2, 1.3 hazard ratio; 1.34; mortality rates were inversely associated with ED LOS; increased volume was associated with mortality rates. • LWBS increased by 11% as volume increased • Treatments times increased 28 to 69% as ED occupancy increased. • Hospital LOS increased with ED LOS by 10%. • One study showed no relationship with total hospital LOS. • Poorer neighborhoods had increased waiting time of 10.1 min longer. 	C
Bhakta, A., et al. (2013). The impact of implementing a 24/7 open trauma bed protocol in the surgical intensive care unit on throughput and outcomes. <i>J Trauma</i> , 75(1), 97-101.	Retrospective Study	Comparative pre & post study following implementation of a 24/7 open trauma bed protocol in a surgical ICU at a level 1 trauma center. Evaluated ED LOS and mortality after implementation for a decrease.	Twelve months pre and post implementation of a 24/7 open trauma bed in a surgical ICU. Age, ISS, AIS, ISS, were adjusted for. ED LOS, ICU readmission rates, and mortality were measured. Group 1 – pre = 267 admitted directly to ICU Group 2 – post = 262 admitted directly to ICU.	<ul style="list-style-type: none"> • ED LOS decreased from 4.2 ± 4 hours to 3.2 ± 2.1 hours ($p = 0.07$) in all patients. • Mortality was unchanged for all patients (9% vs. 8%). • Trends of improved mortality after protocol in patients with ISS > 24 (30% vs. 13%, $p = 0.07$), & patients with head AIS > 2 (12% vs. 6%, $p = 0.01$). • ICU readmissions were unchanged (0.3% vs. 1.5%, $p = 0.21$). 	C

Reference	Type of Study	Purpose	Sample	Key Findings	Level of Evidence
<p>Mowery, N.T., et al. (2010). Emergency department length of stay is an independent predictor of hospital mortality in trauma activation patients. <i>J Trauma</i>, 70(6), 1317-1325.</p>	<p>Retrospective Study</p>	<p>To examine the relationship between ED LOS on activated trauma patients and hospital mortality of patients that do not undergo immediate surgical intervention.</p>	<p>One Level 1 Trauma Center’s database for years 2002 to 2009 admitted to trauma service. <i>N</i> = 3,973 Excluded: patient taken directly to OR < 2 hours, nonsurvivable brain injury, & ED deaths, & patients spending > 5 hours in ED due to having significantly lower acuity.</p>	<ul style="list-style-type: none"> • Group had mean age of 38.9 ± 17.4 years, ISS of 17.1 ± 12.6, overall mortality of 7.4%. • ED LOS = 195 ± 61 min; avg LOS from 216 min to 187min in 2009. • Hospital mortality increased for each additional hour spent in ED, with patients with ED LOS between 4 to 5 hours mortality was 8.3%. • Group 1 < 2 hours; Group 2 > 2 hours ED LOS. Groups: ISS, RTS, & age, were accounted for. Group 1 had shorter hospital LOS 2 days vs. 5 days. Group 2 had higher mortality rate 13.2% vs. 5.7%. ED LOS was shown to be independent predictor of mortality by OR of 1.003. • Cause of death most often were late complications. • Lactates had larger mean correction in the TICU vs. ED by -0.69 vs. -0.40mmol/L; <i>p</i> = 0.001. 	<p>C</p>

Reference	Type of Study	Purpose	Sample	Key Findings	Level of Evidence
<p>Richardson, J.D., et al. (2009). Effective triage can ameliorate the deleterious effects of delayed transfer of trauma patients from the emergency department to the ICU. <i>J Am Coll Surg</i>, 208(5), 671-681.</p>	<p>Retrospective Study</p>	<p>Evaluation to determine the impact of delayed transfer from the ED on outcomes in trauma/emergency general surgical patients in a center that has a policy to triage more critically ill/severely injured patients to earlier ICU admission.</p>	<p>Two year evaluation of one Level 1 Trauma Center’s database. Group 1 \leq 6 hours ED LOS (nondelayed); Group 2 $>$ 6 hours ED LOS (delayed). $N = 3,918$ ICU admits = 1643 Group 1 = 472 Group 2 = 1171 Excluded: ED deaths, patients admitted directly to OR within 4 hours. Age, gender, mechanism of injury, race, GCS, ISS, CT head findings were accounted for. Outcomes evaluated: ICU LOS, Hospital LOS, functional outcomes, post-discharge disposition, and mortality.</p>	<ul style="list-style-type: none"> • Group 1 vs. Group 2: ICU LOS = 9.6 ± 13.7 vs. $6.9\% \pm 7.8$ ($p = 0.001$); Hospital LOS = 10.5 ± 14.2 vs. 6.7 ± 8.4 ($p = 0.001$); FIM = 10.4 ± 2.5 vs. 10.7 ± 1.8 ($p = 0.001$); Home discharge = 74% vs. 75% ($p = 0.822$); Mortality = 18% vs. 2.3% ($p = 0.00001$). • Group 1 had lower GCS and higher incidence of positive CT head findings (58% vs. 41%; $p < 0.0001$). • Compared GCS and delay in 2 groups; GCS $<$ 8 mortality fivefold higher with early ICU admission $<$ 6 hours. GCS $>$ 9 stratified into 2 groups found four times greater mortality showing severe head trauma early admits did not impact outcomes. • Their data suggests that experience ED physicians & surgeons can effectively triage patients to appropriate care & can mitigate deleterious effects of prolonged ED LOS. 	<p>C</p>

Reference	Type of Study	Purpose	Sample	Key Findings	Level of Evidence
<p>Carr, B.G., et al. (2007). Emergency department length of stay: a Major risk factor for pneumonia in intubated blunt trauma patients. <i>J Trauma</i>, 63(1), 9-12.</p>	<p>Retrospective Cross-control Study</p>	<p>To study the association between prolonged ED LOS and rates of pneumonia.</p>	<p>Two year evaluation of one Level 1 Trauma Centers database. All patients that were intubated prehospital or in ED and developed pneumonia were identified as cases. A control group was matched for age, ISS, AIS chest & head that did not develop pneumonia. <i>N</i> = 509 Case group = 33 developed pneumonia. Control group = 107 Outcomes: pneumonia risk, ED LOS, ICU LOS, hospital LOS, mortality.</p>	<ul style="list-style-type: none"> • ED LOS was a significant risk factor for pneumonia. • Risk of pneumonia increased 20% for each additional hour the patient spent in the ED, (OR 1.21, <i>p</i> < 0.05, 95% CI = 1.04 – 1.39). • Pneumonia associated with longer ICU LOS (16.3 vs. 5.1, <i>p</i> < 0.001), & longer hospital LOS (25.2 vs. 11.2, <i>p</i> < 0.001). • ISS did not affect pneumonia rate. Age did affect pneumonia risk with increased ED LOS. Age > 50 years by OR 1.3, CI = 1.00-1.60. • Patient with low AIS chest injury AIS <3 appeared to be more likely to get pneumonia as a function of ED LOS (OR = 1.3, CI = 1.08 – 1.65 vs. OR = 0.9, CI = 0.72 – 1.20). 	<p>C</p>

Reference	Type of Study	Purpose	Sample	Key Findings	Level of Evidence
<p>Chalfin, D.B., et al. (2007). Impact of delayed transfer of critically ill patients from the emergency department to the intensive care unit. <i>Crit Care Med</i>, 35(6), 1477-1483.</p>	<p>Retrospective cross-sectional analytical review</p>	<p>To determine the association between emergency department boarding and outcomes for critically ill patients.</p>	<p>Cross-sectional analytical study using the Project IMPACT database (multicenter U.S. database of ICU patients). Patients admitted from ED to ICU for 3 year period. Group divided into 2 groups; Group 1 < 6 hours (nondelayed) & Group 2 ≥ 6 hours (delayed). <i>N</i> = 50,322 Group 1 nondelayed = 49,286 Group 2 delayed = 1,036 Groups adjusted for age, gender, DNR, APACHE II.</p>	<ul style="list-style-type: none"> • Mortality was lower in group 1 vs. group 2 (13.7% vs. 17.2%, <i>p</i> = 0.006). • ICU LOS (median) = 1.8 vs. 1.9 <i>p</i> < 0.001. • Hospital LOS = 6.0 vs. 7.0 <i>p</i> < 0.001. • ICU mortality rate 8.4% (nondelayed) vs. 10.7% (delayed) <i>p</i> < 0.01. • In-house mortality rate 12.9% (nondelayed) vs. 17.4% (delayed) <i>p</i> < 0.001. • Critically ill ED patients with ED LOS ≥ 6 hours had an increased hospital LOS, ICU mortality, & inpatient hospital mortality. 	<p>C</p>
<p>Singer, A.J., Thorde, Jr., H.C., Viccellio, P., & Pines, F.M. (2011). The association between length of emergency department boarding and mortality. <i>Acad Em Med</i>, 18(12), 1324-1329.</p>	<p>Retrospective Cohort Study</p>	<p>To evaluate the association between ED LOS and patient outcomes.</p>	<p>Evaluation of 1 academic medical center database with annual ED census of 90,000 visits. Outcomes: ED & hospital LOS, & inpatient mortality. Boarding defined as ED LOS ≥ 2 hours after decision to admit. <i>N</i> = 41,256 Adjusted for case mix; age, gender, race, weekend & shift.</p>	<ul style="list-style-type: none"> • Mortality increased with increasing boarding time from 2.5% for boarding < 2 hours to 4.5% in patients boarding ≥ 12 hours, (<i>p</i> < 0.001). • ICU admission increased with increased ED LOS • Hospital LOS increased with increasing boarding time from 5.6 days in patients boarding < 2 hours to 8.7 days for boarding ≥ 24 hours or more. 	<p>C</p>

Reference	Type of Study	Purpose	Sample	Key Findings	Level of Evidence
Richardson, D.B. (2006). Increase in patient mortality at 10 days associated with emergency department overcrowding. <i>Med J Aust</i> , 184(5), 213-216.	Retrospective Stratified Cohort Study	To quantify the relationship between ED overcrowding and 10 day mortality.	Evaluation of one tertiary care facility’s database for two years. Groups divided into overcrowded (OC) and not overcrowded (NOC). Group OC = 34,377 Group NOC = 32,231 Groups were adjusted for age and sex. Evaluation was also directed to shift, day of the week, interfacility transfer, & ambulance diversion.	<ul style="list-style-type: none"> • Mortality was higher in the OC group (0.42% vs. 0.31%, $p = 0.025$). • The relative risk of 10 day inpatient death was 1.34(95% CI, 1.04-1.72) • The cohort of patients presenting when ED had overcrowding had significantly higher 10 day mortality than NOC when adjusted for shift, day, season, & year. 	C
de Araujo, P., Khraiche, M., & Tukan, A. (2013). Does overcrowding and health insurance type impact patient outcomes in emergency departments? <i>Health Econ Rev</i> , 3(25), 1-7.	Retrospective Cross-sectional Study	To examine the impact of ED overcrowding on wait times & patient outcomes.	Evaluate one Level 1 Trauma Centers ED database for 9 months. Facility is located in an urban, low socioeconomic demographic area in the US. $N = 32,000$ Defined negative outcome as: mortality, elopement, LWBS, or leaving AMA.	<ul style="list-style-type: none"> • Adjusting for patient characteristics & patient’s medical condition at time of presentation to ED, they were able to isolate the direct impact of wait times on patient outcomes. • On average waiting an extra hour at the ED increases the likelihood of a negative outcome by 1.9%. • Private insurance & Medicare decreased the risk of negative outcomes by 0.6% to 0.8%. • No insurance increased the risk of a negative outcome by 0.14% 	C

Note: Abbreviated Injury Scale = AIS, Acute Physiology and Chronic Health Evaluation II = APACHE II, Against Medical Advice = AMA, Do Not Resuscitate = DNR, Emergency Department = ED, Glasgow Coma Score = GCS, Injury Severity Score = ISS, length of stay = LOS, left without being seen = LWBS, Revised Trauma Score = RTS, Trauma Intensive Care Unit = TICU, Waiting Room = WR

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A Trauma ICU Charge Nurse: Impact on Efficiency

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Abstract

Objective: To describe role development, implementation, and impact on efficiency of a Trauma Intensive Care Unit (TICU) Charge Nurse at a Level 1 Trauma Center.

Background: This academic medical center serves as the region's only Level 1 Trauma Center verified by the American College of Surgeons. The center provides the highest level of surgical care to trauma patients and efficient structures and processes are essential to quality patient outcomes. During calendar year 2012, a group of staff nurses was challenged to improve TICUs admission efficiency. Focusing specifically on improving throughput for the highest level of trauma activations, the nurses proposed the creation, development, and implementation of a formal charge nurse role for the Trauma Service Line. Nursing leadership for the Trauma Service Line supported the concept and served in an advisory capacity and provided support to evaluate outcomes.

Methods: Following a review of the literature and communication with other Level 1 Trauma Centers, the nurses created a TICU charge nurse position description, developed an implementation plan, and initiated a pilot project. Following the pilot project, the nurses and service line leadership identified the need for further refinement to improve communication, employee engagement, and the change management process.

Evaluation: Implementation of the Trauma Service Line charge nurse resulted in a decrease in emergency department (ED) average length of stay (ALOS) from 260 minutes to 110 minutes for the first month of the pilot project. Improved communication and collaboration among the TICU charge nurse, the ED shift supervisors, nursing operations, and the physician house staff were identified. Improved handoff for these high acuity patients was another positive outcome with frontline staff. Other benefits of the newly created Trauma Service Line charge nurse role

included an improved continuum of care, most specifically transitions in care from critical care to progressive and acute care.

Conclusion: The addition of the Trauma Service Line charge nurse as a nursing leadership role resulted in sustained ED to TICU throughput efficiency at a 50% decrease from the baseline 249 minutes to 126 minutes for the pilot study. Trauma Service line leadership believed this change was pivotal in the evolution of this trauma center from delivering episodic quality trauma care to complete trauma management. Expected outcomes associated with this important role were increased efficient care for the critically injured trauma patient with an end goal of improved morbidity and mortality.

Introduction

Recent health changes in health care reimbursement strategies have resulted in new challenges for the United States health care system. Institutional leaders changed their focus from volume-based care to value-based care, with a specific focus on population health (Kaiser Family Foundation [Kaiser], 2012). These changes focused attention on the management of chronic conditions, preventative medicine, health and wellness programs, primary care, and prevention of hospital acquired conditions (Institute of Medicine [IOM], 2010). As the largest sector of the healthcare workforce, with more than 3 million registered nurses in the United States, nursing is well positioned to make an impact on population health (IOM, 2010).

The Institute of Medicine (IOM) recommended that nurses be prepared and enabled to lead change to advance healthcare in the United States (IOM, 2010). Nursing leaders are expected to provide high-quality nursing care resulting in positive patient outcomes while often being pressured to reduce costs. The nurse leader must understand and support the ‘value aspect’ of patient outcomes. ‘Value’ is defined as maintaining nurse care team efficiency while continuing to deliver high-quality patient outcomes (IOM, 2010). It is important to have strong leadership at all levels of an organization in order to achieve this transformation in healthcare. Nurses should be full partners with physicians and other healthcare providers in order to realize this change (Sherman, Schwarzkopf, & Kiger, 2011). Clinical nurse leaders such as the frontline charge nurse are key positions to lead the change from volume-based to value-base operations while maintaining focus on quality and outcomes.

There is an increasing demand on academic medical centers to function more efficiently and continue to maintain high performance standards. Level 1 Trauma Centers are expected to function as regional resources for trauma care (American College of Surgeons, Committee on

Trauma [ACS-COT], 2006). In the early 1990s, emergency departments (ED) began experiencing ‘overcrowding’ in response to a decrease in ED and inpatient beds with an increase in ED patient volume (Olshaker, 2009). Managed care forecasted that the need for inpatient beds would decrease and emergency departments would see only patients with major trauma (Howard, 2005). However, this decrease in ED volume of low acuity patients has not been realized and ED length of stay (LOS) for all patients has increased (Carter, Pouch, & Larson, 2014). The leaders of the Trauma Service Line saw the need to develop a charge nurse role that would assist in efficiently moving the critically injured trauma victim out of the ED to the Trauma Intensive Care Unit (TICU).

Background

It is well documented that ED LOS contributes to increases in mortality and morbidity of the critically ill and injured (Chalfin, Trzeciak, Likourezos, Baumann, & Dillinger, 2007; Olshaker, 2009; Johnson & Winkelman, 2011; & Carter et al., 2014). Critically ill and injured patients evaluated in the ED that require hospital admission often remain in the ED when no hospital beds or appropriate ICU staffing are available. This trauma center struggles with throughput as do most trauma centers. The trauma volume at this trauma center outstrips the TICU’s bed availability most days which requires a highly efficient trauma team to manage the throughput. The TICU was staffed with the required number of nurses to manage the patient volume that was on hand. In the event of unplanned trauma, TICU staffing was not always prepared to accept these additional patients efficiently. The TICU charge nurse role was poorly defined with little focus on specific duties and lacked professional development of the individual charge nurse. Prior to the pilot the charge nurse was picked from a large pool of TICU staff that performed the role periodically and had no formal training in needed leadership competencies.

The TICU charge nurse also had a full clinical patient assignment, making it difficult to manage the timely and efficient movement of high acuity trauma patients to TICU. The need to limit the number of staff that formally functioned as the charge nurse and provide them with additional education and leadership development was identified. In response to these needs an ad hoc team of experienced staff nurses were asked to develop this role.

Theory

Transferring trauma patients from the ED to the TICU requires nurses from both areas to carefully coordinate their activities. Gittell (2003) Relational Coordination theory was developed to support such highly interdependent activities. According to Gittell (2003) high-quality communication and high quality relationships are the required elements that result in highly interdependent work units. High-quality communication is defined as frequent, timely, accurate, and problem-solving (Gittell, Seidner, & Wimbush, 2012). This type of communication allows parties to build relationships that focus on resolutions through familiar respectful conversations. High quality relationships develop based on shared goals, shared knowledge, and mutual respect (Gittell, 2003). Achieving a highly interdependent work environment through relational coordination should also result in improved staff outcomes and ultimately improve employee engagement and workforce commitment.

In order to be a high performing work unit, there must be high-commitment and high-relational characteristics within the team. Based on the theory of relational coordination, charge nurse development can be designed to use the creativity of these nurses (Gittell, 2003). Leveraging the nurse's creativity would result in a highly-effective and well-coordinated trauma team. These high-effective trauma teams are the essential group that guarantees Level 1 Trauma Centers function seamlessly to manage the unplanned event of trauma. Critically injured patients

require specialized trauma care that is best provided in a specialized TICU staffed highly trained trauma ICU nurses. Working to efficiently move these patients to the TICU for definitive trauma care was the focus of the charge nurse role.

One of the components of the relational coordination theory is the role played by the ‘boundary spanner’. According to Gittell (2003) boundary spanners have historically played an information-processing role. The charge nurse role as defined for this project acted as a boundary spanner: collecting, filtering, translating, interpreting, and disseminating not only information but clinical expertise across the patient’s care continuum from the ED to Acute Care and to the health care enterprise at-large. The charge nurse’s effectiveness in carrying out the relational characteristics depended on his/her ability to “read emotional and context cues” when dealing with physicians, administrators, and other health care team members (Gittell, 2003, p. 286). Looking at the charge nurse role through the lens of relational coordination allowed the development of strong employee to employee relationships through high-quality communication. When these relationships were developed and strengthened, improved patient outcomes and throughput efficiency resulted (Gittell, Seidner, & Wimbush, 2012).

Methods

In 2012, a cohort of experienced nurses developed the role of the TICU charge nurse. The ad hoc nurse team met with the Trauma Service Line nurse leaders to develop a list of job responsibilities and an implementation plan. The group’s main responsibility was to work collaboratively with the inpatient bed coordinator and trauma faculty member to always have a readily available trauma bed. The charge nurse assured staff readiness to receive the trauma victims through development of a formalized trauma resuscitation team in the TICU that would be led by a charge nurse. This resuscitation team was modeled after the ED resuscitation team.

The TICU resuscitation team was made up of TICU staff. The resuscitation team members had specific roles and responsibilities related to a defined trauma resuscitation. The charge nurse did not have a direct clinical patient assignment, in order to quickly respond to the unplanned event of trauma. The charge nurse is the constant and consistent health care team member arriving in the ED and facilitating movement of the patient to the TICU for continued resuscitation.

Other duties of the charge nurse role included participation in the daily multi-disciplinary TICU rounds in order to facilitate efficient movement and coordination of care for those trauma patients across the continuum of injury and healing. The charge nurse also rounded with the TICU team to facilitate dissemination of the pertinent information for patient progression from critical care to home. The charge nurse served as a liaison to the inpatient bed coordinator to ensure timely, efficient, and patient centered transfer of all patients across the trauma service line. The charge nurse also assisted the trauma service line patient care manager with purposeful patient rounds in order to positively impact the patient experience and satisfaction with care received. Finally, the charge nurse functioned as an expert clinical nurse resource for the trauma progressive and acute care units serving to improve throughput and patient outcomes.

Once in place, the charge nurses and Trauma Service Line leaders identified the need to develop effective communication, empowering skills to engage nursing colleagues and other staff in workplace initiatives, and change management processes. Weekly meetings with Trauma Service Line nurse leaders were used as a vehicle to assist with the leadership development. These meetings were designed to problem-solve issues and concerns that had been identified and guests-experts were invited to serve in supportive and mentoring roles. A leadership workshop that focused on crucial conversations, empowerment, and ownership of their work unit was included in the training. The nurses also attended a formal two-day course on Crucial Conversations. Development of nurse leadership skills has been a continued as a priority for the Trauma Service Line nursing leadership.

Evaluation

The overarching goal of this process was to facilitate a safe, efficient, and timely transfer of the most critically injured patients to the TICU, thereby decreasing the ED LOS without negatively impacting patient outcomes. Efficiency was enhanced by the addition of the charge nurse role. A retrospective analysis of the effect of the charge nurse on ED LOS was performed. The time periods pre and post-implementation were matched to account for trauma seasonal variation. An average decrease of 50% was seen in ED LOS with 249 minutes in the pre-implementation group to 126 min ($p < .001$) in the post-implementation group with no negative impact on clinical outcomes such as infection rates, pulmonary emboli, and acute renal failure.

The Trauma Service Line nursing leaders and the ad hoc nursing group realized the TICU charge nurse role had evolved into a nursing leadership role. The expansion of the responsibilities made it necessary to limit the charge nurse group to a small number of experienced staff. When considering the charge role changes, it was identified that more training in leadership was needed. The staff identified areas of focus as: managing conflict, understanding finance, delegating to others, coaching, making staffing decisions, and specific patient satisfaction information. Weekly meetings with nursing leaders addressed finance, staffing decisions, patient satisfaction questions, and real-time issues. Through these meetings nursing leaders were able to coach staff in conflict management and offered opportunities for staff to speak directly with guest-experts to resolve these issues. The leadership workshop was designed to develop the charge nurse's leadership skills. A solid foundation for leadership development was established through this training. This pilot saw an improvement in communication and collaboration among the TICU charge nurses, the ED shift supervisors, inpatient bed coordinators, and the physician house staff. Improved handoffs for these high

acuity patients with frontline staff were also realized. The new role also supported the continuum of care in the acute and progressive care units. Although the crucial conversations education was effective, the need for additional communication training was identified. Future educational programs need to use case-based methods to develop communication strategies to manage difficult situations.

Conclusion

Although succession planning is an essential competency for the nurse executive (American Organization of Nurse Executives [AONE], 2005), developing nurse leaders is a responsibility of everyone in the nursing profession. Nurse leaders are present throughout all levels of care within organizations, with the clinical nurse being perhaps the most important. Through the development of the charge nurse role, the Trauma Service Line created efficient throughput for critically injured trauma patients and developed the nurse leaders for the future. There has been emphasis on the development of formal nurse leader roles, but this project put in place a program that went deeper in the organization and started with the leaders at the bedside. The charge nurse role gives nurses the opportunity to experience a nursing leadership role in a protected environment (Sherman et al., 2011). Development of nursing leadership with the charge nurse across the Trauma Service Line has expanded the provision of quality, efficient, and patient centered care to encompass trauma care management across the care continuum.

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Trauma ICU Resuscitation Team Program Evaluation

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Abstract

Objective: To evaluate the effectiveness of a newly implemented charge nurse-led trauma resuscitation team approach in the Trauma Intensive Care Unit (TICU). The approach was developed to improve patient throughput efficiency at a Level 1 Trauma Center. Measures of effectiveness include patient throughput efficiency, patient clinical outcomes, and financial impact.

Design: A retrospective comparative analysis

Setting: A rural/suburban Adult Level 1 Trauma Center

Participants: All level 1 trauma activations during the pre and post-implementation period that were admitted directly to the TICU. The time periods pre- (October 1, 2011 to June 30, 2012) and post- (October 1, 2012 to June 30, 2013) implementation were matched to control for seasonal variation in trauma volume.

Main Outcome Measures: Data were obtained from the institution's trauma database and compared emergency department (ED), ICU, and hospital length of stay, complication rates, and mortality of the pre- and post-implementation groups. Nursing productivity data and hospital cost data for the same time periods were obtained from the institution's departments of nursing and finance.

Results: The implementation of the charge nurse-led trauma resuscitation team showed an improvement in efficiency of patient throughput by rapidly mobilizing the critically injured patients to the TICU. Complication rates did not change. Mortality rates showed a small increase during the post-implementation group, but the group's observed mortality remained below the expected. The two groups did not differ significantly in demographics and the post-implementation group showed a small increase in injury severity. Nursing productivity data

showed an increase in staffing; however, the cost savings of the decreased ICU length of stay outweighed the added cost of one nurse.

Conclusion: The TICU charge nurse-led trauma resuscitation team made possible the efficient move of critically injured trauma patients to the appropriate ICU. The essential element of this team was the charge nurse without a direct patient assignment. This efficiency has potential cost savings without adversely affecting patient outcomes.

Trauma ICU Resuscitation Team Program Evaluation

Introduction

As early as 1918, early intervention for traumatic injuries was identified to result in improved outcomes (Marquis, 1918). Soldiers treated within one hour of injury were found to have only a 10% mortality rate, but with increasing time between injury and treatment the mortality rates increased in the 1918 investigation by Marquis. Based on these data, the concept of the “Golden Hour” was developed, emphasizing that early initiation of definitive trauma care improved survival rates and outcomes for these patients (Cowley et al., 1973). Today, unintentional injury is the fifth leading cause of death in adults for all age groups in the United States, and is the most common cause of death in individuals ages 1 to 44 (Center for Disease Control [CDC], 2012, Findelstein, Corso, & Miller, 2006).

Patients with life threatening injuries present to the emergency department (ED) for initial care and stabilization. Critically ill and injured patients evaluated in the ED that require hospital admission often remain in the ED when no hospital beds or appropriate staffing are available. A 40% decrease in hospital inpatient beds and a 10% decrease in ED beds occurred between 1981 and 2006 (Olshaker, 2009). At the same time inpatient bed availability was declining there was a 32% increase in ED visits. This mismatch in patient volume and bed availability was overburdening emergency departments. The Joint Commission and the General Accounting Office (GAO) recognized and acknowledged ED crowding as a system problem, and have further identified the failure to move admitted patients out of the ED to inpatient beds as the most significant factor in ED crowding (Olshaker, 2009).

Emergency Department data have long suggested that an increase in ED length of stay (LOS) has a negative impact on overall patient outcomes and satisfaction (Parkhe, Myles, Leach, & Maclean, 2002; Carr et al., 2007; Olshaker, 2009). Little data exists about ED LOS’s relationship on specific outcomes in trauma patients. Currently, the majority of early

resuscitation of trauma patients occurs in the ED of many trauma centers. The critically injured trauma patient is unique and complex, requiring a higher level of specialized trauma care. The development of standardized protocols in trauma care has led to improved outcomes (American College of Surgeons, Committee on Trauma [ACS-COT], 2006, Mowery et al., 2011).

Guideline/protocol adherence is greatest when staff most familiar with the guidelines is executing them (Mowery, et al, 2011). This trauma center struggles with throughput issues in the ED as do many trauma centers nationally. One focus should be the rapid mobilization of the critically injured trauma patient to the TICU.

Adverse outcomes have been reported when patients requiring critical care remain in the ED (Carr et al., 2007; Bernstein et al., 2009; Olshaker, 2009). Although ED nursing is highly specialized, the focus is on caring for all patients with all conditions. The ED system is designed to efficiently diagnose injuries but typically does not have the dedicated manpower to treat the critically injured trauma patient. Standardized ICU bundles have long shown a positive impact on patient outcomes in ICU care (Resar, Griffin, Haraden, & Nolan, 2012). Trauma protocols have been developed over the past twenty to thirty years using evidence-based practice to achieve optimal outcomes for this complex population (ACS-COT, 2006). These trauma/ICU protocols are highly specialized and are not always implemented in the ED due to the volume of patients the ED nurse must manage (Mowery et al., 2011). Delivering inpatient critical care is resource intensive, and the inability to deliver this specialized care in the ED has been shown to have negative outcomes (Carr et al., 2007; Chalfin, Trzeciak, Likourezos, Baumann, & Dillinger, 2007; Parkhe, Myles, Leach, & Maclean, 2002).

The severely injured trauma patient requires specialized trauma care driven by standardized protocols. Emergency department staffing does not have the same patient nurse ratio as ICU staff. ICU patient nurse ratio will be one or two patients to one nurse depending on the patient acuity. The ED staff ratio could be as many as six patients to one nurse with a mix of ED, ICU, and/or intermediate patients. The ED staff also contends with a constant influx of patients requiring immediate triage which results in multiple episodes of interrupted and fragmented care. Most importantly, it is unrealistic for ED staff to maintain competency in all patient specific guidelines. In order to provide quick definitive care to critically injured trauma patients in a Level 1 Trauma Center, it is essential that the patients arrive to the TICU in a timely manner (ACS-COT, 2006). In addition, the TICU must be prepared to receive the patients without delay. Long ED LOS has been found to be associated with an increase in hospital mortality and morbidity rates, overall hospital LOS, and ICU LOS (Bernstein et al., 2009, Mowery et al., 2010). Understanding ED and ICU practice differences and the negative impact long ED LOS can have on patient outcomes, patient satisfaction scores, and employee engagement scores led to the development of a proposal for a TICU charge nurse-led trauma resuscitation team to facilitate throughput to the TICU.

This study was approved by the University of Kentucky Medical Institutional Review Board. All data were de-identified before analysis and reporting. All data will be maintained on a password-protected computer that is HIPPA compliant.

The purpose of this study was to evaluate the implementation of the TICU charge nurse-led trauma resuscitation team on:

- 1) outcomes: (a) ED LOS, (b) Hospital LOS, (c) ICU LOS, (d) complication rates, and (e) mortality between the pre and post-implementation groups

- 2) the model's impact on nursing unit staff productivity
- 3) the model's effect on financial cost effectiveness

Methods

Study Setting

UK HealthCare is an 825 bed quaternary care center that serves central and southeastern Kentucky. UK HealthCare Chandler campus is verified by the American College of Surgeons Committee on Trauma (ACS-COT) as an Adult Level 1 Trauma Center. The trauma team evaluates and/or admits between 2900 and 3200 adult patients annually and of these approximately 460 are the highest level of activation. The blunt versus penetrating trauma distribution is 90% blunt and 10% penetrating. This distribution is significant because blunt trauma patients have a higher percentage of multi-system injuries and a higher injury severity score (ISS) in general resulting in a longer length of stay. To further control the study setting, the charge nurse-led trauma resuscitation team was implemented in the TICU. This unit has a dedicated group of surgeons and staff that operate in a highly protocolized manner with a priority for trauma care.

Study Population

The study population consisted of all the highest-level of trauma activation patients' ages 15 and greater during the pre- and post-implementation periods. Patients undergoing emergent surgery, dead on arrival, death within 24 hours, nonsurvivable head injury as defined by a head abbreviated injury scale (AIS) of 5 or 6, and patients admitted to other ICUs and non ICU units were excluded leaving only patients admitted directly to TICU from the ED for analysis.

Trauma Activation Criteria

A trauma centers' level of response for trauma patients is defined by the resources required to manage that particular patient's injuries. UK HealthCare has two levels of activation. The highest-level of activation is labeled a Trauma Alert Red (TAR); which is reserved for the patients that are potentially the most critically injured (American College of Surgeons, Committee on Trauma [ACS-COT], 2006). The TAR criteria include the ACS-COT's required standards for a facility's highest level of activation (ACS-COT, 2006). The second tier of activation is designed for the less severely injured and is labeled a Trauma Alert (TA). These levels of activation are triggered by physiology, anatomical injuries, and mechanisms of injury that are recognized to be associated with the need for emergent intervention (ACS-COT, 2006).

Trauma ICU Resuscitation Team Model

The unplanned event of trauma and the complex care required to treat these patients makes planning and providing quick definitive care challenging. Exceptional trauma care relies on a framework of a well-communicated and organized approach to the delivery of trauma care (ACS-COT, 2006). The pre-intervention standard staffing model in TICU was for all staff nurses to have an acuity based patient assignment including the charge nurse. This staffing plan drastically reduced the ability to move additional critically injured patients to definitive care in the TICU in a timely manner. The TICU charge nurse-led trauma resuscitation team model was designed so that the charge nurse did not have a direct patient assignment. The group of charge nurses consisted of a small group of experienced trauma nurses from the TICU. The remaining trauma resuscitation team members were made up of the TICU staff. Their trauma resuscitation team roles and responsibilities were well defined using the ED resuscitation team as their model (ACS-COT, 2006). The TICU staff participated in the resuscitation team following trauma team training which consisted of critical clinical elements of the trauma resuscitation.

During the pilot of the TICU charge nurse-led trauma resuscitation team, the charge nurse would start the shift without an assignment. Some key duties of the charge nurse were to make patient assignments, develop alternative assignments to accommodate rapid admission if a trauma patient arrived, and to round with the physician teams to understand and facilitate patient movement strategies. The essential role of the charge nurse was to respond to the ED when a TAR activation occurred. Their responsibility in the ED was to communicate with the trauma attending to determine if the patient needed rapid movement to the TICU. At this time the inpatient bed coordinator was involved in the decision to assist in making a bed available. The charge nurse then alerted the unit and the TICU resuscitation team prepared for the patient. Preparation involved readying the room and handing off assignments as directed by the charge if necessary. The patient was moved to the unit without delay where the trauma team was ready and the resuscitation continued. The TICU charge nurse-led trauma resuscitation team model allowed for the more efficient move and resuscitation of the critically injured patient. The TICU charge nurse-led trauma resuscitation team implementation has addressed these potential constraints through expanded communication with the trauma team, inpatient bed coordinator, ED staff, and TICU staff.

Data Collection

A retrospective comparative analysis study evaluating implementation of the TICU charge nurse-led trauma resuscitation team was completed. The study reviewed the records of all TAR patients admitted directly to the TICU from the ED in the pre- and post-implementation groups. The groups compared for clinical and financial outcomes. The clinical and finance data were obtained from the institution's trauma database and finance department. The pre- and post-implementation time periods were matched to account for trauma seasonal variation. The pre-

implementation period was October 1, 2011 – June 30, 2012 and the post-implementation period was October 1, 2012 – June 30, 2013. De-identified demographic and outcome data were obtained from the institution's trauma database and stored on a secure password protected computer.

Outcome Measures

The outcome data for ED LOS were reported in minutes, ICU and hospital LOS data were reported in days. Complications included in the analysis were ventilator acquired pneumonia (VAP), pneumonia, acute respiratory distress syndrome (ARDS), pulmonary emboli (PE), and renal failure as noted in the trauma database. Complication rates were reported in percentages for positive diagnoses for each group. Mortality data were reported as observed vs. expected (O/E) ratio from the trauma database. Nursing productivity data evaluated full time employee (FTE) usage for the pre- and post-implementation groups for potential overstaffing using the University Health Consortium (UHC) Operational Database (ODB). The institution benchmarks with UHC for clinical, staffing, and financial outcomes. ICU room and board cost was chosen to evaluate for potential cost savings since ICU stay is one of the biggest drivers of cost for a hospital stay. Using ICU room and board only eliminated the variability in patient specific treatments/procedures and supply usage. Financial evaluation included the affect the charge nurse without an assignment had on the unit staffing budget.

Statistical Analysis

The two groups were compared for age, gender, ISS, mechanism of injury defined as blunt and penetrating, outcomes, and trauma injury severity score (TRISS). Bivariate analysis was used to compare demographic and clinical characteristics between the two groups. Group comparisons for normally distributed continuous variables were compared using the two-sample

t-tests. Continuous variables in the two groups that were not normally distributed were compared using the Mann Whitney U test and presented using the median and ranges. Group comparisons for categorical variables were compared using the chi-square test of association. Multivariate linear regression analyses were performed using log-transformed versions of ED, ICU, and hospital LOS because of right skewed distributions. Variance inflation factors (VIFs) were used to assess multicollinearity. The coefficient for the intervention along with 95% confidence interval (CI) was then exponentiated to obtain the percent change in LOS outcomes. Complication rates were compared using the Fisher's exact test for binary variables. Mortality was evaluated using a Z-score and reported as observed vs expected (O/E) ratio. Significance was set at $p < .05$ for all statistical tests. SPSS version 22.0 (SPSS Corp., Chicago, IL) was used for analysis.

Nursing productivity was compared using the average FTE usage between the pre- and post-implementation groups. Hours per Patient Day (HPPD) were calculated and benchmarked using the UHC ODB compare groups for Academic Medical Centers with Level 1 Trauma Centers. The ODB establishes a target HPPD for like units, and the finance department reports each unit's actual FTE usage as compared to the established target HPPD. Nursing productivity was reported FTEs required to provide appropriate patient care by acuity. ICU room and board cost was obtained from the finance department for the defined time periods. The cost was calculated using the mean change in ICU LOS multiplied by the daily ICU room and board cost.

Results

There were 4,343 trauma admissions during the pre- and post-implementation periods. Of these, 2,377 met trauma activation criteria. A total of 698 patients arrived meeting TAR criteria; in the pre-implementation group ($n = 368$) and the post-implementation group ($n = 330$).

Patients undergoing emergent surgery, deaths within 24 hours, dead on arrival, ED deaths, nonsurvivable head injuries, and patients admitted to other ICUs and non ICUs were excluded for a total of 169 patients in this study. The final analysis included 75 patients in the pre-implementation group and 94 patients in the post-implementation group (Figure 1).

The group's demographics were well matched with respect to age, ISS, mechanism of injury, and TRISS. The mean age in the pre-implementation group was 46.28 years \pm 19.20 years and in the post-implementation group was 45.37 years \pm 18.40 years. The mean ISS in the pre- and post-implementation groups was 15.89 \pm 8.92 and 18.37 \pm 9.43 respectively. Table 1 shows characteristics of the study groups. The mean ISS and TRISS were slightly higher in the post-implementation group but not statistically significant.

Median LOS for ED, ICU, and hospital are displayed in Figure 2. ED LOS reported in minutes was significantly less in the post-implementation group (239 vs 66; $p < .001$). Median ICU and hospital LOS are reported in days. Compared to the pre-implementation group, the median ICU LOS was shorter in the post-implementation group (3.29 vs 2.98; $p = .13$) and the median hospital LOS was shorter in the post-implementation group (10.71 vs 7.98; $p = .13$) though these differences did not reach statistical significance. The distribution of the ED, ICU, and hospital LOS is less variable in the post-implementation groups as compared to the pre-implementation groups. Although the median LOS was slightly less in the post-implementation group for ICU and hospital LOS it was not statistically significant.

A regression model was built with known risk factors for LOS outcomes. Results from the linear regression models are displayed in Table 2. All models included the same set of covariates: age, gender, mechanism of injury, ISS, and intervention group. All VIFs were less than 1.1, suggesting multicollinearity was not an issue. The overall model for log-transformed

hospital LOS (in days) was significant ($F= 12.97$; $p<.001$). Age, ISS, and intervention were significantly associated with total hospital LOS. Controlling for all other variables in the model, a ten-unit increase in age was associated with an 8% increase in hospital LOS. For every one-unit increase in ISS, the expected number of hospital days increased by 6%. Compared to those in the pre-implementation group, those in the post-implementation group had a 28% decrease in LOS ($p=.026$) resulting in a 4.34 day decrease in hospital LOS.

The overall model for log-transformed ICU LOS (in days) was significant ($F= 13.16$; $p<.001$). Age, ISS, and intervention were significantly associated with total ICU LOS. A ten-unit increase in age was associated with a 1% increase in ICU LOS. For every one-unit of increase in ISS, the expected number of ICU days increased by 6%. Compared to those in the pre-implementation group, those in the post-implementation group had a 29% decrease in ICU LOS ($p=.042$) resulting in a total of 2.12 day decrease in ICU LOS.

The overall model for log-transformed ED LOS (in min) was significant ($F=10.41$; $p<.001$). The intervention had the only significant association with ED LOS. Patients in the post-implementation group had a 54% decrease in ED LOS compared to the pre-implementation group ($p<.001$) resulting in a 154.56 min decrease in ED LOS.

Complication rates are compared in Table 3. There were no differences between the rates of the two groups. The rates were the same or showed a downward trend in the post-implementation group. Mortality did show an increase in the post group, but the O/E index ratio remained below 1.00 (pre = 0.87 vs post = 0.92).

The FTE average usage in the post-implementation group differed by an increase of 3.89 FTE of actual worked hours (Table 4). After adjusting for increased volume and acuity the actual staffing was associated with one nurse over the ODB target for actual worked hours in the

TICU. At this institution one nurse around the clock equals 3.75 FTEs for actual worked hours. The average cost for an ICU nurse at this institution during the study period was \$624/day. Using the mean ICU LOS decrease of 1.71 days at a rate of \$1144 for average room and board there was a total cost savings of \$1,956/patient. The decreased ICU LOS dollars minus the increase in nurse salary dollars resulted in an overall savings of \$889 per patient.

Discussion

There have been many triaging protocols developed to decrease ED LOS that positively impact patient outcomes (Parkhe et al., 2002). Combining bed management with the TICU charge nurse-led trauma resuscitation team was a new initiative in managing the critically injured trauma patient. The charge nurse and inpatient bed coordinator worked together to maintain an open TICU bed. The charge nurse was essential in relaying patient placement needs to the inpatient bed coordinator. The two worked with the trauma attending to identify patients that no longer required ICU management, and collaborated with nursing managers to ensure a bed was always readily available and staffed for the next trauma patient. The implementation of the TICU charge nurse-led resuscitation team demonstrated substantial improvement in ED LOS resulting in a median LOS change from 239 minutes in the pre-implementation group to 66 minutes in the post-implementation group.

The TICU charge nurse-led trauma resuscitation team protocol assured that trauma patients were managed in the appropriate units where the nurses were most familiar with trauma specific resuscitation guidelines and endpoints of resuscitation. Prior to the implementation of the TICU charge nurse-led trauma resuscitation team, trauma patients could be admitted to other ICU beds as they were available. This pilot had an increase in appropriate ICU admissions from 37.2% in the pre-implementation group to 47.9% in the post-implementation group.

Without controlling for age, gender, mechanism of injury, and ISS there was not a significant difference between the pre- and post-implementation groups for hospital and ICU LOS. However, when controlling for these variables there was a statistically significant difference in the pre- and post-implementation groups in hospital and ICU LOS of 2.12 and 4.33 days respectively.

The expected outcome was a decrease in complication rates. However, complication rates remained the same or trended downward. The complication rates for the time periods studied were relatively low in both pre- and post-implementation groups at less than 10%. While there were no changes in the complication rates, this is clinically relevant as the intervention did not result in negative outcomes.

Probability of survival is difficult to predict due to the many variables that must be considered. TRISS is a logistic survival probability formula that assesses and adjusts for injury severity, age, and the physiology of the patient's vital signs upon arrival to the ED (Kilgo, Meredith, & Olser, 2006). TRISS remains the standard method used to predict survival and correct for severity in outcome analysis in trauma victims (Kilgo et al., 2006).

Mortality was slightly higher in the post-implementation group but the observed mortality was still lower than expected based on age, injury severity, and vital signs at time of presentation. This can be explained by the slightly higher increase in ISS from 15.89 ± 8.92 in the pre-implementation group to 18.37 ± 9.43 in the post-implementation. The TRISS score was slightly lower from 0.7423 ± 0.2536 for the pre-implementation group to 0.6112 ± 0.2724 in the post-implementation group, indicating a higher number of expected deaths in this group. To address the question of concern that the decrease LOS was due to the mortality, the model was

performed without the deaths. The ED and ICU LOS remained statistically significant and hospital LOS changed to marginally significant ($p=.052$).

The results of this study provide support for positive patient outcomes while appearing to increase the need for RN FTEs. It is important for facilities to improve efficiency while maintaining high quality cost effective care (Institute of Medicine, 2006). The charge nurse without a direct patient assignment for the pilot did have an impact on the staffing budget. The post-implementation group was overstaffed by one nurse per the ODB target. When first implemented, the staff had difficulty changing assignments mid-shift as this is not the typical workflow of an ICU nurse. The charge nurse worked with the staff to ensure flexibility in patient assignments resulting in a more seamless process. In this study the charge nurse without a direct patient assignment did not have a negative effect on the overall cost. The cost savings realized from the ICU LOS mean day decrease offset the cost of the additional nurse needed to staff the charge nurse role. There was an actual cost saving of \$889 per patient. This is a conservative cost estimate as there are other foreseeable cost savings with the decrease in ED and hospital cost savings that was not calculated in this study.

This pilot was conducted in a TICU where beds are limited and being responsive to the unexpected event of trauma was critical to manage highly effective quality trauma care. The pilot TICU charge nurse-led trauma resuscitation team demonstrated a significant improvement in ED LOS and a small decrease in hospital and ICU LOS among trauma patients admitted directly to the TICU from the ED. The essential element of this team was the charge nurse without a direct patient assignment. This study provided support for the role of the charge nurse without a patient care assignment. Implementation of a charge nurse without a direct patient assignment to lead the trauma resuscitation team demonstrated improved efficiency while

providing a potential cost savings. The combined results of this study illustrate the benefits of ensuring a TICU bed is always available and staffed with specialty trained trauma staff for next trauma patient.

Limitations

The study was retrospective in nature and was performed at a single center. The evaluation was strictly limited to patients admitted to TICU and a small percentage of TAR patients were admitted to other ICUs within this facility. A comparative study is needed to evaluate patient outcomes when care is provided in non-trauma ICU environments and without specialty trained staff in trauma care. The review of outcomes only included ED, ICU, and hospital LOS without evaluating for ICU readmissions, number of procedures performed, and barriers to transfers. Resuscitation markers were not reviewed to determine the effectiveness of the resuscitation in the TICU vs the ED. Resuscitation markers such as normalization of pH, lactate, base deficit, and the amount of crystalloids and blood products used during the resuscitation should be examined. Understanding if these markers were reached sooner with the rapid transfer to the TICU resulting in less aggressive resuscitation should be the next question to evaluate.

Conclusion

Rapid access to the TICU facilitated by the TICU charge nurse-led trauma resuscitation team provided a potential cost savings without adversely affecting patient outcomes at this Level 1 Trauma Center. The pilot provided data that showed an improvement in ED, ICU, and hospital LOS as well as an improved admission to the appropriate ICU with specialty trained staff for critically injured patients. The essential element of this team was the charge nurse without a direct patient assignment. When the charge nurse did not have an assignment they were able to

maintain the unit readiness through collaboration with the inpatient bed coordinator, the trauma physician, and staff. The expanded leadership role of the charge nurse has developed into an integral part of the Trauma Team. These charge nurses are expected to lead staff in continuing efforts to accomplish the unit's goals to insure the needs of the patients are met (Eggenberger, 2012). The process of admitting critically injured patients more efficiently to the TICU has been sustained at this Level 1 Trauma Center. The data suggest that the potential positive clinical and financial impact this model provides is an innovative approach to improve patient flow in today's challenging health care environment.

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Figure 1: Pre and Post-Implementation Patient Volume

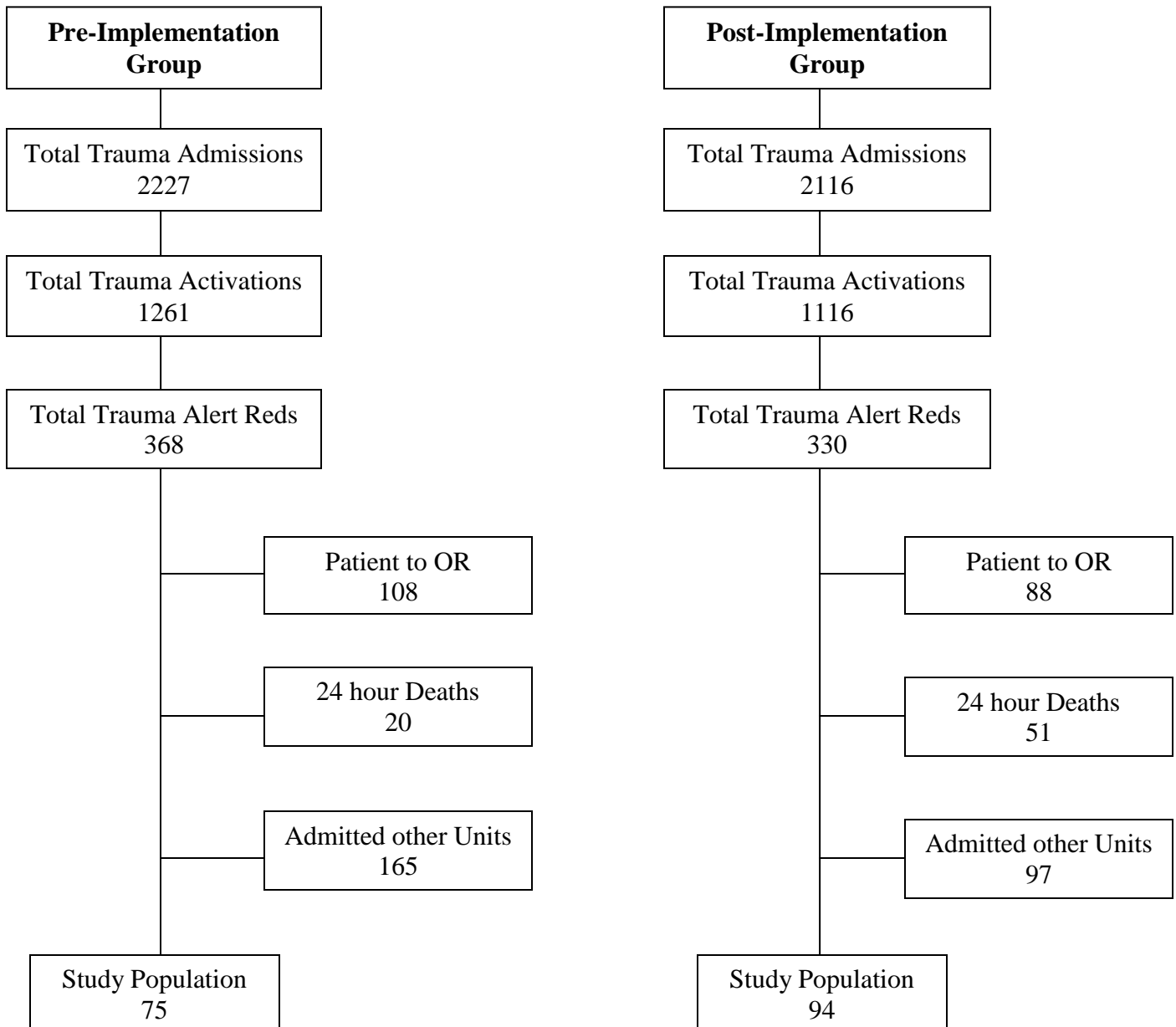


Table 1: Demographic Data of Trauma Activations Groups

Demographics	Pre (n = 75)	Post (n = 94)	Total (N = 169)	p
Age (years)	46.28 ± 19.20	45.37 ± 18.40	45.78 ± 18.71	.756
Gender				.726
% Male	76%	73.4%	74.7%	
% Female	24%	26.6%	25.3%	
Injury Severity Score(ISS)	15.89 ± 8.92	18.37 ± 9.43	17.27 ± 9.26	.085
Trauma Injury Severity Score (TRISS)	.7423 ± .2536	.7132 ± .2724	.7261 ± .2637	.481
Mechanism of Injury				.302
% Blunt	93.3%	88.3%	90.8%	
% Penetrating	6.7%	11.7%	9.2%	
Mortality	14.25%	23.14%		
O/E Ratio	0.87	0.92		

Data is expressed in mean ± standard deviation unless otherwise noted.

Figure 2: Length of Stay Comparison

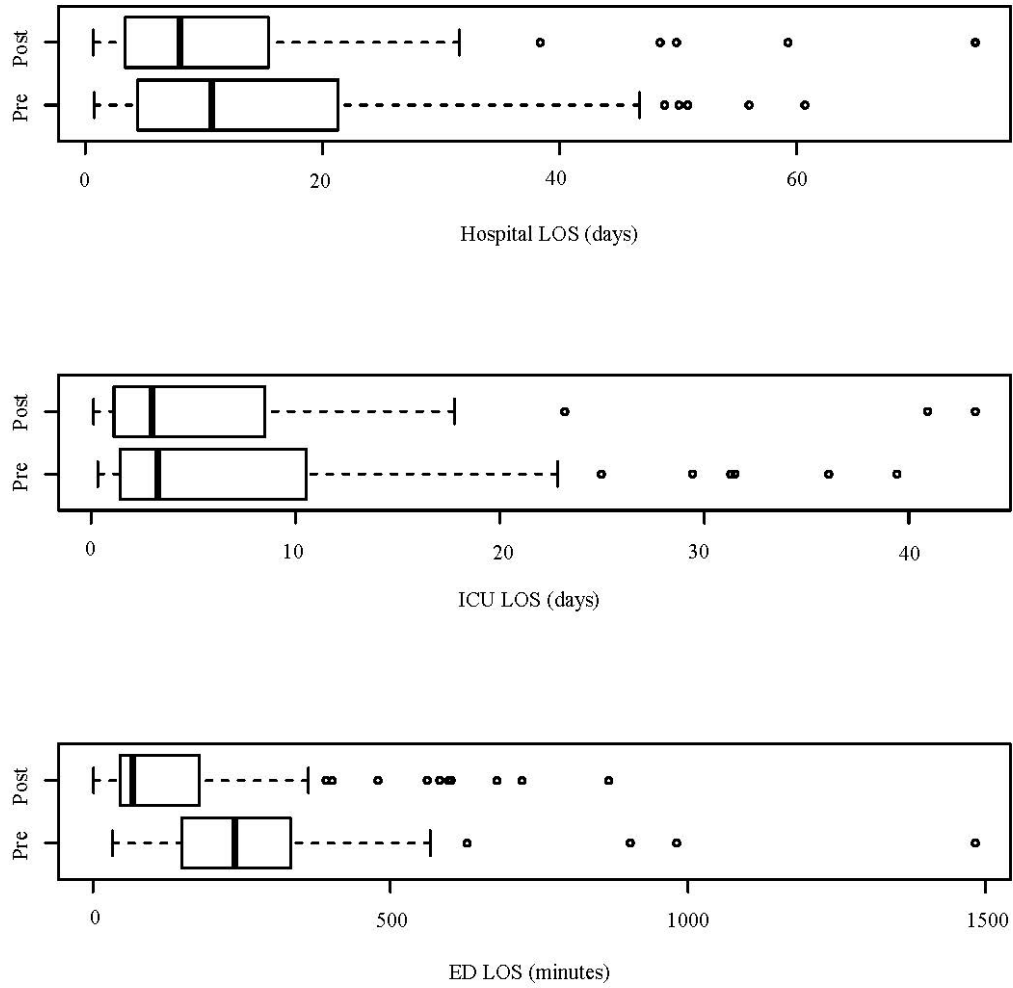


Table 2: Multivariate linear regression modeling the association between study variables and length of stay for Hospital, ICU, and ED

Regressor									
	Hospital LOS (<i>N</i> = 169)			ICU LOS (<i>N</i> = 169)			ED Min LOS (<i>N</i> = 169)		
	Parameter estimate	Exponentiated (Parameter estimate)	SE (p-value)	Parameter estimate	Exponentiated (Parameter estimate)	SE (p-value)	Parameter estimate	Exponentiated (Parameter estimate)	SE (p-value)
Age	0.008	1.008	0.004 (.031)	0.013	1.013	0.005 (.004)	0.006	1.001	0.004 (.104)
Gender (F)	0.214	1.239	0.164 (.194)	-0.146	0.864	0.193 (.451)	-0.308	0.735	0.156 (.050)
Mechanism Injury	-0.218	0.804	0.242 (.369)	-0.475	0.622	0.284 (.097)	-0.419	0.658	0.229 (.070)
ISS	0.055	1.057	0.008 (<.001)	0.062	1.064	0.009 (<.001)	-0.011	0.989	0.007 (.145)
Post	-0.324	0.723	0.144 (.026)	-0.347	0.707	0.169 (.042)	-0.808	0.446	0.137 (<.001)

Note. For Model: Hospital LOS $R^2 = 0.29$, $F(5, 160)=12.97$, $p<.0001$; ICU $R^2 = 0.29$, $F(5, 160)=13.16$, $p<.001$; ED $R^2 = 0.29$, $F(5, 160)=10.41$, $p<.001$. Exponentiated age is denoted in a decade unit.

Table 3: Complication Rates

Complications	Pre	Post	<i>p</i>
VAP	1.3%	0%	.44
Pneumonia	5.3%	1.1%	.17
ARDS	2.7%	1.1%	.59
PE	0%	1.0%	>.99
Renal Failure	2.7%	2.1%	>.99

Complication rates reported in percentage of patients with complications present

Table 4: RN FTE Usage

Pre-Implementation (Oct 2011 – June 2012)	Oct '11	Nov '11	Dec '11	Jan '12	Feb '12	Mar '12	April '12	May '12	June '12	Average FTE
RN (Over) Under Target	No Data	No Data	No Data	1.99	(0.19)	0.21	(0.12)	(1.37)	2.05	(0.43)
Post-Implementation (Oct 2012 – June 2013)	Oct '12	Nov '12	Dec '12	Jan '13	Feb '13	Mar '13	April '13	May '13	June '13	Average FTE
RN (Over) Under Target	(2.77)	(4.92)	(2.08)	(4.82)	(4.43)	(4.16)	(5.40)	(2.68)	(3.78)	(3.89)

Note. RN Over/Under is obtained by: TICU UHC ODB target FTE minus Actual worked FTE. 'No Data' - finance did not have this data

Capstone Report Conclusion

The three manuscripts offer background data that supports the development, implementation, and maintenance of the TICU charge-nurse led trauma resuscitation team. Trauma is unplanned and demands highly specialized care in order to maintain high quality and financially sound outcomes.

An additional priority of this capstone is to translate knowledge related to the innovation of the TICU charge-nurse led trauma resuscitation team approach. A poster presentation at the 2014 general conference of American Organization of Nurse (AONE) titled 'A Trauma ICU Charge Nurse can Impact Efficiency' was presented. A podium presentation has been accepted at the Eastern Association for the Surgery of Trauma (EAST) 2015 general conference titled 'Maintaining an Open ICU Bed for Rapid Access to the Trauma Intensive Care Unit is Cost Effective'. This innovation was a new approach that combined unit and organizational goals to create efficient clinical care in an ever changing health care climate. This innovation needs continued unit and organizational support and development to maintain the clinical outcomes that have been realized.

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