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Original Research

Decreased transport time to the surgical intensive care unit

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HIGHLIGHTS

- Extended ED stay is associated with increased mortality among critically ill trauma patients.
- Human factors analysis revealed disruptions in trauma patient flow from the ED to the ICU.
- After implementation of human factors intervention, a reduction in time spent in the ED was noted.

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ABSTRACT

Introduction: Extended stay in the emergency department (ED) is associated with worse outcomes in critically ill trauma patients. We conducted a human factors analysis to better understand impediments for patient flow when a surgical ICU (SICU bed is available in order to reduce ED LOS.

Methods: This is a retrospective review of all trauma patients admitted to a protected SICU through the ED during 2011 and 2014. In 2010, a 24-hour protected SICU bed protocol was implemented to make a bed readily available. During 2013 human factors analysis helped to describe flow disruptions; related interventions were introduced to facilitate rapid transport from the ED to SICU. The interventions required the following prior to CT scanning: immediate ICU bed orders placed by the ED physician and ED to ICU personnel communication. Direct transport from the CT scanner to the ICU was mandated. Data including patient demographics, injury severity, ED LOS, ICU LOS, and hospital LOS was collected and compared between 2011 (PRE) and 2014 (POST).

Results: A total of 305 trauma patients admitted from the ED to the SICU were analyzed; 174 patients in 2011 (PRE) and 131 in 2014 (POST). Average age was 46 years and patients had a mean admission GCS and injury severity score (ISS) of 12.3 and 15.9, respectively. The cohorts were similar in age, mechanism of injury, initial vital signs, and injury severity. After implementing the human factors interventions, decreases were noted in the mean ED LOS (2.4 v. 3.0 hours, p=0.005) and ICU LOS (4.0 v. 4.8 days, p=0.023). No differences in hospital LOS or mortality were observed.

Conclusions: While an open SICU bed protocol may facilitate rapid transport of trauma patients from the ED to the ICU, additional human factors interventions emphasizing improved communication and coordination can further reduce time spent in the ED.

Level of Evidence: Level IV, Economic/Decision.

1. Background

Extended stay in emergency departments (ED) due to a lack of available inpatient beds is a major problem contributing to ED overcrowding and increased operating costs in large hospitals around the country [1–6]. For critically ill patients, the resulting delay in ICU admission contributes to increased hospital length of stay (LOS), time spent on a ventilator, and mortality in trauma patients, as ICU interventions are more effective than ED

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interventions in treating the severely injured [7–11]. In theory, the implementation of a 24-h protected surgical ICU (SICU) bed should decrease delays to SICU admission and improve patient outcomes. Disruptions in the flow from the ED to the ICU bed frequently occur and need to be analyzed to better understand why delays occur with SICU admissions.

Imaging by CT scan, a typically necessary and vital portion of the trauma evaluation, has been identified and cited in the literature as a bottleneck adjunct in ED critical patient care, contributing to longer ED LOS [2,12,13]. Additionally, some critical patients may meet ICU admission criteria irrespective of CT scan results [14]. It is not known how implementing protocols to coordinate patient transport to and from the CT scanner and methods to improve physician communication might affect ED throughput times and subsequent patient outcomes.

After detailing where flow disruptions occur in the transport of trauma patients from the ED to SICU, we implemented a series of human factors driven measures in the care of critically ill patients in the ED. This included requiring physicians to place an initial ICU bed request prior to patient transport to the CT scanner and to speak directly to admitting ICU personnel during the CT scan, as well as mandating transport directly from the CT scanner to the ICU [15–18]. The primary objectives of the human factors initiatives were to decrease ED LOS and time to SICU admission. Secondary objectives were to determine how these initiatives impacted patient outcomes and mortality. We predicted that these measures would decrease ED LOS and time to SICU admission.

2. Methods

This was a retrospective review of 305 trauma patients at an urban level 1 trauma center who were admitted to the SICU directly from the ED during 2011 (PRE) and 2014 (POST). There are four dedicated trauma bays within the ED. In 2010, a 24-h protected SICU bed protocol was implemented so that a bed was always available for trauma patients [11]. Between 2010 and 2013, disruptions in trauma patient flow were prospectively recorded and human factors analyses were conducted to better understand flow disruptions. Related interventions were introduced to facilitate more rapid transport from the ED to SICU [15–18]. Patients admitted in 2011 were treated without any new protocols and constituted the pre-protocol population (PRE), while patients admitted in 2014 constituted the post-protocol population (POST). The interventions implemented included placement of immediate ICU bed orders by the ED physician and communication between ED and ICU personnel. Direct transport from the CT scanner to the ICU was also mandated after imaging studies were completed.

Data for 2014 were extracted from a prospectively collected emergency department database that included all patients directly admitted to the SICU from the ED. For 2011, the trauma registry was queried to identify all patients with a direct SICU admission from the ED. Additional data extracted included patient age, sex, admission heart rate (HR), admission systolic blood pressure (SBP), Glasgow coma scale (GCS) score, blood alcohol level, mechanism of injury (blunt vs. penetrating), regional abbreviated injury scale (AIS) score, injury severity score (ISS), whether or not the patient underwent any computed tomography (CT) scans while in the ED, and whether or not the patient was intubated in the ED. Outcomes data including ED LOS, hospital LOS, ICU LOS, days on mechanical ventilation, and mortality were collected and compared between 2011 and 2014.

Descriptive statistics were summarized by mean ± standard deviation or percentages. Student's t-test or Mann-Whitney *U* test were performed to compare means for parametric and non-parametric data respectively. Categorical variables were compared using Fisher's exact test or Pearson's chi-squared test when appropriate. P-value of <0.05 was considered statistically significant. Mean duration of ED LOS was also compared adjusting for confounders such as age, sex, mechanism of injury, GCS, SBP, whether a CT scan was obtained in the ED, whether the patient was intubated in the ED, head/neck AIS, and ISS. These variables were selected because they were considered theoretical confounders of length of stay in the ED. All statistical analyses were conducted using the Statistical Package for the Social Sciences (Version 22, SPSS Inc., Chicago, IL). This study was approved by the Cedars-Sinai Medical Center Institutional Review Board.

3. Results

In 2014 (POST), 169 patients were admitted to the SICU directly from the ED, of whom 131 were trauma patients. In 2011 (PRE), the trauma registry captured 268 patients who were admitted to any ICU from the ED, 174 of whom were admitted specifically to the SICU. A total of 305 trauma patients directly admitted from the ED to the SICU were included for analysis; 174 patients in the PRE group and 131 in the POST. Average age was 46 years and patients had a mean admission GCS of 12.3 with an injury severity score (ISS) of 15.9.

The two cohorts were similar in age, sex, mechanism of injury, initial ED vitals (SBP, HR, GCS), alcohol intoxication, head/neck AIS, and injury severity. They were also noted to have similar rates of intubations and CT scans obtained in the ED (Table 1). However, after implementing the human factors interventions, significant decreases were noted during POST in the mean ED LOS (2.4 v. 3.0 h, $p = 0.007$) and ICU LOS (4.0 v. 4.8 days, $p = 0.023$). No differences in hospital LOS, ventilator days, or mortality were observed (Table 2). After adjusting for possible confounders such as age, sex, mechanism of injury, GCS, SBP, whether a CT scan was obtained in the ED, whether the patient was intubated in the ED, head/neck AIS, and ISS, the reduction in ED LOS during POST cohorts remained statistically significant (2.4 v. 3.0 h, $p = 0.005$).

4. Discussion

Overcrowding in hospitals and rising health care costs are two significant issues that are becoming increasingly problematic. As the number of patients seen in the ED increases, cost effective tools are imperative in resource allocation of ED beds and transferring

Table 1
Clinical characteristics of direct SICU admissions during PRE and POST.

	Total N = 305	PRE N = 174	POST N = 131	*P value*
Age (years)[a]	45.7 ± 21.7	45.9 ± 21.7	45.4 ± 21.8	0.874
Male, n (%)	217 (71.1)	126 (72.4)	91 (69.5)	0.574
GCS[a]	12.3 ± 4.1	12.5 ± 3.9	12.1 ± 4.2	0.187
SBP (mmHg)[a]	136.2 ± 28.5	135.4 ± 29.0	137.2 ± 27.9	0.574
HR (bpm)[a]	96.7 ± 23.8	95.3 ± 23.2	98.5 ± 24.6	0.087
Positive for Alcohol, n (%)	100 (32.8)	53 (30.5)	47 (35.9)	0.318
Blunt (v. Penetrating), n (%)	283 (92.8)	164 (94.3)	119 (90.8)	0.254
Head/Neck AIS[a]	1.8 ± 1.8	2.0 ± 1.8	1.7 ± 1.8	0.141
ISS[a]	15.9 ± 10.7	15.9 ± 10.1	15.9 ± 11.5	0.822
CT scan in ED, n (%)	300 (98.4)	172 (98.9)	128 (97.7)	0.655
Intubated in ED, n (%)	104 (34.1)	58 (33.3)	46 (35.1)	0.745

GCS, Glasgow coma scale; SBP, Systolic blood pressure; HR, heart rate; bpm, beats per minute; AIS, abbreviated injury scale; ISS, injury severity scale; CT, computed tomography; ED, emergency department.

[a] Data are presented as mean ± standard deviation.