**From Emergency Department to Intensive Care Unit, Does The Delay Matter to Trauma Patients?**

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**Introduction:** Emergency department (ED) overcrowding with critically ill trauma patients has been a major concern globally. It has been shown that longer stays in the hospital before Intensive Care Unit (ICU) admission have a higher mortality rate. **Objective:** The objective of this study was to find whether the delay in ICU admission from ED is associated with significant mortality in a trauma patient. **Methods:** A prospective trauma registry data of 232 patients collected from the ED of JPNATC trauma center between September 2015 and March 2016 were used in the study. The study participants were all admitted trauma patients. Dead-on-arrival patients were excluded from the study. **Results:** All included patients had a blunt injury at the time of arrival. Of 232 patients, 66 died during treatment and 166 were discharged. Of these, 196 (84.5%) were male and 36 (15.5%) were female. Most of the patients among 66 who died were referred from different hospitals; however, most survivors arrived directly at JPNATC as compared to another group \( (P < 0.001) \). Waiting time in ED was calculated by the difference between arrival time and ED disposition time. There was statistically significant difference found in ED waiting time in both the groups \( (P = 0.015) \); however, the odds ratio is closer to 1, that is, 0.998. Similarly, age, gender, oxygen saturation, Glasgow Coma Scale, ICU stay days, heart rate, referring status, and injury severity score were found to be significant at the level of 25% under univariate analysis. **Conclusion:** The ED delay is not associated with adverse outcome in terms of mortality. Other factors may play a much greater role in determining the prognosis.

**Keywords:** Emergency department, Intensive Care Unit, trauma registry

**INTRODUCTION**

Emergency department (ED) overcrowding with critically ill trauma patients has been a major concern globally. The duration from ED to Intensive Care Unit (ICU) admission is a critical period and can have a significant effect on patient prognosis. In developed countries, the time spent in the ED is shorter and care provided in the ED is of the highest standard. Yet, studies have shown that longer stay in the hospital before ICU admission increases mortality rate.\(^{[1,2]}\) Increase in delay of ICU admission for ED patients is very common in the low- and middle-income country (LMIC) setting due to limited ICU resources, overcrowded ED, and unavailability of ICU beds.\(^{[3,4]}\) Therefore, ED duration before ICU admission may be a significant risk factor for bad outcomes. The risk may be disproportionately high in resource-constrained settings of developing countries. The risk may also vary depending on the nature of the emergency. Trauma forms a subpopulation which if not provided, optimum care may often lead to poor prognosis and high mortality rate. Often, delay in ICU admission is directly associated with lack of appropriate infrastructure. Studies exploring the relation between ICU admission and ED stay are sparse and do not represent the situation in a resource-limited environment.

Previous studies have shown inconsistent results based on the population studied and settings of emergency care. Few have shown a significant effect of delayed ICU admission in critically ill trauma patients.\(^{[5,6]}\) Other studies have also investigated the adverse effect of ED waiting time before the...
ICU admission. Others have reported insignificant effects of ED delay on overall outcomes of the patients. In the US, Tilluckdharry et al. found no difference in the hospital mortality rate between patients admitted to ICU from ED within 24 h or for more than 24 h of hospital admission. Similar findings were supported by another study. However, the impact of delay in ICU admission for trauma patients on mortality has not been studied previously in LMIC or middle-income country (MIC) setting. Most of the critically ill patients who arrive at a trauma center have to wait in ED for a prolonged time to get an ICU bed, but an appropriate care provided in the ED can nullify the harm associated with delayed ICU admission. Given the dissimilarity in patient’s population presenting to the trauma center in LMIC or MIC and in developed system of care, we could not assume any impact of ED delay on the outcome of critically ill patients. Therefore, the current study was undertaken to study the impact of delay in ICU admission in patients with trauma presenting at Level 1 trauma center of a developing country. We hypothesize that delay in ICU admission from ED is associated with higher mortality in critically ill trauma patients.

**Methods**

A prospective trauma registry data of 232 patients collected from ED of JPNATC trauma center, AIIMS, New Delhi, from September 2015 to March 2016 were analyzed after approval from the Institutional Ethics Committee. ED adopted a three-level triage system (red, yellow, and green areas) with the designated area equipped with portable monitors for blood pressure, respiratory rate, heart rate, and oxygenation. During the stay in ED, the patient is cared for by the senior resident on duty and a trauma nurse coordinator posted in ED round the clock. In case of any emergency, faculty in-charge on call is available to take important discussions related to patient safety.

**Inclusion and exclusion**

The study participants were enrolled as all admitted trauma patients who arrived within 24 h of injury, referred or nonreferred cases, irrespective of their age and gender, and being admitted to ICU. Dead-on-arrival patients were excluded from the study.

**Data collection for trauma registry**

Data were collected in the form of observed and nonobserved, where one data collector used to sit in ED for 10 h in a day. Therefore, real-time data from arrival to ED disposition were collected, and for the rest of the 14 h, data were considered as nonobserved for which data were captured directly through computerized patient record system installed in ED. Directly admitted and referred cases from other hospitals were also enrolled. The demographics (age and sex), vital signs (systolic and diastolic blood pressure, pulse rate, respiratory rate, Glasgow Coma Scale [GCS], and oxygen saturation [SpO₂]), patient’s arrival time, admission time, hospital disposition, time gap, injury time, ED disposition, place of injury, mechanism of injury, primary vehicle involved, referred-nonreferred, mode of arrival, systolic blood pressure, injury severity score (ISS), and mortality status at hospital disposition were collected and outcome was measured. Time gap was considered as the time interval between arrival time and ED disposition time.

**Statistical analysis**

The statistical analysis carried out using STATA/SE version 14.2 (StataCorp LP, College Station, TX, USA). Values obtained by the study of each qualitative variable were expressed as absolute and relative frequencies, whereas continuous variables organized as mean or median. Chi-square test or Fisher’s exact test was used to compare the phenomena of qualitative variables (gender and admission), and for quantitative measures, Student’s t-test or Wilcoxon test was used according to the distribution of data (age, GCS, ISS, ED waiting hours, ICU stay, heart rate, respiratory rate, and SpO₂). Variables which were found to be significant at the level of 25% under crude association (univariate) and/or on the basis of its clinical relevance were taken as covariates for stepwise logistic regression. The result is presented in the form of odds ratios (ORs) and corresponding 95% confidence interval. Performance of the models was assessed using the measure of discrimination (i.e., the correctness of the prediction probability). P < 0.05 was considered as statistically significant.

**Results**

Of 997 patients, 232 were selected which were transferred from ED to ICU at JPNATC, AIIMS, New Delhi. All patients had a blunt injury at the time of arrival. Of 232 patients, 66 (28.5%) died during the treatment phase, while 166 (71.5%) were discharged alive [Figure 1]. Of 232 patients, 196 (84.5%) were male and 36 (15.5%) were female. Most of the patients who died were referred from different hospitals; however, most of those who survived arrived directly at JPNATC when compared to the nonsurvivor group (P < 0.001). Waiting time in ED was calculated by the difference between arrival time and ED disposition time. There was statistically significant difference found in ED waiting time in both the groups (P = 0.015); however, the OR is closer to 1, that is, 0.998 on multivariable analysis [Table 1]. Age, gender, SpO₂, GCS, ICU stay days, heart rate, referring status, and ISS were found to be significant at the level of 25% under univariate analysis which was further assessed in a multivariable model. Hourly waiting time for ICU admission was also analyzed in logistic regression model which showed no impact on mortality [Figure 2].

As evident from result under multivariable logistic regression, age 1.03 (1.01–1.05), SpO₂ 1.09 (1.01–1.18), GCS score 0.87 (0.79–0.96), referring status 3.34 (1.56–7.16), ICU stay days 0.92 (0.85–0.99), and ED waiting time 0.998 (0.996–0.999) of the patients were associated factors for mortality status [Table 2]. Further, developed model can discriminate a case of mortality with a probability of 0.816 (area under the curve = 0.816) [Figure 3].
Soni, et al.: From emergency department to intensive care unit, does the delay matter to trauma patients?

Table 1: Demographic and clinical characteristics of selected patients

| Variables          | Death (n=66)   | Survived (n=166) | P     |
|--------------------|--------------|-----------------|------|
| Age                | 31.81±18.67  | 27.57±16.78     | <0.096|
| Sex (male/female)  | 61/5         | 135/31          | <0.042|
| SpO₂               | 11.33±4.18   | 7.58±6.02       | <0.001|
| GCS                | 7.37±4.53    | 10.78±3.95      | <0.001|
| ICU stay days      | 5.36±5.59    | 6.35±5.64       | <0.23 |
| ED waiting hours (min) | 322.39±186.68 | 422.60±297.95   | <0.01 |
| Heart rate         | 101.16±34.64 | 95.20±25.74     | <0.15 |
| Referring hospital | 47/19        | 74/92           | <0.001|
| ISS                | 13.01±8.25   | 11.45±5.97      | <0.12 |

GCS: Glasgow Coma Scale, SpO₂: Oxygen saturation, ICU: Intensive Care Unit, ED: Emergency department, ISS: Injury severity score

Table 2: Multivariate results

| Variables          | OR          | CI            |
|--------------------|-------------|---------------|
| Age                | 1.031679    | 1.009795-1.054037 |
| SpO₂               | 1.089761    | 1.00417-1.182647 |
| GCS                | 0.8697005   | 0.7901671-0.9572393 |
| Referred status    | 3.341472    | 1.560281-7.156043 |
| ICU stay days      | 0.917500    | 0.8530358-0.9868376 |
| ED waiting hours (min) | 0.9977354 | 0.996009-0.9994647 |

GCS: Glasgow Coma Scale, SpO₂: Oxygen saturation, ICU: Intensive Care Unit, ED: Emergency department, OR: Odds ratio, CI: Confidence interval

Figure 1: Flowchart of the study

Figure 2: Mortality risk (expressed as adjusted odds ratio of death) with increasing delay in ICU admission

Figure 3: Discriminate analysis for prediction of mortality

Discussion

The retrospective review shows no effect of ED delay on overall mortality. There was no difference in ED waiting hours between the survivors and nonsurvivors. The odds of death did not change with each passing hour in ED. This can be attributed to the provision of similar care in ICU and ED, representing the continuum of care process. A well-functioning and protocolized system in ED and ICU exists in the settings in which study was carried out, providing timely acute care. This could have influenced the results. This effect may also be because of the patient cohort itself. All patients were trauma patients and it is been known that the outcome depends on the performance of life-saving interventions in ED and a time of arrival. Once the patients are stabilized meaning airway, breathing, and circulation secured, it does not matter how quickly they are transferred to ICU.

Several studies have been carried out on ED crowding and their impact on patients’ treatment outcome. Most of the studies show contradictory results on delay in ICU admission. Some studies show no clear association between delayed ICU admission and poor outcome. Other studies report five times higher risk of death and doubling of the length of stay among patients not immediately admitted to ICU. A previous study investigated whether prolonged ward-based care impacted the hospital mortality of patients who were admitted to the ICU. They showed the length of stay on a ward before admission to ICU as an independent predictor of mortality. However, this may specific to patients cared for inwards and in locations unable to support critical care needs. In another study, no effect of ED delay was found on patients transferred to ICU within 24 h and beyond from ED. Similar results were also reported by Saukkonen et al. However, in both the above studies, the patient cohort represented medical patients with no representation of trauma victims. Furthermore, the settings and quality of ED care process vary from institutions to institutions, and results may not be extrapolated to a trauma patient cohort. In comparison, instead of within 24 h, in the present study, we sought for effect of hourly delay to ICU admission on inhospital mortality. An opposite effect was seen in case of a community pneumonia patient cohort.
Delayed ICU admission was associated with significant OR 9.61 of mortality and an independent risk factor. The authors attributed this effect to deterioration in general ward, whereas in the current study, we specifically looked for the delay in ED only and excluded delay at general ward which could have confounded the results.

Servía et al. investigated the impact of ED delay on mortality in a trauma patient cohort and found no association. The study overall mortality was approximately 20%, unlike the present investigation which has a higher mortality (28% approximately). The above study reflected the care process of high-income countries with robust prehospital systems of care and access to greater resources unlike the settings of the present study, which was conducted in an overcrowded ED and with limited resources. Servía et al. also included ED deaths, which shortened the overall average ED time, thereby reducing the effect of ED delay. They arbitrarily chose a cutoff point of 120 min for multiple log regression analysis, which could have impacted the interpretation. In our investigation, we did not conduct multiple log regression analysis to identify the different factors as it was not our objective. We looked for the hourly delay to admission to ICU and found no difference as well.

In our multivariable analysis, we found that age, SpO2, GCS, and referred status were associated significantly with the mortality. The GCS was low in nonsurvivors, which is in accordance with the previous study. The effect of referred patients having higher mortality is an unexpected finding. It may be speculated that the referred patients were much sicker and had higher physiological disturbances. However, in the present study, we did not conduct subgroup analysis as it was beyond the objective.

Limitation
The present study is a single center and limited by the settings and environment, which may differ widely within the LMIC environment. Whether this effect is limited to trauma ED or applicable to other settings is also unknown and not explained by this study. The results should be interpreted with caution. Extrapolation to other systems or settings may not be suitable.

The result also may not be applicable to mass casualty or disaster settings, in which patients may not be all stabilized before triaging to ICU, and an ICU delay may have an effect on overall mortality.

The effect related to the different patient cohort, for example, sepsis is unanswered by the present investigation and further studies may find the effect of ED delay.

Conclusion
The ED delay is not associated with adverse outcome in terms of mortality. Other factors may play a much greater role in determining the prognosis.

Acknowledgement
The data used in this study is a part of Trauma Registry which is running under the Australia- India Trauma System Collaboration (AITSC) project at JPNATC, AIIMS. The Authors sincerely thank Department of Science and Technology, Government of India for continuous financial support throughout this study.

Financial support and sponsorship
This study was financially supported by the Department of Science and Technology, Government of India.

Conflicts of interest
There are no conflicts of interest.

References