Comprehensive Analysis of Time Metrics in the Emergency Department for Admitted Patients

Potula Namrata

Department of Emergency Medicine, Great Eastern Medical School and Hospital, Srikakulam India

ABSTRACT
Emergency Department Length of Stay (ED-LOS) is a critical metric in healthcare delivery, reflecting departmental efficiency and patient outcomes. This study investigates the factors influencing ED-LOS, focusing on patient demographics, clinical severity and operational variables in a tertiary care center. A prospective analytical study was conducted with 6000 patients at a 360-bed tertiary care center and Level I Trauma Center in Hyderabad. Data on patient demographics, Injury Severity Score (ISS) Early Warning Score (EWS) and various time metrics related to ED processes were analyzed. The majority of patients were older adults, with 23.3% aged 65 and above. Males constituted 58% of the sample. Night shifts experienced the highest patient influx (48%). Patients with higher ISS had shorter ED-LOS but longer hospital and ICU stays. Time-related metrics varied significantly with Canadian Triage and Acuity Scale (CTAS) levels, indicating quicker processing for higher acuity levels. Laboratory and radiology turnaround times (TAT) were longest for patients shifted towards. ED-LOS is influenced by a complex interplay of patient demographics, clinical severity and operational efficiency. Higher acuity patients are processed faster but increased severity correlates with longer hospital and ICU stays. Optimizing ED operations requires targeted strategies to balance medical thoroughness with efficiency, especially during peak hours and for specific patient groups. Emergency department, length of stay, patient demographics, injury severity score, early warning Score, triage, healthcare efficiency.

INTRODUCTION

The landscape of healthcare delivery, particularly in emergency departments (Eds) is an intricate tableau marked by dynamic interactions between various clinical processes and patient outcomes. The objective of this study pivots on two pivotal axes firstly, quantifying the time measures pertinent to patients admitted through emergency departments and secondly, delving into the influence of specific independent variables namely, the resuscitation period, laboratory testing, diagnostic imaging and specialty consultations on the length of stay (LOS) in Eds. A critical aspect of this exploration lies in understanding the temporal dimensions of patient care in emergency settings. The ED length of stay (ED-LOS) is a vital metric, serving not only as a barometer for patient flow and departmental efficiency but also as an indirect indicator of clinical outcomes and patient satisfaction[1]. Previous studies have illuminated the multifaceted nature of factors affecting ED-LOS, highlighting the need for a nuanced examination of individual components[2].

The resuscitation period a critical phase in emergency care, often involves life-saving interventions that could significantly extend LOS. Understanding its impact is essential for both clinical and administrative decision-making[3]. Laboratory testing and diagnostic imaging are pivotal in clinical decision-making however, their contribution to prolonged ED-LOS has been a subject of ongoing debate[4]. The necessity to balance thorough investigation with timely patient processing underscores the complexity of this relationship.

Furthermore, specialty consultations in the ED are crucial for specific clinical scenarios but can potentially contribute to delays. The coordination between emergency physicians and specialists and the inherent variability in response times, play a substantial role in overall LOS[5].

This study aims to dissect these components, employing a robust methodological framework to quantify their individual and collective impacts on ED-LOS. By doing so, it endeavors to contribute meaningful insights into optimizing emergency department operations, enhancing patient flow and ultimately improving the quality of care delivered in these high-stakes environments.

MATERIAL AND METHODS

Study design and setting: This prospective analytical study was conducted in a real-time environment to capture current practices and their impact on emergency department length of stay (ED-LOS). The research was carried out at a 360-bed tertiary care center and Level I Trauma Center located in L.B. Nagar, Hyderabad. This hospital is accredited by the National Accreditation Board for Hospitals and Healthcare Providers (NABH) and handles a substantial volume of emergency cases, being equipped with advanced medical technologies and staffed by a team of dedicated professionals.

Quantifying time measures in the Emergency Department for admitted patients. Investigating the impact of independent variables like resuscitation duration, laboratory tests, diagnostic imaging and specialty consultations on the length of stay in the Emergency Department.

Study population: The study included patients who presented to the emergency department of the hospital. The inclusion criteria were.

- Patients aged 18 years or above
- Both genders
- All patients reporting to the emergency department during the study period

Patients were excluded based on the following criteria:

- Age below 18 years
- Presence of retroviral diseases
- Malignant tumors with or without metastasis
- Patients recently treated elsewhere and referred directly
- Patients who were stable and did not require admission from the emergency department
- Patients who left against medical advice after admission

The sample size was determined to be 6000 patients, selected according to the existing hospital databases related to emergency department admissions and outcomes.

Data collection: Data collection was conducted following approval from the institutional ethics committee and the scientific committee of the hospital. An undertaking was given to maintain patient confidentiality. Data was collected through several sources during shift hours in the Emergency Department. ED logs and registries, which included information about patient arrival, treatment and discharge or admission times. Turnaround time (TAT) data maintained by the laboratories and Radiology Department. Medical Records Department for detailed patient histories and outcomes.

Statistical analysis: For data analysis the study employed analysis of variance (ANOVA) to assess the statistical significance of the variables under study. This included examining the relationship between
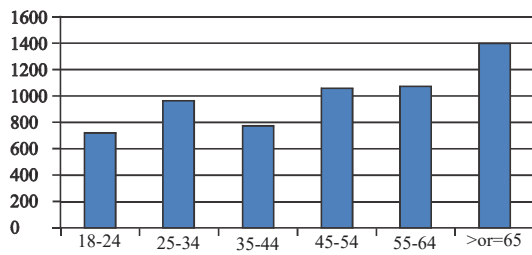
Fig..1: Age Distribution of Patients in the Study Population

Fig. 3: Correlation Between Injury Severity Score (ISS) and Emergency Department Length of Stay (ED LOS).
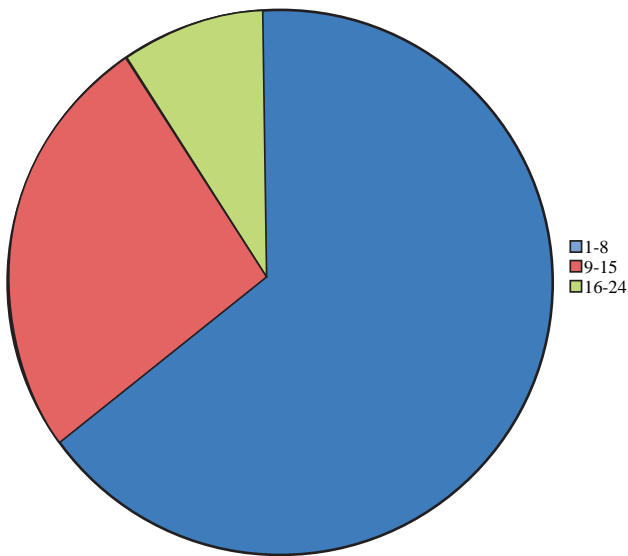

Fig. 2: Injury Severity Score and Number of patients distribution in the Study Population

independent variables such as resuscitation period, laboratory testing, diagnostic imaging, specialty consultations and the dependent variable, which was the length of stay in the emergency department.

RESULTS

Figure 1 shows, out of the 6000 patients studied a significant proportion belonged to the older age groups. The largest group was patients aged 65 years and older, totaling 1402 individuals, which accounted for 23.3% of the sample. Young adults aged 18-24 years represented a smaller portion, with 720 patients making up 12% of the total. Those in the 25-34 years age bracket comprised 968 patients or 16.1% of the sample. The group aged 35-44 years included 772 patients, accounting for 12.8%. A considerable number of patients fell into the 45-54 years category, with 1062 individuals representing 17.7% of the total. Lastly the age group of 55-64 years was almost as large as the oldest group, with 1076 patients making up 17.9% of the study population. Table 2 presents the distribution of patients by sex in the study population of 6000 patients. There were 3456 male patients, which
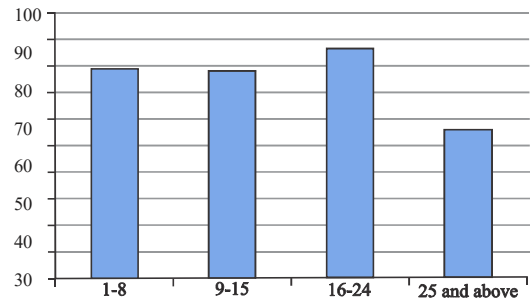
constitutes 58% of the total study population. This majority indicates a higher representation of male patients in the emergency department for the duration of this study. The number of female patients was 2544, making up 42% of the total. This figure shows a lesser, yet significant, representation of female patients compared to male patients in the emergency department visits covered in this study. The total number of patients accounted for in this study is 6000, with the combined percentage of male and female patients adding up to 100%.

Table 2 presents the distribution of 6000 patients across different shifts in the emergency department. The morning shift (8:00-2:00 pm) saw the lowest patient volume with 1212 individuals (20%) indicating a quieter start to the day. In contrast the evening shift (2:00-8:00 pm) experienced a moderate increase with 1916 patients (32%). The highest patient influx occurred during the night shift (8:00-8:00 am) accounting for nearly half of the total at 2872 patients (48%). This data underscores a significant variation in patient volume throughout the day, with a notable peak during nighttime hrs.

Table 3 displays the distribution of the 6000 patients in the study based on the Early Warning Score (EWS) a tool used for assessing the degree of illness. Patients with an EWS of 0, suggesting minimal immediate health risk, accounted for 936 cases (16%). Those with an EWS of 1, indicating slightly more concern, numbered 1580 (26%). The majority of patients, 2630 (44%) had an EWS of 2, signifying a moderate level of concern. Finally, 854 patients (14%) had an EWS of 3, pointing to a higher level of medical concern. This distribution highlights the varying levels of medical urgency among the patients.

Figure 2 categorizes 6000 patients based on the Injury Severity Score (ISS) a scale used to assess trauma severity. The majority, 777 patients, had an ISS ranging from 1-8, indicating minor injuries. A smaller group of 327 patients had scores between 9 and 15, reflecting moderate injuries. Those with more serious injuries, with ISS scores from 16-24, numbered 103. Only 2

Table 1: Sex distribution of patients in the study population

Sex	Number of patients
Male	3456(58%)
female	2544(42%)
Total	6000(100%)

Table 2: Shift and number distribution of patients in the study population

Shift	Number of patients
Morning (8.00-2.00 pm)	1212(20%)
Evening (2.00-8.00 pm)	1916(32%)
Night (8.00-8.00 am)	2872(48%)

Table 3: Early warning score and number of patients s in the study population

EWS	Number of patients
0	936(16%)
1	1580(26%)
2	2630(44%)
3	854(14%)

Table 4: Relationship between injury severity score (ISS) categories and both hospital length of stay (hospital LOS) and intensive care unit length of stay (ICU LOS).

ISS	Hospital LOS	ICU LOS
1-8	4.28	0.85
9-15	6.07	4.2
16-24	7.03	2.61
25 and above	3	1

Table 5: Mean laboratory, radiology TAT and specialty consultation time (min) for patients admitted to OT, ICU and Ward from ED

Area of disposition	Laboratory TAT	Radiology TA	Consultation time
OT	41.2	30.1	11.5
ICU	38.4	25.4	13.3
WARD	44.6	31.1	12.9

patients had an ISS of 25 or above, signifying extremely critical injuries. This data reveals a predominance of minor to moderate injury cases in the patient population.

Figure 3 explores the relationship between the Injury Severity Score (ISS) and the average length of stay (ED LOS) in min in the emergency department, along with the standard deviation (SD) for each ISS category. Patients with ISS 1-8 had an average ED LOS of 78.8 min (SD: 21.3) while those with ISS 9 to 15 stayed for an average of 78.16 min (SD: 24.69). A slightly longer duration was observed in the 16-24 ISS category, with an average LOS of 86.46 min (SD: 31.73). Interestingly the most severe cases (ISS 25 and above) had the shortest average LOS at 56 min albeit with an SD of 0.0, indicating no variability in this small sample. This data suggests a complex relationship between injury severity and ED LOS, with the most critical cases potentially being expedited through the ED.

The ISS categories are divided into four ranges 1-8, 9-15, 16-24 and 25 and above. The results show a notable increase in HOspital LOS and ICU LOS as the ISS categories become more severe. Specifically, for patients with an ISS of 1-8 the average HOSPITAL LOS is 4.28 days, while for those with an ISS of 25 and above the average Hospital LOS significantly increases to 7.03 days. Similarly, the ICU LOS also follows this trend, with patients in the 25 and above ISS category having the longest ICU LOS at 4.2 days compared to 0.85 days for those with an ISS of 1-8 (Table 4). The

analysis of various time-related metrics in the Emergency Department reveals significant findings. Firstly, the mean arrival-to-registration time is longest for patients with CTAS level 5 (18 min) and shortest for CTAS level 2 (7.62 min) with a statistically significant $p < 0.00001$. Secondly, patients with CTAS level 1 experience the shortest mean door-to-response time (less than 1 min) while CTAS level 5 patients have the longest mean door-to-response time (13.07 min) also supported by a highly significant $p < 0.00001$. Thirdly, regarding response time to admit, CTAS level 4 patients have the shortest mean time (25 min) while CTAS level 1 patients have the longest (37.1 min) again with a highly significant $p < 0.00001$. Lastly, in terms of admit time to disposition, CTAS level 4 patients have the shortest mean time (36 min) whereas CTAS level 1 patients have the longest mean time (53 min) with a statistically significant $p < 0.00001$. These findings underscore the importance of timely responses and care allocation in the Emergency Department, with significant variations based on CTAS levels. (Data not shown). The consultation time is the lowest for patients admitted in ward and highest for patients who are admitted under ICU. Laboratory TAT is the highest for patients shifted to ward and lowest for patients admitted under ICU . Radiology TAT is highest for shifted to ward and lowest for patients admitted under ICU. ANOVA was done to analyze the statistical significance and $p < 0.00001$ which is statistically significant (Table 5).

DISCUSSIONS

The findings of this study offer crucial insights into the dynamics of patient flow and care processes in Emergency Departments (ED). The analysis of patient demographics, clinical severity scores and various time metrics in the ED reveals significant patterns and correlations that are essential for optimizing ED operations and patient care. The predominance of older patients ($\geq$65 years) in the ED aligns with the trends observed in other studies, reflecting an aging population with complex health needs[6]. This demographic shift underscores the need for EDs to adapt their resources and care protocols to cater to the unique needs of elderly patients, who often present with multiple comorbidities and require comprehensive care[7]. The study's finding that patients with the most severe injuries (ISS 25 and above) had the shortest average ED LOS suggests an efficient triage and expedited care for critically injured patients, which is consistent with the principles of emergency medicine [8] However, this also raises concerns about potential over-triage and resource allocation for less severe cases, as indicated by the longer LOS for moderate ISS scores[9]. The variations in arrival-to-

registration time and door-to-response time across different Canadian Triage and Acuity Scale (CTAS) levels highlight the impact of triage systems on patient flow. The longer times for lower-acuity patients (CTAS level 5) suggest a possible area for improvement in managing non-critical presentations[10]. The study's findings on the admit time to disposition reiterate the need for efficient decision-making processes in EDs to prevent bottlenecks and enhance patient throughput[11]. The significant impact of laboratory and radiology turnaround times (TAT) on ED-LOS, particularly for patients admitted to wards, underscores the need for streamlined diagnostic services in emergency settings [12]. The longer consultation times for ICU admissions reflect the complexity of care required for critically ill patients and highlight the importance of efficient communication and coordination between emergency physicians and specialists[13]. The lower consultation times for patients admitted to wards compared to those in ICU might reflect the urgency and streamlined decision-making processes in critical care scenarios. Similarly the higher TATs for patients shifted to wards could be indicative of the lower immediacy assigned to non-critical patients, as discussed in the literature[14]. In conclusion, this study contributes valuable data to the ongoing discourse on ED efficiency and patient care optimization. The findings underscore the importance of adapting ED practices to accommodate changing patient demographics, improving the management of various severity levels and enhancing coordination among different hospital services. Future research should focus on implementing and evaluating targeted interventions based on these findings to further improve ED operations and patient outcomes.

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