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Assessment of Triage Stratification Efficacy in Predicting Length of Stay and Patient Outcomes in Emergency Departments

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ABSTRACT

Emergency Department (ED) efficiency and patient outcome optimization are crucial areas of study in healthcare. This research aims to examine the relationship between patient demographics, Canadian Triage and Acuity Scale (CTAS) levels, Length of Stay (LOS) in the ED and patient outcomes. A retrospective analysis was conducted on 6000 patients who presented to a tertiary care center's ED. The study focused on diverse patient demographics, categorized by CTAS levels and analyzed data on ED LOS, ICU LOS, total hospital LOS and patient outcomes including cure rates, symptom relief, morbidity and mortality. The study revealed a significant concentration of patients in higher urgency CTAS categories (Levels 1 and 2), with a corresponding impact on LOS and patient outcomes. Longer ED LOS was associated with higher morbidity and mortality, particularly in patients with prolonged ICU and total hospital stays. Additionally, the study identified a correlation between the length of ED stay and the distribution of less urgent cases (CTAS 4 and 5), as well as mortality and morbidity rates. The findings suggest that ED LOS, influenced by CTAS levels, significantly impacts patient outcomes. Efficient management of high-acuity patients in the ED is critical and the study highlights the need for ongoing optimization of triage protocols and patient flow management to improve care delivery and outcomes.

INTRODUCTION

The role of Emergency Departments (EDs) as critical hubs in healthcare systems is universally acknowledged. These departments not only handle acute medical crises but also significantly influence overall patient outcomes and healthcare resource allocation. Central to the functioning of EDs is the process of triage, a system designed to manage patient flow and ensure that the most critical cases receive immediate attention. The triage process, with its historical roots in military medicine, has evolved into an integral component of emergency care. This system categorizes patients based on the severity of their conditions, guiding the urgency of medical interventions^[1]. The efficacy of triage in allocating resources and managing patient flow is a determinant of ED operational efficiency and has been the subject of extensive research^[2].

Studies have consistently shown that accurate triage is essential for maintaining the quality of emergency care Jones *et al.*^[3] However, the impact of triage level assignment on ED LOS remains a complex issue. Prolonged LOS, particularly for high-acuity patients, can lead to overcrowding, a problem associated with adverse outcomes, including increased morbidity and mortality rates. Moreover, LOS is a critical indicator of ED throughput efficiency, directly impacting patient satisfaction and care quality^[4].

The correlation between triage decisions and long-term patient outcomes extends beyond the initial phase of emergency care. Triage influences the entire trajectory of hospitalization, affecting the need for intensive care, total hospital LOS and readmission rates^[5]. An effective triage system should thus not only prioritize immediate care but also consider the downstream effects on patient health outcomes.

In the context of resource allocation, the increasing demand on emergency services globally necessitates efficient triage systems. These systems must balance the immediate needs of critically ill patients with the overall management of healthcare resources^[6]. Inefficient triage can lead to either underutilization or overstretching of resources, both of which can adversely affect patient outcomes.

Moreover, the triage process is subject to various challenges, including the subjectivity of assessments, variations in triage scales and the evolving nature of emergency medicine. Recent advancements in triage methodologies, incorporating technology and standardized protocols, seek to address these challenges^[7].

In addition to clinical factors, demographic and socioeconomic factors can also influence triage decisions and outcomes. Studies have indicated disparities in triage assignment based on patient age,

race and social determinants of health^[8]. Addressing these disparities is crucial for ensuring equitable and effective emergency care.

This study aims to dissect the influence of triage on two critical metrics the length of stay (LOS) in the ED and the broader clinical outcomes of patients. This study will also employ a comprehensive methodological approach, analyzing data from a wide range of patient demographics and clinical scenarios. By evaluating the impact of triage-level assignment on ED LOS and patient outcomes, the study aims to provide actionable insights for enhancing patient care and operational efficiency in emergency medicine.

MATERIALS AND METHODS

Study design and setting: This study was designed as a prospective analytical investigation conducted in a real-time clinical environment, focusing on quantifying time-related metrics and exploring factors influencing the length of stay (ED-LOS) in the Emergency Department. The research setting was a 360-bed tertiary care center and Level I Trauma Center located in L.B. Nagar, Hyderabad. The hospital, accredited by the National Accreditation Board for Hospitals and Healthcare Providers (NABH), is a high-volume emergency care facility equipped with state-of-the-art medical technologies and staffed by experienced healthcare professionals.

Objectives: The study was structured around two primary objectives:

- **Quantification of time measures in the emergency department:** This objective aimed to systematically quantify the various time measures related to patient stay in the Emergency Department, particularly for those who were admitted
- **analysis of the impact of various factors on ED-LOS:** The study investigated how independent variables such as the duration of resuscitation, laboratory testing, diagnostic imaging, and specialty consultations influenced the length of stay in the Emergency Department

Study population: The study encompassed a diverse patient population presenting to the emergency department, adhering to the following inclusion and exclusion criteria:

Inclusion criteria:

- Patients aged 18 years or older
- All genders
- All patients who reported to the emergency department within the study period

Exclusion criteria:

- Patients younger than 18 years
- Patients with retroviral diseases
- Patients with malignant tumors, regardless of metastasis status
- Patients who had recently received treatment elsewhere and were referred directly
- Patients who were stable upon presentation and did not require admission from the emergency department
- Patients who left the hospital against medical advice after admission

The sample size was determined to be 6000 patients, selected from the hospital's existing databases on emergency department admissions and outcomes.

Data collection: Data collection commenced post-approval from the institutional ethics committee and the scientific committee of the hospital. An assurance of maintaining patient confidentiality was provided. The data was sourced from multiple channels during various shift hours in the Emergency Department:

- ED logs and registries, detailing patient arrival, treatment and discharge or admission times
- Turnaround time (TAT) records from the laboratories and Radiology Department
- Comprehensive patient histories and outcomes from the Medical Records Department

Statistical analysis: The study employed Analysis of Variance (ANOVA) for the statistical analysis of the collected data. This approach was used to evaluate the significance of various independent variables, including the resuscitation period, laboratory testing, diagnostic imaging, and specialty consultations, in relation to the primary dependent variable, which was the length of stay in the emergency department. The ANOVA was chosen for its effectiveness in comparing multiple groups and determining the influence of these variables on ED-LOS.

RESULTS

Figure 1 illustrates the distribution of 6000 patients according to the Canadian Triage and Acuity Scale (CTAS). CTAS Level 1, indicating the most critical cases, comprised 1036 patients (17%). Level 2, for less severe but still high-priority cases, included the largest group with 2550 patients (43%). Patients classified under CTAS Level 3, denoting moderate urgency, numbered 1506 (25%). Those in Level 4, representing less urgent cases, accounted for

682 patients (11%). Finally, Level 5, the least urgent category, had the smallest patient count at 226 (4%). This distribution reflects the varying degrees of medical urgency among patients visiting the emergency department.

The Table 2 illustrates the variation in the mean Length of Stay (LOS) in the Emergency Department (ED), segmented according to the Canadian Triage and Acuity Scale (CTAS) levels. For the most urgent cases (CTAS Level 1) the mean LOS is 91 min with a standard deviation of 19 min, indicating a longer duration typically required for more severe conditions. In contrast, CTAS Level 2 patients, who have less urgency, exhibit a mean LOS of 80 min but with a wider spread of stay durations (SD 22.5 min). Moderately urgent patients (CTAS Level 3) have an almost comparable mean LOS of 88.2 min (SD 22.2 minutes), suggesting substantial care needs. The less urgent patients (CTAS Level 4) have a shorter mean LOS of 69 min (SD 21.03 min). Interestingly, the least urgent cases (CTAS Level 5) spend a relatively high mean LOS of 85.3 min in the ED, with a standard deviation of 17.7 min. This data highlights the nuances of patient flow and operational efficiency in the ED, underscoring how patient urgency levels impact the duration of their stay.

This Fig. 2 delineates the average length of stay in both the Intensive Care Unit (ICU LOS) and total hospital stay (Total Hospital LOS), segmented by the Canadian Triage and Acuity Scale (CTAS) levels, complete with standard deviations (SD). It reveals a gradient of care intensity CTAS Level 1 the most urgent, requires the longest ICU LOS (3.36 days) and a substantial Total Hospital LOS (4.88 days). As the urgency decreases from CTAS Level 2 to Level 4, there's a corresponding decrease in ICU LOS (3.13-0.79 days), though Level 4 shows a slightly longer overall hospital stay (5.29 days). Interestingly, CTAS Level 5, while least urgent, still necessitates considerable care, with an ICU LOS of 1.92 days and a Total Hospital LOS of 4.08 days. This pattern underscores the complexity of patient needs across different urgency levels in healthcare management.

Table 3 shows a varying pattern for the most urgent CTAS Level 1 patients, the ICU stay averages 3.36 days, with a shorter subsequent ward stay of 1.52 days. CTAS Level 2 and 3 patients, with high-moderate and moderate urgency, respectively, show a balanced distribution between ICU (3.13 and 2.71 days) and ward stays (1.79 and 1.56 days). In contrast, CTAS Level 4 patients, needing less intensive care, have the shortest ICU stay at 0.79 days but the longest ward stay at 4.5 days. Lastly, CTAS Level 5 patients, the least urgent, still require considerable time in both ICU (1.92 days) and ward (2.16 days), reflecting a mix of

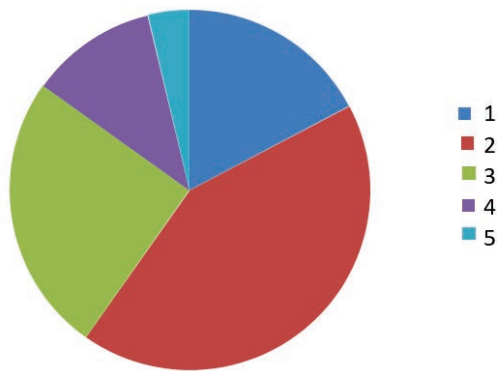


Fig. 1: Canadian triage and Acuity scale and Number of patients

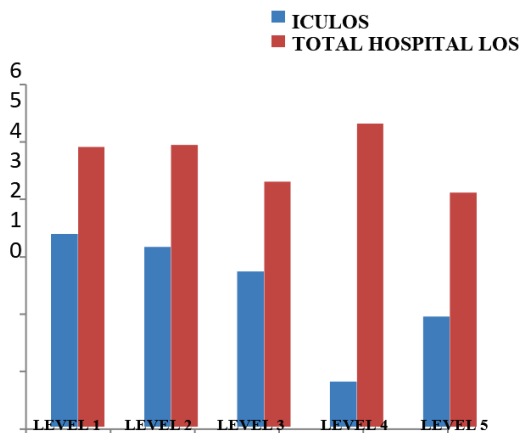


Fig. 2: Comparison of ICU and total hospital length of stay by CTAS level

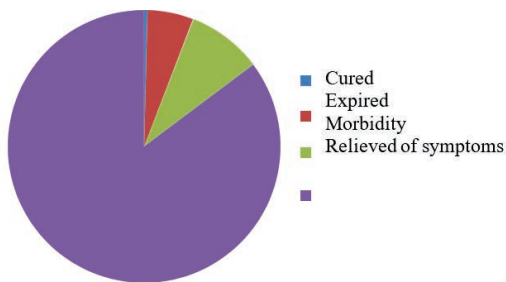


Fig. 3: Emergency Department length of stay and patient outcomes

intensive and standard care needs. Table 4 shows, the shortest stays (0-30 min), no cures or symptom relief were reported but morbidity cases were present. In the 31-60 min range, there's a notable uptick in positive outcomes, with 4 patients cured and 956 relieved of symptoms, alongside increased morbidity and mortality. The 61-90 min and 91-120 min brackets show a substantial rise in symptom relief and cures, but also higher morbidity and mortality, suggesting a complex interaction between longer ED stays and patient outcomes. Interestingly, the 121-150 min range sees a decrease in morbidity with some patients cured or relieved, while the over 150-min category has no

cures or morbidity but some relief of symptoms, underscoring varied outcomes based on the length of ED stay.

Fig. 3 succinctly correlates patient outcomes with their duration of stay in the Emergency Department (EDLOS). For the briefest stays (0-30 min), no cures or symptom relief were reported but morbidity cases were present. In the 31-60 min range, there's a notable uptick in positive outcomes, with 4 patients cured and 956 relieved of symptoms, alongside increased morbidity and mortality. The 61-90 min and 91-120 min brackets show a substantial rise in symptom relief and cures but also higher morbidity and mortality, suggesting a complex interaction between longer ED stays and patient outcomes. Interestingly, the 121-150 min range sees a decrease in morbidity with some patients cured or relieved, while the over 150-min category has no cures or morbidity but some relief of symptoms, underscoring varied outcomes based on the length of ED stay.

In Quartile 1 (1584 patients), 21.3% are in less urgent categories (CTAS 4 and 5) with a mortality and morbidity rate of 17.5%. Quartile 2, with 1428 patients, shows a slight increase in less urgent cases (23.2%) and a decrease in mortality and morbidity (16.1%). Quartile 3, encompassing 1512 patients, marks a significant drop in less urgent cases to 7.8% and a reduced mortality and morbidity rate of 10.84%. This stratified analysis suggests that longer ED stays are associated with more severe conditions and a consequential shift in mortality and morbidity rates (Table 5).

DISCUSSIONS

This study's comprehensive examination of patient demographics, clinical outcomes and length of stay (LOS) in the Emergency Department (ED) at a tertiary care center offers valuable insights into emergency medicine's operational efficiency and patient care quality. Our findings indicate a diverse patient population, with a notable concentration in the higher urgency CTAS categories (Levels 1 and 2), aligning with studies by Gorick *et al.*^[9] which emphasized the criticality of managing high-acuity patients in EDs. The distribution across CTAS levels reflects the typical trend in emergency care, where a significant proportion of patients require immediate and intensive medical intervention^[10].

The variation in ED length of stay (LOS) across different CTAS levels underscores the complexity of patient care. Patients in CTAS Level 1, despite their critical status, did not have the longest LOS, a finding consistent with Harding *et al.*^[11] who noted that high-acuity patients often receive faster care due to their urgent needs. In contrast, CTAS Levels 2 and 3,

Table 2: Comparison of mean length of stay by CTAS level in the emergency department

CTAS level	Mean EDLOS in min	SD
1	91	19
2	80	22.5
3	88.2	22.2
4	69	21.03
5	85.3	17.7

Table 3: Distribution of subjects according to ICU and Ward Length of Stay by CTAS Level

CTAS (levels)	1	2	3	4	5
ICU LOS (days)	3.36	3.13	2.71	0.79	1.92
WARD LOS(days)	1.52	1.79	1.56	4.5	2.16

Table 5: Quartile analysis of EDLOS: CTAS 4 and 5 and mortality/morbidity rates

Quartile	Size	Quartile ctas 4 and 5 in (%)	Quartile mortality and morbidity in (%)
1	1584	21.3	17.5
2	1428	23.2	16.1
3	1512	7.8	10.84

encompassing less critical patients, showed longer LOS, potentially due to extensive diagnostic and treatment processes^[12]. The analysis of ICU and total hospital LOS reveals that higher urgency patients (CTAS Levels 1 and 2) have longer ICU stays but not necessarily prolonged total hospital stays. This pattern, highlighted in studies by Bijani and Khaleghi^[13], suggests efficient ICU management but raises questions about overall hospital stay efficiency, especially for lower urgency patients who had longer ward stays.

The relationship between EDLOS and patient outcomes presents a nuanced picture. While shorter ED stays (0-30 min) were associated with higher morbidity and no significant cases of cure or symptom relief, longer stays showed an increase in both positive outcomes and mortality rates. This finding aligns with research by Puls *et al.*^[14] who indicated that prolonged ED stays could result in better diagnosis and treatment, yet also increase risks, particularly for vulnerable patients.

The quartile analysis further refines our understanding of ED operations. It highlights a decrease in less urgent cases and mortality/morbidity rates in higher quartiles, suggesting that longer ED stays correlate with more severe medical conditions, as discussed in Acharya *et al.*^[15]. In conclusion, this study contributes to the growing body of literature on emergency medicine, providing insights into how triage levels, LOS and patient demographics interplay in determining patient outcomes. The findings underscore the need for continuous evaluation and optimization of triage protocols and patient flow management in EDs. Future research should focus on targeted interventions based on these insights to improve care delivery and patient outcomes in emergency settings.

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