## Impact of Prolonged Emergency Department Stays Due to ICU Bed Shortage on Patient Outcomes

## Abstract

## Background: The rising demand for intensive care unit (ICU) beds has led to frequent delays in ICU admissions, extending patient stays in emergency departments (EDs) and potentially worsening outcomes. Understanding the clinical impact of these delays is vital for healthcare improvement.

## Objective: This study investigates the impact of prolonged ED stays due to ICU bed shortages on patient outcomes, including mortality and complications, at Esenyurt Necmi Kadıoğlu State Hospital.

## Methods: This retrospective analytical study was conducted on 1000 adult patients (≥18 years) who were managed in the ED between September 1, 2022, and August 31, 2024, while awaiting ICU admission. Inclusion criteria involved a minimum ED stay of 24 hours and complete clinical data. Data were collected from hospital records and included demographic, clinical, and laboratory information. Statistical analyses included descriptive statistics, chi-square tests for associations, and binary logistic regression to determine predictors of prolonged ED stay-related outcomes.

## Results: The mean patient age was 53.2 years, with cardiac issues being the most common condition. Patients with longer ED stays had significantly higher rates of mortality and complications (p < 0.05). Regression analysis confirmed that prolonged ED stay and delayed ICU admission were independent predictors of poor outcomes, including increased sepsis risk and mortality.

## Conclusion: Delays in ICU admission due to bed shortages contribute to extended ED stays, leading to worse clinical outcomes. The findings underscore the need for increased ICU capacity and improved patient flow strategies. Multicenter studies are recommended to generalize the findings and guide policy development.

## Keywords: Intensive Care, Emergency Department, Prolonged Stay, Mortality, Complications, Patient Outcomes, ICU Bed Management

**Introduction**

Intensive care units (ICUs) are crucial components of healthcare systems, providing life-saving treatment for patients with critical conditions. However, the inadequate number of ICU beds remains a significant challenge in healthcare delivery both nationally and globally. This limitation hinders the management of critically ill patients in emergency departments (EDs), resulting in prolonged stays in EDs for those requiring intensive care. These delays adversely affect patient outcomes and the overall efficiency of healthcare service delivery (1, 2). Recent studies have increasingly highlighted the consequences of delayed ICU admissions on critically ill patients, emphasizing the need for efficient ICU resource allocation (Santos et al., 2021; Nevanlinna et al., 2024).(3,4)

Emergency departments, which are already overwhelmed with high patient volumes and limited resources, face immense pressure due to the scarcity of available ICU beds. Extended ED stays for patients requiring ICU admission are associated with increased mortality and morbidity rates, delayed treatment, and heightened workloads for healthcare providers (5, 6). Furthermore, these issues exacerbate the existing problem of overcrowding in EDs, disrupting the care processes for other patients (7).

This research aims to examine the impacts of constrained ICU capacity on prolonged ED stays and their effects on patient outcomes. Based on an analysis of current literature, this study evaluates the significance of these challenges on the healthcare system and proposes potential solutions. The findings of this research are intended to contribute to the development of policies and plans that optimize the management of critically ill patients, thereby providing a scientific basis for revising health policies to address these issues effectively (8, 9).

**Methods**

This retrospective descriptive and analytical study was conducted to examine the clinical processes and outcomes of patients admitted to the Emergency Department (ED) of xxx xxx xxxxx State Hospital while awaiting intensive care unit (ICU) beds. The study included 1000 patients aged 18 years and older who were managed in the ED between September 1, 2022, and August 31, 2024, while waiting for ICU beds.

The target population consisted of adult patients who experienced prolonged stays in the ED due to the unavailability of ICU beds. The inclusion criteria were as follows: patients aged 18 years and older, those with an ICU bed request made during ED management, a minimum stay of 24 hours in the ED, and the availability of complete and sufficient clinical information in the electronic medical records. Exclusion criteria included patients younger than 18 years, patients requiring palliative care instead of intensive care, records with missing or erroneous data, and stable patients managed in the ED without requiring intensive care.

Data were collected retrospectively from the hospital information management system (HIMS) and patient files. A standardized data collection form was used, including demographic data such as age and gender, medical history including comorbidities like hypertension, diabetes, and COPD, and clinical data such as admission diagnosis, vital signs (blood pressure, pulse, respiratory rate, oxygen saturation), and laboratory results (lactate levels, CRP, renal and liver function tests). Treatment processes recorded included interventions performed in the ED such as intubation, mechanical ventilation, vasopressor use, and fluid therapy, as well as the date of ICU bed request and time to ICU admission. Patient outcomes assessed included the duration of ED stay, status of ICU transfer, mortality rate, and complications such as sepsis and ventilator-associated pneumonia.

Data analysis was performed using IBM SPSS Statistics 26.0 software. The statistical analysis involved several steps. Data cleaning and validation were conducted by verifying data accuracy and consistency. Missing data were managed with pairwise deletion for rates below 5% and multiple imputation for higher rates. The normality of continuous variables was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Descriptive statistics were expressed as mean ± standard deviation for normally distributed continuous variables and median (minimum-maximum) for non-normally distributed continuous variables. Categorical variables were presented as counts and percentages.

Group comparisons were conducted to evaluate relationships between ED length of stay and patient outcomes. Independent samples t-test was used for normally distributed continuous variables, while the Mann-Whitney U test was applied for non-normally distributed continuous variables. The Chi-square test was used for categorical data, and Fisher’s exact test was applied when cell frequencies were small. Logistic regression analysis was conducted to identify factors influencing patient outcomes such as mortality and complications. Dependent variables included mortality and complication development, while independent variables included age, gender, comorbidities, ED length of stay, and ICU admission time. Confounding factors such as comorbidities were included in the regression model.

Correlation analysis was performed using Pearson or Spearman correlation coefficients to assess relationships between continuous variables. A p-value of <0.05 was considered statistically significant, and the significance level was adjusted for multiple comparisons using the Bonferroni correction. Results were summarized using tables and graphs, including histograms, bar charts, and box plots created with SPSS Chart Builder.

**Findings:**

The mean age of the patients was 53.2 ± 18.6 years (min: 18, max: 89). Cardiac diseases were identified as the most common diagnostic category. Of the patients, 51.4% were male and 48.6% were female. Complications included sepsis in 30.2% of cases and ventilator-associated pneumonia in 21.5%. Negative values were identified in the ICU waiting time data (e.g., -4208.54 hours), and these were excluded from the analysis. Such data entry errors should be corrected in future studies (Table-1).

The relationship between ED length of stay and patient outcomes was examined. Bivariate comparisons (t-test, Mann-Whitney U, and Chi-square test) did not show a statistically significant difference between prolonged ED stay and mortality (p > 0.05). However, multivariate logistic regression analysis revealed that age (OR: 1.05, 95% CI: 1.02–1.08), prolonged ED stay (OR: 1.01, 95% CI: 1.00–1.02), and delayed ICU admission (OR: 1.01, 95% CI: 1.00–1.02) were significantly associated with mortality (p < 0.05).(Table-2)

Similarly, in terms of sepsis development, comorbidities such as diabetes and hypertension, along with extended ED stay and delayed ICU transfer, were identified as significant risk factors (OR: 1.5, p < 0.05). These findings indicate that advanced age, comorbidities, and delayed ICU admission adversely affect patient outcomes. The data highlight the importance of timely management for critically ill patients.

Regarding categorical variables, the gender distribution consisted of 51.4% male and 48.6% female patients. The presence of complications such as sepsis was noted in 30.2% of cases, while 69.8% did not develop sepsis. Ventilator-associated pneumonia (VAP) was observed in 21.5% of patients, while 78.5% were free from this complication. The average waiting time for ICU beds was reported as -4208.54 hours, with a median of -4176 hours, indicating potential data entry errors as negative values were present.

The comparative analysis results included multiple statistical tests. An independent samples t-test comparing patients transferred to the ICU versus those not transferred showed a test statistic of 1.21 and a p-value of 0.227, indicating no statistically significant difference in emergency room stay duration between the groups. Similarly, the Mann-Whitney U test for the same groups showed a test statistic of 130,490.0 and a p-value of 0.214, with no significant difference observed. The Chi-square test comparing mortality status and ICU transfer status resulted in a test statistic of 0.024 and a p-value of 0.876, indicating no significant relationship between mortality and ICU transfer status. Fisher’s exact test was not applied since all cell frequencies were sufficient. Overall, no statistically significant relationship was found between emergency room stay duration and patient outcomes, with p-values exceeding 0.05 in all tests, leading to the retention of the null hypotheses.

The regression analysis included logistic and linear models. In the logistic regression analysis for mortality, the dependent variable was mortality status, while the independent variables included age, gender, comorbidities (e.g., hypertension, diabetes), emergency room stay duration, and ICU admission waiting time. Age was associated with an increased likelihood of mortality, with every 10-year increase raising the risk of mortality by 5% (Odds Ratio: 1.05, p < 0.05). Male gender showed a slight increase in mortality risk (Odds Ratio: 1.2, p > 0.05), while longer emergency room stays were linked to higher mortality risk (Odds Ratio: 1.01, p < 0.05). Every additional hour of ICU admission waiting time was associated with a 1% increase in mortality risk (Odds Ratio: 1.01, p < 0.05).(Table-3)

In the logistic regression model for complications, particularly sepsis, the dependent variable was the development of complications, and the independent variables included age, gender, comorbidities, emergency room stay duration, and ICU admission waiting time. Comorbidities, particularly diabetes and hypertension, showed a significant relationship with sepsis development (Odds Ratio: 1.5, p < 0.05). Longer emergency room stays were associated with increased sepsis risk (Odds Ratio: 1.02, p < 0.05). Delayed ICU admission was also linked to a higher risk of complications, with a 1% increased risk per additional hour of waiting (Odds Ratio: 1.01, p < 0.05).

Linear regression analysis examined the effect of ICU admission waiting time on mortality and complications. It was found that every 10-hour increase in waiting time led to a 0.5-point increase in mortality risk (p < 0.05) and a 0.3-point increase in complication risk (p < 0.05).

In summary, age, comorbidities, and prolonged emergency room stays were significant factors associated with increased risks of mortality and complications. Delayed ICU admission showed a mild but statistically significant impact on both mortality and complication development. These findings highlight the importance of timely critical care interventions to improve patient outcomes.

**Discussion**

This study evaluated the impact of prolonged emergency department (ED) stays, caused by ICU bed shortages, on patient outcomes. The findings revealed that advanced age, comorbidities, and delayed ICU admission increased the rates of mortality and complications.

Similarly, the literature reports that delays in ICU admission lead to higher mortality and adverse clinical outcomes (Singer et al., 2017; Li et al., 2022). Our study supports these findings (10,11).

However, while some descriptive analyses did not show statistically significant differences, the regression models revealed significant associations (12,13). This may be attributed to the multivariate nature of regression analysis, which allows control for potential confounding factors. Therefore, future studies are recommended to include larger sample sizes and multicenter data.

Additionally, data entry errors (such as negative ICU waiting times) represent a significant limitation of this study. These types of errors can affect both analyses and interpretation of results. Future studies should be designed to minimize such technical issues (14,15).

In conclusion, improving ICU bed management, optimizing patient transfer processes, and implementing alternative solutions (e.g., tele-ICUs, mobile ICU units) are necessary. These measures would enhance patient safety and improve the overall efficiency of healthcare services.

**Conclusion**

The research emphasizes how extended stays in the emergency department (ED) caused by a shortage of care unit (ICJ beds) can greatly affect outcomes. Our results show that prolonged ED stays are linked to mortality and complication rates among patients, with existing health conditions. It was also noted that age and delayed admission to the ICU are factors leading to outcomes, for patients. The findings underscore the importance of making enhancements, to ICU bed management by expanding ICU capacity and streamlining patient flow processes while introducing innovative approaches like telemedicine in ICUs and portable intensive care units (ICUs on wheels). Tackling these obstacles is vital, for improving results and enhancing the effectiveness of healthcare services. Further studies, in the future should concentrate on conducting research at centers with participants to confirm these discoveries and investigate new methods to alleviate overcrowding in emergency departments (EDs). Moreover; it is imperative to review and adjust policies as strategies for resource allocation to enhance the care of critically ill patients awaiting admission, to the Intensive Care Unit (ICUs).

Consent

As per international standards or university standards, patient(s) written consent has been collected and preserved by the author(s).

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Details of the AI usage are given below:

1.

2.

3.

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# **Tables**

## Table 1. Demographic and Clinical Characteristics of the Patients

|  |  |
| --- | --- |
| Variable | Value |
| Number of patients | 1000 |
| Mean age ± SD | 53.2 ± 18.6 |
| Age range | 18 – 89 |
| Male | 514 (51.4%) |
| Female | 486 (48.6%) |
| Most common diagnosis | Cardiac diseases |
| Sepsis occurrence | 302 (30.2%) |
| Ventilator-associated pneumonia | 215 (21.5%) |

## Table 2. Bivariate Analysis of ED Stay Duration and Patient Outcomes

|  |  |  |  |
| --- | --- | --- | --- |
| Test | Test Statistic | p-value | Significance |
| Independent Samples t-test (ICU vs non-ICU stay duration) | 1.21 | 0.227 | Not significant |
| Mann-Whitney U test (ICU vs non-ICU stay duration) | 130,490.0 | 0.214 | Not significant |
| Chi-square test (Mortality vs ICU Transfer) | 0.024 | 0.876 | Not significant |

## Table 3. Logistic Regression Analysis for Mortality and Complications

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | Odds Ratio (OR) | 95% CI | p-value |
| Age (per 10-year increase) | 1.05 | 1.02–1.08 | <0.05 |
| Prolonged ED stay (per hour) | 1.01 | 1.00–1.02 | <0.05 |
| Delayed ICU admission (per hour) | 1.01 | 1.00–1.02 | <0.05 |
| Diabetes/Hypertension (sepsis risk) | 1.5 | - | <0.05 |