Association between Lengthy Emergency Department Stay and Intensive Care Unit Mortality in Critically Ill Patients at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia

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List of abbreviations and acronyms

AAU Addis Ababa University

AOR Adjusted odds ratio

COR Crude odds ratio

CPR Cardiopulmonary resuscitation

ED Emergency Department

EDLOS Emergency Length of Stay

EMCC Emergency and Critical care

ICU Intensive Care Unit

IPLOS In Hospital Length of Stay

MPM0 Mortality probability admission model at 0 hour

MRN Medical Record Number

MV Mechanical ventilator

SBP Systolic blood pressure

SPSS Statistical Program for Social Sciences

TASH Tikur Anbessa Specialized Hospital

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Abstract

Background

Patients with prolonged emergency length of stay (EDLOS) who are critically ill and awaiting ICU admission constitute a significant number in TASH Emergency unit. Due to several reasons, these patients frequently experience extended stays in the emergency unit. Such delays could impede timely interventions essential for improving patient outcomes, leading to increased mortality rates and longer hospital stays.

Objective

To evaluate the effect of prolonged emergency length of stay (EDLOS) on ICU mortality and overall hospital length of stay among critically ill patients admitted from the emergency department to the Intensive care unit at Tikur Anbessa Specialized Hospital (TASH)

Methods

A retrospective cross-sectional study was conveyed from May 1 to September 30, 2024, at Tikur Anbessa Specialized Hospital, Addis Ababa. Data were collected via the Kobo Toolbox from charts of patients admitted to the ICU from the ED. Patients were categorized based on emergency department length of stay (EDLOS) into three groups: <24 hours, 48-72 hours, and >72 hours, with prolonged EDLOS defined as over 24 hours. An organized questionnaire was developed taking similar studies as a base. Mortality risk was assessed using the Mortality Probability Admission Model- (MPM-0), and comorbidity was evaluated with the Charlson Comorbidity Index. Confounding variables included age, sex, admission diagnosis, financial status, and components of the MPM and Charlson scores. Total hospital length of stay was calculated from

triage to discharge or death. The collected data was analyzed using SPSS version 26, employing descriptive statistics for early and delayed admission groups. Bivariate and multivariate analyses were conducted to evaluate the effects of prolonged EDLOS on ICU mortality and total hospital length of stay, as well as associations between confounding variables and mortality.

Results

A total of 180 patient charts were inspected, excluding 70 due to admission from other parts of the hospital and missing information, resulting in a sample of 110 patients admitted from the ED to the ICU. Of these, 67.3% had an EDLOS of less than 24 hours, while 32.7% experienced delays over 24 hours. The early admission group had a median age of 38 (IQR 25-50), compared to 52 (IQR 37-71) for the delayed group.

After adjusting for confounders, an EDLOS of 48-72 hours was associated with higher ICU mortality (AOR 3.344, $p = 0.019$). Additional factors associated with increased mortality included SBP < 90, respiratory problem-related admission, and a higher Charlson score. However, there was no significant difference in total hospital length of stay between the two groups. Thus, while prolonged EDLOS affected ICU mortality, it did not impact overall hospital length of stay**.**

Conclusion

In summary, this study highlighted that a prolonged emergency length of stay (EDLOS) of 48-72 hours is significantly associated with increased ICU mortality among critically ill patients. Additional risk factors included low systolic blood pressure, respiratory problem-related admissions, and higher Charlson comorbidity scores. However, despite its impact on ICU mortality, prolonged EDLOS did not affect the overall hospital length of stay. These findings underscore the importance of timely interventions for critically ill patients to improve outcomes.

1. Introduction

1.1 Background

Emergency Department Length of Stay (EDLOS) is the total length of time a patient spends from arrival to the ED till departure. (1)

Different countries use different cut-off values for prolonged LOS, >4 h in the United Kingdom, >6 h in Canada and the U.S., and >8 h in Australia are some of the examples. According to the Ethiopian hospital services transformation guideline, patients requiring emergency services should be kept at the emergency for a maximum of twenty four hours. (1, 2).

The prolonged stay of patients in the Emergency has been associated with different outcomes like increased mortality, increased hospital length of stay, and increased consumption of scarce ED resources. Moreover, it was also shown to have an effect on burnout among ED health professionals and patient dissatisfaction (1, 9, 10, 11).

Due to these adverse outcomes, different solutions have come into the picture, England's 4-hour rule which is currently being practiced in the UK is one of the accepted ones, despite showing mixed patient outcomes. (12)

Although efforts are made to reduce prolonged ED stays, it is still a problem seen in emergencies worldwide. Critically ill patients are an important subgroup of patients that are affected by this phenomenon, taking into consideration the imbalance between the need and the availability of ICU beds. (1).

Despite various cutoff values, the Society of Critical Care Medicine (SCCM) commends that patients should be admitted to the ICU within six hours of the decision to be admitted from the ED (13). In recent years caring for and keeping these critically ill patients in the emergency has

shown increment. Mohr et al showed that over 250,000 patients receive mechanical ventilation in the emergency department, and stay a median length of 3 hours. The prevalence of the prolonged stay of critically ill patients in the ED ranged from (2.1% to 87.6%). (14)

In Ethiopia, a Sub-Saharan African country where the shortage of ICU beds is magnified, studies show that nearly 4% of all patients cared for in 2 emergencies in Addis Ababa (the capital city) were critically ill and needing ICU admissions, with a 48hrs median length of stay in the emergency. (7)

Different concerns led to various studies exploring the impact of the delayed admission of these patients, increased mortality, and increased hospital stay being the main impacts studied. The results of these studies have been mostly conflicting. Some found no interdependence, whereas others found an association, coining ED LOS as an independent factor for increased mortality. (1, 4, 5, 6, 15)

1.2 Statement of the Problem

Critically ill patients staying in the emergency while awaiting ICU admission is a common phenomenon worldwide. (16)

Delayed admission of these patients and its clinical outcomes have been an area of debate for long. Increased in-hospital mortality and prolonged hospital stay are the 2 most reported outcomes. (17)

Different studies in Ethiopia reported the magnitude of the problem as well as the outcome. A study done in TASH concluded that 84.3% of ICU-eligible patients stayed in the ED for more than 6 hours before admission to the ICU (24). Sultan et al supported these in a study done in 2 tertiary

hospitals in Addis Ababa, reporting that a large number of patients deserving an ICU admission stay in the ED and nearly 1/3rd of these patients died during their prolonged stay. (7)

Critically ill patients in developing countries are relatively young and productive when compared to developed countries. (17,18). The majority of these patients come to the hospital via the emergency department, and this urges the need to give due attention to the timely admission of these groups of patients from the ED to the ICU(6). Despite the concern, resources studying the stretched effect of delayed ICU admission from ED (ICU mortality and hospital length of stay) are scarce.

1.3 Significance of the Study

This research will contribute markedly to the knowledge and understanding of the impacts of prolonged ED stay on patient outcomes. It intends to bring to light whether prolonged ED LOS is an independent risk factor for ICU mortality or not. It will provide actionable insight into the issue of ICU beds, ED to ICU timely transfer, and its unfavorable outcomes. It will equip health professionals with the knowledge of specific patients at an augmented risk of worse outcomes during delayed admission. It will also help in revising policies about cutoff values regarding prolonged EDLOS in these particular groups of patients.

It provides input to TASH administration, healthcare professionals working at the ED and ICU, clinical service personnel, and policymakers. It guides beneficiaries on which areas to intervene and which areas to strengthen.

2. Literature Review

2.1 Epidemiology

Prolonged EDLOS has been defined in a range of cut-off values in different setups. The 4hr rule is being practiced in the UK and Australia while in Ethiopia 24hrs is taken as a prolonged stay according to the Ethiopian hospital services transformation guideline. Specifically for critically ill patients, Mohr et al state that there is no consensus on the definition of prolonged LOS time cutoff. Different studies and healthcare quality organizations use a time threshold of 2, 4, and 6 hrs. (3, 12, 14,)

As the cutoff values differ in different countries so does the prevalence. The prevalence ranges from as low as 4% in England to 72.5% in Botswana. (2). In Ethiopia studies are showing an even higher number, a cross-sectional study done in one of the regional hospitals showed that ED LOS more than 24 hours occurred in about 91.5 % of patients(2). For critically ill patients the number might be higher, taking into consideration the lack of ICU beds. Hoot and Aronsky in a systematic review reported that one ED delivered care for 154 critically ill patients over a one year period. Another population-based cohort study done in Canada showed that less than half of patients get transferred to ICU in less than 6 hours. (19,20)

In Ethiopia, a study done in 2 tertiary hospitals in Addis Ababa reported that out of 7661 patients cared for in the ED, 291 critically ill patients stayed more than 6 hours. Of these patients 32.3% of them died in the ED, 21.3% of them got admitted to the ICU and 29.6% of them got discharged improved. (7)

2.3 Association

Mortality

The impacts of prolonged ED LOS on critically ill patients have been shown in multiple studies, in a retrospective study done in a tertiary hospital in New Delhi India, the outcome of patients who stayed longer in the emergency, prior to ICU admission was studied. The study reported that in-hospital mortality was higher for all severity categories when the EDLOS was longer, the highest mortality rates were recorded in those who stayed more than 24hrs(6)

Two studies supported this, singer et al by using a cut-off time frame of 2 hrs to define prolonged LOS, reported that mortality increased from 2.5% in those who stayed less than 2 hrs to 4.5% in those who stayed more than 12 hrs. And Cardoso et al concluded that there is an independent 1.5% increase in ICU mortality for every waiting hour in the ED without admission. (9, 21).

In another single-centered retrospective study done in Indonesia on 18,553 patients, which were both pediatrics and adults EDLOS was stratified as <8hrs, 8-24hrs, and > 24hrs. In this study, it was found that both 8-24hrs and >24hrs were associated with in-hospital mortality in both adults and pediatric groups. For the adults group RR was 2.6(2.26-2.97), p= <0.001 in the 8-24hrs and (RR-3.68(3.21-4.22), p=<0.001 in the >24hrs) (22).

Al Qahatani et al, in a study done in Saudi Arabia, and Groenland et al in a study done on 14,788 patients in the Netherlands reported similar findings. (23, 24)

A systematic review was published in 2022, which included 50 studies in a review and 33 studies in a meta-analysis that analyzed both ward and ICU-admitted patients from ED. The study concluded that patients who stayed more than 24 hours in the Emergency waiting for ICU admission were the group of patients with increased hospital mortality compared to non-ICU admitted patients. (1)

Contrary to the above research, a few works of literature showed no significant association between EDLOS and ICU mortality. Puls et al in a study done in the USA reported that there was no significant association between ICU mortality and EDLOS, but one of the limitations of the study was patients were staying in an ED ICU until they were admitted to a formal ICU. This makes it different from the previous studies where patients were waiting in a regular ED rather than an ED ICU. Khan et al support the above result in a study done in KwaZulu-Natal, South Africa. The study compared 3 groups of patients, those admitted from the ED, wards, and the OR. Despite taking 24hrs as a cutoff point to group patients as early or late, no significant difference was seen between the early admitted or late admitted patients regarding ICU mortality. (5, 6)

Different research has been done in specific groups of patients, for instance in sepsis patients requiring ICU admission *Zhang Z, Bokhari F, Guo Y, et al* reported that after adjusting for factors like creatinine level, age, BMI and comorbidities, prolonged EDLOS increased the crude mortality, 21.4% for less than 6hrs, 31.9% for 12-24hrs and 31.8% for >24hrs. (25)

Association with Length of Stay

Most studies included the impact it has on the total in-hospital LOS, Liew et al, in a retrospective study found a dose-dependent correlation between EDLOS and IPLOS. The study concluded that

patients who stay in the ED longer than 4 hours stay 20–50% longer in the hospital. (20) In addition LOS increased from 5.6 days for those who stayed in the ED for less than 2 hours to 8.7 days for those who stayed for more than 24 hours. (26)

Despite these studies, there are a few studies contradicting these outcomes. Parkhe et al in a retrospective study done in Australia reported that although delayed admission (>24hrs) was associated with increased 30-day mortality, it had no effect on length of hospital stay or cost. (27).

In another retrospective cohort study done in KwaZulu-Natal, South Africa the pre ICU length of stay was not found to be linked with either length of stay or mortality. (6)

3. Objectives of the study

3.1 General Objective

To review the association between EDLOS and ICU mortality.

3.2 Specific Objectives

1. To assess the association between EDLOS and ICU mortality.
2. To evaluate the effect of prolonged EDLOS on total in-hospital length of stay.

4. Methods and Materials

4.1 Study area

TASH is a referral hospital in Addis Ababa, Ethiopia. The hospital serves an estimated 700,000 patients annually. The adult emergency department of TASH provides services to approximately 18,000 patients per year. At the Emergency department 2 mechanical ventilators are available for temporarily intubating critical patients. There is one main ICU, consisting of six medical, four pediatrics, and six surgical beds. (12)

TASH was selected for this research as it is the largest referral center for the whole country, with various subspecialty services, trained emergency, and ICU physicians and nurses, and it can exhibit the variety of services provided by the ED and the ICU.

4.2 Study period- data on patients admitted over the past 1 year (2023) was collected (from charts), for a period of 5 months (May- September 2024).

4.3 Study design – a cross-sectional study was be conducted.

4.4 Source population

All patients over the age of 13 years admitted to the ICU during the previous 1 year.

4.5 Study population

Patients over the age of 13 admitted in the previous 1 year from ED to the ICU, fulfilling the inclusion criteria.

4.6 **Study variables**

4.6.**1dependent variables**

ICU mortality

Total in-hospital length of stay

4.6.2 **Independent variables**

- Age
- Sex
- Diagnosed medical condition
- Existing Comorbidities
- The need for a mechanical ventilator

- Emergency length of stay

4.7 **Eligibility criteria**

4.7.1 **Inclusion criteria**

-All patients above 13 years of age admitted from ED to adult ICU with all needed information on the chart.

4.7.2 **Exclusion criteria**

-Patients whose hour of stay is not documented or do not have enough information.

-Patients who died in the ED or on the way to the ICU.

-Patients referred from other facilities after staying in the ED

- Patients who left the ICU against medical advice

4.8 **Sample size determination and sampling technique**

4.8.1 **Sample size determination**

The sample size was calculated using the single population formula, it was calculated to achieve a 95% confidence interval with a 5% margin of error. The proportion level of ICU mortality was taken as 35%, as per a study done on ICU mortality in TASH. (28)

$$\mathrm{n} = \frac{Z^2 x\ (p)\ (1 - \mathrm{p})}{d^2}$$

- Z - z-score -1.96
- D - margin of error- 0.05

- P - population proportion- 0.35
- n - sample size- 348

Since the sampling frame is <10,000, N= 137(over 1 year) (using monthly audit reports) we use the adjustment formula

- $N_{adj.}$= n/((1+(n/N))
- Where $n_{adj.}$= adjusted sample size
- N= calculated sample size
- N= study population
- $N_{adj.}$= 348/(1+(348/137))

  = 99.4

  Adding a 10% nonresponse rate the sample size will be **110.4**

4.8.2 **Sampling technique and procedure**

TASH was selected based on purposive sampling, as it provides a variety of services ranging from hematology and oncology to trauma, cardiac, and neurosurgical patients. The availability of trained emergency and ICU physicians and nurses is an addition as it makes it a good place to assess the ideal ED and ICU care.

The MRN of all patients admitted from ED to ICU during the year 2023 was recorded from the liaison office and HMIS at the ED and ICU.180 charts were collected and charts were reviewed, of which 110 charts which fulfilled the inclusion criteria were included in the study. The prepared questionnaire was filled out according to the data on the charts.

4.9 **Operational definitions**

In-hospital Length of stay- the total number of days a patient stayed in the hospital from the time of triage at the ED to discharge or death. (Including ICU and ward stays)

Prolonged ED LOS- Patients staying in the ED for more than 24 hrs.

ICU mortality – patients who died after being admitted to the ICU.

4.10 **Data collection procedure and data quality**

Structured questionnaire was prepared by the primary investigator based on previous similar researches, the questionnaire included the socio demographics of participants (MRN, Age, sex, method of getting service), the ED triage time, clinical diagnosis at admission, main reason for ICU admission, EDLOS(<24hours, 48-72hours, >72hours), possible reason for delayed admission, Charlson comorbidity score which is composed of (Myocardial infarction ,CHF, Peripheral vascular disease, cerebrovascular disease, dementia, Chronic pulmonary disease, connective tissue disease, peptic ulcer disease, mild liver disease and DM without complications) each given 1 point ,(Hemiplegia, moderate to severe renal disease, DM with end organ damage, any tumor, leukemia, lymphoma) each given 2points,(moderate to severe liver disease given 3 points),(metastatic solid tumor and AIDS each given 6 points.) and the MPM-0 score(rather than total score the individual components were used which were (coma, HR>150,SBP<90,CKD,cirrhosis,metastaticcancer, AKI, arrhythmia, CVA, GI bleeding, ICP,CPR, MV use) , the total in hospital length of stay and the outcome of the patient. After preparation, the questionnaire was copied to the Kobo toolbox.

Charts with the following missing data were excluded (triage date and time, date of acceptance note to the ICU, date of discharge, death summary with documented time, and patients who went home against medical advice both from the ED and ICU). The data was collected by trained

medical interns working at TASH, and continuous follow-up and supervision were conducted throughout the study by the principal investigator. Before analysis and computation using the SPSS program, the collected data was reviewed for completeness.

4.11 **Data processing and analysis**

The collected data was exported into SPSS version 26 from the Kobo toolbox and was analyzed. Results were summarized using descriptive statics. Categorical variables were represented as frequencies and percentages. Continuous variables were represented as median and interquartile range. Continuous variables were correlated using Mann Whitney U test and Spearman correlation. Association between variables was done using chi-square for categorical variables and was considered to be statistically significant when the p-value was below 0.05. The confidence interval was set at 95%. Bivariate and multivariate regression was done to show the association between various variables.

4.12 **Ethical considerations**

After ethical clearance was obtained from the school of medicine review board, the study was conveyed. Prior to data collection a letter of permission was submitted to all responsible bodies. Informed consent was not taken as it was a retrospective chart review. The collected data was used for the study only and the original data was stored with a backup.

5. RESULTS

5.1 Baseline characteristics of participants

A total of 110 charts of patients who were admitted from ED to the ICU were included in the study. The delayed and early admission groups had several differences in baseline characteristics. As shown below the early admission group was relatively younger with a median age of 38(IQR 25-50) while the median age in the delayed group was 52(IQR 37-71).

Of the 110 patients (67.3% n=74) of the patients were admitted in less than 24hrs while (32.7% n=36) of them were admitted after 24 hrs stay in the ED. Of the late-admitted patients (21.4% n=23) of the patients got admitted after staying 48-72 hours in the ED and (11.3% n=12) of them were admitted after 3 days.

The median Charlson score was lower in the early admitted group with a score of 1(IQR 0-2) while it was 2(IQR 4-1) in the late group. Early admitted patients had an increased MV use (45.9% n=34) when compared to those in the late admitted group (47.2% n=17).

The main reason for ICU admission in general was respiratory (35.4% n= 46) followed by cardiovascular (29.2% n= 38) and neurology (17.7% n=23) respectively. Of these, cardiovascular was the main reason for admission in the early group (29% n=29), while respiratory was the major one in the late group (44.9% n=22).

Patients in the early group had a longer in-hospital length of stay, with the median in-hospital length of stay being 12(IQR 22-6) in the early and 11(IQR= 18-7) in the late group.

When it comes to the components of MPM score, coma, and CPR before admission were seen more in the early group (25.7 %n=19), (25%n=9), and (6.8% n=5), (2.8% n=1) respectively.

Regarding outcome, the early admission group had a better outcome with (60.85% n= 45) leaving the ICU alive and (39.2% n=29) of them dying. While in the late group only (40.7% n=15) left the ICU alive while (58.3% n=21) died in the ICU.

Table 1. Sociodemographics of patients admitted early and late

	Total number (n= 110)	
variables	<24hrs n =74	Late(>24hrs) n =36 23(48-72hrs) 12(>3days)
Age	38(IQR 25-50)	52(IQR 37-71)
Sex		
Male	35(47.3)	12(33.3)
Female	39(52.7)	24(66.7)
Charlson score	1(IQR 0-2)	2(IQR 4-1)
Mechanical ventilation	34(45.9%)	17(47.2)
The main reason for admission		
Respiratory	24(24)	22(44.9)

Cardiovascular Neurological Airway protection	29(29) 13(17.6) 8(10.8)	9(18.4) 3(8.3) 4(11.1)
Total in-hospital length of stay	12(IQR 22-6)	11(18-7)
MPM score Coma SBP < 90mmHg AKI CPR before admission	 19(25.7) 22(29.7) 22(29.7) 5(6.8)	 9(25) 13(36.1) 15(41.7) 1(2.8)
Outcome of patients	Alive 45(60.85) Dead 29(39.2)	Alive 15(40.7) Dead 21(58.3)

5.2 Association between EDLOS and ICU mortality

Binary logistic regression was performed to evaluate the association between EDLOS and ICU mortality. A significant association was taken as a P value of <0.25. During the binary logistic regression both EDLOS (48-72 hours) and < 24 hours showed significant association with ICU mortality (p= 0.076, p= 0.045 respectively). However, when adjusted for confounding variables (age, charlson score, MV use, respiratory and cardiovascular causes of admission, coma, and SBP<90), only EDLOS for 48-72 hours had a significant association with ICU mortality.(AOR-

3.344(CI-1.22-9.155),P=0.019) According to this result, patients who were admitted in this time frame had a 76.9% increased probability of dying in the ICU.

When the association between other confounding factors and ICU mortality was assessed using binary logistic regression age, total Charlson score, MV use, respiratory and cardiovascular causes of admission, coma, and SBP<90mmhg showed significant association(with a p-value of 0.187,0.009,<0.001,<0.001,0.013,0.023 and 0.039 respectively).However during the multivariate analysis, only SBP<90mmHg(AOR=7 CI-1.691-29.7,p-0.007),respiratory causes of admission(AOR=3.906,CI 1.055-14.62,p-0.043) and total charlson score(AOR=1.612,CI-1.094-2.373,p-0.016) were significantly associated with ICU mortality. These results show that SBP<90 and respiratory causes of admission increase the probability of mortality by 87.5% and 79.6% respectively.

Table 2 cross-tabulation of EDLOS(independent variable) and ICU mortality(dependent variable)

ED LOS in hours	ICU mortality n(%)		n(%)
	YES	NO	
< 24hrs	29(39.2)	45(60.85)	74(100)
>24hours	21(58.3)	15(4.7)	36(100)
Total	50(45.4)	60(54.5%)	110(100)

Table 3. Association of EDLOS (using 3 categories) and ICU mortality (Bivariate and multivariate regression)

Variables	COR(95%CI)	p-value	AOR(CI)	P value
Age	-	-	1.022(0.98-1.06)	0.283
EDLOS				
<24hrs (reference)	1		1	
48-72hrs	4.050(1.030-15.924)	0.045	3.344 (1.22-9.155)	0.019
>3days	1.211(0.473-3.098)	0.69		
Mechanical ventilator in the 1st 1 hr	-			
No(Reference)				
Yes			2.244(0.586-8.437)	0.240
AKI	-			
No (Reference)				

Yes			1.522(0.512-4.524)	0.449
SBP<90 No (Reference) Yes	-		 7(1.691-29.7)	 0.007
Coma or stupor No (Reference) Yes	-		 4.003(0.835-19.19)	 0.083
The main reason for admission(respiratory) No (Reference) Yes	-		 3.906(1.055-14.462)	 0.043
The main reason for admission(cardiovascular) No (Reference) Yes	-		 2.054 (0.370-11.393)	 0.410
Charlson score 0(reference) >0	-	-	 1.612(1.094-2.373)	 0.016

Table 4. Association of other confounding factors and ICU mortality (Bivariate and multivariate regression)

Variables	COR(95%CI)	p-value	AOR(CI)	P value
Age	1.014(0.993-1.035)	0.187	0.979(0.94-1.018)	0.283
EDLOS				
<24hrs (reference)	1		1	
48-72hrs	4.050(1.030-15.924)	0.045	3.344 (1.22-9.155)	0.019
>3days	1.211(0.473-3.098)	0.69		
Mechanical ventilator in the 1st 1 hr				
No(Reference)				
Yes	4.529(2.026-10.126)	<0.001	2.244(0.586-8.437)	0.240
AKI				
No (Reference)				
Yes	1.991(0.893-4.44)	0.092	1.522(0.512-4.524)	0.449

SBP<90 No (Reference) Yes	2.379(1.047-5.405)	0.038	7(1.691-29.7)	0.007
Coma or stupor No (Reference) Yes	2.812(1.153-6.858)	0.023	4.003(0.835-19.19)	0.083
The main reason for admission(respiratory) No (Reference) Yes	4.895(2.162-11.081)	<0.001	3.906(1.055-14.462)	0.043
The main reason for admission(cardiovascular) No (Reference) Yes	0.345(0.149-0.799)	0.013	2.054 (0.370-11.393)	0.410
Charlson score 0(reference) >0	1.288(1.066-1.556)	0.009	1.612(1.094-2.373)	0.016

5.3 Association between EDLOS and total in-hospital LOS (secondary outcome)

The secondary outcome, which is the total hospital length of stay was evaluated to see if there is any difference between the two groups. The median in hospital length of stay was shorter in the late-admitted group when paralleled with the early group. (11(IQR=7-18), 112(IQR6-22). Regarding the association between prolonged EDLOS and total in hospital length of stay, no significant association was found. (U=1279.5, Z=-0.335, P=0.738).These suggest that delayed admission from ED to ICU is not a contributing factor for prolonged in hospital length of stay.

Regarding other confounding factors including age, charlson score, MV use, respiratory and cardiovascular causes of admission, coma, and SBP<90, none of them showed an association with the length of time a patient stays in the hospital.

Table 5. Association between EDLOS and total in-hospital LOs

ED LOS in hours	Total in-hospital length of stay (median and IQR)	Mann-Whitney U test	P value
< 24hrs	12 (6-22)		

>24hours	11 (7-18)	Z= 0.035, R=0.335	0.738

6. Discussion

This study was done to examine if there is any association between prolonged EDLOS and ICU mortality in critically ill patients. The cutoff value of 24 hours was taken as a prolonged stay. What was found in the study was that 67.3% of the patients requiring ICU got admitted early (<24hrs) while 32.7% were admitted late. When the two groups were compared, 58.3% of the patients admitted late died in the ICU while only 39.2% of them died in the early admission group. Moreover, this study reported that prolonged EDLOS was an independent risk factor for ICU mortality. Other significant factors included SBP<90, respiratory causes of admission, and a higher total Charlson score. However, it has found no association between prolonged EDLOS and total in-hospital LOS.

In opposition to this study, a study was done in the same hospital (TASH) previously, which reported that only 16(15.7%) of ED patients were admitted early and 86 (84.3%) had a delayed admission. The huge difference in the results can be attributed to the difference in the cutoff value for delayed admission, which was 6hrs in the previous study and is taken as 24 hrs in this study. In addition, since the time to ICU admission is usually not documented, taking only dates and approximation may have played a part in exaggerating the percentage of the early admitted group. Commenting on the improvement of the ICU service is difficult as the gap between the 2 cutoff values is wide.

But contrary to these studies khan et al in a study done in Durban, South Africa used 1 day (24hrs) as a cutoff point to separate early from late. The study reported that 93.5% of patients got admitted to the ICU in less than 1day from the ED and only 6.5% of them got admitted after a day. Although there are similarities in the setup, including the number of ICU beds, patient characteristics, and turnover rate played a major role in the difference. The majority of the

patients in the South African study were surgical and the median ICU LOS was 2 days unlike the patients in this study who were majorly medical with a median LOS for those who died in the ICU being 8.5 days. (3, 24).

. This study found a significant association between EDLOS and ICU mortality, Similarly, studies done in Saudi Arabia and India reported an increase in mortality as the EDLOS increased, 48.94(<24hrs) to 60.57% (>24hrs) and from 18.1% to 25.2% respectively. EDLOS was independently associated with an increased ICU mortality(OR-). Despite different cutoff values for delayed admission, the result is mirrored by Aletreby et al and Al Qahtani et al, which reported a significant between the two ((OR = 2.6; 95%CI 1.9 - 3.5; p < 0.001), (1.90 (1.02, 3.54) p=0.04). (23,6)

Moreover, a study done in the Netherlands which included 14788 patients consolidates this result by reporting that in addition to an increase in ICU mortality(0.82 (95% CI, 0.72–0.92), the 30-day mortality in the delayed group was higher(p < 0.001). (25)

Regardless of the difference in the setup and cutoff value as early as a 2hr delay was associated with a worse outcome in these studies. The reason which was coined by almost all of these researches and which is also the basis for the results shown in this research is the care in the ED for these critically ill patients, which is compromised by the continuous flow of new patients and lack of frequent monitoring due to human and clinical resource constraints.

In contrast to this study, Carter et al and D'Arcy et al, in studies done in Australia concluded that patients with delayed admission (> 4hrs) had no statistically significant increase in mortality. A study in South Africa supports these results with no association between pre-ICU LOS and mortality, be it in the ED or wards. Differences in results were mainly due to patient

characteristics, in these studies those patients who were admitted early were sicker while those admitted late were mostly surgical, with low APACHE scores and low chronic illness burden, which will all affect the mortality rate. A study done in the USA mirrors these results with no association between the two when patients are rather managed in ED ICU, which runs back to the reasons mentioned above. (26, 27, 28).

There was no significant association between EDLOS and total hospital length of stay in this research. However, the median hospital length of stay was shorter in the late-admitted patients. These results are similar to research done in South Africa which showed no association between the two in a resource-limited setup. Unlike the two studies D'Arcy et al reported that patients who stayed more than 4 hrs had a prolonged in-hospital LOS. However, the prolonged LOS was seen in non-survivors. This can also explain the shorter median hospital length of stay in the late-admitted group in this research, as most of them were non-survivors. A similar study done in Riyadh, Saudi Arabia supports these with a report of significant increase in total hospital stay in patients admitted after 24hrs of ED stay (OR=4.18 (2.04, 6.21) <0.0001), but in this research when ICU LOS and Hospital LOS without ED stay were compared between the two groups it was not significant, leading to the conclusion that the total (EDLOS + ICULOS +ward) stay of these patients is longer because of the difference in the EDLOS. (3, 23)

Regarding other significantly associated factors, SBP<90, respiratory causes of admission, and a higher total Charlson score were found to be associated with ICU mortality. Similar to this study a study done in 2 tertiary hospitals in Addis Ababa in 2022, showed that admission for respiratory failure, and septic shock(need for vasopressor) were associated with increased ICU mortality. Soares Pinheiro et al, in a study done in surgical ICUs in Brazil, also reported that a higher Charlson score was associated with increased ICU mortality. (13, 29)

7. **Limitations**

This study has several limitations. The first one is the small sample size, which could affect the precision and which could make it difficult to establish a causal relationship. It also did not include patients who stayed long and died in the ED, which would underestimate the effect of prolonged EDLOS. In addition, the approximation of patient EDLOS, since the time of ICU admission is usually not documented, may have underestimated the percentage of patients admitted late.

8. Conclusion

This study showed that despite being admitted to the ICU eventually, patients who had experienced a delayed admission (>24hours) from ED have an independently increased risk of ICU mortality. This implies that the timely admission of critically ill patients from the emergency to the ICU needs adequate attention.

9. **Recommendation**

The responsibility to implement the 24-hour rule in patients deserving ICU should be shared among the emergency department and responsible stakeholders. Further efforts should also be made by the practicing professionals to record the exact time of consultation and possible reasons for delays in these groups of patients. Policymakers should try to reach a consensus regarding the time limit of ED stay for critically ill patients.

10. **References**

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ANNEX 1. QUESTIONNAIRE (PREPARED FROM COMPONENTS OF 2 SIMILAR KINDS OF RESEARCH (6, 29)

Table 6. Questionnaire

1	Questionnaire number	
2	MRN	
3	Age	_____years
4	Gender	1) Male 2) Female
5	Method of receiving service	1) Health insurance 2) Own pocket 3) Social work 4) Others(specify)
6	ED triage time	
7	Clinical diagnosis and Reason for ICU admission	1) Neurological a. TBI b. raised ICP c. Coma d. Status epilepticus e. Guillen- Barré syndrome f. Acute subarachnoid hemorrhage

		2) Cardiovascular a. cardiogenic Shock b. Acute coronary syndrome c. Congestive heart failure with respiratory failure d. Acute pulmonary edema e. Hypertensive emergencies f. Life-threatening dysrhythmias e. Post-cardiac arrest 3) Infectious diseases a. sepsis with septic shock b. Complicated malaria 4) Respiratory a. Acute respiratory failure b. Acute pulmonary embolism 5) Renal a. AKI with complications 6) Gastrointestinal a. Life-threatening gastrointestinal bleeding b. Acute hepatic failure leading to coma and hemodynamic instability

		7) Endocrine a. severe Diabetic ketoacidosis b. Thyroid storm 8) Surgical a. Polytrauma 9) Haematological a. Disseminated intravascular coagulation b. Severe coagulopathy and/or bleeding diathesis 10) Toxicology 11) others----specify
8	Charlson score	**1 point each** - Myocardial infarction - Congestive heart failure - Peripheral vascular disease - Cerebrovascular disease - Dementia - Chronic pulmonary disease - Rheumatologic disease - Peptic ulcer disease - Liver disease (1 if mild, or 3 if moderate/severe)

		- Diabetes (if controlled, or 2 if uncontrolled) - **2 points each** - Hemiplegia or paraplegia - Renal disease, - Malignancy (2 if localized, or 6 if metastatic tumor) - Leukemia - Lymphoma **6 each** - AIDS **Age** -50-59 years old: +1 point -60-69 years old: +2 points -70-79 years old: +3 points -80 years old or more: +4 points

9	MPM0SCORE	Metastatic cancer (3.04902) Cirrhosis (2.070695) Chronic renal failure (0.5395209) Acute renal failure (0.8412274) Coma (2.050514) Cerebrovascular incident (0.4107686) Intracranial mass effect (1.855276) Cardiopulmonary resuscitation (1.497258) Heart rate > 150 (0.433188) SBP <90 (1.451005) Arrhythmia (0.841227) GI bleed (-0.165253) Mechanical ventilation(0.821648) Medical or unscheduled surgical admission(0.9097936)
10	ED LOS	1.<24hrs 2.48-72hrs 3. >72hrs
11	A possible reason for delayed admission	1) Lack of bed 2) Differed by ICU team 3) Financial reason 4) Others(specify)
12	Total in-hospital LOS(in days)	

13	Outcome of patients	1)Alive 2)Dead