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EVALUATION OF EMERGENCY SERVICE ADMISSIONS FOR PLANNING THE NUMBER OF INTENSIVE CARE BEDS IN HOSPITALS

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Abstract: A significant portion of intensive care unit (ICU) admissions occur through the emergency department (ED). Since there are insufficient ICU beds, critically ill patients may have to be monitored and treated in ED for an extended period. In this study, we aimed to show the importance of the emergency department intensive care unit (EDICU) and that ED applications should be taken into account in determining the number of intensive care unit (ICU) beds in hospitals by analyzing the patients hospitalized in intensive care units from the ED. In this retrospective descriptive study, patients over 18 who applied to the ED of a tertiary hospital between July 1, 2018, and July 1, 2019, and were deemed suitable for ICU admission were included. In descriptive statistics, percentages were used in categorical data, and mean, and standard deviation were used in numerical data. Chi-square test was applied for categorical variables. Since the distribution within the groups was normal in the analysis of continuous variables, one-way analysis of variance (ANOVA) was used when more than two groups were compared. The student's t-test was used when two groups were compared. Of the 2783 patients who applied to the ED and were suitable for admission to the ICU, 1341 (48.2%) were admitted to the second-level ICU, and 1442 (51.8%) were admitted to the third-level ICU. 1140 (40.96%) patients were hospitalized in the EDICU and toxicology ICU within the ED. These units played an important role in facilitating the ED operation and reducing crowding. Patients admitted to the ICU were divided into three groups based on their length of stay. Of the patients, 2312 (%83.1) were hospitalized in the first 6 hours, 337 (%12.1) in 6-12 hours, and 205 (7.36%) in more than 12 hours. It was observed that the mortality rate increased significantly when hospitalization in the ICU was delayed (P=0.014). ED admissions should be considered when determining the number of ICU beds and step levels of hospitals. In addition, the presence of EDICU in tertiary care hospitals relieves the density of the emergency department and indirectly reduces the mortality rate.

Keywords: Emergency medicine, Intensive care, Hospitalization, Emergency department intensive care unit, Toxicology intensive care unit

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1. Introduction

The number of emergency department (ED) applications is increasing every year. Hospitalizations also rise due to the rise in chronic and comorbid diseases (Kekeç et al., 2009). A significant portion of intensive care unit (ICU) admissions occurs through ED. Since there are insufficient ICU beds, critically ill patients may have to be monitored and treated in ED for an extended period. This situation brings about an increase in mortality and morbidity (Parkhe et al., 2002).

Just as pre-hospital care and interventions determine the clinical course in the ED, the clinical course of the patient admitted to the intensive care unit is determined by the quality of the treatment received in the ED. Pre-hospital, emergency, and intensive care processes should be uninterrupted, not independent, and complement each other. In the literature, there are many studies on the effect of the time between the ED and the ICU on the clinical course of the critically ill. Mortality rates of patients admitted to the ICU within the first 24 hours are lower than those admitted later (Bernstein et al., 2009).

While the number of ICU beds required in a hospital was previously calculated as 2% of the total number of hospital beds, this rate has risen to 15% as the need for these beds has grown over time (Beeknoo and Jones, 2016). The number of ICU beds should be determined by considering the type of hospital, the specific disease group admitted, the geographical location of the hospital, and the number of beds that will be needed urgently. The number of ICU beds in university hospitals is around 10% of the total number of beds. In order for an intensive care unit to work ideally and efficiently, the number of

beds should be a minimum of 6 and a maximum of 10. As isolation beds, it should be calculated as 1 or 2 rooms for an ICU with ten beds (Bertolini et al., 2003; Beeknoo and Jones, 2016).

In this study, we aimed to show the importance of the emergency service ICU and that emergency service applications should be considered in determining the number of ICU beds in hospitals by analyzing the patients hospitalized in ICUs from the ED.

2. Materials and Methods

2.1. Study Design and Settings

This is a retrospective descriptive study. In the research, historical information was obtained by using the Hospital Information Management System. The research protocol prepared for patients admitted to a tertiary care hospital's ED and hospitalized to the ICU was scanned and recorded retrospectively. Patients were classified according to their respective clinical diagnoses.

There are 14 surgical and internal ICUs in our hospital. The treatment of patients who applied to the emergency department and could not be admitted to the relevant ICU was continued primarily in the emergency department ICU (EDICU) and toxicology ICU, which were within the ED. The term EDICU was used to refer to "a unit within an ED with the same or similar staffing, monitoring, and therapy capability as an ICU" (Weingart et al., 2013). One associate professor of emergency medicine, two senior residents, and six nurses were responsible for the 11-bed EDICU. Critical care provided to patients admitted to EDICU (including invasive and noninvasive mechanical ventilation, invasive monitoring, vasoactive drug use, weaning, hemodialysis, paracentesis, and thoracentesis). One emergency medicine associate professor, one senior resident, and three nurses were responsible for the toxicology ICU, a 6-bed second-level intensive care unit. In the toxicology ICU, priority suicidal interventions, environmental emergencies, and intoxications were followed and treated.

Patients over 18 who applied to the hospital's ED between 1 July 2018 and 1 July 2019 and were deemed suitable for ICU were included in the study. Patients with missing data, critically ill patients who died without hospitalization after admission to the ED, and patients under 18 were excluded from the study. Since the majority of the patients admitted to the ICU in our clinic are the adult patient population.

2.2. Statistical Analysis

SPSS version 18.0 was used for data analysis. In descriptive statistics, percentages were used in categorical data, and mean and standard deviation was used in numerical data. Chi-square test was applied for categorical variables. Since the distribution within the groups was normal in the analysis of continuous variables, one-way analysis of variance (ANOVA) was used when more than two groups were compared. The student's t-test was used when two groups were compared. The significance level was accepted as $P<0.05$.

3. Results

Between July 1, 2018, and July 1, 2019, 343,120 patients visited the ED. Of these patients, 10,473 were hospitalized in wards and 2881 in ICU. Of the 343 people who were referred, 183 were transferred to other hospitals due to intensive care occupancy. Since 98 patients admitted to the intensive care unit were under 18, they were not included in the study, and our study was conducted with 2783 patients.

The majority of patients requiring ICU hospitalization were in the EDICU, toxicology ICU, coronary, internal medicine, and neurology ICU. As for the total hospitalization rate, the least neurosurgery and thoracic surgery ICUs were hospitalized. 59.17% of the hospitalizations in ICUs in the hospital were from patients who applied to the ED (Table 1). 1140 (40.96%) patients were hospitalized in the EDICU and toxicology ICU within the ED. These units played an important role in facilitating the emergency room operation and reducing crowding.

Of the patients included in the study, 1516 (54.47%) were male. The mean age of males was 62.27±20.41, and the mean age of females was 62.72±23.32. The age range was between 18 and 105, and there was no significant difference between the mean ages of males and females ($P=0.588$).

It was seen that the patients who applied to the emergency department with shortness of breath, respiratory distress, neurological, and infection complaints had a higher average age ($P=0.008$) (Table 2).

When the patients were examined according to the degree of ICU level to which they were admitted, it was seen that the mean age of the patients admitted to the third-level ICI was higher than those admitted to the second-level ICU ($P<0.001$) (Table 3).

The average length of stay of the patients in the ED was 230±229 minutes. Considering the relationship between the age of the patients and the duration of their stay in the ED, it was seen that the mean age of the patients who were hospitalized in the ICU in the first 6 hours was 62.62, and the mean age of the patients who were hospitalized in the ICU between 6-12 hours was 65.96 (Table 4). When 134 patients with a waiting time of more than 12 hours in the ED were examined, it was observed that 63 patients applied with poisoning and drug intoxication, and were kept waiting in the emergency observation room to make room for hospitalization in the toxicology ICU. Therefore, it was not included in some statistical calculations to not affect our study's overall results. Excluding these 63 patients, it was found that as the age of the patients increased, the length of stay in the ED was significantly longer ($P=0.008$) (Table 4).

Table 1. Distribution of hospital intensive care unit hospitalizations

Intensive care unit (ICU)	Admission from emergency department	Admission from other units	Total hospitalization
Emergency department intensive care unit (EDICU)	468 (%65.09)	251 (%34.91)	719
Toxicology ICU	672(%80.09)	167 (%19.01)	839
Thoracic Surgery ICU	36 (%32.72)	74 (%67.28)	110
General Surgery ICU	75 (%50.67)	73 (%49.33)	148
Neurosurgery ICU	32 (%36.78)	55 (%63.22)	87
Cardiovascular Surgery second-level ICU	107 (%51.69)	100 (%48.31)	207
Internal Medicine ICU	232 (%52.48)	210 (%47.52)	442
Lung diseases ICU	169 (%50.59)	165 (%49.41)	334
General ICU (1)	153 (%62.44)	92 (%37.56)	245
General ICU (2)	141 (%54.02)	120 (%45.98)	261
Coronary ICU	309 (%60.82)	199 (%39.18)	508
Cardiovascular Surgery third-level ICU	46 (%29.67)	109 (%71.33)	155
Nephrology ICU	117 (%48.95)	122 (%51.05)	239
Neurology ICU	98 (%60.86)	63 (%39.14)	161
Neurology, stroke ICU	16 (%34.78)	30 (%65.22)	46
Anesthesia and Reanimation ICU	112 (%55.44)	90 (%44.56)	202
TOTAL	2783 (%59.17)	1920 (%40.83)	4703

Table 2. Examination of the age and the emergency department application complaints

Application complaint	n	Age (mean ± SD)
Shortness of breath	397	73.63±13.28
Chest Pain	375	66.78±14.15
Respiratory Distress	135	72.91±12.95
Neurological complaints	593	72.71±16.76
Infection	22	72.82±16.05
Abdominal pain	401	68.75±18.43
Traffic accident	90	46.64±20.35
Assault	26	46.50±22.16
Environmental Emergencies (Intoxications, electric shock, poisonous animal bites, etc.)	559	36.11±15.67
Other copmlaints	185	64.25±22.04
Total	2873	62.48±21.78

ANOVA test was applied.

Table 3. Age analysis according to the level of intensive care unit

The level of intensive care unit (ICU)	n (%)	Age (mean ± SD)
Second-level ICU	1341 (48.2%)	54.36 ±22.74
Third-level ICU	1442 (51.8%)	70.03 ±17.79

Student's t-test was applied.

Table 4. Examination of the age of the patients and the length of stay in the emergency department

Time	n (%)	Age (mean ± SD)
0-6 hours	2312 (83.1%)	62.62±21.57
6-12 hours	337 (12.1%)	65.96±21.22
12 hours or more (including toxicology)	134 (4.81%)	51.37±23.41
12 hours and more (excluding toxicology)	71 (2.55%)	67.07±17.62
Total	2783 (100%)	62.48±21.78

ANOVA test was applied.

When the duration of the patient's stay in the ED was divided into three groups (0-6 hours, 6-12 hours, >12 hours), and the mortality numbers were compared, it was observed that the mortality rate increased significantly when the hospitalization of the patients in the ICU was delayed (P=0.014) (Table 5).

Table 5. Duration of stay in the emergency department and mortality analysis of the patients

Time	Survival (n)	Mortality (n)
0-6 hours	1700	612
6-12 hours	256	42
>12 hours	42	29
Total	1998	722

Chi-square analysis was applied.

4. Discussion

Critical patients who apply to the ED of tertiary hospitals and require intensive care admission are first admitted to the ICU of the relevant branch. If there is no relevant ICU or vacant bed, or if the level of the ICU is not appropriate, the patient is admitted to another appropriate ICU.

In the literature, it has been observed that the patients hospitalized in ICU units from the ED are not subject to any classification specific to the ICUs in the hospitals. Our study is the first study in this respect, and it was tried to determine the use of the intensive care units in the hospital of the patients who applied to the emergency department. It also aimed to give an idea about the level and the number of beds in the ICUs in the hospital.

The number of ICU beds in hospitals should not be determined according to a certain standard but according to the geographical region where the hospital is located and the needs of its population. In this regard, the most important and practical method is the examination of critically ill patients admitted to the ED.

In this study, we examined all patients over 18 who applied to the ED within a year who were hospitalized in the ICU. As a result of our study, we found that 59.17% of the patients hospitalized in all intensive care units in our hospital were critically ill patients who applied to the ED. In a retrospective cohort study by Wunsch et al. (2011), this rate was found to be 58% in the USA and 34% in the UK.

According to the United States National Hospital Ambulatory Medical Care Survey data, the average age of patients who need to be admitted to the ICU has increased over the years. This is due to the prolongation of life expectancy all over the world. With aging, chronic diseases, and the need for hospitalization (including ICU) increase (Mullins et al., 2013). In the study conducted by Aslaner et al. (2015) with 400 patients over six months, 244 (61%) of the patients admitted to the ICU for medical reasons were male, 156 (39%) were female, the mean age of male was 62, and the mean age of female was 63. In our study, the number of males was higher, consistent with the literature. The mean age of the patients was similar to the literature.

In 1999, "The Society of Critical Care Medicine" prepared ICU admission, triage, and discharge guidelines. In this guide, the intensive care admission decision; are based on priority, diagnosis, and objective parameter models. According to the diagnosis model, the most common reasons for hospitalization in Simchen et al. (2004)'s study were; diseases related to pulmonary, cardiac, and neurological systems, shock, and sepsis. In a large-scale study by Mullins et al. (2013) in which admissions to intensive care units from emergency departments in the USA between 2002 and 2009 were examined, the reasons for hospitalization were found to be cardiac, respiratory distress, and abdominal pain. In our study, diseases related to pulmonary, cardiac, and neurological systems and poisoning were among the most common causes of ICU hospitalization. The main reason for this is that the majority of the patients who are hospitalized in the ICU are the elderly population. In addition, the presence of the toxicology ICU within the ED explains the high number of poisoning cases.

There are many studies about the prolonged stay in the ED of critically ill patients increasing mortality. Aslaner et al. (2015)'s study determined that the mortality rate increased 2.4 times for patients hospitalized in the ICU staying in the ED for longer than 24 hours (Simchen et al., 2004). In a multicenter study conducted by Chalfin et al. (2007) with many critically ill patients, it was found that the mortality of patients with a stay in the ED longer than 6 hours increased by 1.5 times. Cardoso et al. (2011) found a 1.5% increase in ICU mortality for each hour of increase in the length of stay in the ED. Another study by Simchen et al. (2004) showed that mortality rates were lower in patients hospitalized in the ICU within 72 hours. Al-Qahtani et al. (2017) grouped the patients hospitalized from the ED to the ICU as 0-6 hours, 6-24 hours and more than 24 hours, and it was observed that the mortality increased as the duration increased. In this study, the duration of hospitalization was grouped as 0-6 hours, 6-12 hours and more than 12 hours, and mortality increased as the length of stay increased, supporting the literature. Our advantage was that there were two intensive care units, an EDICU, and a toxicology ICU, in the ED, and the waiting times were shorter. If EDICUs become widespread in hospitals, the mortality rates of critically ill patients may be further reduced.

The study conducted by Herring et al. (2013) between 2001 and 2009 found that the number of critically ill patients admitted to the emergency services increased three times compared to previous years. In contrast, a smaller increase in intensive care beds was associated with a longer stay in the emergency room and increased intensive care mortality. In a large-scale study by Mullins et al. (2013) examining ICU admissions in the USA between 2002 and 2009, the average length of stay in the ED was 304 minutes. In a study conducted in Korea, the mean duration of stay in the ED was 198 minutes in critically ill adult patients admitted directly from the ED to the ICU (Lee et al., 2022). While the duration of stay of critically ill patients in the ED was 150 minutes in Australia, it was 240-300 minutes in the USA (Flabouris et al., 2013; Mullins et al., 2013; Ansah et al., 2021). In Canada, this period was longer (420min) (Rose et al., 2016). In our study, the average length of stay of the patients in the ED was 230 minutes, and they were admitted to the ICU in less time compared to the literature.

In addition, 19.4% of admissions to this ICU did not meet the ED length of stay (EDLOS) < 6 hours criterion, an internationally recognized performance indicator that assesses the quality of emergency care (Chalfin et al., 2007; Horwitz et al., 2010; Affleck et al., 2013; Zhang et al., 2019). However, our rate was better than the study of Lee et al. (25.3%) (Lee et al., 2022).

5. Conclusion

Emergency service applications should be considered in determining the number of ICU beds and ICU levels of hospitals. In tertiary hospitals, the presence of EDICUs is preferred when there is no place in the relevant intensive care units throughout the hospital, and it relieves the density of the ED.

Limitations

This study is a single-center and retrospective study. Since pediatric patients were not included in our study, it does not cover all age groups. In addition, the follow-up period and mortality period of the patients were not included in the study.

Author Contributions

The percentage of the author(s) contributions is present below. All authors reviewed and approved final version of the manuscript.

	E.K.	R.K.	N.V.	M.D.
C	25	25	25	25
D	70	30		
S		100		
DCP	25	25	25	25
DAI	25	25	25	25
L	25	25	25	25
W	25	25	25	25
CR	25	25	25	25
SR	25	25	25	25
PM	25	25	25	25
FA	25	25	25	25

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The authors declared that there is no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

Ethical Approval/Informed Consent

Approval for our study was obtained from the Ethics Committee of Necmettin Erbakan University Meram Faculty of Medicine (approval date: November 11, 2019, protocol code: 2019/2175). The present study was conducted in line with the Declaration of Helsinki.

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