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İbrahim Sarbay, Ayşe Çağla Şahin, Atilla Beştemir; Edirne, İstanbul, Ankara, Turkey



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Predictive Value of Base Excess for Mortality in Methanol Intoxication

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Abstract

Objective: Methanol intoxication is among the common reasons for emergency department admissions, apart from suicide attempts. In this study, we investigated the predictive value of base excess (BE) for methanol-related mortality and its potential use in clinical practice.

Materials and Methods: All patients with a confirmed diagnosis of methanol intoxication in an 8-year retrospective study were included. Cases with in-hospital mortality were included in the mortality group. Blood gas and biochemical parameters of the patients were recorded. Receiver operating characteristic curve and regression analyses were performed for variables with significant differences between the groups.

Results: We found that pH, HCO₃, and BE were significantly lower, whereas lactate levels were significantly higher in the mortality group. According to the cut-off values of the independent variables, we determined the area under the curve values to be 0.852, 0.855, 0.900, and 0.708, respectively. We found that the BE value of <-23.65 had the highest sensitivity, specificity, and odds ratio (OR) values [sensitivity: 86.4%, specificity: 89.47%, OR: 0.780 (95% CI; 0.656-0.929)].

Conclusion: We suggest that BE values can be useful for clinicians in prioritizing patients in mass emergency department admissions, such as those with methanol intoxication.

Keywords: Base excess, intoxication, methanol, predictive

Introduction

Methanol, also known as wood alcohol, is a substance that has been shown to be deadly even in small amounts and is found in various substances (such as cleaning agents, windscreen washer fluids, antifreeze, aviation fuels, solid fuels, copier fluids, and perfume) often used in household or industrial sectors. is an alcohol derivative. Methyl alcohol intoxication is often oral or accidental. However, it has been reported that the consumption of fake drinks, suicide, inhalation, or skin contact also causes toxication [1-5]. Alcohol and aldehyde dehydrogenase enzymes are responsible for the metabolism of methanol and other alcohols [1,6].

In our country, methanol poisoning mostly causes mass applications because of fake alcohol consumption [7]. Although their timing and clinics are different, these cases often cause congestion in the emergency departments. With the

introduction of the coronavirus disease-2019 pandemic into our lives, an increase was observed in the number of methanol intoxication cases in neighboring countries in the early periods [8]. According to a synthesis study conducted by 12 major clinical toxicology centers in Iran, the number of applicants with methanol poisoning in February and May 2020 is five times larger than the mass methanol poisonings seen in Libya in 2013. The reason for this has been shown to be the widespread use of alcohol recommended for disinfecting the mouth in social media and the large number of hand disinfectants that do not comply with the standards with high methanol content [8].

High anion gap metabolic acidosis is observed in patients presenting with methyl alcohol poisoning. Low pH and HCO₃ values, as well as low base excess (BE), another parameter that can be easily measured in blood gas, have been shown to be associated with mortality [9]. We believe that the BE value



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may be useful for clinicians in assigning priority to patients in collective emergency department admissions such as those with methanol intoxication.

Materials and Methods

This study was conducted retrospectively on patients who applied to the Emergency Department of University of Health Sciences Turkey, Kanuni Sultan Süleyman Training and Research Hospital because of methanol intoxication. University of Health Sciences Turkey, Kanuni Sultan Süleyman Training and Research Hospital Ethics Committee approval was obtained for the study (KAEK/2022.04.97) and the Helsinki statement was strictly adhered to throughout the study. Informed consent was not obtained because this was a retrospective study.

Patient records were accessed from archive data and the Data Processing Automation system. The study included 51 patients aged 18 years and over who applied to the emergency department with a prediagnosis of methanol intoxication between May 1, 2014, and May 1, 2022. Ten patients were excluded from the study after ethanol intoxication was detected in 4 of the patients' triggers, and six of them left the hospital by signing a treatment rejection form. Age, gender, clinical follow-up, and in-hospital mortality of the patients were recorded.

From the blood gas analysis of the patients at the time of admission to the emergency service, pH, HCO₃, pO₂, pCO₂, lactate, and BE values and biochemistry parameters, glucose, urea, creatinine, sodium, and potassium values were recorded in the study form. Blood gas samples from the blood samples taken from the patients were studied in the ABL 800 device, and biochemistry samples were studied in the COBAS 501 device. BE is calculated automatically by the device.

Statistical Analysis

Categorical data are expressed as numbers and percentages. The Mann-Whitney U test was used in the analysis of data that did not fit the normal distribution, and the data are shown as median inter quantile range. The cut-off values were determined by performing a receiver operating characteristic (ROC) curve analysis of the variables that were found to be significant between the groups. Binary logistic regression analysis was performed to determine the effect of the independent variables in the mortality group. The obtained data were analyzed using the Statistical Package for the Social Sciences statistics 26.0 (IBM Inc., New York, USA) program. P<0.05 and 95% confidence interval (CI) were used for statistical significance.

Results

A total of 41 patients (4 females and 37 males) were included in the study. We did not find a statistically significant difference

between the gender distribution and mean age of the groups with mortality (p=0.639, 0.053, respectively) (Table 1).

When we grouped patients based on mortality, we found that in the group with mortality, pH, HCO₃, and BE values were significantly lower, whereas pO₂, lactate, glucose, and creatinine values were significantly higher. A comparison of other data is shown in Table 2.

The ROC curves of the independent variables where a statistically significant difference was detected between the groups with mortality are shown in Figures 1 and 2. In the ROC analysis of pH, HCO₃, BE, and lactate values, statistical significance was determined, and the area under the curve (AUC) values were 0.852, 0.855, 0.900, and 0.708, respectively, for the determined cut-off values. We observed that BE had the highest sensitivity and specificity values at a value of <-23.65 (86.4% and 89.47%, respectively). The ROC analysis of the independent variables, sensitivity, specificity, negative likelihood ratio, and positive likelihood ratio values are shown in Table 3.

In the univariate logistic regression analysis conducted to verify the accuracy of the independent variables that showed statistical significance and had high AUC values in the ROC analysis for predicting mortality, we found that BE had the highest odds ratio (OR) value [OR: 0.780 (95% CI; 0.656-0.929)] (Table 4).

Table 1. Analysis of general data

		Mortality n (%)		p
		Absent	Present	
		19 (46.35)	22 (53.65)	
Gender	Woman	2 (50)	2 (50)	0.639 ^a
	Man	17 (45.9)	20 (54.1)	
Age median (IQR)		38 (16)	43.5 (14.25)	0.053 ^b

^aFisher's exact test, ^bMann-Whitney U test, IQR: Interquartile range

Table 2. Comparison of variables in groups with mortality

Parameters	Mortality		p
	Absent	Present	
pH	7.11 (0.22)	6.87 (0.39)	<0.01
pCO ₂ (mmHg)	33.10 (15)	35.25 (21.35)	0.695
pO ₂ (mmHg)	47.30 (12.50)	93.15 (121.93)	<0.01
Lactate (mmol/L)	2.9 (3.40)	7.13 (5.61)	0.023
HCO ₃ (mmol/L)	9.5 (10)	5.65 (2.98)	<0.01
BE (mmol/L)	-18.60 (14.40)	-25.35 (4.13)	<0.01
Glucose (mg/dL)	116 (41)	185 (166)	0.011
Urea (mg/dL)	30 (24.90)	26 (22.68)	0.320
Creatinine (mg/dL)	1.14 (0.50)	1.41 (0.66)	0.023
Sodium (mmol/L)	135 (11)	136 (6.5)	0.885
Potassium (mmol/L)	5.2 (1.2)	5.35 (1.30)	0.784

*Mann-Whitney U test, BE: Base excess

Discussion

Methanol poisoning is a serious medical emergency that can have lasting effects and can even be fatal. Substances containing methanol can be accidentally or intentionally ingested (suicide attempt) [10]. The severity of the patient’s condition determines the priority of treatment. For methanol intoxication, the main principles of treatment are prompt diagnosis and resuscitation. It is also crucial to provide cardiopulmonary support, inhibit the conversion of toxic metabolites (by targeting the alcohol dehydrogenase enzyme),

correct any existing metabolic acidosis, and remove toxic metabolites from the body [11,12].

In our study, we found that patients diagnosed with methanol intoxication in the emergency department who had hospital mortality had significantly lower pH, HCO₃, and BE values than those who did not experience mortality. The conversion of the toxic metabolite formic acid, which is responsible for toxicity and metabolic acidosis in methanol poisoning, can be facilitated by high-dose folate or folinic acid treatment. This treatment leads to its conversion to carbon dioxide and water

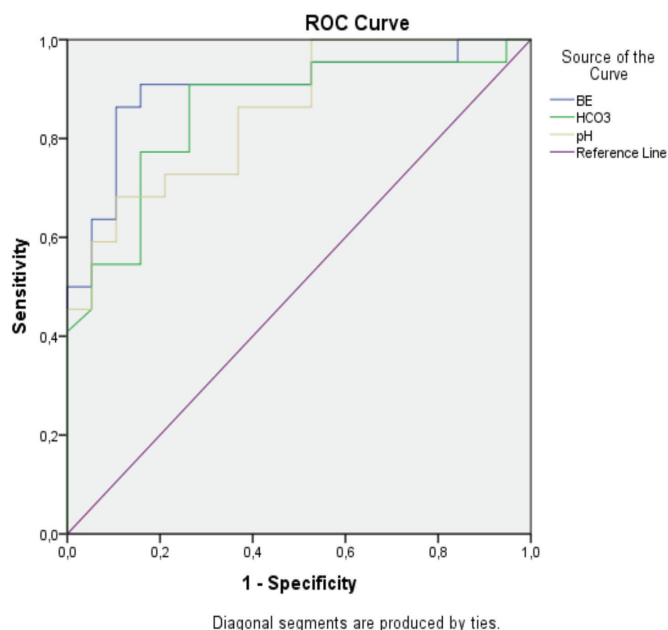


Figure 1. ROCs of BE, HCO₃, and pH values

ROC: Receiver operating characteristic, BE: Base excess

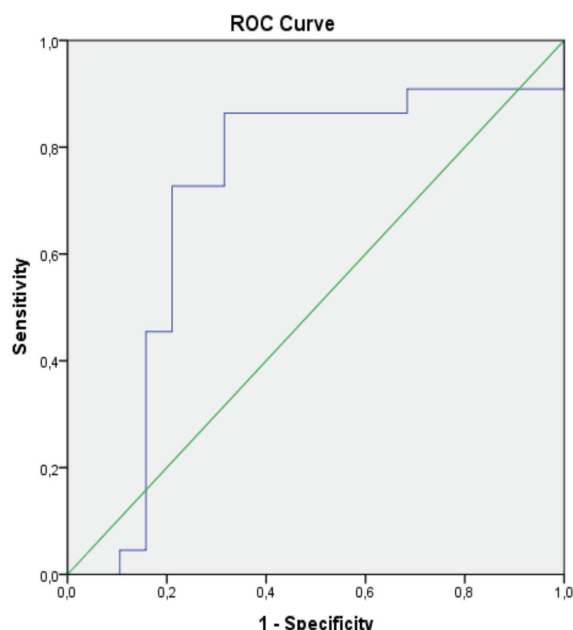


Figure 2. ROC of lactate value

ROC: Receiver operating characteristic

Table 3. ROC analysis results of significant independent variables								
Test result variables	Area	Sensitivity	Specificity	NLR	PLR	p	Asymptotic 95% CI	
							Lower	Upper
pH <6.99	0.852	68.2	80.95	0.39	3.58	0.000	0.739	0.965
HCO ₃ <7.15 (mmol/L)	0.855	77.3	84.21	0.27	4.89	0.000	0.736	0.974
BE <-23.65 (mmol/L)	0.900	86.4	89.47	0.15	8.20	0.000	0.799	1.000
Lactate >4.25 (mmol/L)	0.708	86.4	68.42	0.20	2.73	0.023	0.530	0.887

NLR: Negative likelihood ratio, PLR: Positive likelihood ratio, BE: Base excess, CI: Confidence interval, ROC: Receiver operating characteristic

Table 4. Univariate logistic regression results					
	B	p	OR	95% CI	
				Lower	Upper
pH	-8.808	0.002	0.000	0.000	0.036
HCO ₃	-0.298	0.008	0.743	0.595	0.927
BE	-0.248	0.005	0.780	0.656	0.929
Lactate	0.098	0.163	1.103	0.951	1.266

CI: Confidence interval, OR: Odds ratio, BE: Base excess

[11]. HD is the best method for rapidly removing both toxic acid metabolites and parent alcohols and plays a fundamental role in treating severely poisoned patients [13]. A study conducted by Kute et al. [14] reported that a pH value ≤ 6.9 was highly associated with mortality [9]. Additionally, it was determined that coma, seizures, and severe metabolic acidosis during presentation predicted a poor prognosis [14]. Our study also yielded similar results, with pH values below 6.9 in the mortality group.

Patients with methanol intoxication may develop life-threatening complications such as gastrointestinal involvement, central nervous system involvement, acute kidney failure, and metabolic acidosis (with an increased anion gap). In a retrospective study conducted in our country, 31 patients were admitted to the emergency department because of methanol poisoning. This condition was more common in men and those with a history of chronic alcohol use. In addition, low pH, HCO_3^- , and BE values, and high sodium values, were associated with mortality [10]. Our study is supported by the results found in the literature.

In the study conducted by Smuszkiewicz et al. [15], it was reported that both BE and lactate have prognostic value in determining mortality in patients in the intensive care unit (ICU). Similarly, Smith et al. [16] found that both lactate and BE were correlated with mortality in 148 patients admitted to the ICU for various reasons. In the literature, lactate and BE have been reported as biomarkers of traumatic shock and as significant predictors of mortality in trauma and sepsis patients [17]. In our study, the statistically significant differences in pH, lactate, and BE values between the group with and without mortality were consistent with these findings.

In our study, we retrospectively analyzed 41 patients who presented to the emergency department with a suspected diagnosis of methanol poisoning based on their history and clinical evaluation, including 37 men and 4 women, as methanol levels were not measured in our center. We did not detect a statistically significant difference in the gender distribution and mean age between the mortality groups. In the study by Kute et al. [14], it was reported that all methanol intoxication cases were men with a mean age of 40 ± 8.5 years. We believe that these results may be related to the fact that men are more likely to produce alcohol at home and generally consume more alcohol. Our results are consistent with the literature.

Study Limitations

We had no possibility of using fomepizole because it is not available in our country. The retrospective design of our study, the inability to determine methanol levels in patients, and the relatively small number of cases can be considered limitations.

Conclusion

In conclusion, many people who consume counterfeit alcohol hide their stories because of guilt, shame, or potential legal problems, which makes it difficult for clinicians to evaluate and delays diagnosis and treatment. Despite advanced treatments, morbidity and mortality in methanol poisoning remain high, mostly due to late diagnosis. In our study, we found that lower BE values in patients with methyl alcohol poisoning were associated with mortality. We believe that more comprehensive studies will provide more effective results.

Ethics

Ethics Committee Approval: University of Health Sciences Turkey, Kanuni Sultan Süleyman Training and Research Hospital Ethics Committee approval was obtained for the study (KAEK/2022.04.97) and the Helsinki statement was strictly adhered to throughout the study.

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Impact of Erythrocyte Suspension Transfusion and Viscosity on Perfusion Index in the Emergency Department

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Abstract

Objective: Erythrocyte suspension (ES) transfusion is a frequently needed and performed procedure in emergency departments. In this study, the effect of transfusion on the perfusion index (PI), shock index (SI), vital parameters, hemoglobin (Hb), and hematocrit (Hct) values in adult patients who applied to the emergency department and required ES transfusion was investigated.

Materials and Methods: Fifty-five adult patients who applied to the emergency medicine clinic within three months and underwent ES replacement were included in the study. The changes in PI, SI, vital parameters, Hb, and Hct values of patients with ES transfusion compared with those pre-transfusion were analyzed.

Results: The mean age of 55 patients included in the study was 62.5±16.5 years, of which 28 (50.9%) were female. Pre-transfusion values of the patients were Hb 6.4±1.2 g/dL, mean arterial pressure (MAP) 83.2±11.6 mmHg, SI 0.73±0.19, and PI was 3.07±2.21. After the transfusion procedure, Hb was 9.0±1.2 g/dL (p<0.001), MAP 90.0±13.0 mmHg (p<0.001), SI 0.67±0.14 (p=0.003), PI 4.25±3.18 (p=0.004).

Conclusion: The ES transfusion procedure causes a statistically significant increase in post-transfusion PI, MAP, Hb, Hct, and body temperature values compared with pre-transfusion, and a statistically significant decrease in mean pulse and SI. PI can be used as a parameter to evaluate treatment response as well as transfusion decisions in patients.

Keywords: Perfusion index, emergency department, erythrocyte suspension, transfusion, shock index

Introduction

Using non-invasive methods such as the perfusion index (PI) in the emergency department can provide clinicians with a preliminary estimate of patients' hemodynamic status. In emergency medicine, pulse oximetry may be more useful than interventional perfusion measurement techniques. This is a result of its ability to provide continuous monitoring, cost-effectiveness, suitability for bedside applications, and swift and simultaneous measurement capabilities. Regarding PI, there are few published works, and studies involving large patient populations, such as emergency room patients, are required. Tissue perfusion is essential for cellular resistance to infectious organisms, metabolic continuity, and tissue repair [1]. Numerous

clinical studies have demonstrated that in critically ill patients, early resolution of tissue-level hypoxia and systemic oxygen supply can reduce the incidence of mortality and morbidity [2].

Non-invasive imaging methods are recommended as an alternative approach to identifying and correcting hemodynamic deficits as early as possible because time is the most important determinant in first aid, resuscitation, and treatment in emergency clinic patients [3]. In terms of the early identification of hemodynamic instability, it is more appropriate to use non-invasive imaging methods in patients with short-term emergencies [3].

The main aim of continuous circulation monitoring is to accurately evaluate peripheral tissue perfusion in a clinical



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environment and detect probable circulatory diseases in their early stages. The rationale underlying this method posits that peripheral tissues serve as primary markers of hypoperfusion in cases of shock and as ultimate indicators of reperfusion following resuscitation [4]. Impaired peripheral circulation can be detected with a comprehensive clinical assessment, the use of optical monitoring systems, and the quantification of body temperature [5-7]. In contemporary times, there has been a proposal suggesting that pulse oximetry can be used as an indicator of changes in peripheral perfusion [8].

The objective of this study was to precisely assess the impact of transfusion on PI, shock index (SI), and other essential parameters in patients requiring erythrocyte suspension (ES) transfusion in the emergency department. Additionally, this study attempted to identify the appropriate candidates for transfusion.

Materials and Methods

Study Design and Population

The study was conducted as a prospective, single-center, cross-sectional, descriptive study. A total of 55 individuals who were above the age of 18 years and needed medical attention at the Emergency Medicine Clinic of University of Health Sciences Turkey, Istanbul Training and Research Hospital between the dates of 15.04.2015 and 15.06.2015 were selected for this study. These individuals underwent ES transfusion following a comprehensive evaluation.

The physician in charge of the study was informed of the patients who needed ES transfusion because of the physical examination, examination, and clinical condition performed by the physician in charge after their admission to the emergency service. The physician who was supervising the research provided the participants with information about the study. Individuals who volunteered for the study were provided with information and provided written and verbal consent. To ensure ethical participation in the study, informed consent was obtained directly from each patient. In instances where the patient could not provide assent, arrangements were made to obtain consent from a first-degree relative. In the absence of a first-degree relative, consent was obtained from the individual accompanying the patient to the hospital. Exclusion criteria for this study included patients who were admitted to the intensive care unit in a state of cardiopulmonary arrest and subsequently underwent resuscitation, individuals who required immediate surgical intervention and subsequent treatment as indicated by a referral, participants who could not be reached for follow-up, individuals under the age of 18, patients whose vital signs could not be measured accurately, and those who experienced complications during the study. The research was designed as a prospective, single-center, descriptive cross-sectional study. A total of 55 adults over the

age of 18 who presented to the Emergency Medicine Clinic of University of Health Sciences Turkey, Istanbul Training and Research Hospital between April 15, 2015, and June 15, 2015, and received ES transfusions because of the evaluation were included.

Vital signs, including blood pressure, arterial pressure, pulse, respiratory rate, body temperature, and saturation, were measured with the General Electric farmscape V100 Dinamap SH612260165SA device before and after the transfusion of the patients included in the study, and they were recorded in the patient file. Simultaneously with the vital signs of the patients, PIs were measured noninvasively by waiting for 30 seconds with the Massimo-SET Root 7362A RDS7 pulse oximetry device saturation probe from the fourth distal phalanx of the non-dominant hand, with the hand at the heart level. Hemoglobin (Hb) and hematocrit (Hct) values from the hemogram parameters sent before and after the transfusion of the patients were taken from the automation system and recorded. The next measurement was taken immediately after completion of the ES transfusion, simultaneously with the control blood values. The formula "Shock index: heart rate/systolic blood pressure" was used to calculate the SI [9].

The procedures adhered to the ethical standards set forth by the institutional and national committees overseeing human experimentation and the principles outlined in the Declaration of Helsinki. The study participants who volunteered were provided with information and subsequently acquired written and verbal consent. The author responsible for correspondence hereby affirms, representing all authors, that there are no conflicts of interest present. The University of Health Sciences Turkey, Istanbul Training and Research Hospital Clinical Research Ethics Committee granted approval for the study, as evidenced by document date and number 09.01.2015/569.

Statistical Analysis

The patient data used in the study were documented inside the Statistical Package for the Social Sciences 15.0 for Windows software and then subjected to analysis. The provided information included descriptive statistics, which encompassed numerical measures such as numbers and percentages for categorical variables, as well as the mean, standard deviation, minimum, and maximum values for numerical variables. The Mann-Whitney U test was employed to compare two independent groups because of the non-normal distribution of the numerical variables. Spearman correlation analysis was employed to examine the correlations between numerical variables because the parametric test assumption was not satisfied. The numerical variable was analyzed using the linear regression analysis backward technique. The statistical significance level, denoted as alpha, was deemed acceptable when it was 0.05.

Results

The mean age of 55 patients included in the study was 62.5±16.5 (range: 22-89 years), and 28 (50.9%) were female. The mean age of women was 61.2±18.0 years, and that of men was 63.8±15.1 years. While active bleeding was in 8 (14.5%) of the cases, 50 (90.9%) patients had symptomatic anemia. The mean number of ES transfusions administered was 2.1±0.5 units.

Considering the additional diseases of the cases included in the study, malignancy ranked first with 17 (30.9%). Anemia of chronic disease was observed in 15 (27.2%) cases and hypertension was observed in 13 (23.6%) cases. No statistically significant correlation was found between the presence of the disease and the mean PI values before the transfusion according to the additional disease types of the patients included in the study (Table 1).

Hb values of the cases were 6.4±1.2 before transfusion and 9.0±1.2 after transfusion (p<0.001). PI was 3.07±2.21 before transfusion and 4.25±3.18 after transfusion (p=0.004). The SI was 0.73±0.19 before and 0.67±0.14 after (p=0.003). While there was a statistically significant increase in the mean values of Hb, hematocrit (Hct), mean arterial pressure (MAP), body temperature, and PI with blood transfusion in the patients included in the study, a statistically significant decrease was found in the mean pulse and SI values. There was no statistically significant change in the mean saturation levels of the patients after transfusion (Table 2, Figure 1).

Discussion

Using PI as an alternative metric for cardiac output was used in various fluid responsiveness evaluation maneuvers. A passive limb-raising test increased PI by 9%, whereas an end-expiratory obstruction test increased PI by 2.5%. These findings suggest that these tests can predict fluid responsiveness with reasonable accuracy. According to a study, the administration of a 200-mL fluid infusion results in a 5% increase in the PI, which can serve as a predictor of fluid responsiveness in patients with septic shock [10-13]. According to a study [14], the lung recruitment method significantly reduces the PI by 26%. This decrease in PI can be used as a predictor of fluid responsiveness during surgery. In the absence of a cardiac output monitor, this application represents a significant achievement in guiding fluid therapy [14]. There was a significant association between the average PI within the initial 30 min following an out-of-hospital arrest in individuals with post-return spontaneous circulation and their subsequent clinical outcomes [15]. The mortality rate of patients with PI levels in the lowest tertile was found to be twice that of patients with PI levels in the highest tertile [15]. Higher PI is associated with improved patient outcomes because it indicates enhanced tissue perfusion. Alakaya and Arslanköylü [16] also reported in their study that the PI permits non-invasive evaluation of unstable patients, either alone or in conjunction with the pediatric trauma score.

Co-morbidity	Yes/no	n (%)	Perfusion index Mean ± SD	*p value
Malignancy	Yes	17 (30.9)	2.61±1.76	0.500
	No	38 (69.1)	3.27±2.37	
Anemia of chronic disease	Yes	15 (27.2)	2.79±1.55	0.992
	No	40 (72.8)	3.17±2.42	
Hypertension	Yes	13 (23.6)	3.11±2.06	0.774
	No	42 (76.4)	3.06±2.28	
Coronary artery disease	Yes	7 (12.7)	3.90±2.32	0.261
	No	48 (87.3)	2.95±2.19	
Diabetes mellitus	Yes	6 (10.9)	3.72±3.21	0.617
	No	49 (89.1)	2.99±2.09	
Chronic renal disease	Yes	5 (9)	2.08±1.13	0.372
	No	50 (91)	3.17±2.27	
Congestive heart failure	Yes	2 (3.6)	1.45±1.20	0.270
	No	53 (96.4)	3.13±2.22	
Chronic obstructive pulmonary disease	Yes	2 (3.6)	6.65±4.74	0.138
	No	53 (96.4)	2.93±2.03	
Cerebrovascular disease	Yes	1 (1.8)	1.80±1.03	-
	No	54 (98.2)	3.09±2.22	

*Mann-Whitney U test, SD: Standard deviation

In the study, the mean PI of 55 patients before transfusion was 3.07. Although there are not enough studies in the literature reporting the value of PI in the normal population, the mean PI value was found to be 1.4 in a study by Lima et al. [7] in 108 healthy adults with a mean age of 30, but the pulse oximetry used in this study is a different device than ours, but the value it

can measure. It has been reported to be between 0.3 and 10.0 [7]. While this value stated in this study was analyzed with data from healthy individuals included in the study, it was taken from patients who applied to the emergency department and needed erythrocyte transfusion in our study. It can be considered that this difference in PI is due to the difference in the device used and the patient groups [7]. Arslan et al. [17] in the study on PI, which included 2.300 patients, the mean PI value was found to be 3.71. In addition, Akben and Topaçoğlu [18] in a study that included 288 patients, the mean PI was found to be 2.9. The fact that the patient selection in all three studies covers different groups and the number of patients; it can be thought that this difference in mean values is caused by this difference. In the literature, precise expressions for the mean PI value could not be found.

In the study, the mean PI before transfusion was 2.64 in female patients and 3.52 in male patients. There was no statistical relationship between gender and pre-transfusion PI. Although the number and mean age of the female and male patients included in our study were similar, the mean PI of male patients was higher than that of female patients. Akben and Topaçoğlu [18] also found that the mean PI of male patients was higher than the mean PI of female patients, but there was no statistically significant difference. In the study conducted by Arslan et al. [17], which included 2.300 patients, the mean PI of male patients was found to be higher than that of female patients, and a statistically significant difference was found between gender and PI. The fact that there were not as many cases in our study as in the mentioned study may be the reason for this. It would be appropriate to conduct more comprehensive studies to determine whether there is a statistical difference.

In the study by Lima et al. [7], it was shown that PI was not associated with additional diseases such as diabetes and hypertension. In our study, there was no significant relationship between PI measured before transfusion and additional diseases of the patients, which supports this finding.

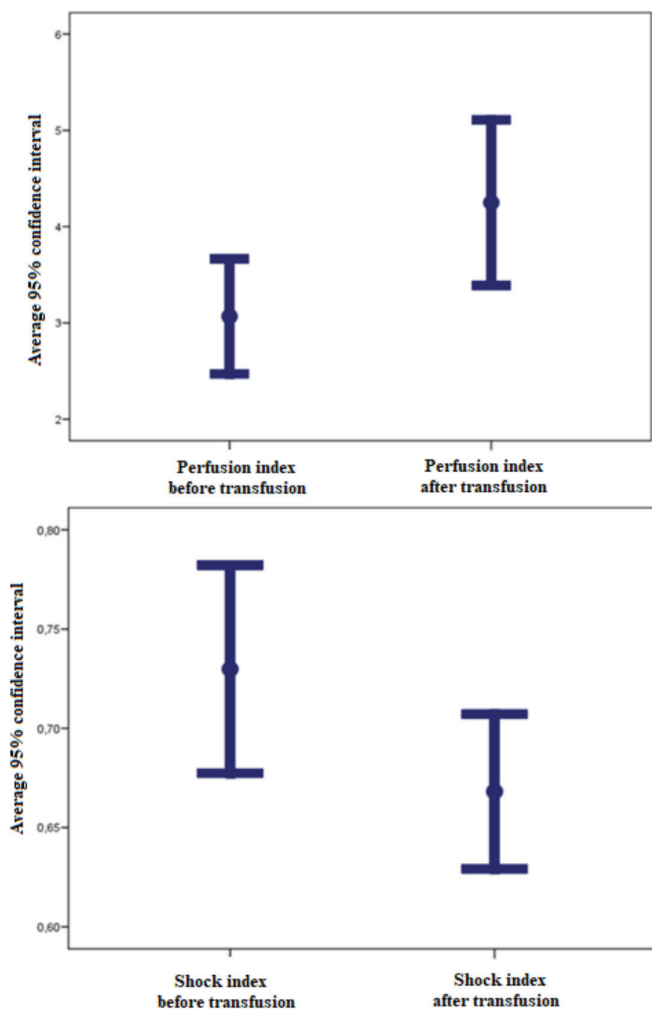


Figure 1. Perfusion index and shock index distribution before and after transfusion

Table 2. Comparison of changes in patient’s parameters with blood transfusion				
Parameters	Pre-transfusion Mean ± SD	Post-transfusion Mean ± SD	Difference Mean ± SD	*p value
Hemoglobin (g/dL)	6.4±1.2	9.0±1.2	2.5±1.2	<0.001
Hematocrit (%)	21.5±3.6	28.7±3.8	7.3±3.7	<0.001
Mean arterial pressure (mmHg)	83.2±11.6	90.0±13.0	6.7±13.3	<0.001
Pulse (/min)	87.1±15.1	83.5±10.3	-3.5±11.2	0.023
Body temperature (°C)	36.4±1.3	36.8±0.4	0.4±0.5	0.004
Saturation (%)	97.7±1.3	97.3±1.7	0.4±1.5	0.082
Perfusion index	3.07±2.21	4.25±3.18	1.18±3.14	0.004
Shock index	0.73±0.19	0.67±0.14	-0.06±0.15	0.003

*t-test independent groups, SD: Standard deviation

Randomized controlled studies are needed to determine whether PI values change in any disease. In addition, it was not determined how long the patients included in the study had these diseases or their stages.

PI is determined by calculating the ratios of pulsatile and non-pulsatile blood flow based on infrared light absorption [10]. The Hct is determined by the ratio of the cellular portion of the blood to the blood volume, and as the number of shaped blood cells increases, so does the Hct value [19]. In our study, a statistically significant positive correlation was discovered between the mean values of Hb and Hct before transfusion and the mean PI values before transfusion. In a similar study, a positive, significant, and strong relationship was observed between blood Hct values and PI [18]. Blood Hb levels are also one of the most significant determinants of Hct. In our study, the positive correlation between pre-transfusion Hb and Hct levels and the pre-transfusion PI may indicate this. In the literature, there was a correlation between the Hb and Hct values of patients and PI, but in our study, there was no correlation between the post-transfusion Hb and Hct values and the post-transfusion mean PI values. The effect of blood transfusions administered to patients on Hb or Hct levels can be interpreted as a small percentage of the overall effects. Patients who participated in the study received a maximum of three ES transfusion units.

While a statistically significant increase was found in the mean MAPs measured before and after blood transfusion in the patients included in the study, a statistically significant decrease was found in the mean pulse and SI. Considering that 50 of the 55 patients included in our study did not have active bleeding, the intravascular volume of these patients may have increased with the transfusion procedure. We believe that this is the reason for the increase in MAP in these patients. As expected, the minute pulse rates of patients whose volumes increased and tissue perfusion improved were also found to be decreasing. Because the SI was calculated as the ratio of heart rate to systolic blood pressure, the SI tended to decrease in patients with increased MAP and decreased heart rate in our study.

Statistically significant increases were found in the mean Hb, Hct, and PI values of the patients included in the study with ES transfusion compared with pre-transfusion. In a study conducted by Tanrıverdi et al. [20] on the effects of erythrocyte transfusion on PI in 132 newborns, it was shown that the PI of newborns whose anemia was corrected with erythrocyte transfusion also increased significantly. In a study by Kanmaz et al. [21] in which they measured PI by administering ES to anemic infants born below 35 weeks of age, PI values increased significantly after transfusion compared with pre-transfusion [21]. However, there was no correlation between PI and Hct

values before and after transfusion. The lack of correlation at the same level may be the relatively low increase in blood Hb and Hct levels, as defined above. In addition, it seems possible that this result may be because other studies were not conducted in adults. The definitive conclusion that can be deduced from both studies is the significant increase in the PI with the transfusion procedure.

Study Limitations

The most important limitation was the duration of the study and the relatively small number of cases we included. The uncertainty of the relationship between erythrocyte volume and PI and SI was another limitation of our study.

Conclusion

The rise in the PI during the transfusion process is anticipated to be primarily influenced by the elevation of Hb and Hct levels. This finding is supported by the identification of a statistically significant positive correlation between the initial PI value and the corresponding Hct and Hb values before transfusion. The procedure of transfusing ES leads to a notable rise in the average values of MAP, Hb, Hct, and body temperature post-transfusion, in comparison with the pre-transfusion levels. Additionally, there was a significant decrease in the average values of pulse and SI following the transfusion. A statistically significant positive association exists between the mean values of Hb and Hct and the mean PI values before transfusion. Because of the study, significant changes in PI and SI values during the pre-and post-transfusion process showed that they are parameters that can be used in transfusion, especially in the evaluation of treatment response.

Ethics

Ethics Committee Approval: The study was conducted with the permission of the University of Health Sciences Turkey, Istanbul Training and Research Hospital Clinical Research Ethics Committee (date: 09.01.2015, decision no: 569).

Informed Consent: The study participants who volunteered were provided with information and subsequently acquired written and verbal consent.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: M.O.A., H.T., B.D., N.A., B.A., A.C., Design: M.O.A., H.T., B.D., N.A., B.A., A.C., Data Collection or Processing: M.O.A., H.T., B.D., N.A., B.A., A.C., Analysis or Interpretation: M.O.A., H.T., B.D., N.A., B.A., A.C., Literature Search: M.O.A., H.T., B.D., N.A., B.A., A.C., Writing: M.O.A., H.T., B.D., N.A., B.A., A.C.

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Role of Platelet Indexes, Neutrophil Lymphocyte Ratio, and Platelet Lymphocyte Ratio in Determining Mortality in Mesenteric Ischemia

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Abstract

Objective: Here is no disease-specific marker that gives a definite result in the diagnosis of mesenteric ischemia (MI). However, high-intensity inflammation and infection are observed in the presence of MI, and there are studies on the subject by evaluating routine Complete blood count examinations. The objective of this study is to present the relationship between platelet indices (PI), platelet/lymphocyte value (PLR), and neutrophil-lymphocyte ratios (NLR) parameters in patients with a diagnosis of MI and the morbidity and mortality of the disease.

Materials and Methods: The study was carried out retrospectively with the information of 59 patients whose data were fully accessible by scanning the patient files. The primary endpoint of the study was the mortality association of PI, PLR, and NLR.

Results: A total of 59 patients with a mean age of 72.5±13.8 (min-max: 39-96) and 44.1% (n=26) female were included in the analysis. While 23.7% of the patients had more than one vascular thrombus, the most common (61.0%) involvement was spinal muscular atrophy. It was observed that the patients underwent surgery at a rate of 39.0%, and the 1-month and 12-month mortality rates were 37.3% and 67.2%, respectively. When 1-month and 1-year periods were evaluated, age was found to be significantly higher in the mortal groups. Other demographic characteristics appear to be statistically similar. In the multiple logistic regression analysis performed for 1-month and 1-year mortality prediction, no statistically significant parameter that could predict 1-month mortality was found. For 1-year mortality, age was found to be an independent predictor.

Conclusion: PI, PLR, and NLR values are not statistically significant in predicting 1-month and 1-year mortality of the disease.

Keywords: Mesenteric ischemia, lymphocytes, neutrophils, platelet activation

Introduction

Mesenteric ischemia (MI) is an inflammatory condition that often comes to the fore in the elderly population, is secondary to the deterioration of the nutrition of the mesenteric visceral organs, and leads to necrosis in the intestinal wall if not treated [1]. Patients are at a higher risk of complications such as peritonitis or sepsis. Although mortality is high, early diagnosis and surgical treatment are lifesaving. However, patients are usually diagnosed late, and the most important reasons for this are delayed admission, the absence of typical disease-specific findings, and the lack of disease-specific and lack of parameters in laboratory evaluations [2,3]. There is no sensitive and specific

marker specific to the disease that gives a definite result in the diagnosis of MI. However, high-intensity inflammation and infection are observed in the presence of MI, and there are studies on the subject by evaluating routine complete blood count (CBC) examinations [4,5].

In addition to hemostasis or the inhibition of bleeding, platelets assist the inflammatory process, host-microbial defense, wound healing, angiogenesis, and remodeling. In addition, although there are many pathophysiological pathways in which platelets are involved, the oxidative stress state seen in inflammation can also activate platelets. This shows that platelets can undertake many basic tasks in revealing the pathophysiology of diseases,



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considering the ability of platelets to affect other cells. Platelet indices (PI) are markers that show platelet activation. Thrombocytocrit, mean platelet volume (MPV), and platelet distribution width (PDW) are values that can be measured free of charge in hemogram tests [6].

It has been shown that high platelet/lymphocyte value (PLR) and distribution red cell distribution width (RDW), white blood cells (WBC), neutrophil-lymphocyte ratios (NLR), and advanced age and female gender are associated with the risk of postoperative complications of acute MI [7]. In addition, PLR is a measure of inflammation that correlates with adverse outcomes [8,9]. The NLR value, on the other hand, shows an increased value in patients with diabetes mellitus (DM) in autoimmune inflammatory disease states such as impaired glucose metabolism, ulcerative colitis attacks, hashimoto and euthyroid and/or chronic autoimmune thyroiditis, and this is directly proportional to the strength of autoimmune diseases [10].

The objective of our study was to determine the relationship between PI, PLR, and NLR in patients with MI and their mortality and morbidity.

Materials and Methods

This study was conducted retrospectively by scanning the files of the patients. The study was initiated after ethical approval was obtained from the Ankara City Hospital Ethics Committee (decision no: E2-21-432, date: 21.04.2021). The study was conducted in accordance with the Declaration of Helsinki. Study patients with a diagnosis of MI who were admitted to the emergency department between May 2019 and December 2020 were included in the study. Fifty-nine patients whose data were fully accessible were included in the study. Because the study was conducted as a retrospective file review, informed consent was not obtained from the patients.

A form was prepared for the patient data records. Demographic data [gender, age, comorbid diseases (DM, coronary artery disease (CAD), hypertension (HT))] and history of smoking, blood cell counts, biochemistry, and blood gas parameters of the samples were recorded. Two groups of mortal end-surviving patients were compared.

The devices used in the laboratory for CBC, blood analysis, blood gas, and coagulation parameters were studied on Advia 2120 (Siemens/Germany), Siemens atellica solution device (Siemens/Germany), RAPIDLAB 1200 Series (Siemens/Germany), and Sysmex cs-5100 (Siemens/Germany) devices, respectively. MI diagnoses of the patients were made with contrast-enhanced abdominal computed angiography arterial phase 64 slide spiral GE/Revolution CT (General Electric/USA) tomography device.

The data obtained from the patients were compared with their 30-day and 1-year mortality rates. Patients were divided into two groups: deceased (group 1) and alive (group 2). Demographic data, comorbidities, hemogram, biochemistry, blood gas results, and coagulation parameters of the patients in groups 1 and 2 were analyzed by comparing them.

The hospital automation system [Health Integrated Campus (HiCamp)] and national health database (e-pulse) were used to access and record the available data. The data were recorded by 2 emergency specialists, and another emergency medicine specialist checked.

Outcome

The primary outcome of the study was the PI, NLR, and PLR values for the prediction of 1-month and 1-year mortality. The second endpoint was whether demographic data and other blood parameters increased with mortality.

Statistical Analysis

Statistical analysis of the study was performed using the IBM SPSS Statistics 20.0 for the Windows package program. The Shapiro-Wilk test and histogram graphs were used for normality analysis of continuous data. Assuming that the parameters with $p < 0.05$ do not satisfy the assumption of normality, these data are presented with median and interquartile ranges. Data that were considered to be normally distributed are presented as mean and standard deviation. The mean and median comparisons between the two independent groups were performed using the independent samples-t-test for normally distributed data and the Mann-Whitney U test for non-normally distributed data. Ratio comparisons in categorical data were performed using Pearson's chi-square test and Fisher's exact test. Multiple logistic regression analysis was used to determine mortality predictors. The level of $p < 0.05$ was set as statistically significant.

Results

A total of 59 patients with a mean age of 72.5 [13.8 (min-max: 39-96)] and 44.1 percent ($n=26$) female were included in the analysis. Although 23.7% of the patients had more than one vascular thrombus, the most common (61.0%) involvement was spinal muscular atrophy). The patients underwent surgery at a rate of 39.0%, and the 1-month and 12-month mortality rates were 37.3% and 67.2%, respectively. When the 1-month and 1-year periods were evaluated, age was found to be significantly higher in the mortal groups. Other demographic characteristics appear to be statistically similar (Table 1).

The distribution of laboratory parameters according to 1-year and 1-month mortality is given in Table 2.

In the multiple logistic regression analysis performed for 1-month and 1-year mortality prediction, no statistically significant parameter that could predict 1-month mortality was found (Table 3). For 1-year mortality, age was found to be an independent predictor (Table 3). Prognostic accuracy statistics are presented in Table 4 to reveal the value of age as a mortality indicator. In addition, the receiver operating characteristic curve for “age” in terms of 1-year mortality estimation is also given (Figure 1).

Discussion

MI is a disease that can progress to necrosis in the intestinal wall and has a high mortality (40-70%). Its causes include embolism in mesenteric vascular structures, thrombosis, and thrombosis of the mesenteric vein [2,11]. Definitive diagnosis is made by methods such as computed tomography or angiography, but sometimes difficulties can be encountered in emergency cases [6].

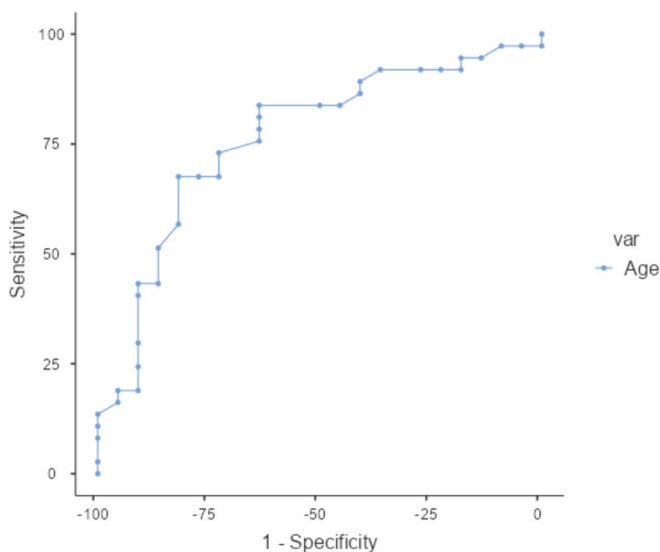


Figure 1. ROC curve for “age” in terms of 1-year mortality prediction
ROC: Receiver operating characteristic

Table 1. Distribution of demographic parameters according to one-month/year mortality							
Variables	Survival-1 month			Survival-1 year			
	Survived	Mortal	p value	Survived	Mortal	p value	
	n (%)	n (%)		n (%)	n (%)		
Total	37 (62.7)	22 (37.3)	-	22 (37.3)	37 (62.7)	-	
Age-mean ± SD	69±12	78±14	0.019*	65±12	77±13	0.001	
Gender	Male	22 (66.7)	11 (33.3)	0.479*	12 (36.4)	21 (63.6)	0.869*
	Female	15 (57.7)	11 (42.3)		10 (38.5)	16 (61.5)	
DM	4 (50)	4 (50)	0.455**	2 (25)	6 (75)	0.697**	
COPD	4 (57.1)	3 (42.9)	1.000**	3 (42.9)	4 (57.1)	1.000**	
CAD	23 (63.9)	13 (36.1)	0.815*	13 (36.1)	23 (63.9)	0.815*	
HT	17 (58.6)	12 (41.4)	0.523*	10 (34.5)	19 (65.5)	0.661*	
Malignancy	7 (70)	3 (30)	0.729**	1 (10)	9 (90)	0.074**	
Blood type-ABO	A	17 (63)	10 (37)	0.133†	13 (48.1)	14 (51.9)	0.259†
	B	6 (85.7)	1 (14.3)		3 (42.9)	4 (57.1)	
	AB	1 (20)	4 (80)		1 (20)	4 (80)	
	0	10 (66.7)	5 (33.3)		3 (20)	12 (80)	
Blood type-Rh	Positive	31 (63.3)	18 (36.7)	1.000**	18 (36.7)	31 (63.3)	1.000**
	Negative	3 (60)	2 (40)		2 (40)	3 (60)	
Localisation-2 or more vascular	7 (50)	7 (50)	0.260*	4 (28.6)	10 (71.4)	0.440*	
Localisation	SMA	20 (55.6)	16 (44.4)	0.155*	12 (33.3)	24 (66.7)	0.432*
	IMA	10 (62.5)	6 (37.5)	0.984*	5 (31.2)	11 (68.8)	0.559*
	SMV	9 (100)	0 (0)	0.020**	6 (66.7)	3 (33.3)	0.066**
	TC	6 (42.9)	8 (57.1)	0.079*	3 (21.4)	11 (78.6)	0.160*
Surgery	13 (56.5)	10 (43.5)	0.432*	8 (34.8)	15 (65.2)	0.750*	

Age: independent samples t-test (mean ± SD), †The analysis is not reliable due to insufficient expected and observed sample numbers in this parameter. *Pearson chi-square test; n (%), **Fisher’s exact test; n (%).

SD: Standard deviation, DM: Diabetes mellitus, COPD: Chronic obstructive pulmonary disease, CAD: Coronary artery disease, HT: Hypertension, SMA: Spinal muscular atrophy, IMA: Internal mammary artery, SMV: Superior mesenteric vein, TC: Truncus celiacus

Table 2. Distribution of laboratory parameters according to one-month/year mortality

Variables	Survival-1 month			Survival-1 year		
	Survived	Mortal	p value	Survived	Mortal	p value
	Mean ± SD or med (25-75%)	Mean ± SD or med (25-75%)		Mean ± SD or med (25-75%)	Mean ± SD or med (25-75%)	
WBC	10.7 (8.93-15.11)	16.99 (9.55-28.18)	0.067*	10.6 (8.93-14.28)	15.53 (9.4-21.18)	0.128*
Neu	8.22 (5.8-13.38)	13.4 (7.06-21.53)	0.117*	7.7 (5.1-12.31)	12.34 (7.06-19.09)	0.105*
Lymph	1.23 (1.13-1.77)	1.04 (0.86-1.87)	0.225*	1.45 (1.17-2.04)	1.09 (0.87-1.76)	0.035*
NLR	6.58 (4.3-10.68)	12.97 (3.81-21.01)	0.148*	5.33 (2.62-8.67)	10.13 (4.93-19.98)	0.043*
PLR	202.88 (151.96-313.11)	242.2 (126.87-329.11)	0.633*	185.21 (141.24-277.3)	242.95 (162.2-330.41)	0.158*
Hb	12.98±2.05	12.2±1.95	0.153**	13.41±1.78	12.26±2.08	0.033**
Htc	39.74±6.06	39.44±5.73	0.848**	40.88±6.11	38.88±5.71	0.210**
RDW	15.5 (13.9-16.5)	15.85 (15.1-17.1)	0.249*	15.6 (13.5-16.5)	15.7 (14.7-17)	0.319*
Plt	292 (243-373)	262 (217-340)	0.297*	300 (248-373)	272 (211-340)	0.372*
MPV	8.5 (7.8-9.3)	8.9 (8.6-9.6)	0.022*	8.3 (7.5-8.7)	8.8 (8.3-9.6)	0.021*
PCT	0.26±0.09	0.26±0.13	0.946**	0.26±0.07	0.26±0.12	0.783**
PDW	55.22±8.22	60.78±8.49	0.016**	51.6 (49.9-59.6)	57.9 (55.7-62.5)	0.034*
LUC	0.15 (0.12-0.19)	0.11 (0.08-0.21)	0.257*	0.15 (0.12-0.19)	0.14 (0.09-0.21)	0.619*
NRBC	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.184*	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.165*
DNI	0 (0-2.2)	1.7 (0-4.6)	0.123*	0.2 (0-2.2)	1.1 (0-5.25)	0.285*
Urea	39.5 (30-51.5)	71 (47-87)	0.001*	34 (28-43)	52 (45-75)	0.001*
Cre	0.88 (0.72-1.21)	1.24 (1.02-1.64)	0.006*	0.92 (0.74-1.21)	1.12 (0.86-1.53)	0.213*
T-prot	63.42±7.18	62.36±8.97	0.624**	64.38±6.04	62.24±8.7	0.323**
Alb	39.5 (35-42.5)	35.5 (32-38)	0.185*	39.33±4.6	35.92±6.52	0.039**
AST	26 (16.5-34.5)	63 (40-146)	<0.001*	20.5 (16-32)	58 (28-79)	<0.001*
ALT	20 (16-28)	33.5 (25-46)	0.002*	18 (15-25)	28 (17-41)	0.017*
LDH	259 (198-341)	523 (341-852)	<0.001*	222.5 (196-286)	394 (303-708)	<0.001*
Na	138 (135-140)	139 (137-143)	0.137*	138 (135-141)	138 (137-141)	0.441*
K	4.17±0.42	4.55±1.12	0.150**	4.1±0.36	4.43±0.93	0.065**
Cl	103.69±5.73	104.63±7.94	0.625**	106 (104-108)	103 (100-109)	0.643*
PT	13.4 (12.4-14.8)	16.9 (13.1-22.5)	0.020 *	13 (12.1-15.1)	14.3 (13.1-17.6)	0.032*
INR	1.1 (1.1-1.2)	1.4 (1.1-1.7)	0.195 *	1.1 (1.1-1.2)	1.2 (1.1-1.5)	0.128*
D-dimer†	3.28 (1.12-8.1)	13.91 (12.11-15.7)	0.178†	1.97 (1.15-10.66)	5.54 (4.59-12.11)	0.690†
Fibrinojen†	3.01 (2.99-7.57)	5.86 (1.01-6.41)	1.000†	5.28 (2.99-7.57)	4.44 (2.01-6.14)	0.800†
Proc†	0.06 (0.03-0.44)	0.93 (0.16-4.31)	0.008†	0.06 (0.04-0.38)	0.49 (0.15-1.06)	0.087†
CRP	0.06 (0.02-0.14)	0.18 (0.06-0.21)	0.045*	0.05 (0.02-0.11)	0.14 (0.05-0.2)	0.061*
pH	7.4 (7.34-7.46)	7.38 (7.21-7.43)	0.078*	7.38 (7.34-7.44)	7.41 (7.28-7.46)	0.891*
HCO ₃	22.19±4.52	19.85±6.39	0.128**	21.44±4.3	21.21±5.89	0.891**
Lct	2.12 (1.48-3.6)	2.97 (2.36-6)	0.005*	2.04 (1.33-3.55)	2.52 (2.08-4.83)	0.103*
BE	-1.8±4.19	-6.01±8.15	0.042**	-2.1 (-5.5-0.5)	-3.1 (-5.6-1.3)	0.868*

†The reliability of the analysis is limited due to the redundancy of missing data, *Mann Whitney-U test, **Independent samples t-test, SD: Standard deviation, WBC: White blood cell, Neu: Neutrophil, Lymph: Lymphocyte, NLR: Neutrophil-lymphocyte ratios, PLR: Platelet/lymphocyte value, Hb: Hemoglobin, Htc: Hematocrit, RDW: Distribution diameter of red blood cells, Plt: Platelet, MPV: Mean platelet volume, PCT: Thrombocytocrit, PDW: Platelet distribution width, LUC: Large unstained cells, NRBC: Nucleated red blood cell, DNI: Do-not-intubate, Cre: Carbapenem-resistant Enterobacteriaceae, Alb: Albumin, AST: Aspartat aminotransferaz, ALT: Alanine aminotransferaz, LDH: Lactate dehydrogenase, PT: Prothrombin time, INR: International normalized ratio, CRP: C-reactive protein, Lct: Lactase, BE: Base excess, T-prot: Total protein, Proc: procalcitonin

Considering the demographic data of the studies conducted by Klar et al. [2] and Acosta [12], it has been reported that its incidence and mortality increase with advanced age. The data of this study are statistically similar to those in the literature. While Acosta [12], reported that the female-male ratio was equal, there was no statistical difference in our study, which is similar to the literature.

In a review by Klar et al. [2], they stated that heart failure, atrial fibrillation, CAD, and primary HT are among the predisposing factors of the disease. The most common chronic and serious diseases of the patients included in the study, such as DM, chronic obstructive pulmonary disease, CAD, HT, and malignancy, were recorded, and it was concluded that it was not statistically significant at this stage.

In a study conducted by Kisaoglu et al. [5], it was reported that RDW, WBC, lactate dehydrogenase (LDH), and blood urea nitrogen values increased significantly. RDW, WBC, LDH, and urea values obtained in this study were statistically inconsistent.

There are many studies in the literature suggesting that high MPV values are associated with mortality and reporting that mortality is higher in patients with patients [13-16]. In this study, however, MPV values did not show compatibility in predicting both 1-month and 1-year mortality. Wang et al. [17], reported

in a study that high PLR, NLR, and concomitant coronary heart disease were associated with poor outcomes in the prognosis of patients. In a retrospective study conducted by Karadeniz et al. [18], they showed that PLR, NLR, PDW, and RDW values were significantly higher in MI, but lymphocyte values were significantly lower. In another study, it was reported that PLR and PDW values showed a positive correlation in recognizing MI [19]. It was also revealed that the NLR value was also diagnostically significant [20]. However, the values recorded in this study were statistically insignificant. There is a study in the literature reporting that PLR is a significant predictor of 1-month mortality in patients who come to the emergency department with acute MI, but NLR is not as significant as PLR [21]. The results of this study are inconsistent in terms of PLR and support the literature in terms of NLR.

In a retrospective study, Toptas et al. [4], reported that the neutrophil and lymphocyte levels were significantly higher in the control group, but the platelet count was similar between the two groups. Although the data of this study do not support the data of the current study in terms of neutrophil and lymphocyte counts, they are similar in that the platelet count was also insignificant in our study. In the same study, it was found that PLR, NLR, and C-reactive protein (CRP) values were higher than those in the control group, and there was a

Table 3. Regression model for 1-month and 12-months mortality

Model coefficients-survival-1 month					Model coefficients-survival-12 months				
			95% Confidence interval					95% Confidence interval	
Predictor	p	Odds ratio	Lower	Upper	Predictor	p	Odds ratio	Lower	Upper
Intercept	0.117	2525.720	0.142	4.50E+07	Intercept	0.334	295.073	0.003	3.02E+07
Age	0.340	0.962	0.889	1.040	Age	0.011	0.888	0.809	0.974
Cre	0.453	0.480	0.071	3.260	Lymph	0.529	1.466	0.446	4.824
ALT	0.782	0.996	0.968	1.020	Hb	0.260	1.347	0.803	2.259
PT	0.434	0.970	0.899	1.050	MPV	0.610	0.788	0.316	1.964
CRP	0.440	0.007	2.78E-08	1935.77	Alb	0.290	1.092	0.928	1.286
Lct	0.075	0.610	0.354	1.050	AST	0.111	0.926	0.843	1.018
PDW	0.979	1.002	0.886	1.130	ALT	0.389	0.954	0.858	1.062
					PT	0.734	1.011	0.949	1.078

Note: Estimates represent the log odds of “survival” vs. “mortal”

Cre: Creatin, ALT: Alanine aminotransferase, PT: Prothrombin time, CRP: C-reactive protein, Lct: Lactase, PDW: Platelet distribution width, Lymph: Lymphocyte, Hb: Hemoglobin, MPV: Mean platelet volume, Alb: Albumin, AST: Aspartat aminotransferaz

Table 4. Diagnostic statistics for “age” in terms of 1-year mortality prediction

Scale: age					
Cutpoint	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Youden’s index
66	83.8	63.6	79.5	70.0	0.474
72	73.0	72.7	81.8	61.5	0.457
77	67.6	81.8	86.2	60.0	0.494

AUC: 0.763 (95% CI: 0.635-0.891); p=0.001, PPV: Positive predictive values, NPV: Negative predictive values, AUC: Area under the curve, CI: Confidence interval

positive correlation between PLR and CRP and between NLR and CRP [4]. However, this study is not similar to other studies.

When we look at the above studies, it is seen that there are contradictory results in studies with PI in the literature. Therefore, it is difficult to establish a meaningful and precise link between diseases and PI. Significant values are likely to occur in these values in the chronic inflammatory processes of the patients. However, because the activation of platelets varies in acute inflammatory events, it is not reflected in the laboratory with meaningful results. In addition, the development of MI on a background such as atherosclerosis and atrial fibrillation suggests that these patients may receive antiaggregant and anticoagulant therapy. This situation causes variability in platelet count and activation. Therefore, PI may not have shown effective results in acute inflammatory and thromboembolic conditions. As a result, PI, PLR, and NLR values are suspicious of the diagnosis of MI, and their relationship with mortality was significant in some of the previous studies, whereas it was insignificant in others. None of the parameters included in our study, except advanced age, were statistically significant in predicting mortality.

Study Limitations

Among the limitations of the study, it is of great importance that it is retrospective. In addition, it is not known how the blood is taken from the patients and the current conditions, the way and time of blood reaching the laboratory is not known, and it is not known whether all these are fully in accordance with the standards.

Conclusion

It is significant in 1-month and 1-year mortality in advanced age patients in MI patients. However, PI, NLR, and PLR values have no clinical or statistical significance in predicting the mortality of patients.

Ethics

Ethics Committee Approval: The study was initiated after ethical approval was obtained from the Ankara City Hospital Ethics Committee (decision no: E2-21-432, date: 21.04.2021).

Informed Consent: Informed consent was not obtained from the patients.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: S.D., A.B.E., A.Ş., G.K.Ç., Concept: S.D., A.B.E., A.Ş., G.K.Ç., Design: S.D., A.B.E., A.Ş., G.K.Ç., Data Collection or Processing: S.D., A.B.E., A.Ş., G.K.Ç., S.Ö., B.I., Analysis or Interpretation: S.D., A.B.E., A.Ş., S.Ö., B.I., Literature Search: S.D., A.B.E., A.Ş., S.Ö., B.I., Writing: S.D., A.B.E., A.Ş., S.Ö., B.I.

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The 6th February 2023 Turkey Earthquake and Emergency Department Admissions: A Catastrophic Disaster

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Abstract

Objective: This study aimed to examine the impact of the February 6th, 2023 earthquake in Turkey on emergency department (ED) admissions, especially at the Ankara Bilkent City Hospital, and to identify the lessons learned from this disaster.

Materials and Methods: The study analyzed the data of all earthquake victims who applied to the Ankara Bilkent City Hospital ED between February 6th and February 28th, 2023, after the earthquake. The patients' demographic characteristics, reasons for application, transfer methods, hours of application after the disaster, diagnosis, the service where they were hospitalized, and patient outcomes were recorded. A total of 1.577 earthquake victims were admitted to the ED during the study period, and their data were analyzed using IBM SPSS software.

Results: Of the patients, 719 (45.59%) were male and 858 (54.40%) were female, and the average age was 42±12.63. During their follow-up, 770 (48.82%) patients were hospitalized, 783 (49.65%) were treated and discharged, and 27 (1.71%) patients refused treatment. ED admissions were mainly related to trauma, fractures, and injuries from falling debris. Crush syndrome developed in 393 (24.92%) of the 1.577 patients. Of the patients with crush syndrome, 211 (53.60%) were on dialysis during their follow-up. Compartment syndrome developed in 215 (13.63%) patients. Fasciotomy was performed on 155 (9.82%) patients.

Conclusion: The February 6th, 2023 earthquake in Turkey resulted in overwhelming ED admissions, highlighting the importance of disaster preparedness and the need for trained medical professionals equipped with the necessary resources to respond quickly and effectively to such disasters. The study revealed that the emergency response system needs to be improved to handle large numbers of patients during a disaster. The study also emphasized the importance of effective communication and coordination among emergency response teams, aid organizations, and government agencies.

Keywords: Earthquake, emergency department, disaster

Introduction

On February 6th, 2023, Turkey experienced a catastrophic disaster when a massive earthquake measuring 7.7 on the Richter scale struck the city of Kahramanmaraş at 04.17 in the morning. The earthquake was felt in at least 10 provinces throughout the country, causing widespread damage and loss of life. Just hours later, at 13.24, a second earthquake with a magnitude of 7.6 struck the Elbistan district of Kahramanmaraş, adding to the devastation. The aftermath of the earthquake, in which over 100.000 buildings were destroyed, has been overwhelming, with the emergency department (ED) inundated with patients

seeking medical care. As of March 20th, the death toll has risen to 50.096, the number of injured has reached 107.204, and 100 thousand or more buildings were demolished [1].

The 6th February 2023 earthquake in Turkey, especially in Kahramanmaraş, has been one of the deadliest earthquakes in the country's recent history. The earthquake has left thousands homeless and caused significant damage to infrastructure, including hospitals and healthcare facilities. The emergency response system, including the ED and hospitals, was quickly overwhelmed by the influx of patients seeking medical assistance.



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In the aftermath of the earthquake, the Turkish Government and aid organizations mobilized quickly to provide assistance to those affected by the disaster. Emergency shelters were established to provide temporary housing for the displaced, and food and water supplies were distributed to those in need. The healthcare sector played a vital role in the relief efforts, with medical teams working around the clock to treat the injured.

Despite the challenges faced by the ED, the medical professionals demonstrated extraordinary dedication and resilience. Their tireless efforts to save lives and provide medical care to the injured were commendable.

A lesson learned from the earthquake was the importance of preparedness in disaster response. This includes having well-equipped and well-staffed EDs and hospitals, trained medical professionals, and sufficient medical supplies and equipment to handle large numbers of patients.

Another crucial lesson was the need for effective communication and coordination among emergency response teams, aid organizations, and government agencies. Efficient sharing of information and resources can greatly improve response efforts and ensure that aid reaches those who need it most.

The impact of the earthquake on ED admissions highlights the importance of disaster preparedness and the need for trained medical professionals equipped with the necessary resources to respond quickly and effectively to such disasters. However, the disaster also revealed weaknesses in the emergency response system that need to be addressed to improve future disaster response efforts.

Despite not being located in one of the cities at the epicenter of the Ankara earthquake, Ankara Bilkent City Hospital experienced a high influx of patients from the earthquake zone, both through air and land ambulances, because it is the most well-equipped and highest-capacity hospital in Turkey. In our study, we shed light on the impact of the earthquake on ED admissions and the lessons learned from this devastating disaster.

Materials and Methods

Our hospital has an annual patient admission of 470.000 and is located in the capital city. We accept intensive referrals from surrounding provinces with the highest bed capacity. During this process, patients from earthquake-stricken cities mainly visited our ED via air ambulances, land ambulances, and their own means. The study was conducted with the approval of E1-23-3355 dated 22.03.23 and numbered 3355 of the Number 1 Clinical Applications Ethics Committee of the Ankara Bilkent City Hospital. In our study, 1,577 earthquake victims

who applied to the Ankara Bilkent City Hospital ED between February 6th and February 28th, 2023, after the February 6th earthquake, were retrospectively examined. Demographic characteristics of the patients, reasons for application, transfer methods, hours of application after the disaster, diagnosis, the service where they were hospitalized, and patient outcomes were recorded. Patients whose data could not be accessed from the hospital automation system were excluded from the study.

Statistical Analysis

The study data were analyzed using IBM SPSS Statistics for Windows, Version 22.0 (Armonk, NY: IBM Corp.) software package. The Kolmogorov-Smirnov test was used to test the normality of the distribution of the study data. Normally distributed study data are reported as mean \pm standard deviation, and non-normally distributed study data are reported as median (minimum-maximum). Non-normally distributed quantitative data were compared using the Mann-Whitney U test, whereas normally distributed quantitative data were compared using the independent samples t-test. A p value of <0.05 was considered statistically significant.

Results

During the planned duration of the study, 1,577 earthquake victims were admitted to the ED with the X-31 code assigned to the automation system. The average age of the patients was 42 ± 12.63 , with 719 (45.59%) male patients and 858 (54.40%) female patients. Of the patients, 526 (33.35%) were transferred to our clinic by ambulance from the earthquake zones, while 1,051 (66.64%) came to the ED on their own.

During their follow-up, 770 (48.82%) patients were hospitalized, while 783 (49.65%) were discharged. Twenty seven (1.71%) patients refused treatment and left the ED voluntarily. Among the 526 (33.35%) patients transferred by ambulance, 490 (93%) were hospitalized and 36 (6.82%) were discharged. The hospitalization rate was found to be significantly higher among patients transported by ambulance ($p < 0.001$) (Table 1).

Crush syndrome developed in 393 (24.92%) of the 1,577 patients. Of the patients with crush syndrome, 211 (53.60%) were on dialysis during their follow-up. Compartment syndrome developed in 215 (13.63%) patients. Fasciotomy was performed on 155 (9.82%) patients from the ED, and emergency amputation was performed on 33 (2.09%) patients. The most requested consultations were from the orthopedics (69%), internal medicine (32%), and plastic surgery (23%) departments (Table 1).

Of the patients, 35 (2.21%) had isolated head trauma, 98 (6.21%) had isolated spinal injuries, 69 (4.37%) had isolated chest trauma, 6 (0.36%) had isolated abdominal trauma, 357 (22.63%) had isolated extremity injuries, 23 (1.45%) had

isolated pelvic injuries, 185 (11.73%) had multiple traumas, and 503 (31.89%) had isolated soft tissue injuries. A total of 301 (19.08%) patients were admitted to the ED with non-traumatic symptoms.

Discussion

The findings reveal the significant impact of the earthquake on the healthcare system and the high number of patients who required medical attention. The hospitalization rate of patients transferred by ambulance was significantly higher than that of those who came to the ED on their own, indicating the severity of their conditions. This is consistent with previous studies that have found that ambulance transport is associated with a higher likelihood of hospitalization and increased severity of illness [2,3].

The high incidence of injuries and casualties during disasters underscores the need for proper disaster management and preparedness to minimize the adverse effects of such catastrophic events. Effective disaster management and preparedness require a well-coordinated response involving various stakeholders, including emergency medical teams,

healthcare providers, public health officials, and the community [4].

Previous studies have also shown that earthquakes can result in several injuries, including head trauma, spinal injuries, chest trauma, abdominal trauma, extremity injuries, pelvic injuries, compartment syndrome, and crush syndrome [5]. Our study adds to this body of knowledge and highlights the importance of emergency preparedness and response in minimizing the adverse effects of natural disasters.

The findings of this study agree with previous research on earthquake-related injuries, which have shown that crush syndrome and compartment syndrome are common complications of earthquakes, especially in urban areas where there are large numbers of people in buildings that may collapse [6]. This study also highlights the importance of preparedness measures in mitigating the effects of such disasters, including ensuring that healthcare facilities are equipped to handle large influxes of patients and that medical personnel are trained in managing earthquake-related injuries.

The high incidence of crush syndrome observed in this study is a well-known complication of earthquake-related injuries

		n	%
Sex	Female	858	54.40
	Male	719	45.59
Age	Mean (± SD)	42±12.63	
Transferred by ambulance		526	33.35
Transferred by on their own		1,051	66.64
Outcome	Hospitalized	770	48.82
	Discharged	783	49.65
	Refused treatment	27	1.71
Reasons for application	Isolated head trauma	35	2.21
	Isolated spinal injuries	98	6.21
	Isolated chest trauma	69	4.37
	Isolated abdominal trauma	6	0.36
	Isolated extremity injuries	357	22.63
	Isolated pelvic injuries	23	1.45
	Multiple traumas	185	11.73
	Isolated soft tissue injuries	503	31.89
	Non-traumatic symptoms	301	19.08
Consultations	Orthopedics	69%	
	Internal medicine	32%	
	Plastic surgery	23%	
Crush syndrome		393	24.92
Need for dialysis		211	53.60
Compartment syndrome		215	13.63
Fasciotomy		155	9.82
Emergency amputation		33	2.09
SD: Standard deviation			

[7]. The use of dialysis in more than half of the patients with crush syndrome is consistent with previous reports of high rates of renal failure in such patients [8,9]. The high rate of crush syndrome in our study population suggests the need for early recognition and treatment of this condition in disaster settings.

Similarly, compartment syndrome is a common complication of crush injuries and is associated with significant morbidity and mortality if not recognized and treated promptly [10]. In our study, compartment syndrome was also found in 13.6% of patients, and fasciotomy was performed in 9.8% of patients. These findings agree with previous studies that have reported high rates of compartment syndrome in earthquake disasters [8,9]. Early recognition and intervention are crucial for preventing the development of this potentially life-threatening condition.

Internal medicine and plastic surgery were also frequently consulted, likely reflecting the broad range of medical issues that arise in the aftermath of a major disaster. The most commonly requested consultations in our study were from orthopedics, internal medicine, and plastic surgery departments. The finding that orthopedics was the most requested consultation is not surprising given that fracture and musculoskeletal injuries are common after earthquakes [11]. This finding is consistent with other studies on earthquake disasters, which have identified orthopedic and surgical specialties as the most needed services in disaster settings [9,10]. The high demand for these specialties emphasizes the importance of disaster preparedness plans that include the allocation of adequate resources and personnel to meet the needs of these patients.

This study highlights the significant burden placed on the healthcare system by earthquakes and the importance of prompt recognition and treatment of complications such as crushes and compartment syndromes. It also underscores the critical role of ambulance transport in identifying and triaging patients with severe injuries. Future research should focus on developing strategies to improve the response to earthquakes and other natural disasters and mitigate their impact on public health.

Study Limitations

This study has several limitations. First, it is a single-center study, which may limit the generalizability of the findings to other settings. Second, the study only included patients who presented to the ED and may not have included patients who were treated elsewhere or who did not seek medical attention. Finally, this study only examined the immediate aftermath of the earthquake and did not assess the long-term impact on the healthcare system or the broader community.

Despite these limitations, the findings of this study provide valuable insights into the impact of earthquakes on the healthcare system and highlight the need for ongoing research to improve our understanding of earthquake-related injuries and their management.

Conclusion

The earthquake on February 6th, 2023, had a devastating impact on the people of Turkey. The EDs of hospitals were overwhelmed with patients, and healthcare professionals worked tirelessly to provide care to those in need. Our study provides valuable insights into the characteristics and management of earthquake victims in ED settings. The high rate of crush syndrome and compartment syndrome in our study population emphasizes the need for early recognition and intervention of these conditions. The high demand for orthopedic and surgical specialties highlights the importance of disaster preparedness plans that include the allocation of adequate resources and personnel. The findings of this study highlight the need for disaster preparedness and response planning to ensure that EDs are equipped to deal with large-scale disasters. It is important to learn from this experience and take steps to improve disaster response planning and emergency preparedness to minimize the impact of future disasters.

Ethics

Ethics Committee Approval: The study was conducted with the approval of E1-23-3355 dated 22.03.23 and numbered 3355 of the Number 1 Clinical Applications Ethics Committee of the Ankara Bilkent City Hospital.

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: N.G.K., Concept: N.G.K., Design: N.G.K., H.O., Data Collection or Processing: N.G.K., F.E.A., C.Ç., R.İ.M., Analysis or Interpretation: N.G.K., Literature Search: N.G.K., Writing: N.G.K.

Conflict of Interest: No conflicts of interest were declared by the authors.

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Mersin University Medical Faculty Hospital Emergency Department and Triage Organization After the 2023 Kahramanmaraş Earthquake

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Abstract

Objective: On February 6, 2023, at 04.17, a powerful earthquake measuring 7.7 on the Richter scale struck Kahramanmaraş, Turkey, causing extensive damage in 10 provinces. A state of emergency was declared in the 11 most severely affected provinces. The earthquake had significant global repercussions, leading the World Health Organization to declare a level 3 emergency, which calls for the mobilization of agency-wide resources. At the time of writing, official reports indicate that 50.096 people lost their lives and 107.204 were injured. Following the earthquake affected patients began seeking medical attention at hospitals in Mersin, one of the closest provinces not affected by the earthquake. This study aimed to examine the emergency department and hospital organization arrangements at Mersin University Medical Faculty Hospital, triage protocols, and interventions implemented to assist patients affected by the disaster.

Materials and Methods: This observational study examines the measures taken after an extraordinary situation such as a disaster in our hospital, which serves as a tertiary university hospital, and the effectiveness of these measures.

Results: Over a 15-day period following the earthquake, 2.043 patients were treated in our hospital's adult emergency department with the diagnosis of earthquake victims. There were 1.115 traumatic injuries among these patients, while 928 were affected by the earthquake but were not physically injured and were presented to the hospital for other medical reasons. In the triage category of 1.115 patients with traumatic injuries, 52 were assigned to the red zone, 487 to the yellow zone, and 576 to the green zone.

Conclusion: By ensuring an optimal match between patients and their treatment areas after the disaster, the health team working within the context of the disaster can work in harmony and coordination, preventing delays in post-disaster treatment and minimizing health-related effects. With proper team and area arrangements based on the type of disaster and the supply of materials and equipment that match the patient profile that may require hospitalization, it is possible to reduce morbidity and mortality due to the effects of the disaster.

Keywords: Disaster, earthquake, triage

Introduction

Earthquakes are natural disasters that cause various problems in human life, such as medical, social, psychological, and economic. In Turkey, the Kahramanmaraş-centered earthquake was described as one of the biggest disasters of the century by both the local and foreign press. With a total population of 13 million residing in the 11 severely damaged provinces, the scale of the affected human population can be imagined. According to official figures, 50.096 people lost their lives and 107.204 were injured.

In the aftermath of an earthquake, emergency rooms and hospitals operate differently from their usual processes because of the mass loss of life and multiple injuries. At this point, the idea of providing the best care for many injured people rather than doing everything for everyone is emphasized. A triage system is essential for using available hospital resources appropriately and orderly. Disaster triage is crucial for all personnel working in the scene, hospital, and emergency, and continuous training on this subject is necessary. Additionally, pre-disaster preparedness and



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precautions play a vital role in minimizing the problems that may arise after the disaster [1].

After significant disasters, hospital capacity may be insufficient to provide adequate medical care to patients, and different strategies may need to be developed. Disaster triage should develop simple and understandable algorithms [2]. According to a study on triage practices in the emergency department, 30% of triage workers lacked confidence in their decision-making [3]. Disaster drills are an important means of improving personnel's knowledge, skills, and attitudes about disaster preparedness [4].

Materials and Methods

This study is an observational study that examines the measures taken after an extraordinary situation such as a disaster in our hospital, which serves as a tertiary university hospital, and the effectiveness of these measures. Our study focused on post-disaster hospital and emergency department arrangements, disaster triage and area arrangements, and social and medical support offered to patients affected by the disaster. In the 15-day period after the disaster, 2,043 patients were admitted to our hospital, and the distribution of these patients according to triage category and common medical conditions after the disaster was examined. The general characteristics of our hospital, general precautions taken in the hospital in case of a disaster, area arrangements and disaster triage in the emergency department, health personnel, and area and equipment arrangements in the emergency department were examined as sub-headings.

The approval of the Ethics Committee, dated March 15, 2023, and numbered 2023/169, was obtained from the Mersin University Rectorate Clinical Research Ethics Committee.

Statistical Analysis

The Shapiro-Wilk test was used to check whether the data were suitable for normal distribution. The mean and standard deviation were given as descriptive statistics for parameters that were suitable for normal distribution. Numbers and percentages are given for categorical variables.

Our Hospital

Mersin University Medical Faculty Hospital is a multidisciplinary, academic, and third-level hospital located in the province of Mersin, situated at the southern tip of Turkey, approximately 271 kilometers by road from Kahramanmaraş, the epicenter of the earthquake. Due to its proximity to the disaster area, Mersin became a city that provided health services and social support to earthquake victims. Our hospital has a bed capacity of 860, with 145 intensive care beds and 715 non-intensive care unit beds. The emergency department consists of a triage area, areas A and B for patients requiring yellow and green

care, an emergency intensive care unit for first-level intensive care, a critical patient/trauma care area, and a resuscitation room. It is a university hospital emergency department that can serve 52 patients simultaneously.

In the Event of a Disaster, General Precautions are Taken in the Hospital

It is possible to reduce morbidity and mortality due to the effects of the disaster with team and area arrangements according to the situation of the disaster and the provision of materials and equipment foreseen according to the patient profile that may apply [5].

As soon as the news of the earthquake arrived, our hospital's inpatient services, operating rooms, intensive care units, and emergency departments were reorganized in accordance with the emergency disaster plan. Given the disaster situation, our hospital's chief physician and related departments coordinated the discharge of stable patients who had been hospitalized for further examination. In anticipation of the large number of intensive care admissions that may be required, the number of intensive care beds was increased, and elective surgeries were postponed.

The radiology and biochemistry laboratories were put on high alert, and the number of physicians and health workers needed increased. To meet the need for blood and blood product transfusions within the scope of the disaster, the transfusion center was contacted, and the number of blood and blood product stocks in stock was increased in collaboration with the "Kızılay" blood center. We established contact with the Kızılay blood center located at the entrance of our hospital's polyclinic, and announcements were disseminated to encourage citizens to participate in blood donation.

Our hospital has established psychological support units to cater to individuals impacted by the earthquake. In coordination with the Provincial Directorate of Family and Social Policies, orphaned earthquake victims were provided with support. Again, for the earthquake victims who were discharged, accommodation was provided by contacting the Credit Dormitories Institution through the coordination of the hospital management and the provincial disaster commission. A vehicle was arranged for the transfer of the discharged earthquake victims to these dormitories.

As it was foreseen that the number of patients who may need urgent dialysis would be high because of the earthquake, dialysis patients receiving treatment in our hospital were provided with an agreement with an external center, and their treatment was provided in the external center. Thus, the dialysis unit within our hospital was reserved for earthquake victims.

Considering that the capacity of the morgue would be exceeded for earthquake victims brought from the external center, thermoking coolers were arranged.

Simultaneously, because crush injuries are an important health problem in patients under collapse, a training titled “Approach to Crush Syndrome Patients” was organized by the Nephrology Department of our hospital for the doctors who will take part in the care of the patients.

Emergency Department Area Regulations and Disaster Triage

Our emergency department typically operates with 52 beds, comprising 7 critical care beds, 2 resuscitation rooms, 1 isolation room, 30 A and B areas (yellow and green areas), 2 orthopedic surgery areas, and 10 emergency intensive care units. In the event of a disaster, the number of beds in the emergency department has been reconfigured. The number of beds in the critical care area has increased from 7 to 12, the number of beds in the resuscitation room has increased from 2 to 4, and the number of beds in the orthopedic surgery area has increased from 2 to 6. Figure 1 shows the critical patient/trauma care area on a day when earthquake survivors were intensively treated. An additional area with a monitor has been designated as a rapid examination area for patients who received green or yellow ratings in the triage area. This newly created area is also depicted in Figure 2. Although the emergency intensive care unit normally serves up to 10 patients requiring primary

intensive care services, this area has been expanded as part of disaster preparedness, and a 16-bed primary intensive care unit has been established. These preparations have increased the number of beds in our emergency department, which normally has 52 beds, including the emergency intensive care unit, to 81 beds (as shown in Figure 3).

Under normal conditions in Turkey, a 5-category triage algorithm is applied, which classifies patients into red 1-2, yellow 1-2, and green categories. However, in the case of a disaster, a triage system with four categories -black, red, yellow, and green- is applied in accordance with the disaster plan of the hospital. The patients were evaluated and treated in areas suitable for their category. For disaster preparedness, the emergency triage area has been reorganized, and a preliminary triage area has been created at the entrance of the emergency department. In the triage area, a team consisting of one lecturer physician, four assistant physicians, four intern physicians, four nurses, and one member of the patient transport staff has been assembled.

During the disaster, patients from neighboring provinces were transported to the hospital using their own vehicles, helicopter ambulances, and ships. Patients brought by sea and air were taken from certain regions such as the port and brought to our emergency department by land ambulance. Regarding the reception of patients arriving by ambulance, the hospital frequently communicated with the Mersin 112 Provincial Ambulance Command and Control Center, and the emergency department organization was reorganized accordingly. On February 7, 2023, 32 patients with moderate to poor general conditions were transferred by road ambulance from the port in the evening hours and entered the emergency department in a total of 1 hour. The patients were appropriately triaged and received prompt medical care from the physicians.



Figure 1. Critical patient/trauma care area on a day when earthquake survivors were intensively treated



Figure 2. Triage area created in the event of an earthquake

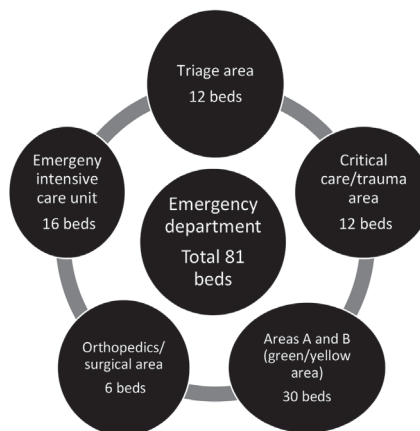


Figure 3. Arrangement of the number of beds in the emergency department in a disaster (the total capacity of the emergency department is arranged to be 81 with 1 isolation room and 4 resuscitation room beds)

Formation of the Emergency Medical Team

Under normal circumstances, the emergency department has nine doctors on duty in each shift, including one lecturer doctor, one senior emergency medicine assistant, three critical area assistant doctors, two green-yellow area assistant doctors, one assistant doctor in intensive care, and one assistant doctor in triage. However, within the scope of the disaster, 19 doctors worked each shift. The team consists of three lecturers, one of whom is the team chief; two senior emergency medicine assistants; four assistant doctors working in critical areas; two intensive care doctors; four yellow-green area doctors; and four triage doctors. In addition, the chief physician assigned 8 physicians per shift, including 2 family physicians, 1 general surgeon, 1 otolaryngologist or ophthalmologist, 1 cardiology, 1 radiology, and 2 internal medicine assistant doctors. Three orthopedic doctors stay in the emergency room throughout the process and work on the evaluation and first intervention of the patients. To speed up the process in the critical care/trauma care area and the yellow-green areas, the support of a two-person secretary is provided. The emergency department has been reorganized to have 16 nurses and 12 patient transport personnel in each shift as part of disaster preparedness. The team arrangement in the emergency department in case of a disaster is shown in Figure 4.

Organizations for Emergency Equipment and Materials

In the emergency department, the number of monitors per bed was increased to one monitor per bed. As soon as the news of the disaster was received, stocks to be used in the emergency department under disaster conditions were checked. In this regard, the chief physician provided 20 extra trauma boards, pelvic belts, and disposable arm and leg splints for use in the emergency room. The number of plaster and splint materials was also increased because extremity injuries were expected to be more prevalent in the emergency department. The stocks of dialysis and central venous catheters were increased in anticipation of emergency dialysis, blood and fluid resuscitation, and drug applications. We have one dialysis unit in our emergency department. The dialysis unit of the hospital has also been put on alert, anticipating that patients may need urgent dialysis. On February 8, 2023, a day when patients were intensively transferred after the disaster, hemodialysis was administered to 18 earthquake victims. Normal saline stocks, which are crucial for the initial intervention of patients with Crush syndrome and hemorrhagic shock, were checked, and their numbers were increased. Tetanus vaccine, tetanus immunoglobulin, and antibiotic support were made available for use in the emergency department by establishing a connection with the hospital pharmacy.

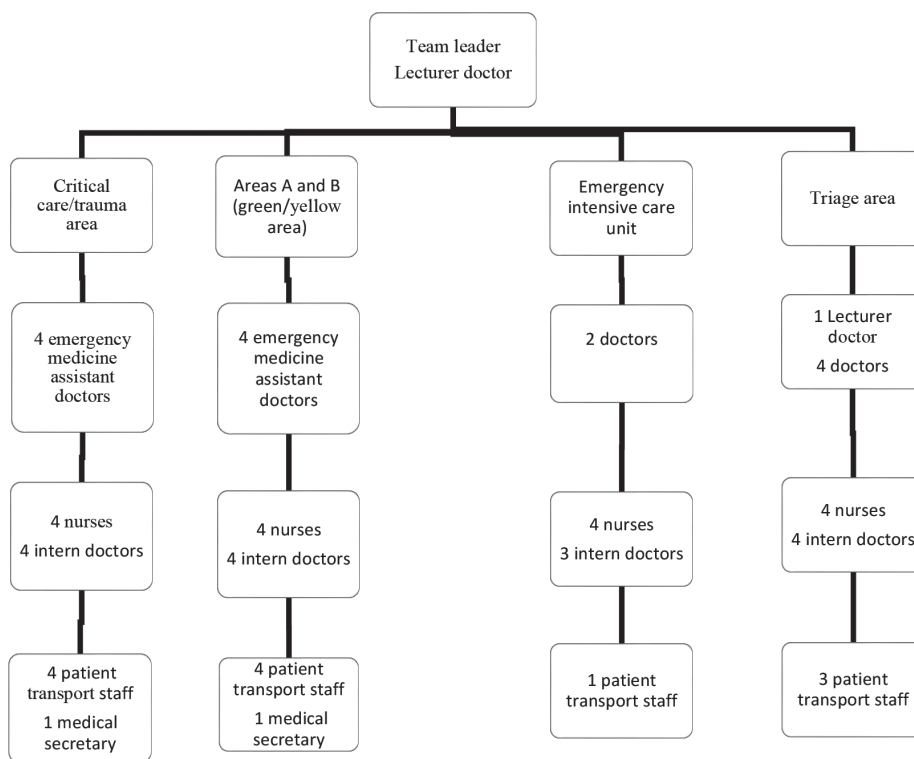


Figure 4. Illustrates the team arrangement in the emergency department in the event of a disaster (in addition, one lecturer doctor is responsible for the critical patient/trauma care area, which includes areas A and B as well as the emergency intensive care unit. One senior emergency medicine assistant is responsible for the critical patient/trauma care area and the emergency intensive care unit, whereas another senior emergency medicine assistant is responsible for areas A and B)

A radiology physician was in the emergency room for patients requiring urgent ultrasonography. An echocardiography device was also brought to the emergency room, enabling bedside evaluation of patients who might require emergency echocardiography. The number of technicians in the radiology unit was increased to ensure that patients were evaluated quickly using direct radiography and two multidetector computed tomography devices.

Because of the risk of hypothermia during winter and the length of time patients were under the debris, the number of heating devices in the emergency room was increased from two to eight.

Results

After the earthquake, 2,043 individuals were admitted to the adult emergency department of our hospital within a span of 15 days and were diagnosed as earthquake survivors. Among these patients, 1,115 sustained traumatic injuries, while the remaining 928 were affected by the earthquake but did not experience physical trauma. Instead, they sought medical attention for various other reasons, such as psychiatric support, exacerbation of pre-existing conditions, and routine hemodialysis requirements.

Regarding the triage classification of the 1,115 patients with traumatic injuries, 52 were designated as red zone patients, 487 as yellow zone patients, and 576 as green zone patients. The distribution of patients across these triage categories in the 15-day period following the earthquake is graphically depicted in Figure 5.

In terms of emergency department outcomes for patients with traumatic injuries, 787 patients were discharged, 292 patients were admitted to the non-intensive care units, and 36 patients were admitted to the intensive care unit. The distribution of patients with traumatic injury in terms of emergency department outcomes is shown in Figure 6. The most common injury was an extremity injury, which occurred in 350 patients, or approximately one-third of all patients. Crush syndrome was diagnosed in 184 of these patients, and emergency hemodialysis was administered to 18 of them. Of the 184 patients diagnosed with Crush syndrome, 16 underwent

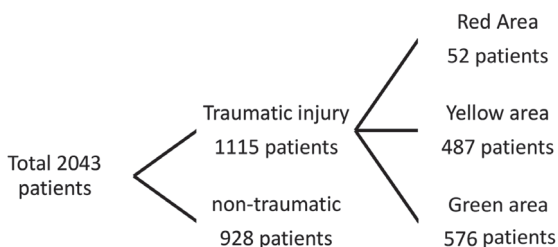


Figure 5. Distribution of earthquake survivors admitted to the hospital in the 15-day period after the earthquake by triage category

fasciotomy. Among these cases, five patients required limb amputation because the initial fasciotomy intervention proved inadequate. In total, 27 patients underwent amputation, encompassing 22 primary amputations and five cases in which amputation followed fasciotomy procedures. Chest trauma was observed in 83 patients, with 23 having hemothorax, 14 having pneumothorax, and three having pneumomediastinum. The study found that 73 patients had been diagnosed with vertebral fractures at different levels, whereas 66 patients had rib fractures. The classification of patients according to gender, mean age, triage category, emergency department outcome, and type of injury is shown in Table 1.

Discussion

Over the past five decades, natural disasters have tragically claimed numerous lives worldwide, causing disabilities and disrupting essential necessities such as food and shelter. Among the most devastating natural calamities, earthquakes stand out because of their significant toll on both human life and property. Turkey, which is located within an earthquake-prone region, is frequently exposed to this type of catastrophe. The 2023 Kahramanmaraş earthquake resulted in the loss of 50,096 lives, the 1999 Marmara earthquake claimed 17,127 lives, and the 2011 Van earthquake resulted in 644 casualties. Factors such as the use of non-earthquake-resistant structures and inadequate disaster preparedness contribute to heightened mortality and disability [6].

In the event of a disaster, triage becomes crucial, guided by the principle of maximizing the efficient use of limited resources, particularly within emergency departments. The primary goal is to ensure the maximum possible benefit for a substantial number of patients. During such circumstances, it is advisable for triage to be performed by physicians possessing the highest levels of knowledge, skills, and expertise [7]. At our hospital, in case of a disaster, the triage process was orchestrated under the supervision of senior faculty members who hold the highest ranks in terms of medical expertise and experience.

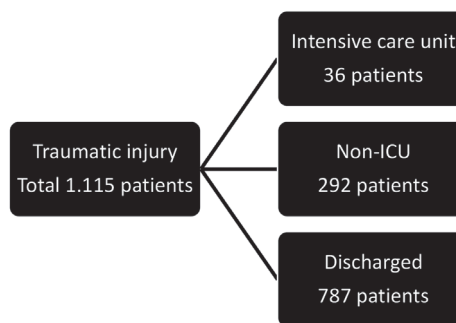


Figure 6. Distribution of earthquake survivors with traumatic injuries according to emergency department outcomes

ICU: Intensive care unit

The incorporation of triage protocols proves invaluable in facilitating decision-making during crises. These protocols should possess a robust capability to effectively differentiate between patients requiring urgent treatment and those likely to derive the greatest benefit from treatment, setting them apart from other patients. While an alternative approach would involve relying solely on clinical judgment, contemporary literature underscores the significance of employing triage protocols [8,9]. At our hospital, the triage process adhered to the four-tier system delineated within our hospital's disaster plan.

In a study aimed at assessing the efficacy of hospital disaster plans, it was revealed that certain variables -such as the number of resuscitation beds and the capacity for radiological imaging were inaccurately estimated within the plans, proving inadequate when faced with a disaster scenario [10]. Another investigation similarly appraised hospital disaster plans and identified their inefficacy. This study advocated the formation of specialized teams within the emergency department for situations involving mass casualty transport. The establishment of such teams led to a reduction in the required number of doctors and concurrently enhanced the quality of patient care [11]. In our study, we addressed the issue by augmenting the number of resuscitation beds as per our hospital's disaster plan while also reinforcing the radiology unit with additional medical personnel. This initiative entailed the establishment of teams that functioned across four distinct areas within the emergency department, ensuring uninterrupted patient care. Nevertheless, we firmly believe in the ongoing necessity of

consistently reviewing hospital disaster plans. It remains vital to systematically identify and rectify shortcomings through regular drills and exercises.

There are studies reporting the importance of optimal utilization of resources in emergency departments during events such as hurricanes, earthquakes, and the H1N1 pandemic, in which intensive admissions to emergency departments occur and society is massively affected. Although the scope and environment of these events were different, the available resources in hospitals were insufficient for each of them [12]. This scenario underscores the necessity of meticulously managing material and equipment capacities within hospitals during instances marked by significant admissions to emergency departments, such as disasters. The framework known as the "four-resource strategy" serves as the foundation for effectively augmenting hospital capacity. This strategy encompasses the following components: establishing suitable patient care areas, ensuring the presence of well-trained and adequately equipped personnel, supervising medical supplies and equipment, and tailoring specific preparations to the nature of the event. Illustrative examples of these tailored preparations include the provision of isolation rooms for airborne diseases and the setup of orthopedic rooms in the context of earthquake readiness [13-15]. At our hospital, we have implemented several strategies to enhance patient care during disasters. These include augmenting the bed capacity within the emergency department, using the reverse triage approach to free up hospital beds, bolstering the availability of devices and personnel essential for emergency scenarios,

Table 1. Classification of patients according to sex, mean age, triage category, emergency department outcome, and type of injury*

Total (n, %)	Traumatic injury (n, %)		Non-traumatic (n, %)	
2.043 (100%)	1.115 (54.5%)		928 (45.5%)	
Triage categories for traumatic injuries				
Red area (n, %)	Yellow area (n, %)		Green area (n, %)	
52 (4.8%)	487 (43.6%)		576 (51.6%)	
Classification of patients with traumatic injuries by gender				
Total (n, %)	Female gender (n, %)		Male gender (n, %)	
1.115 (100%)	616 (55.2%)		499 (44.8%)	
Classification of patients with traumatic injuries according to the mean age (\pm SD)				
Mean age	Female sex mean age		Male sex mean age	
45.94 \pm 16.7	46.74 \pm 17.1		44.93 \pm 16.3	
Classification of patients with traumatic injuries by emergency department outcome (n, %)				
ICU	Non-ICU		Discharged	
36 (3.4%)	292 (26.1%)		787 (70.5%)	
Classification according to the type of injury (n, %)				
Extremity injury	Crush syndrome	Amputation	Fasciotomy	Chest trauma
350 (31.4%)	184 (16.5%)	27 (2.42%)	16 (1.43%)	83 (7.44%)

*Mean and standard deviation values were used as descriptive statistics for normally distributed parameters. Number and percentage values are given as descriptive statistics, SD: Standard deviation, ICU: Intensive care unit

anticipating dialysis requirements, temporarily halting elective surgeries, streamlining patient procedures, and optimizing resources such as neck collars and trauma boards for potential trauma cases. These measures have significantly contributed to the efficiency and effectiveness of patient care.

In research conducted both in Turkey and other countries, particularly concerning earthquakes, findings consistently reveal that orthopedic injuries constitute the majority of post-earthquake patients, with rates ranging from 26% to 44.5% [16-18]. In our study, we observed that 31.4% of the 1.115 patients with traumatic injuries exhibited orthopedic injuries, aligning with the established literature. The prevalence of orthopedic cases can be attributed to several factors. Notably, extremity and musculoskeletal injuries such as crush injuries, ruptures, and fractures are more frequently encountered in disaster situations than in other systems. We think that another factor may be due to the fact that the rate of patients with extremity injuries being brought to the hospital from the scene of the incident is higher than that of other life-threatening system injuries.

One frequent cause of hospital admissions following an earthquake is Crush syndrome, which stems from extensive muscle damage that triggers hemodynamic and metabolic disruptions in patients, particularly leading to renal failure, which can prove fatal. The incidence of Crush syndrome after an earthquake exhibits variability across studies. For instance, this rate ranged from 33% to 33.8% in China and following the Marmara earthquake, whereas it was recorded as 2.9% to 4.2% in the aftermath of the Van and Nepal earthquakes [6,16,18,19]. In our study, we determined that 16.5% of patients with traumatic injuries developed Crush syndrome. It's noteworthy that in disaster scenarios, multiple factors, including search and rescue operations, building characteristics, and the duration of being trapped under debris, can contribute to fluctuations in these incidence rates.

Within the existing literature, amputation rates among patients with Crush syndrome following earthquakes in Iran and Turkey have been documented to range from 2.5% to 16.3% [16,20,21]. In our investigation, this rate was determined to be 2.71%. Swift intervention is critical in preventing disability arising from crush injuries in the aftermath of earthquakes. Ensuring prompt treatment, even at the incident site, is of paramount importance in these cases. Thus, maintaining a continuum of timely and effective care spanning the initial scene response, patient transportation, and subsequent hospital management remains pivotal.

Another important problem after the earthquake is the need for hemodialysis. Post the Van earthquake, 42.8% (9 out of 21) of patients diagnosed with Crush syndrome and 69.7% (491 out of 704) following the Marmara earthquake necessitated

hemodialysis [16,20]. In our study, 18 (9.78%) out of 184 patients diagnosed with Crush syndrome required emergency hemodialysis. Our study exhibited a lower proportion of patients requiring hemodialysis than other literature findings. We speculate that the need for hemodialysis might have been diminished because of the administration of intravenous fluid support to patients referred to our hospital from field hospitals.

Despite the strides in science and technology today, the potential to find ourselves in vulnerable situations when confronted with natural disasters remains. Hence, preparing for disasters necessitates taking measures to mitigate their impact, conducting research for future readiness, and devising well-structured plans [5]. In times of disaster, proactive steps are required to mitigate the aftermath. Consistently evaluating hospital disaster plans, organizing training sessions, and conducting drills at regular intervals play a vital role in averting potential chaos in disaster scenarios. This approach ensures effective utilization of available resources and curtails the repercussions of the disaster [22]. Post-disaster, achieving an optimal alignment between patients and available healthcare resources, coupled with the synchronized efforts of the dedicated healthcare team, can forestall delays in post-disaster treatment and mitigate the health-related ramifications of the catastrophe [23]. By adhering to strategic team and facility arrangements that align with the disaster's context and by supplying materials and equipment pertinent to the potential patient profile, it becomes plausible to curtail morbidity and mortality attributable to disaster-related consequences [24].

Conclusion

During times of disaster, hospitals and emergency departments function under exceptional circumstances. Despite the strides made in science and technology, the potential to encounter dire situations in the wake of natural disasters remains. Consequently, preparedness becomes imperative to avert potential chaos. To forestall potential disorder, it is vital to exercise vigilance and regular oversight over hospital disaster plans. Organizing training sessions and conducting drills at predetermined intervals are crucial steps in this endeavor. These practices not only aid in preventing potential chaos during disasters but also ensure efficient utilization of available resources and mitigation of disaster effects.

Ethics

Ethics Committee Approval: The approval of the Ethics Committee, dated March 15, 2023, and numbered 2023/169, was obtained from the Mersin University Rectorate Clinical Research Ethics Committee.

Informed Consent: Informed consent was obtained from all participants.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: Ç.S.B., C.A., Concept: A.K., S.B.B., Design: A.Y., S.B.B., Data Collection or Processing: Ç.S.B., C.A., Analysis or Interpretation: A.K., H.N., Literature Search: A.Y., S.B.B., Writing: A.Y., H.N.

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Effect of Defensive Medicine on Clinical Practices of Emergency Medicine Physicians

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Abstract

Objective: To determine the perspectives of emergency medicine physicians on defensive medicine practices under the influence of malpractice thought, the frequency of these practices, and their relationship with crowded emergency departments, and to reveal the factors affecting physicians in this practice.

Materials and Methods: A questionnaire consisting of questions including positive and negative defensive medicine practices was prepared and delivered to emergency medicine physicians who were in a patient-physician relationship by hand or e-mail.

Results: Physicians answered the following questions: protecting themselves from possible medical errors, keeping more detailed records (87.4%), requesting additional examinations when not necessary (56.8%), keeping the patient under observation for long hours (47.2%), asking for additional consultations (32.7%), avoiding treatments with high complications (17.3%), referring patients (17%), trying to avoid invasive procedures (11%) and prescribing extra medications (10.6%).

Conclusion: Emergency medicine physicians preferred positive defensive medicine practices over negative defensive medicine practices. It has been observed that the pressure of the relatives of the patients and the threat of lawsuits were the main factors influencing defensive medicine practices.

Keywords: Emergency medicine, defensive medicine, malpractice

Introduction

Defensive medicine refers to the physician's excessive use of diagnostic and therapeutic procedures to protect against lawsuits and avoid approaches with a high risk of malpractice lawsuits [1]. For example, the World Medical Association's malpractice; defines it as "harm caused by the physician's failure to perform standard up-to-date practice during treatment, lack of skill, or not giving treatment to the patient". Unfortunately, medical malpractice cases and criminal and civil lawsuits have been increasing in recent years. As a result, physicians in high-risk specialties are exposed to medical malpractice and similar claims, and they turn to defensive medicine practices for fear of being sued and violence. Defensive medicine is divided into

two: positive (defensive) and negative (recessive) according to the way it is applied [2].

Positive defensive medicine consists of approaches that are not medically necessary but that the physician tends to show that the patient is doing more than expected for the diagnosis and treatment of the patient. It may include requesting more examinations and consultations [3]. Although it has been observed that the defensive medicine approach increases patient satisfaction, its long-term benefits for the patient and the country's economy are controversial when evaluated in terms of financial resources and time [4].

Negative defensive medicine is "physicians refraining from applying diagnosis and treatment methods with a high risk of



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resulting in malpractice lawsuits to protect themselves from legal risk situations” [5]. Negative defensive medical practices are not only a method that the physician uses to protect himself from a medical error that may occur but may also be in the form of avoiding patients or diseases that they do not consider cost-effective for purposes such as spending less time and less cost from a commercial point of view [6,7].

This study aims to determine the perspectives of emergency medical workers on defensive medicine practices in a malpractice environment, the frequency of these practices, and their variability (if any) in crowded emergency departments.

Materials and Methods

This study was conducted between 12.06.2013 and 12.07.2013 at İstanbul Medeniyet University Göztepe Training and Research Hospital. We prepared a questionnaire that included demographic information, positive and negative defensive medicine practices, liability insurance, and experiences about malpractice events. The answers were formed with a 4-point scale: always, frequently, occasionally, and never. The questionnaire was delivered to emergency medicine physicians (the assistants, emergency medicine specialists, and emergency medicine lecturers) by face-to-face or e-mail, and it was aimed to be completed by at least 200 emergency medicine physicians. E-mails were sent to approximately 900 physicians from different cities in Turkey, and 189 of the e-mailed physicians answered the questionnaires. Questionnaires were completed by 117 physicians face-to-face. Because 6 questionnaires were discontinued, they were not included in the study. Physicians working in private hospitals were excluded because financial concerns may play a more significant role in treating patients.

No informed consent was obtained because the study participants were not patients.

Questionnaire

The socio-demographic questions were physicians' age, gender, the city they work in, how many years they have been physicians, how many years they have been working in the emergency department, and their job titles.

Questions were formed to evaluate the positive defensive medicine practices: asking for additional examinations when not necessary, prescribing extra medication, asking for consultation when not necessary, hospitalization without indication, explaining medical practices in more detail to patients and their relatives, keeping records in more detail, and giving more importance to informed consent forms [8]. Questions were prepared to evaluate the negative defensive medicine practices: avoiding patients with a high probability of litigation, avoiding treatments with a possibility of complications, and referral of high-risk patients although

treatment is available [8]. Upon the physicians' request to explain the definition of “defensive medicine” in the pretest, we conducted a survey to check the intelligibility of the survey questions we prepared. The definition of defensive medicine has been added before the questionnaire questions.

Questions were prepared to ask whether professional liability insurance creates a sense of security in physicians and the role of the relatives of patients in medical applications.

Ethical Approval

Istanbul Medeniyet University Göztepe Training and Research Hospital Ethics Committee approval was obtained (decision no: 0005, date: 25.06.2013).

Statistical Analysis

SPSS 16.0 for Windows computer programs was used. Chi-square and p values were shown in the analysis tables using the chi-square test in statistical analysis. $p < 0.05$ was considered significant for the chi-square test.

Results

The questionnaire was completed by 300 physicians (187 male). Two hundred and seven were younger than 35 years of age (69%). One hundred and eighty-two were assistant doctors (60.7%), 95 were specialist doctors (31.7%), and 23 were medicine lecturers (7.6%). A total of 156 physicians were studying at an education and research hospital, 105 at a university hospital, and 39 at a local government hospital. The daily patient visit number was 296 at a university hospital, 798 at education and research hospital, and 569 at local government hospital. Female physicians had a mean of 5.3 years of working time in the emergency department (total working time as a physician: 7.2 years) and male physicians had a mean of 5.9 years (total working time as a physician: 8 years) (no statistical differences were shown). We asked if they had experienced a lawsuit against you. A total of 63 physicians (43 male) answered yes (21.1%). We also asked do you think that there has been more malpractice lawsuits recently. Ninety-eight percent answered yes. Ninety-five percent of physicians had insurance against lawsuits.

We evaluated the physicians for positive and negative defensive medicine practices. We asked if they requested more examinations to protect themselves from medical malpractice claims. One hundred and sixty-nine (56.7%) physicians answered always and frequently, and 129 (43.3%) answered occasionally and never (Table 1). Physicians with a working time of less than 10 years, assistant doctors, and physicians working at education and research hospitals had higher scores ($p < 0.05$) compared to others. There was no statistical difference in terms of the physician's age, daily patient visit number, experience of lawsuits, and having medical insurance against lawsuits.

We asked if they requested more medical records to protect themselves from medical malpractice claims. A total of 141 (47.7%) physicians answered always, 118 (39.7%) answered frequently, 34 (11.4%) answered occasionally, and 4 (1.3%) answered never. Always and were frequently answered higher in medical lecturers ($p < 0.05$). There was no statistical difference in terms of other factors.

The physicians participating in the study were asked whether they would need diagnostic imaging even though they thought it was unnecessary. Twenty-three (7.7%) physicians answered always, 109 (36.5%) answered frequently, 157 (54.3%) answered occasionally, and 9 (3%) answered newer questions. Occasionally and newer were answered higher in women physicians, physicians with a working time of 10 years or longer, specialists, and medical lecturers ($p < 0.05$).

The physicians participating in the study were asked whether they would need a consultation even though they thought it was unnecessary to protect themselves from medical malpractice claims. Ninety-seven (32.2%) physicians answered always and frequently (Table 2). The specialists had more never/occasionally answers than the assistant doctors. There was no statistical difference in terms of the physician’s age, gender, daily patient visit number, working period, experience of lawsuits, and having medical insurance against lawsuits.

Physicians participating in the study were asked whether they were writing more drugs to protect themselves from medical malpractice claims. Only 32 physicians (10.7%) answered always and frequently. Male physicians and physicians who were older than 35 years had higher newer/occasional answers ($p < 0.05$). There was no statistical difference in terms of other factors.

Physicians participating in the study were asked whether they were referring patients at risk to avoid the possibility of medical error. Only fifty-one (17%) participants answered always and frequently (Table 3). Female physicians and physicians working at the university hospital had higher newer/occasional answers ($p < 0.05$). There was no statistical difference in terms of other factors.

Physicians participating in the study were asked whether they were prolonging their emergency department stay to avoid the possibility of medical errors. One hundred and forty (47.2%) participants answered always and frequently.

Physicians who participated in the study were asked whether they were avoiding treatments with the possibility of complications. Only 52 (17.3%) had answered always and frequently. Female physicians had higher newer/occasional scores ($p < 0.05$). There was no statistical difference in terms of other factors.

Physicians who participated in the study were asked whether they avoided patients with a high probability of litigation. Fifty-two (17.3%) participants answered always and frequently. Female physicians had higher newer/occasional scores ($p < 0.05$). There was no statistical difference in terms of other factors.

Physicians who participated in the study were asked whether there was pressure from the relatives of the patients to turn to defensive medicine. Two hundred and forty-two (80.9%) physicians answered yes, 25 (8.3%) answered no, and 32 (10.7%) answered undecided (Table 4). If relatives of patients are more inquisitive and more threatening, physicians practice their profession under pressure and act more defensively to protect themselves. Assistant doctors had higher yes scores than others ($p < 0.05$).

Table 1. Do you want additional examination without an indication?

	Male		Female	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Occasionally	71	8	53	47
Frequently	73	40	45	40
Always	37	20	14	12
Never	4	2	1	1
Total	185	100	113	100

Table 2. Do you want a consultation even though you think it is not necessary to protect yourself from medical malpractice claims?

	Male		Female	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Occasionally	109	59	73	65
Frequently	52	28	29	26
Always	13	7	3	3
Never	10	6	7	6
Total	184	100	112	100

Physicians were asked if they had a second chance and if they would choose emergency medicine again. Female physician's answers were; 46 (41%) yes, 31 (27%) no, 36 (32%) undecided; male physician's answers were; 75 (40%) yes, 74 (40%) no, 37 (20%) undecided. There was a statistically significant difference according to gender. If the answer is no, the physicians were asked why emergency medicine is a high-risk specialty. Female physician's answers were; 51 (85%) yes, 8 (13%) no, and 1 (2%) undecided, male physician's answers were; 88 (89%) yes, 7 (%) no, 4 (4%) undecided, and there was no difference in terms of gender. Physicians working for less than 10 years had higher yes scores compared to those working for longer periods. There was no statistical difference in terms of other factors.

Discussion

Defensive medicine is a phenomenon affecting diagnostic-therapeutic areas, leading to a waste of human, organizational, and economical resources. It includes both avoidance behavior when the physician is dealing with high-risk procedures and excessive ordering of extra imaging, laboratory tests, and consultation [9,10]. Emergency medicine is known from high-risk specialties such as gynecology, orthopedics, and vascular surgery [11]. Physicians working in emergency medicine departments frequently use defensive medicine practices with the fear of being sued or violence [12]. Perea-Pérez et al. [12] evaluated defensive medicine in hospital emergency services in Spain and showed that 89.8% of physicians perform diagnostic tests that may not be necessary and 63% stated that they extend the stay in the emergency department. 91.3% of the physicians felt that they are under more legal pressure and they are conditioned under the threat of judicial claims. They declared that they did not feel protected by the structure and supported by the center's management [12].

In our study, 21% of the physicians experienced lawsuits. To avoid possible medical errors, physicians' most common method is to request additional examinations even though there is no indication. We showed that the rate of physicians who stated that they did not request an additional examination was only 1.6%; on the other hand, 98.4% of the physicians said that they requested an additional examination. Physicians with a working time of less than 10 years, assistant doctors, and physicians working at education and research hospitals had requested more additional examinations than others. The other methods used by the physicians participating in our study to protect themselves from possible medical errors were keeping more detailed records (87.4%), keeping the patient under observation for long hours (47.2%), asking for additional consultations (32.7%), avoiding treatments with high complications (17.3%), referring patients (17%), avoiding invasive procedures (11%), and prescribing extra medication (10.6%). We analyzed the factors affecting defensive medicine methods. Physicians studying for more than 10 years, female physicians, medical lecturers, and specialists requested less diagnostic imaging. Pressure from relatives is an important factor for assistant doctors. Female physicians tended to avoid treatments with a possibility of complications and avoid patients with a high probability of litigation. In a scoping review, the factors influencing defensive medicine were analyzed, and social media, patients adopting a consumer attitude, healthcare system-based working conditions, and physician's tolerance for uncertainty were the main factors [13].

Physicians participating in the study were asked the following question: do you think defensive medicine practices have increased? Ninety percent of emergency medicine physicians thought defensive medicine practices had increased. This finding was consistent with the study by Studdert et al. [14]. They

Table 3. Do you struggle to refer patients at risk to avoid the possibility of medical error?

	Male		Female	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Occasionally	89	48	50	45
Never	57	30	51	45
Frequently	31	17	8	7
Always	9	5	3	3
Total	186	100	112	100

Table 4. Do you think that there is pressure from the relatives of the patients to turn to defensive medicine?

	Male		Female	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Yes	150	81	92	81
Undecided	21	11	11	10
No	15	8	10	9
Total	186	100	113	100

performed a mail survey of six specialties at high risk of litigation (emergency medicine, general surgery, orthopedic surgery, neurosurgery, obstetrics/gynecology, and radiology); the rate of asking for more tests and referrals was 92%. Among practitioners, the most recent defensive act was using imaging technology in clinically unnecessary circumstances [14].

In contrast to our results, Waxman et al. [15] evaluated the effect of malpractice reform on emergency department care in Texas, Georgia, and South Carolina and demonstrated no reduction in the intensity of care, rates of computed tomography or magnetic resonance imaging use, or per-visit emergency department charges (except Texas).

Our study results show that emergency medicine physicians apply positive defensive medicine practices more than negative defensive medicine practices. The behavior patterns of patient relatives and legal cases are more critical factors for emergency medicine physicians to turn to defensive medicine. Physicians resort to defensive practices to protect themselves from the fear of being sued or exposed to violence while performing their profession, and this makes it challenging to perform life-saving interventions during the critical hours of the patient, increasing the workload of emergency medicine physicians, and may cause disruptions in the functioning of the emergency service. A physician's perception of malpractice generally overestimates their own risk. To decrease defensive medicine, detailed information about malpractice laws during medical schools and assistant doctor education, clinical practice guidelines, malpractice-specific courts, and apology laws are potential remedies [16].

Study Limitations

Because it was a survey study, the lack of knowledge of the interviewer or the respondent was a limitation of this study.

Conclusion

It has been observed that defensive medicine concerns are an important problem for emergency department physicians. Younger physicians, assistant doctors, and physicians with shorter working periods have an increased risk of performing defensive medicine. Approximately half of the emergency department physicians want to change their specialty due to hard working conditions and fear of lawsuits.

Ethics

Ethics Committee Approval: This study was conducted between 12.06.2013 and 12.07.2013 at the İstanbul Medeniyet University Göztepe Training and Research Hospital Ethics Committee (decision no: 0005, date: 25.06.2013).

Informed Consent: No informed consent was obtained because the study participants were not patients.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.D., O.İ., Concept: A.D., O.İ., A.O., Design: A.D., O.İ., A.O., Data Collection or Processing: O.İ., Analysis or Interpretation: O.İ., A.O., Literature Search: A.D., O.İ., Writing: A.D., O.İ.

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Satisfaction and Knowledge Levels of Adult Patients Admitted to the Emergency Department of a Secondary State Hospital: An Observational Survey Study

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Abstract

Objective: Emergency departments (EDs) operate continuously (“24/7”) throughout the year. However, an increase in ED admissions often compromises the quality of service and patient satisfaction. This study identified problems related to overcrowding in the ED.

Materials and Methods: We conducted a patient satisfaction survey of adult patients presenting to the ED of a secondary state hospital. The patient satisfaction questionnaire, comprising 17 closed-ended questions, was administered to patients who agreed to participate in the study.

Results: The study included 148 patients: 70 men (47.3%) and 78 women (52.7%). We found that 91.2% (n=135) of the patients were aware of their family physician, but only 30.4% (n=45) had sought a consultation with before approaching the ED. The most common reason for visiting the ED was the ability to undergo an immediate medical examination without an appointment. Furthermore, 43.2% of the patients were unaware of the triage system. We found that 66.9% of the patients were very satisfied with our ED services, whereas 25% were satisfied.

Conclusion: Our findings indicate that a significant proportion of patients approach the ED with non-urgent complaints, which contributes to longer waiting times and reduced patient satisfaction. To improve this situation, it is crucial to enhance public awareness of the role and function of EDs and establish effective referral systems.

Keywords: Patient satisfaction, emergency department, length of stay, waiting time

Introduction

Emergency departments (EDs) are dedicated units that operate round the clock throughout the year in our country. Their primary purpose is to identify and manage life-threatening or organ-damaging conditions [1]. However, it has been widely reported that many patients not in a state of emergency tend to seek medical assistance from EDs, often because of sociocultural factors such as the patient’s unfamiliarity with ED procedures, ignorance about when ED care should be sought, the convenience of immediate and free examinations in the ED, and the need to procure a prescription [2,3].

To manage the flow of patients and determine their priority based on medical urgency, a triage system is implemented

[4]. Many hospitals in our country employ a three-tier (green-yellow-red) triage system. Green represents non-emergency patients in stable condition who can be treated on an outpatient basis. Yellow and red indicate emergency and highly urgent patients, respectively. A red triage patient is expected to be examined within 10 minutes, a yellow patient within 1 hour, and a green patient within approximately 2 hours [2]. While the waiting time from admission to physician consultation is perceived to be shorter in our EDs, it negatively impacts patient satisfaction.

Patient satisfaction, despite being a subjective measure influenced by various factors such as lifestyle, past experiences, knowledge level, expectations, and sociocultural values, is a critical indicator of healthcare quality [5]. Positive changes



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to modifiable factors could mitigate the issues faced by emergency services.

Healthcare services worldwide are transitioning from a paternalistic approach toward a model in which patients take more responsibility for decisions concerning their health. Encouraging patient participation by enhancing their health awareness and understanding of healthcare services improves satisfaction, reduces costs, and helps patients receive optimal care [6]. A similar shift is anticipated for emergency healthcare services in Japan.

The objective of our study was to analyze survey data to enhance public knowledge about EDs, help reduce ED overcrowding, ensure quality services for true emergency patients, and enhance patient satisfaction.

Materials and Methods

This descriptive study was conducted in the adult ED of our hospital from April 1 to 30, 2023. This study was approved by the provincial health directorate and the Ethics Committee of Tokat Gaziosmanpaşa University Faculty of Medicine (approval number: 23-KAEK-017, date: 19.01.2023). Patients aged ≥18 years who consented to participate and signed the consent form were included in the study. Patients aged <18 years, those who declined to participate, and those who did not respond to all questions were excluded from the study.

A total of 148 patients participated in our study. A questionnaire consisting of 17 closed-ended questions was administered to the patients. The patient satisfaction questionnaire was divided into two sections. The first section solicited sociodemographic information from the participants, including age, gender, educational status, and employment status. The second section consisted of questions aimed at assessing patients’ knowledge about the ED and evaluating their satisfaction with the services received (Table 1).

Statistical Analysis

For statistical analysis, the SPSS for Windows software package (version 16.0; SPSS Inc., Chicago, IL, USA) was employed, and data were analyzed using descriptive statistical methods.

Results

In April 2023, 148 adult patients were admitted to our ED and agreed to participate in the study. Of these patients, 78 (52.7%) were female and 70 (47.3%) were male. The demographic data revealed that 34.5% (n=51) of participants were aged 18-30 years, 23% (n=43) were aged 30-40 years, 20.3% (n=30) were aged 41-50 years, 15.5% (n=23) were aged 51-65 years, and 6.8% (n=10) were aged ≥66 years.

Regarding educational status, 2% of participants were uneducated, 17.6% were primary school graduates, 15.5% were

Table 1. The questionnaires of the survey

1. Age
• 18-30
• 30-40
• 41-50
• 51-65
• 66 and older
2. Gender
• Female
• Male
3. Education status
• Uneducated
• Primary school graduates
• Secondary school graduates
• High school graduates
• University graduates
4. Employment status
• Employed
• Student
• Retired
• Unemployed
5. Frequency of admitted the emergency department
• Once a year or less
• 2-6 times a year
• Every time when I feel sick
6. Did You consult your family physician before admitted the emergency service?
• Yes, I admitted to my family doctor
• No, I did not admitted to my family doctor
7. Do you know who your family doctor is?
• Yes, I know
• No, I do not know
8. What is your complaint to admit the emergency service? (You can choose more than one)
• Sore throat, body pain, fever, cough
• Headache, migraine
• Back/neck pain
• Itching, skin eruption
• Nausea, vomiting, diarrhea, dysurea
• Severe abdominal pain
• Shortness of breath
• Chest pain/palpitations
• Falling (body injury; cut or fracture)
• Traffic accident
• Nervous breakdown
• Other (Write:.....)

Table 1. Continued	
9. What is your reason for choosing emergency service?	
• To be examined quickly without an appointment	
• To receive an injection or serum that will make me feel good	
• To obtain a rest report	
• Giving a blood/urine test, pregnancy test, or get prescription medications	
• Intervention if I am in a life-threatening situation.	
10. How did you arrive to the emergency service ?	
• By ambulance	
• By my own transportation	
11. Do you know the triage system used in the emergency department?	
• Yes, I know	
• No, I do not know	
12. How long can green area patients wait for examination?	
• 0-10 minute	
• 10-30 minute	
• 30 minute-2 hours	
• I do not know	
13. In which area did you examined in the emergency department?	
• Green triage area	
• Yellow-red triage area	
• I do not know	
14. Select your examination and treatment (You can tick more than one)	
• Blood/urine analysis requested	
• X-ray/tomography/MR requested	
• Serum/injection given	
• Prescription written	
• I was hospitalized	
15. Mark about emergency service that is appropriate for you.	
• I immediately visit to the ED when I feel sick, this is useful in emergencies	
• The ED is for the diagnosis and treatment of life-threatening serious diseases, I will visit the ED in case of an emergency.	
16. Rating the service you receive from our emergency department between 5 and 1. (5: very satisfied; 4: satisfied; 3: neither satisfied nor dissatisfied; 2: not satisfied; 1: not at all satisfied)	
• 5	
• 4	
• 3	
• 2	
• 1	
17. Would you admit to our hospital emergency department if needed?	
• Yes	
• No	
ED: Emergency department, MR: Magnetic resonance	

secondary school graduates, 25.7% were high school graduates, and 39.2% were university graduates. The participant group comprised 47.3% employed individuals, 16.2% students, 9.5% retirees, and 27% unemployed individuals. Demographic data are presented in Table 2.

In our study, when asked how often they visited the ED, 29.1% (n=43) of the patients responded “once a year or less,” 37.8% (n=56) stated “2-6 times a year,” and 33.1% (n=49) stated “every time when I feel sick.”

To the question “Do you know who your family doctor is?”, 91.2% (n=135) of the patients responded “Yes, I know,” while 8.8% (n=13) answered “No, I don’t know.” Additionally, when asked if they had sought help from their family doctor before visiting the ED, 30.4% (n=45) of the patients responded “Yes,” while 69.6% (n=103) responded “No.”

In total, 19.6% (n=29) of our patients reported arriving at the ED by ambulance, whereas 80.4% (n=118) arrived via their own transportation. When asked about the area where they were examined, 53.4% reported being seen in the green triage zone and 35.8% in the yellow-red triage zone; 10.8% were unsure. The total number of hospitalized patients was 12 (4.6%).

The reasons for seeking ED care varied in this study. Notably, 42.4% (n=72) of the patients cited “to be examined quickly without an appointment” as the reason. Other reasons included “to receive an injection or serum that will make me feel good” (21.2%, n=36), “to obtain a rest report” (5.3%, n=9), and “to have a blood test, pregnancy test, or get prescription medications” (4.7%, n=8). A total of 26.5% (n=45) of patients cited the need for intervention in a life-threatening situation as the reason for their ED visit.

When asked about their perspective in the ED, 57.4% (n=85) of patients chose the answer option “I immediately visit the ED when I feel sick; this is useful in emergencies,” while 42.6% (n=63) selected the answer option “The ED is for diagnosis and treatment of life-threatening serious diseases, I will visit the ED in case of an emergency.”

Patient satisfaction was rated on a scale of 1-5, with 5 corresponding to “very satisfied.” In total, 66.9% of the patients scored 5, 25% scored 4, and 8.1% scored 3 (neutral regarding satisfaction). No patient scored 2 or 1, indicating a high level of satisfaction overall. All participants stated that they would revisit our hospital if necessary.

In terms of education level, participants with university-level education reported higher satisfaction with the health services provided than those with high school education. However, patients with primary or secondary school education and those with no education reported the highest satisfaction levels (Table 3).

Discussion

In our study, the majority of ED patients were female (52.7%). There are varying reports in the literature regarding ED patient gender ratios, with some studies reporting a higher number of female patients and others reporting more male patients [7]. The rate of ED visitation in our cohort was 1.5 times higher than that in the country overall. The population stood at 84.6 million in 2021, with 129.5 million ED visits and 136.9 million outpatient visits [8].

When asked about the frequency of ED visits, only 29.1% of the patients reported visiting “once a year or less”; 37.8% indicated “2-6 times a year” and 33.1% stated “every time I am sick.” The high number of visits can be attributed to easy, free access to EDs, the opportunity for quick, appointment-free examinations at any time, and the general lack of understanding about how EDs function [2,3].

Efficient primary healthcare services could reduce the number of secondary and tertiary healthcare visits. In our country, a family medicine system has been in place since 2010, providing each individual with a family physician [9]. However, the lack

of a compulsory referral system allows patients to choose their preferred healthcare provider, leading to an increase in secondary and tertiary hospital visits without primary care consultation. Although 91.2% of the patients knew their family physician, 69.6% did not consult their physician before their ED visit. Green triage zone patients, who commonly visit the ED [7], can receive treatment from their family physicians. By bypassing primary care physicians, such patients contribute to the overcrowding in EDs.

Sert et al. [7] reported that 79.7% of ED visits were by green triage (non-emergency) patients. Kılıçaslan et al. [10] found that the hospitalization rate of ED patients was 12%. In our study, 68.5% of the patients were classified as non-emergency (green triage zone), in line with the literature (Table 4).

Red triage patients should be examined within 10 minutes, yellow triage patients within 1 hour, and green triage patients within 2 hours [2]. However, our patients were not familiar with the triage system or the associated potential wait times. In fact, 43.2% of the patients were completely unaware of the triage system. When asked about expected wait times in the green triage area, 48% of patients estimated “0-10 minutes,” 26.4% estimated “10-30 minutes,” and 4.7% estimated “30 minutes to 2 hours”. The average green triage zone examination time in our hospital is approximately 11 minutes, and dissatisfaction often stems from this wait time. Even during typical wait periods in the ED, a tense atmosphere can contribute to violent incidents. However, 91.9% of our participants indicated that they were “very satisfied” or “satisfied” with the service they received, possibly because of our relatively short average green triage zone examination time. Nevertheless, enhancing public understanding of the triage system and potential wait times could help prevent negative experiences.

Aljarallah et al. [11] discovered that university graduate patients were more satisfied with hospital services, which they attributed to better awareness of the services offered by the hospital among higher-educated participants. However, our findings in this regard were contrary to those of Aljarallah et al. [11]. Primary and secondary school graduates, and illiterate patients, exhibited the highest satisfaction rates, whereas high school graduates reported the lowest satisfaction rates. This could be due to a lack of education in our country about

Table 2. Socio-demographic features of the participants

		n	%
Gender	Female	78	52.7
	Male	70	47.3
Years	18-30	51	34.5
	31-40	34	23
	41-50	30	20.3
	51-65	23	15.5
	≥66	10	6.8
Educational status	Uneducated	3	2
	Primary school	26	17.6
	Secondary school	23	15.5
	High school	38	25.7
	University	58	39.2
Employment status	Employed	70	47.3
	Student	24	16.2
	Retired	14	9.5
	Unemployed	40	27

Data are expressed as numbers (n), percentages (%)

Table 3. Satisfaction score by education status

		5 point		4 point		3 point		1 point	
		n	%	n	%	n	%	n	%
Educational status	Uneducated, primary, secondary school	39	75	11	21.2	1	1.9	1	1.9
	High school	19	50	15	39.5	4	10.5	0	0
	University	40	69	11	19	7	12	0	0

Data are expressed as numbers (n), percentages (%)

Table 4. Clinical characteristics of the participants admitted to the our ED in 1-30 April 2023

		n	%
Patient	Green triage zone	14.993	68.5
	Yellow/red triage zone	6.886	31.5
		Mean	
Duration of examining (minute)	Green triage zone	11,45	
	Yellow/red triage zone	4.6	
		n	
The most common diagnoses			
Upper respiratory tract infection/cold		6333	28.9
Soft tissue disorder		2471	11.3
Myalgia/lumbalgia		1341	6.1
Acute gastroenteritis		977	4.5
Headache		533	2.4
Data are expressed as numbers (n), percentages (%). ED: Emergency department			

emergency services operations or because the less-educated elderly population perceives ED services to have improved over the years.

In analyzing the reasons for choosing ED care, we found some notable trends. Patients who visited the ED “to be examined quickly without an appointment” often did so with non-urgent complaints, as outpatient clinic appointment systems were consistently at full capacity. The absence of a compulsory referral system and patients’ freedom to select their healthcare provider have resulted in an overflow of outpatient clinic appointments in secondary and tertiary hospitals. Some patients appear unaware of the scope of the emergency healthcare system. Moreover, the preference of patients who visit “to receive an injection or serum that will make them feel better” to be involved in treatment decisions, coupled with their propensity for intravenous treatment, are also drivers of ED visits in our country. Non-urgent requests from chronic patients for routine blood tests, prescriptions, reports, and pregnancy tests also contribute to the load on the ED. Inappropriate report requests from patients seeking a rest report rather than a medical examination add to the challenges faced by ED staff. These factors collectively contribute to overcrowding in the ED.

Study Limitations

Our study had several limitations. The study was restricted by its single-center, small-scale design and short-term evaluation of patients. In addition, it only included 148 adult patients admitted to the ED.

Conclusion

In conclusion, it appears that a significant proportion of patients presenting to the ED with non-urgent complaints perceive the wait times to be extensive, which negatively impacts patient

satisfaction. Implementing compulsory referral systems to improve the efficiency of appointment bookings, directing patients deemed to require ED care by family doctors to the appropriate referral center, enhancing public understanding of emergency health services, introducing health literacy lessons at the primary school level, and public service announcements delivered via the media may improve service quality and patient satisfaction, reduce healthcare-related violence, and allow emergency health systems to operate more effectively.

Ethics

Ethics Committee Approval: This study was approved by the provincial health directorate and the Ethics Committee of Tokat Gaziosmanpaşa University Faculty of Medicine (approval number: 23-KAEK-017, date: 19.01.2023).

Informed Consent: Patients aged ≥ 18 years who consented to participate and signed the consent form were included in the study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: T.B.Ü., H.İ.A., Design: T.B.Ü., H.İ.A., Data Collection or Processing: T.B.Ü., Analysis or Interpretation: T.B.Ü., Literature Search: T.B.Ü., Writing: T.B.Ü., H.İ.A.

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A Fatal Case of Opioid Body Packer Syndrome Presented with Seizures

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Abstract

“Body packing” involves concealing drugs filled in packets inside the body to traffic illicit drugs. Packets may leak and rupture, which may have drug-induced toxic effects. We present a case of a 25-year-old male patient brought to the emergency department because of a seizure during an international flight. He was diagnosed with status epilepticus, and tracheal intubation was performed; however, he had a cardiac arrest shortly after. Pinpoint pupils and unclear patient history led to naloxone administration. After successful cardiopulmonary resuscitation, the patient was examined using computed tomography, which revealed multiple foreign bodies in the distal bowels. Blood toxicology tests were positive for opiates and negative for heroin metabolites, amphetamine, cocaine, barbiturate, and benzodiazepine. An emergency colonoscopy was performed, and the patient remained in the intensive care unit for 17 days before he died of to complications of Body Packer syndrome. Early diagnosis and appropriate management of this rare but potentially fatal condition are vital to improve patient outcomes.

Keywords: Body packing, seizure, opioid, computed tomography

Introduction

It is estimated that 296 million people will use drugs in 2021, which means a 23% increase over the next 10 years. Cannabis was the leading drug, followed by opioids, amphetamines, cocaine, and ecstasy [1]. “Body packing” is concealing illicit drugs intracorporeally to avoid detection by law forces. It may be performed either by “body stuffing” or “body pushing” [2]. The difference between the two terms is the introduction path of drugs: body stuffers ingest packets of drugs, whereas body pushers insert packets in the rectum or vaginal cavity [3]. Cocaine, heroin, methamphetamine, and cannabinoids are the main drugs transported via body packing [2]. These drug couriers may be brought to the emergency department by law forces to be examined for medical confirmation of body packing and may not have any medical complaints. However, the presentation may not always be that simple, and patients may present with body Packer syndrome, which is a clinical diagnosis occurring due to the accidental opening of the packages inside the body or drug packages causing bowel

obstruction [4]. Body Packer syndrome occurs in 5% of body packing patients, and the mortality rate may reach up to 56% [5]. Due to the high international demand for drugs and harsher international laws, drug traffickers actively search for new and less recognizable ways to distribute drugs, which makes it a challenge for emergency physicians to suspect and diagnose these cases [4,5].

Case Report

A 25-year-old male patient was brought to the emergency department because of a seizure that terminated spontaneously during an international flight. Since there was no relative present, a history of the patient could not be obtained. During the examination, the patient had a generalized tonic-clonic seizure that resolved with 5 mg intravenous diazepam. On physical examination, the patient appeared to be in a postictal state, his pupils were isochoric, and pupillary light reflex was present. The patient’s vital signs were as follows: blood pressure, 115/65 mmHg; pulse rate, 140 beats/min; respiratory rate, 16



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beats/min; SpO₂, 90%, the temperature was 37.3 °C, and the finger stick blood glucose, 260 mg/dL. An electrocardiogram (ECG) was obtained and interpreted as sinus tachycardia. Supplemental oxygen was administered through a mask. Arterial blood gas, complete blood count, blood chemistry, cardiac marker enzymes, coagulopathy, urinalysis, and blood and urine toxicology tests were measured. 10 min later, the patient had another generalized tonic-clonic seizure, which resolved with 5 mg intravenous diazepam. Due to recurrent seizures without recovery and impending airway compromise, the patient was intubated, and tracheal rapid sequence intubation was performed. Vital signs were stable following intubation. Intravenous levetiracetam infusion was initiated.

Measurement of initial venous blood gas showed pH 7, PaCO₂ 63 mmHg, HCO₃ 16.3 mmol/L, PaO₂ 44 mmHg, glucose 269 mg/dL, and lactate 12.8 mmol/L. A complete blood count showed a WBC count of 45.560/uL with 86.1% neutrophils. After 20 min following intubation, the patient suffered a cardiac arrest. Cardiopulmonary resuscitation (CPR) was initiated. Intravenous naloxone (0.4 mg) was administered because repeated examination revealed pinpoint pupils, and the patient's history was suspicious. Spontaneous circulation returned after 20 min of CPR. Positive inotropes were initiated because of low blood pressure.

A rectal examination revealed three medium-sized (4-5 cm) black packages wrapped with stretch wrap stuffed in the rectal cavity (Figure 1). Non-contrast brain computed tomography (CT) and thoracic, abdomen, and pelvic CT scans with intravenous contrast were obtained. They showed multiple hyperdense findings consistent with foreign bodies within the distal bowel loops (Figure 2). Brain CT was interpreted as normal. Other initial blood test results showed troponin I 346 pg/mL (0-17.5), creatinine 1.42 mg/dL (0.7-1.2), lactate dehydrogenase 593 U/L (135-248), and C-reactive protein 5.1 mg/L (<5). Electrolyte levels were normal. Blood toxicology tests showed an opiate level above 1.800 ng/mL (0-300). Tests were negative for heroin metabolites, amphetamine, cocaine, barbiturate, and benzodiazepine.

Six foreign bodies of the same nature in different sizes were removed by emergency colonoscopy performed by general surgeons, and no signs of necrosis, ischemia, or perforation were found. The patient was transferred to the intensive care unit (ICU) where he was observed with fever, sepsis, acute kidney failure, and acute respiratory distress syndrome (ARDS). Continuous veno-venous hemofiltration is initiated. Echocardiography showed a normal ejection fraction and no valvular abnormalities. Infective endocarditis was excluded.

CT angiography scans performed 15th day post-operatively showed signs of decreased cerebral blood flow, widespread cerebral edema, and subarachnoid hemorrhage. The patient

was diagnosed with brain death 16 days post-operatively because of the complications of body packer syndrome and died one day later.

Discussion

Status epilepticus is a neurological emergency defined as a seizure with at least 5 min of continuous seizure activity or recurrent seizure activity without recovery between seizures. Seizure activity may be convulsive, non-convulsive, focal motor, or myoclonic. It requires immediate evaluation and



Figure 1. Recovered packets filled with opioids in different sizes and shapes (blue arrow: leaked packet)

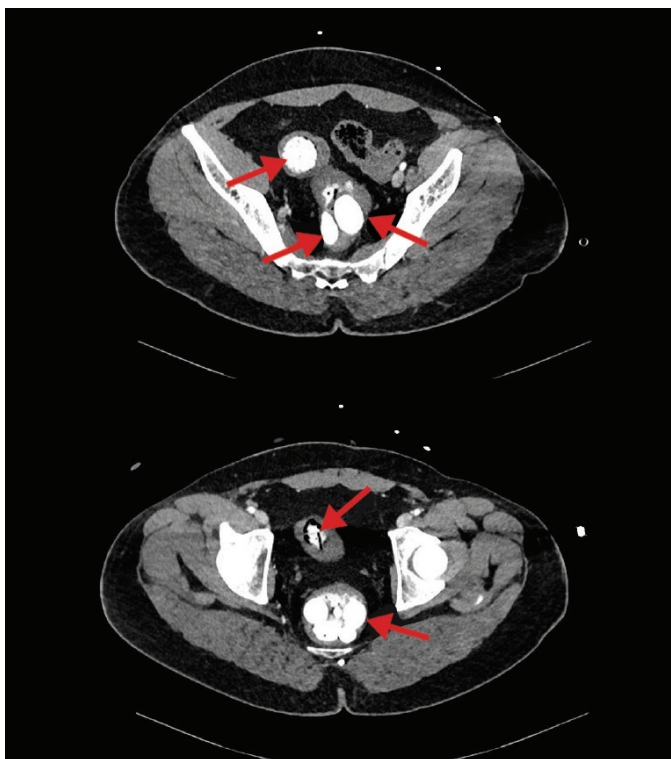


Figure 2. Hyperdense findings consistent with foreign bodies in computed tomography scan images (red arrows: packets)

management to prevent significant morbidity or mortality. Illicit drugs may cause seizures and status epilepticus [2,6,7]. In status epilepticus, guidelines recommend stabilizing the patient, monitoring vital signs and ECG, checking for blood glucose, collecting blood for electrolytes, hematology, toxicology screening, and (if appropriate) anticonvulsant drug levels [6]. CPR guidelines recommend considering naloxone in cardiac arrest patients with suspected opioid poisoning, even for lay responders [8]. In this study, naloxone was administered during CPR.

Opioid overdose is the leading cause of death among young populations. Opioids are substances that act as potent agonists of opiate receptors. While mu, kappa, and delta receptors mediate the effects of opioids, mu receptors are the primary mediators that decrease the respiratory response to hypoxia. Respiratory depression is the primary factor responsible for opioid-related fatalities. Neurons are vulnerable to hypoxia, and hypoxic brain damage may occur due to depressed respiration, which may result in seizures, coma, and stroke [7]. Naloxone is an opioid antagonist with a high affinity for the mu-opioid receptor, which allows for the reversal of opioid effects [8]. Loosely packed packets carried by body packers are highly susceptible to leakage and rupture [9].

Body packers may have a history of international travel originating in the routes of drug transfer, and unusual flight patterns may give a hint. However, it is often difficult to obtain a thorough medical history of the patient because of factors such as the patient's mental status, the patient's tendency to hide the facts, or the language barrier [2]. In this study, it was not possible to obtain the patient's medical history, and it was evaluated as an epileptic seizure in the initial evaluation.

Body Packers develop several complications that are named "body Packer syndrome". Rupturing of the packages may cause drug toxicity, which may lead to respiratory compromise and systemic toxicity [2]. In body packers who suffered from drug toxicity, the mortality rate was as high as 56% in the past. Fortunately, it is reported to be lower than 3% today [2].

Surgery is warranted for patients suffering from body packer syndrome or if there is a concern of developing it. Studies show that 0.7%-3.7% of patients need surgery and the mortality risk is less than 1.4% [3]. A recent study from a referral center in Iran showed a mortality rate of 2.7%, of which 62.5% died before surgery [10]. Abdominal CT scan has a sensitivity of 95.6%-100% to detect drug packets, and oral or rectal contrast should not be used as they are similar to packets in density [9]. In this case, a comprehensive examination after stabilization showed rectal foreign bodies, and a CT scan confirmed the diagnosis. The patient had undergone emergency colonoscopy, and the packets were removed. While the leaked package was identifiable in our case (Figure 1), the absence of disrupted

packages in the evaluation of the patient or even at the autopsy does not exclude a package leak because leaking packages may be incorrectly diagnosed as intact [2].

Opioid overdose patients rarely develop seizures, acute lung injury, and adverse cardiac events [2]. Opioid overdose may cause acute kidney injury due to hypotension and rhabdomyolysis. The present case suffered cardiac arrest and was observed in the ICU with persistent hypotension requiring multiple inotropes, sepsis, acute kidney failure, and ARDS, which led to mortality.

Conclusion

This case underscores the challenges in diagnosing and managing this rare but potentially fatal disease. Maintaining a high index of suspicion for body packing, especially in patients with uncertain medical histories or unexpected clinical courses during the ED observation period, using appropriate imaging and laboratory modalities, timely intervention, and embracing a multidisciplinary approach are vital to improve patient outcomes but may not be enough.

Ethics

Informed Consent: Informed consent was obtained from the patient's relatives in this case report.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Desing: İ.S., A.Ç.Ş., A.B., Literature Search: İ.S., A.Ç.Ş., A.B., Writing: İ.S., A.Ç.Ş., A.B.

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