Osmangazi Journal of Med, 2025;47(3):404-411
DOI: 10.20515/otd.1634233

Research Article
Araştırma Makalesi

Osmangazi Journal of Medicine
e-ISSN: 2587-1579

Retrospective Evaluation of Patients Admitted to Intensive Care Unit in Kahramanmaraş Centered Earthquakes in Türkiye: A Single Center Analysis

Kahramanmaraş Merkezli Depremlerde Yoğun Bakım Ünitesine Kabul Edilen Hastaların Retrospektif Değerlendirilmesi: Tek Merkez Analizi

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Abstract: On February 6, 2023, two major devastating earthquakes hit Turkey, impacting 11 provinces. Kahramanmaraş province was the epicenter. The aim of this study was to investigate the medical analysis and survival status of earthquake victims admitted to the intensive care unit (ICU) after these earthquakes. Factors associated with mortality among hospitalized earthquake victims were also explored. This retrospective, cross-sectional, single-center study was conducted on earthquake victims who were admitted to the ICU between February 6, 2023, and February 21, 2023. Data including demographic characteristics, Acute Physiology and Chronic Health Evaluation II (Apache II) scores, Glasgow Coma Scale (GCS) values, laboratory parameters, in- or out-of-institution referral status, survival status, length of stay in the ICU, and hemodialysis requirements of all the patients were recorded. Of the 45 earthquake victims (20 females and 25 males), the mean age was 38.9 ± 18.7 years. 25 patients were intubated at the time of admission to the ICU. A total of 19 patients required hemodialysis, 20 patients died, 9 patients were referred inside the hospital, 16 were referred outside the hospital. It was observed in the study that higher rates of intubation on admission, higher serum creatinine, procalcitonin, lactate and Apache II values, lower Ph, neutrophil/ lymphocyte ratio (NLR) and GCS values showed an increased risk of death. Earthquakes are life- threatening natural disasters. The definition of the clinical and laboratory parameters of the earthquake victims is crucial on the prediction of survival status.
Keywords: Death, earthquake, intensive care unit, trauma, earthquake victim

Özet: 6 Şubat 2023'te Türkiye'yi vuran iki büyük yıkıcı deprem 11 ili etkiledi. Kahramanmaraş ili merkez üssüydü. Bu çalışmanın amacı bu depremlerden sonra yoğun bakım ünitesine (YBÜ) yatırılan depremzedelerin tıbbi analizlerini ve hayatta kalma durumlarını araştırmaktı. Ayrıca depremde yatan hastaların ölümüyle ilgili faktörler de araştırıldı. Bu retrospektif, kesitsel, tek merkezli çalışma, 6 Şubat 2023 ile 21 Şubat 2023 tarihleri arasında yoğun bakım ünitesine yatırılan depremzedeler üzerinde gerçekleştirildi. Tüm hastaların demografik özellikleri, Akut Fizyoloji ve Kronik Sağlık Değerlendirmesi II (Apache II) skorları, Glasgow Koma Skalası (GKS) değerleri, laboratuvar parametreleri, kurum içi ve dışı sevk durumları, sağ kalım durumları, yoğun bakımda kalış süreleri, hemodiyaliz gereksinimleri gibi verileri kaydedildi.45 depremzede (20 kadın ve 25 erkek) yaş ortalaması 38,9 ± 18,7 yıl idi. Yoğun bakıma kabulde 25 hasta entübe idi. Toplam 19 hastaya hemodiyaliz uygulandı, 20 hasta öldü, 9 hasta hastane içine sevk edildi, 16 hasta hastane dışına sevk edildi. Çalışmada, kabulde daha yüksek entübasyon oranlarının, daha yüksek serum kreatinin, prokalsitonin, laktat ve Apache II değerlerinin, daha düşük Ph, nötrofil/lenfosit oranı (NLR) ve GKS değerlerinin ölüm riskini artırdığı gözlendi. Depremler yaşamı tehdit eden doğal afetlerdir. Deprem mağdurlarının klinik ve laboratuvar parametrelerinin tanımlanması, hayatta kalma durumunun tahmininde çok önemlidir.
Anahtar Kelimeler: Ölüm, deprem, yoğun bakım ünitesi, travma, depremzede

Ethics Committee Approval: The study was approved by Adana City Training and Research Hospital Clinical Research Ethical Committee (Decision no: 2765, Date: 17.08.2023).

Informed Consent: This study did not require informed consent.

Authorship Contributions: Conception or design of the work:Ş.T. Data collection:Ş.T. Data analysis and interpretation:A.D. Drafting the article: Ş.T., A.D. Criticle revision of the article: Ş.T., A.D. Final approval of the version to be published: Ş.T., A. D.

Copyright Transfer Form: Copyright Transfer Form was signed by all authors.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

Received : 07.02.2025
Accepted : 24.03.2025
Published :.08.04. 2025

How to cite/ Atıf için: Sahin T, Akdag D. Retrospective evaluation of patients admitted to intensive care unit in Kahramanmaraş centered earthquakes in Turkey: A single center analysis2025;47(3):404-411

1. Introduction

Two major earthquakes hit Turkey on February 6, 2023, with a measured magnitude of 7.7 and 7.6 on the Richter scale. Kahramanmaraş province was the center of the earthquakes, and 10 other provinces of Turkey were also affected by the earthquake (1).

These earthquakes were not the first devastating ones, because Turkey is located on earthquake zones. In the past years, three major earthquakes, the Van earthquake in 2011, the Marmara earthquake in 1999 and the Erzincan earthquake in 1939, were the other deadliest earthquakes with a magnitude higher than 7.0 Richter scale that Turkey has experienced (2,3,4).

The sudden speed of onset, lack of warning systems, and aftershocks cause earthquakes to be devastating (5). After large and severe earthquakes, earthquake victims may experience injury, disability, multiple trauma and even death. Earthquake victims admitted to the intensive care unit (ICU) may require intubation, experience shock, suffer from multiple organ failure, or undergo limb amputation. Crush syndrome, acute kidney injury, compartment syndrome, infection, sepsis, septic shock may be observed in earthquake survivors in the ICU (6).

Demographic data, clinical and laboratory findings, and intensive care scoring values of the patients can be guiding for the course of the patients.

In a study age, respiratory rate, pulse rate, diastolic blood pressure, presence of coronary heart disease, chronic kidney disease, crush injury, malignant tumor and Glasgow Coma Scale (GCS), are defined as independent mortality related factors in early assessment of the adult earthquake victims (7).

Our aim in this study was to investigate the demographic characteristics, clinical and laboratory outcomes and survival status of the victims in the ICU within fifteen days following the Kahramanmaraş centered earthquakes. We also determined the factors related to earthquake inpatient death.

2. Materials and Methods

The local institutional Ethics Committee of Adana City Training and Research Hospital approved the study (approval no.2765 on August 17, 2023) and the study complied with the principles of the Helsinki Declaration.

This retrospective, cross-sectional, single-center study involved patients who were affected by the Kahramanmaraş centered earthquakes and admitted to the ICU of a training and research hospital. The study comprised of 45 earthquake victims who were admitted to the ICU between February 6, 2023, and February 21, 2023. Patients with missing data were not included in the study. The patients who were in the ICU at that time and were not earthquake victims were excluded from the study.

The earthquake victims' age, gender, length of stay in the ICU, whether they were intubated at the time of admission, whether hemodialysis was applied or not, and whether they died or were alive were recorded. Acute Physiology and Chronic Health Evaluation II (Apache II) scores and GCS values were recorded. Laboratory parameters of the earthquake victims (Serum sodium (Na) , serum potassium (K), serum blood urea nitrogen (BUN), serum creatinine, serum calcium, serum ionized calcium, serum albumin, serum aspartate aminotransferase (AST), serum alanine aminotransferase (ALT), white blood cell (WBC) count, hemoglobin (Hb), hematocrit (Htc), neutrophil/lymphocyte ratio (NLR), pH, lactate, C-reactive protein (CRP), procalcitonin) on admission to the ICU were recorded.

2.1. Statistical analysis

The statistical analysis carried out in this study was the IBM SPSS 25.0 (Armonk, NY: IBM Corp.) and MedCalc 15.8 (MedCalc Software bvba, Ostend, Belgium) program. Qualitative data was compared by using The Chi-Square (χ^2) test. The normality of the parameters was evaluated with the Shapiro-Wilk test, skewness-kurtosis and graphical methods (histogram, Q-Q Plot, Stem and Leaf, Boxplot). In the evaluation of normally distributed quantitative data, Independent Samples t test was used. For the evaluation of the data that is not normally distributed, Mann-Whitney U test was used. In order to determine the distinctiveness of the variables, The Receiver Operating Characteristic (ROC) curve method was used. In the determination of risk ratios, the Binary Logistic Regression test was used. Statistical significance level was accepted as α=0.05. Power analysis was performed with the statistical package program G*Power 3.1.9.7 (Franz Faul, Universitat Kiel, Germany); n1=25 (10.5 ± 4.7), n2=20 (5.6 ± 4.4), α=0.05, Effect Size (d) = 0.94; power = 87%.

3. Results

Among the forty- five earthquake victims in the ICU, there were 20 females and 25 males. The mean age of the patients was 38.9 ± 18.7 years (min: 12, max: 85). When admitted to the ICU, 25 patients were intubated and 20 of them were not intubated. The length of stay of the patients in the ICU was 7.2 ± 18.5 days (min: 1, max: 127). A total of 25 patients were discharged from the ICU; 9 of the patients were referred within the institution and 16 were referred outside the institution. Hemodialysis was applied to 19 of the patients. 20 of the patients died. The general characteristics of patients are shown in Table 1.

In comparisons made according to survival; a statistically significant difference ($p<0.05$) between survivors and non- survivors in terms of intubated status on admission, length of ICU stays, serum creatinine, procalcitonin, pH, lactate, NLR, Apache II, GCS, in-institution referral and out-of-institution referral values was determined.

In the non-survivor group, It was found that the rates of intubation on admission were higher, ICU stay times were shorter, serum creatinine, procalcitonin, lactate and Apache II values were higher, Ph, NLR and GCS values were lower, and there were no in-institution or out-of-institution referrals.

No statistically significant difference ($p>0.05$) between survival conditions in terms of other variables was determined. Table 2 shows the comparisons by survival of the patients.

Serum creatinine, procalcitonin, pH, lactate, NLR, Apache II score, GCS score and intubation on admission: these are the variables that have a clinically more significant difference in pairwise comparisons between Survival-Mortality status and that are not highly correlated. First, single logistic regression was performed on these variables, variables with $p<0.05$ were included in multiple logistic regression, the Backward Stepwise method was used in the analysis, and the model was finalized in the fourth step. In this model, approximately 45% of the dependent variable (Survival-Mortality) could be explained (Nagelkerke $R2 = 0.445$). According to this model, a statistically significant relationship between Survival-Mortality status and lactate, NLR and intubation on admission variables was observed ($p<0.05$).

Mortality is approximately 1-fold higher in those with high lactate values than in those without (OR,1,03; 95% CI,1,00-1,05), approximately 0.9-fold higher in those with high NLR values than in those without (OR,0,90; 95% CI,0,82-1,00) , and approximately 5-fold higher in those who are intubated at admission than in those without (OR,4,5; 95% CI,1,24-16,35). Table 3 shows the evaluations with logistic regression.

Variables found to have differences in pairwise comparisons were evaluated using ROC analysis. Table 4 shows the ROC analysis of serum creatinine, procalcitonin, Ph, lactate, NLR, Apache II score and GCS score. The ROC curve results of these parameters are also shown in Figure 1.a,1.b,1.c,1.d,1.e,1.f,1.g.

Table 1. General characteristics of the patients

		Mean ± SD	**Median(Min-Max)**
Gender *	Female	20	44.4
	Male	25	55.6
Age (years)		38.9 ± 18.7	36.0 (12.0 – 85.0)
Intubated status on admission to the ICU *	Yes	25	55.6
	No	20	44.4
Length of stay in the ICU (days)		7.2 ± 18.5	4.0 (1.0 – 127.0)
Referral inside the institution *	Yes	9	20.0
	No	36	80.0
Referral outside the institution *	Yes	16	35.6
	No	29	64.4
Glasgow Coma Scale Score		8.3 ± 5.2	6.0 (3.0 – 15.0)
Apache II Score		35.0 ± 13.1	34. 0 (8.0 – 62.0)
Hemodialysis *	Yes	19	42.2
	No	26	57.8
Death *	Yes	20	44.4
	No	25	55.6

*Data are presented as mean ± SD, median (min-max) values; *: n / %*

Table 2. Comparisons by survival of the patients

		Survivor (n=25)	**Non-survivor (n=20)**	**P value**
Gender	Female Male	11 (%44.0) 14 (%56.0)	9 (%45.0) 11 (%55.0)	1.000 [a]
Age (years)		38.0 ± 19.2	40.0 ± 18.5	0.732 [b]
Intubated status on admission to the ICU	Yes No	10 (%40.0) 15 (%60.0)	15 (%75.0) 5 (%25.0)	**0.034** [a]
Length of stay in the ICU (days)		7.0 (4.0-8.5)	2.0 (1.0-3.8)	**<0.001** [c]
Serum blood urea nitrogen (mg/dL)		82.0 (46.0-138.0)	86.0 (73.5-122.5)	0.424 [c]
Serum creatinine (mg/dL)		1.8 (0.8-3.4)	2.7 (1.8-3.5)	**0.032** [c]
Serum sodium (mmol/L)		138.6 ± 6.3	138.2 ± 6.1	0.793 [b]
Serum potassium (mmol/L)		5.4 ± 1.3	5.4 ± 1.4	0.980 [b]
Serum calcium (mg/dL)		7.6 ± 1.0	7.3 ± 1.2	0.399 [b]
Serum ionized calcium (mmol/L)		1.0 ± 0.2	0.9 ± 0.1	0.703 [b]
Serum albumin (g/L)		26.1 ± 6.3	22.3 ± 6.5	0.055 [b]
Serum aspartate aminotransferase (U/L)		306.0 (95.5-1039.5)	764.0 (185.0-1578.0)	0.185 [c]
Serum alanine aminotransferase (U/L)		154.0 (55.0-315.0)	335.0 (109.5-669.3)	0.083 [c]
C- reactive protein (mg/L)		112.4 (60.3-169.5)	141.5 (56.2-298.5)	0.288 [c]
Procalcitonin (ng/mL)		7.0 (0.5-20.5)	22.5 (6.4-73.6)	**0.038** [c]
pH		7.28 ± 0.12	7.13 ± 0.17	**0.002** [b]
Lactate (mmol/L)		21.0 (14.0-36.0)	49.5 (23.3-71.5)	**0.019** [c]
White blood cell count ($10^3/\mu L$)		16.4 (13.1-22.8)	15.6 (10.3-32.0)	0.855 [c]
Hemoglobin (g/dL)		11.2 (8.1-15.5)	9.3 (7.7-15.2)	0.615 [c]
Hematocrit (%)		34.4 (25.2-45.6)	29.4 (23.9-48.9)	0.982 [c]
Neutrophil/lymphocyte ratio		14.5 (9.4-20.5)	9.4 (7.9-15.6)	**0.040** [c]
Apache II Score		29.8 ± 12.4	41.6 ± 11.1	**0.002** [b]
Glasgow Coma Scale Score		12.0 (5.0-15.0)	3.0 (3.0-6.8)	**0.001** [c]
Referral inside the institution	Yes No	9 (%36.0) 16 (%64.0)	0 (%0.0) 20 (%100.0)	**0.002** [a]
Referral outside the institution	Yes No	16 (%64.0) 9 (%36.0)	0 (%0.0) 20 (%100.0)	**<0.001** [a]
Hemodialysis	Yes No	10 (%40.0) 15 (%60.0)	9 (%45.0) 11 (%55.0)	0.770 [a]

Data are presented as mean ± SD, n / %; a: Chi-Square Test (n (%)), b: Independent Samples t Test (Mean ± SD), c: Mann-Whitney U test (Median ((Q1-Q3))

Table 3. Evaluations with logistic regression

	Univariate logistic regression analysis						**Multivariate logistic regression analysis**					
Risk factor	B	SE	Wald	OR	95%CI	p*	B	SE	Wald	OR	95%CI	p*
Creatinine (mg/dL)	0.357	0.203	3.113	1.43	0.96 – 2.13	0.078	--	--	--	--	--	--
Procalcitonin (ng/mL)	-0.001	0.003	0.030	1.00	0.99 – 1.01	0.862	--	--	--	--	--	--
pH	-6.697	2.406	7.748	0.00	0.00 – 0.14	**0.005**	--	--	--	--	--	--
Lactate (mmol/L)	0.028	0.012	5.636	1.03	1.00 – 1.05	**0.018**	0.035	0.015	5.579	1.04	1.01 – 1.07	**0.018**
NLR	-0.100	0.050	3.973	0.90	0.82 – 1.00	**0.046**	-0.122	0.058	4.477	0.88	0.79 – 0.99	**0.034**
Apache II	0.084	0.030	7.668	1.09	1.02 – 1.15	**0.006**	--	--	--	--	--	--
GCS	-0.218	0.072	9.258	0.80	0.70 – 0.93	**0.002**	--	--	--	--	--	--
Intubation on admission	1.504	0.658	5.221	4.50	1.24 – 16.35	**0.022**	1.650	0.807	4.180	5.21	1.07 – 25.34	**0.041**

**: Binary Logistic Regression Test (It is given only for the variables remaining in the model), Nagelkerke R^2 = 0.445, Hosmer and Lemeshow Test = 0.065,*
Variable(s) removed on step 2: Apache II, step 3: GKS, step 4: Ph,
B=, SE=, Wald=, CI = confidence interval, OR = odds ratio.

Table 4. ROC analysis of the prognostic parameters in predicting mortality

	AUC	95%CI	Cut-off	Sensitivity	Specificity	Youden index	+PV	-PV	p value
Creatinine (mg/dL)	0.688	0.53 – 0.82	>1.35	95	44	0.390	57.6	91.7	0.019
Procalcitonin (ng/mL)	0.682	0.53 – 0.81	> 2.45	95	44	0.390	57.6	91.7	0.027
pH	0.767	0.62 – 0.88	≤7.15	70	88	0.580	82.4	78.6	0.001
Lactate (mmol/L)	0.706	0.55 – 0.83	>31	70	76	0.460	70.0	76.0	0.012
Neutrophil/lymphocyte ratio	0.680	0.52 – 0.81	≤8.85	50	84	0.340	71.4	67.7	0.027
Apache II	0.771	0.62 – 0.88	>29	95	56	0.510	63.3	93.3	0.00
GCS	0.785	0.64 – 0.89	≤4	70	84	0.540	77.8	77.8	0.00

AUC: area under curve, CI: confidence interval,

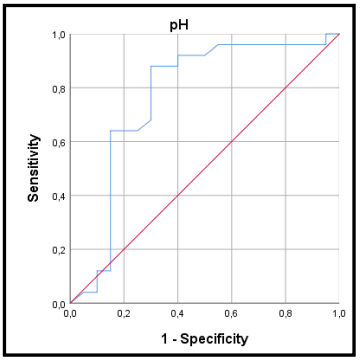

Figure 1.a ROC curve results of the Ph

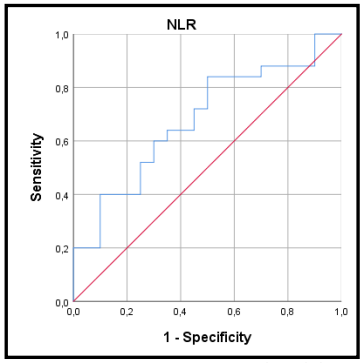

Figure 1.b ROC curve results of the NLR

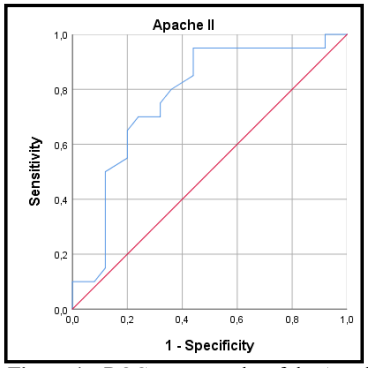

Figure 1.c ROC curve results of the Apache II

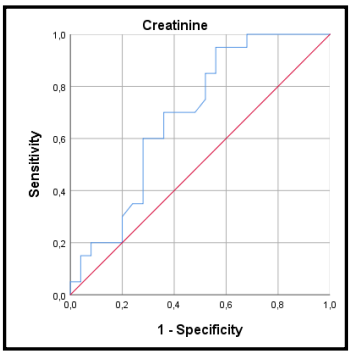

Figure 1.d ROC curve results of the Creatinine

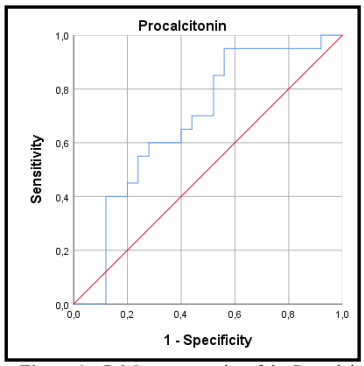

Figure 1.e ROC curve results of the Procalcitonin

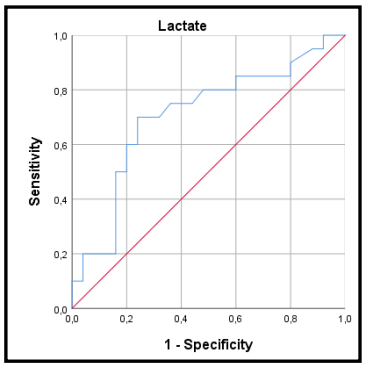

Figure 1.f ROC curve results of the Lactate

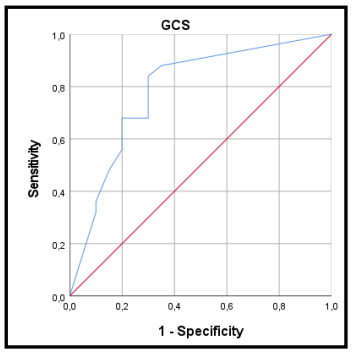

Figure 1.g ROC curve results of the GCS

4. Discussion

This single-center retrospective observational study included 45 earthquake victims admitted to the intensive care unit after devastating Kahramanmaraş centered earthquakes. Medical analysis and survival status of the earthquake victims were examined. Our study revealed that 8 factors were related to earthquake inpatient death: intubated status on admission, serum creatinine, procalcitonin, pH, lactate, NLR, Apache II scores, GCS values.

Earthquakes are sudden natural disasters that can cause major destruction and loss of lives (5). The Kahramanmaraş centered earthquakes were among the strongest earthquakes in the 21st century causing more than 50.000 deaths and 119.000 injuries (8).

Disel et al evaluated the mortality related factors detected in trauma patients admitted to the emergency department after Kahramanmaraş centered earthquakes. They reported that they determined no statistically significant difference in terms of age and gender of the earthquake victims who survived and died. They reported that higher emergence hemodialysis requirement and lower serum calcium, lower base excess and lower pH levels were observed in the non-survivor group (9). Like their study, our study results revealed that there was no statistically significant difference between genders and mortality and also, we found lower Ph levels in the non-survivor group.

Qi et al investigated 72-h mortality in trauma patients by using the base excess, lactate and pH values of arterial blood gas analysis on admission. They reported that the prognostic value of these three parameters was as follows : lactate > BE > pH (10). Like their study, we evaluated lactate and Ph of the blood gas on admission, and we observed that high lactate levels and low pH levels had predictive value on mortality. Their study differed from ours in that they investigated 72-hour mortality in adult polytrauma patients with a large sample size.

Pan et al analyzed 2016 Taiwan earthquake for earthquake related mortality. They evaluated the victims of the earthquakes according to their age definitions as: preschool (under 5 years), school (5-14 years), adult (18-64 years) and elderly (above 64 years). They found that there was a strong association between the time for extrication and earthquake related mortality in their study. They also reported that the elderly group had the highest earthquake related mortality rate (11). Unlike them, we did not assign the earthquake victims into groups according to their ages in our study. Also, we found no statistically significant difference between survivors and non-survivors in terms of age in our study.

Hu et al investigated the early and rapid factors of in-hospital mortality of older adults (aged ≥65 years old) earthquake trauma patients. They analyzed the records of 7308 patients from West China Earthquake Patients Database. They reported that 10 factors were related to in-hospital mortality. These factors were: age, mean arterial pressure, pulse rate, comorbidities such as deep vein thrombosis, coronary heart disease, chronic kidney disease, dementia and malignant tumor, GCS and Triage Revised Trauma Score (12). This study differs from our study in terms of patient population because the earthquake victims participating in this study were only older adults. In our study, we determined GCS as a common mortality determinant with this study.

It was not surprising that higher rates of intubation at the time of admission were found to be associated with earthquake inpatient death in our study as critically ill trauma patients are commonly intubated and admitted to the ICU.

APACHE is one of the predictive scoring systems in the ICU by using the worst physiological values measured within the patient's first 24 hours of admission to the ICU. Higher scores are related to severe disease and higher risk of mortality. Godinjak et al compared APACHE II scoring system and Simplified Acute Physiology Score II (SAPS II) scoring system for patient outcomes in the ICU. They reported that APACHE II score higher than 27.5 can predict the mortality of patients in the ICU with 93.4 % specificity and 74.5% sensitivity (13). In our study, the cut-off value for Apache II was >29 with the sensitivity of 95% and the specificity of 56%. APACHE II scores were 29.8 ± 12.4 in the survivor group and were 41. 6 ± 11.1 in the non-survivor group.

Dilektasli et al investigated the NLR and mortality relationship in critically ill trauma patients. They calculated the NLR for each day in the ICU. They reported that the NLR value on the first day of hospitalization was not useful for outcome prediction but on the 2nd and 5th day of hospitalization the elevation in NLR was independently associated with increased mortality (14). We recorded the NLR only on admission to the ICU. Unlike their study, we found that the lower NLR was found to be related with increased mortality in our study.

Crush syndrome developing after an earthquake has a lethal but reversible complication: Crush related acute kidney injury. Erek et al investigated the morbidity and mortality of a total of 639 patients with crush injury related acute renal failure following 1999 earthquake in the Marmara region, Turkey. They reported that oliguria, hyperkalemia, hyperphosphatemia, hypocalcemia, high creatinine levels and high creatinine phosphokinase levels were the most important clinical findings that were observed. They reported that among 639 patients, 477 patients were dialyzed, and 162 patients were not dialyzed. A total of 97 patients died. Mortality rates were 17.2% (82 of 477) in dialyzed patients and 9.3% (15 of 162) in non-dialyzed patients (15). In our study, among 45 patients,19 patients were dialyzed. 45% of the deceased patients received dialysis and 55 % did not receive dialysis. And also, higher creatinine levels were found to be associated with increased mortality.

Procalcitonin is an acute phase reactant. The serum level of procalcitonin rises in both response to microbial infections and in severe trauma (16,17). The relationship between procalcitonin and lactate levels was associated with meaningful predictive outcomes in a retrospective study that was carried out on pediatric trauma patients (18). Our study findings confirmed the important role of both procalcitonin and lactate levels in predicting mortality.

Our study had some limitations. Due to lack of data of the patient's prior major diseases before the earthquake, the contribution of patient comorbidities to death could not be investigated. Another limitation is rescuing times and injuries of the victims were not investigated for predicting earthquake inpatient death. Serum creatinine kinase levels could have been included among the laboratory parameters in the study, but since the serum creatinine kinase level was not measured in every patient, it could not be evaluated. The single-center nature and small sample size are the other limitations of the study.

In conclusion, earthquakes are life- threatening natural disasters. The definition of the clinical and laboratory parameters of the earthquake victims is crucial in assessing mortality risks. Intubated status on admission, the levels of serum creatinine, procalcitonin, lactate, Ph and NLR, the scores of Apache II and GCS might be valuable in predicting survival status following major destructive earthquakes.

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