RESEARCH ARTICLE

Araştırma Makalesi

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Assessing Intensive Care Requirements in Earthquake Survivors: Role of the Neutrophil Lymphocyte Ratio

Depremden Sağ Kurtulan Hastalarda Yoğun Bakım İhtiyacını Belirlemede Nötrofil Lenfosit Oranının Rolü

ABSTRACT

Objective

This study aims to investigate the utility of Neutrophil-Lymphocyte Ratio (NLR) as a potential biomarker for predicting the need for intensive care unit (ICU) admission in earthquake survivors.

Materials and Methods

A retrospective analysis was conducted on 122 earthquake survivors admitted to the emergency department of a regional hospital following the the 2023 earthquakes in Turkey. Demographic information and blood samples obtained at admission were analyzed. Statistical analyses were used for predictive value of NLR and C-Reactive Protein (CRP) for ICU admission.

Results

The median age of patients was 41 years and the majority were female (54.1%). Most patients (65.9%) were rescued from under the rubble, with a median length of stay beneath debris being 8 hours. Orthopedic surgeries predominated (84.5%), particularly on the lower extremities (59%). Of the patients, 36.1% required ICU follow-up. Elevated levels of NLR and CRP were significantly associated with ICU admission, with NLR demonstrating higher sensitivity (77.3%) and specificity (75.3%) compared to CRP. Logistic regression analysis revealed a 1.6-fold increase in ICU admission risk per unit increase in NLR.

Conclusion

NLR can be a useful predictive tool for admission of earthquake victims to intensive care, allocating resources, and prioritizing treatment during disaster response.

Key Words

Earthquake, Disaster Management, Intensive Care, Neutrophil-Lymphocyte Ratio, Biomarkers

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ÖZ

Amaç

Bu çalışma, Neutrofil-Lenfosit Oranı (NLR) ve bunun, depremzedelerin yoğun bakım ünitesine (YBÜ) kabul edilme ihtiyacını tahmin etmedeki potansiyel biyomarker olarak faydasını araştırmayı amaçlamaktadır.

Gereç ve Yöntemler

Türkiye'de 2023 yılında meydana gelen depremler sonrası bir bölgesel hastanenin acil servisine başvuran 122 depremzede üzerinde retrospektif bir analiz yapılmıştır. Başvuru sırasında demografik bilgiler ve kan örnekleri analiz edilmiştir. YBÜ kabulü için NLR ve C-Reaktif Protein (CRP) değerlerinin prediktif değeri için istatistiksel analizler yapılmıştır

Bulgular

Hastaların medyan yaşı 41 olup, çoğunluğu kadınlardan oluşmaktadır (yüzde 54,1). Hastaların çoğunluğu (%65,9) enkaz altından kurtarılmıştır ve enkaz altında kalma süresinin medyanı 8 saattir. Ortopedik cerrahiler (yüzde 84,5) genellikle alt ekstremitelerde (%59) yapılmıştır. Hastaların %36,1'i YBÜ takibi gerektirmiştir. Yüksek NLR ve CRP seviyeleri, YBÜ kabulü ile anlamlı bir şekilde ilişkilendirilmiş olup, NLR, CRP'ye kıyasla daha yüksek duyarlılık (%77,3) ve özgüllük (%75,3) göstermiştir. Lojistik regresyon analizi, NLR'deki her bir birim artışının YBÜ kabul riskini 1,6 kat artırdığını ortaya koymuştur.

Sonuç

NLR, depremzedelerin yoğun bakıma kabulünü tahmin etmek, kaynakları ayırmak ve afet yanıtı sırasında tedavi önceliklerini belirlemek için faydalı bir araç olabilir.

Anahtar Kelimeler

Deprem, Afet yönetimi, Yoğun Bakım, Nötrofil-Lenfosit Oranı, Biyobelirteç

INTRODUCTION

Earthquakes are among the most unpredictable and destructive natural disasters, causing mass casualties, severe destruction of urban and rural infrastructure, and high mortality rates (1, 2). The principles of medical management during earthquakes are analogous to those of other natural or human-caused disasters. After the earthquakes that affected eleven provinces in the south and southeastern regions of Turkey on February 6, 2023, more than 50,000 people died, more than 110,000 people were injured, and trapped under rubble, and health institutions were extensively damaged along with cities. As healthcare providers in the earthquake zone were also affected, there were shortages in personnel and medical supplies, leading to service disruptions. In this traumatic event, which affected one-eighth of Turkey's population, health services were attempted to be provided both. Patients and relatives of patients from cities outside the earthquake-affected region applied to receive health services via ambulances provided by the Ministry of Health or by their own means. Although our Training and Research Hospital is located 850 km away from the earthquake zone, it admitted many earthquake victims, either through referrals or direct applications (3-6).

The number of patients requiring intensive care unit admission (ICU) admission following earthquake-related injuries has increased. Among the complications are crush syndrome and renal failure. Consequently, it is imperative to meticulously plan the number and configuration of reserve ICU beds. It is of great value to be able to predict in advance which patients will require admission to an ICU. The neutrophil-lymphocyte ratio (NLR) is a hematological parameter commonly used in clinical practice. It is derived from the absolute counts of neutrophils and lymphocytes obtained from a complete blood count (CBC). The NLR is calculated by dividing the number of neutrophils by the number of lymphocytes. NLR is a valuable biomarker that provides insights into the inflammatory status and immune response of an individual. Its predictive value in various clinical conditions, including cardiovascular diseases, cancer, infectious diseases, and autoimmune disorders, underscores the importance of this biomarker in both diagnosis and prognosis.

In this study, the patients who had earthquake injuries in a regional hospital far from the earthquake center and who applied to the emergency department of our hospital by their own means or who were referred to our hospital from other health facilities in the earthquake zone due to overcapacity were identified. The demographic characteristics and blood samples of these patients at the time of admission were analyzed, and the parameters that could be biomarkers for the need for ICU were investigated. Thus, this study aimed to contribute to the rational and appropriate use of hospital services by contributing to the planning for health facilities serving in disasters.

MATERIALS and METHODS

Study design

This retrospective study was initiated following the approval of the local ethics committee (2023/176). By entering the code "earthquake survivor" in the social security section of the hospital's central electronic registration system, it was determined that 259 patients presented to the authors' institutional emergency department (ED) following the earthquake. Patients who were treated medically without the need for surgery and patients with incomplete medical records were excluded from the study. Among the remaining patients, 53 were excluded due to their residence in the earthquake zone and the necessity for a planned or emergency cesarean section operation. Additionally, 84 patients were excluded due to the necessity for non-earthquake-related surgical procedures, including tonsillectomy, transurethral resection of the prostate, cataract surgery, coronary artery bypass grafting surgery, and inguinal hernia repair. The remaining 122 patients were included in the study (Figure 1).

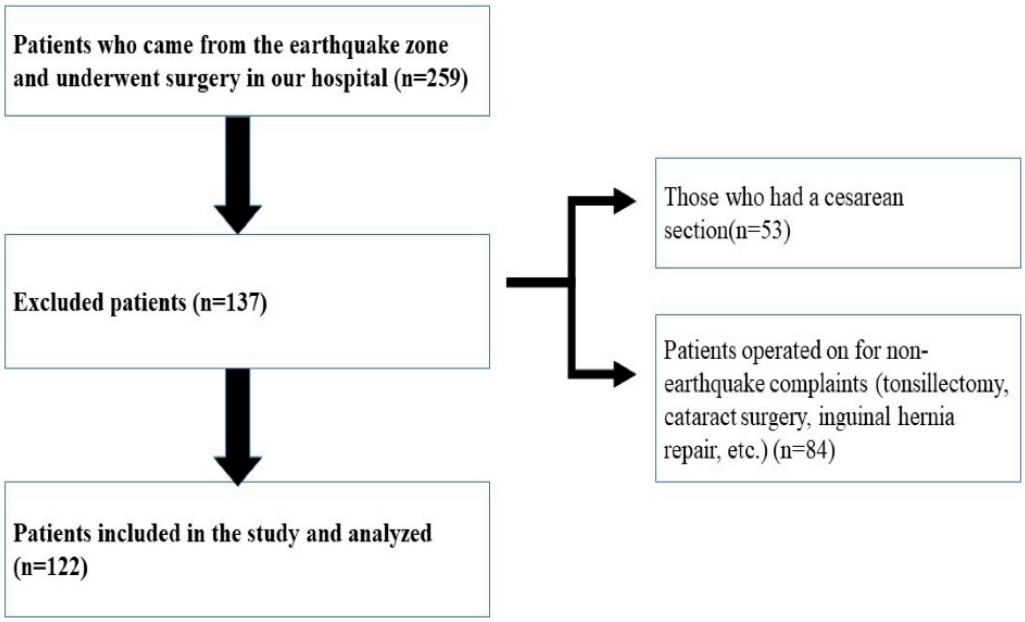

Figure 1. Flow of cases during the study

Data collection

Demographic information (age, gender) and medical conditions of the patients were obtained from the hospital's central electronic record system and physical files. Hemogram and biochemical blood values at the time of admission, body region operated on, surgical branch performing the operation, anesthesia management, need for ICU, length of stay in hospital and ICU, if any, need for hemodialysis, mechanical ventilator, and hyperbaric oxygen therapy were recorded. The NLR was calculated by dividing the absolute neutrophil count by the absolute lymphocyte count.

Statistical analysis

All patients meeting the inclusion criteria during the specified period were included in the study. All data are expressed as mean (percentage), median (95% confidence interval), median (ranges) or number (percentage). After testing for the normal distribution of the data, the Mann- Whitney U-test was used to compare non-normally distributed numerical variables, and Fisher's exact test was used for categorical variables. The t-test was used to compare normally distributed numerical data, and the chi-square test was used to compare categorical variables. Receiver operating characteristic (ROC) curve analysis was conducted to determine the sensitivity and specificity of biomarkers in predicting ICU admission. The optimal cut-off values for each biomarker were determined at the points on the ROC curve where the maximum balance of specificity and sensitivity was reached. Logistic regression analysis was performed using NLR and C-Reactive Protein (CRP) biomarkers, which showed significant results in ROC curve analysis. A p-value < 0.05 was considered statistically significant. SPSS 17.0 (SPSS Inc. Chicago, IL) statistical package was used for all statistical analyses.

RESULTS

The mean age of the patients was 39.3 ± 21 (median: 41 years, range: 5-92). Female patients were the majority (54.1%). Eighty-five patients (65.9%) were rescued from under the rubble. The median length of stay under debris was 8 hours (range: 0.25-120). Most operations were performed by the orthopedics department (84.5%), and the lower extremity (59%) was the most common body region operated on. Demographic and hospital data of the patients are shown in Table I.

Table 1. Demographic and Hospital Data of Study Patients

Age (years)	42 (5-92)
Gender (Female)	66 (54.1%)
Trapped under debris	85 (65.9%)
Hours trapped under debris	8 (0.25-120)
Admission (Self / Referral)	79 / 43 (64.8% / 35.2%)
Time to surgery (days)	1 (0-28)
Clinical Department	n=122
- Orthopedics	109 (84.5%)
- Neurosurgery	14 (10.9%)
- Plastic Surgery	4 (3.1%)
- Others	2 (1.6%)
Surgery Region	n=122
- Lower extremity	72 (59%)
- Upper extremity	24 (19.7%)
- Spine	11 (9%)
- Multiple	7 (5.7%)
- Pelvic	6 (4.9%)
- Head	1 (0.8%)
- Abdomen	1 (0.8%)
General Anesthesia	76 (62.3%)
ICU Admission	44 (36.1%)
ICU Length of Stay (days)	4 (1-28)
Hyperbaric Oxygen Therapy	14 (11.5%)
Dialysis	14 (11.5%)
Mechanical Ventilation	24 (19.7%)
Mechanical Ventilation Duration (days)	4 (1-28)
Hospital Length of Stay (days)	9 (1-90)
Mortality	3 (2.5%)

Fifty-four (36.1%) patients were followed up in the ICU. WBC, BUN, ALT, AST, CK, CRP, and NLR values of the patients who were followed up in the ICU were higher than those who were not followed up in the ICU (Table II).

However, only CRP (AUC: 0.735, sensitivity 65.9%, specificity 74.0%, cut-off value 72.8) and NLR (AUC: 0.823, sensitivity 77.3%, specificity 75.3%, cut-off value 3.96) were statistically significant in our ROC curve analysis (Figure 2).

Logistic regression analysis, as shown in Table III identified NLR as a significant predictor of ICU admission with an odds ratio (Exp(B)) of 1.595 (95% CI: 1.26-2.02, P < 0.001). Although CRP showed a trend towards significance with an odds ratio of 1.007 (95% CI: 1-1.014), it did not reach statistical significance (P = 0.062) (Table III).

Table 2. Predictive Biomarkers for ICU Admission

Biomarker	No ICU (n=78)	ICU (n=44)	P Value
Hours trapped under debris	15.6 (5.4–24.7)	26.3 (13.8–38.8)	0.035
NLR	3.3 (3-3.7)	7.3 (6-8.6)	<0.001
CRP	29.4 (38.9-65.1)	92.9 (91.1-156.5)	<0.001
BUN	15.1 (13.3-17)	30.8 (22.7-38.9)	0.010
Cr	0.85 (0.76-0.94)	1.6 (1.2-2.1)	0.225
ALT	42.6 (32.6–52.6)	147.1 (87.3-207)	0.006
AST	54 (35.2-72.8)	488 (264.6-711.4)	<0.001
CK	1516 (635-2397)	30216 (16131-44300)	<0.001
WBC	9.4 (8.7-10)	12.7 (10.8-14.6)	0.001

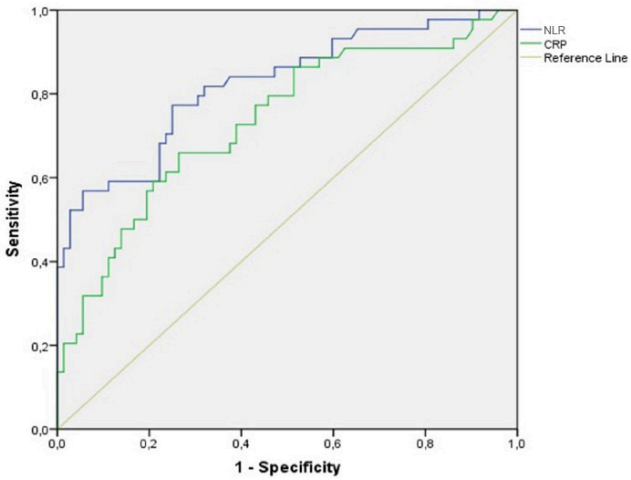

Figure 2. ROC curve analysis of NLO and CRP

Table 3. Logistic Regression Analysis Of Biomarkers

Biomarker	B	p value	OR	95% CI for OR	
				Lower	Upper
NLR	0.467	<0.001	1.595	1.26	2.02
CRP	0.007	0.062	1.007	1	1.014

NLR: Neutrophil-lymphocyte ratio, CRP: C - reactive protein, B: Regression coefficient, OR: Odds ratio, CI: Confidence interval

DISCUSSION

In our study, we analyzed the medical conditions and the need for specialized healthcare services in patients who were injured due to the earthquake and operated in a reference hospital far away from the epicenter of the earthquake. This study is important because it shows that NLR values detected at the time of admission to a healthcare facility can be used alongside classical scores to determine the need for ICU hospitalisation in patients injured in earthquakes.

Recently, researchers have focused on using common blood parameters (e.g., CRP/albumin, neutrophil/lymphocyte, and neutrophil/lymphocyte/platelet ratios) as biomarkers for diagnosis and prognosis (7, 8). Trauma and infections initiate an acute and nonspecific response, which is more prominent in cases where body resistance decreases. In trauma, proinflammatory process starts first and then progresses to inflammatory process and healing begins. Neutrophils are involved in the inflammatory process as well as proinflammation and their levels are independent of diurnal rhythm and gender. Lymphocytes secreted in response to inflammation are negative acute phase reactants. NLR is a prognostic parameter that easily shows proinflammatory process and inflammatory imbalance and can be easily studied in almost every laboratory. Hamed et al. analyzed 865 trauma patients admitted to hospital over a 3-year period and found a cut-off value of 5.27 for NLR. They reported that values above this cut-off value of NLR were prognostic factors for mortality in trauma patients (9). In a study conducted by Younan et al. on 207 patients, increased NLR in the first 48 hours was found to be associated with an increased number of organ failure (10). Yun Jeong Chae et al. analyzed 209 trauma patients admitted to emergency surgery and found that NLR and neutrophil/lymphocyte platelet ratios (N/LP) were biomarkers in predicting late mortality after 48 hours (7). In our study, the cut-off value for ICU admission of earthquake victims was found to be 3.96. This supports the correlation between high NLR rates and ICU hospitalization found in our study.

CRP is one of the positive acute phase reactants produced by hepatocytes in response to IL 6 in inflammation or tissue damage. Its synthesis is stimulated by mediators released from endothelial cells, macrophages and traumatic cells. Its anti-inflammatory properties are dominant compared to its pro-inflammatory properties. It plays a role in inflammation by activating the complement pathway and plays a role in the clearance of cell debris. CRP levels increase or decrease rapidly up to 100-fold in correlation with the onset and end of inflammation. These changes are independent of diurnal rhythm and gender. Even moderate increases in serum levels indicate low-grade inflammation. CRP value, which is easy and inexpensive to study, is a parameter taken into consideration when ICU hospitalization is indicated. It is used in the diagnosis of many diseases and to evaluate the patient in the treatment process (11-13). In a study in which Lingitz et al. compared the survivors and the deceased after polytrauma, they found that CRP levels were significantly higher on the 5th and 10th days in the deceased (14). Trauma itself may increase CRP and WBC levels independently of infection. In our study, CRP levels were found to be elevated in both groups of patients who were hospitalized both in the postoperative ICU and in the ward. In our study, CRP levels were found to be significantly high in ROC curve analysis, but statistically insignificant in logistic regression analysis. This may be explained by the fact that CRP levels may increase in many infectious or traumatic conditions.

Studies related with this earthquake, which had a devastating effect in a very large region of the country and which we investigated in our article, have started to be included in the literature (15-17). Data of 1110 earthquake victim patients in the first 5 days of the same disaster were examined in a hospital close to the earthquake center (18). In this study published by Buyurgan et al., female gender was predominant and the mean age was reported as 45.4/year. These results were compatible with the demographic data in our study. However, the proportion of patients requiring ICU admission, hemodialysis and hyperbaric oxygen treatment was higher in our study. We believe that this difference may be due to the fact that even if renal damage developed in patients admitted to the hospital immediately after the earthquake in our study, it did not progress to renal failure and crush syndrome or occurred with a milder clinical picture. As another reason, since our hospital is far away from the earthquake zone and was not affected by the earthquake destruction, we think that it is due to the fact that it is a health facility to which patients who need hyperbaric oxygen therapy or who are predicted to need this treatment are referred. In another study in which 247 patients were analysed in a hospital in the earthquake center during the same earthquake, the number of patients operated due to earthquake was reported as 91 (19).

In this study, it was reported that most of the patients were operated by orthopedics and traumatology with a rate of 78% and thoracic surgery with a rate of 10%. In our study, the highest rate of operation was performed by orthopedics and traumatology, but the primary operation of thoracic surgery was not included in our records. We believe that the reason for this is that patients with thoracic injuries were treated in the earthquake center or in health facilities located closer to the earthquake. In another study conducted in a tertiary referral hospital in a partially earthquake-affected city close to the disaster area during the same earthquake, extremity injuries were found to be the most common with 66.3%. In this study, 17.4% of all hospital admissions due to earthquake were treated in ICUs (20). In our study, extremity injuries and related orthopedic operations were also the most common, but we believe that the reason for the high rate of ICU hospitalization in our study compared to this study is that the cases analyzed in our study consisted entirely of patients who underwent surgical operations.

In sudden disasters such as earthquakes, the sudden workload of health facilities increases, especially in specialized units. This situation affects not only the hospitals in the earthquake center but also the health facilities far away from the earthquake center. Disaster plans should be made for special units such as emergency services, operating theatres, ICUs and hyperbaric oxygen treatment units, and additional capacity and facilities should be evaluated. Thus, in possible disasters, loss of life can be reduced by ensuring the correct use of units with rapid organization.

Limitations

It is important to acknowledge the limitations of this study. Firstly, the retrospective design inherently carries the risk of selection bias and limits the ability to establish causality. The study was conducted at a single regional hospital, which may not fully represent the broader population of earthquake survivors or the variability in medical management across different institutions. Furthermore, the sample size of 122 patients, while sufficient to identify significant associations, may not provide the power needed to detect more subtle effects or to generalize findings to all earthquake victims. The data collection process relied on electronic health records and physical files, which may have contained inaccuracies or incomplete information. Furthermore, the study did not consider potential confounding variables, such as pre-existing medical conditions, the severity of injuries, or the specifics of the medical interventions received, which could influence the outcomes.

CONCLUSION

The results of this study suggest that the NLR may predict the need for ICU admission in earthquake survivors. A high NLR indicates an increased risk of ICU admission and has a higher sensitivity and specificity than CRP. Logistic regression analysis confirmed that the risk of ICU admission increased 1.6-fold with each unit increase in NLR. NLR stands out as a valuable biomarker for early triage and resource allocation, allowing healthcare providers to optimise ICU beds and other critical care resources. Incorporating NLR into clinical protocols for earthquake-related injuries may increase the effectiveness of emergency management. Larger-scale and multicenter studies are needed to confirm the findings and develop disaster health strategies. Future studies should validate NLR as a biomarker for triaging disaster victims in diverse settings.

Ethics Committee Approval

This research complies with all the relevant national regulations, institutional policies and is in accordance the tenets of the Helsinki Declaration, and has been retrospectively approved by the Antalya Research and Training Hospital Ethical Committee (approval number: 2023-176).

Author Contributions

Concept – A.B, M.T; Design – A.B, M.T, E.Ö; Supervision – Ö.K, N.K.Ö; Resources – A,B. M.T; Materials – A.B; Data Collection and/or Processing – A.B, F.I.U.; Analysis and/ or Interpretation – E.Ö; Literature Search – A.B, M.T; Writing Manuscript – A.B, M.T, E.Ö. Critical Review - Ö.K.

Conflict of Interest

The authors have no conflict of interest to declare.

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