ORIGINAL RESEARCH

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Mersin University Medical Faculty Hospital Emergency Department and Triage Organizatıon 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).

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

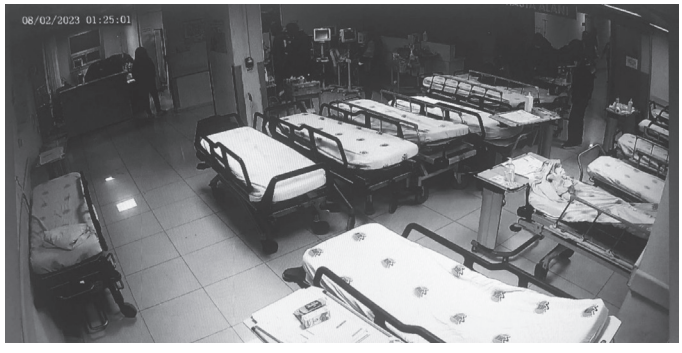

Figure 2. Triage area created in the event of an earthquake

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.

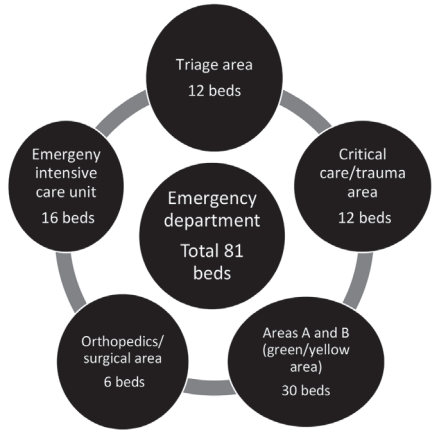

Figure 3. Arrangement of the number of beds in the emergency department in a disaster (the total capacity of the emergency department is arranged to be 81 with 1 isolation room and 4 resuscitation room beds)

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.

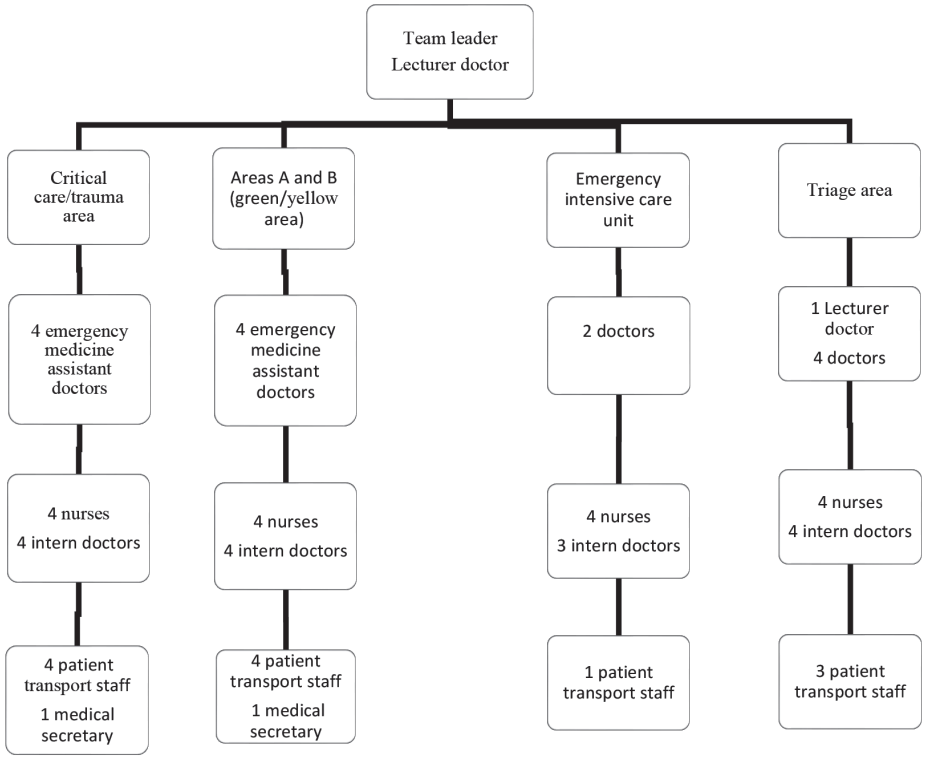

Figure 4. Illustrates the team arrangement in the emergency department in the event of a disaster (in addition, one lecturer doctor is responsible for the critical patient/trauma care area, which includes areas A and B as well as the emergency intensive care unit. One senior emergency medicine assistant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

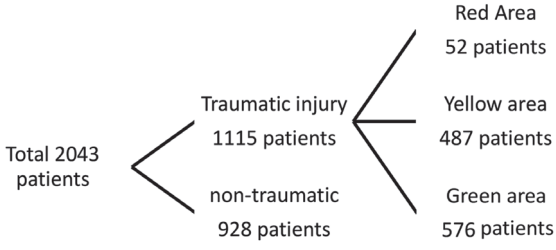

Figure 5. Distribution of earthquake survivors admitted to the hospital in the 15-day period after the earthquake by triage category

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.

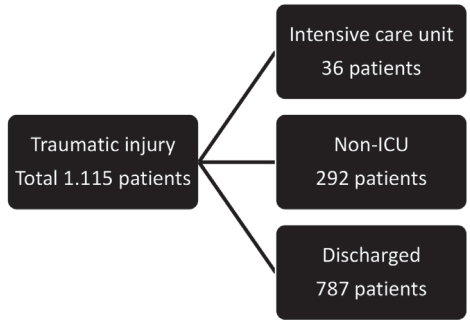

Figure 6. Distribution of earthquake survivors with traumatic injuries according to emergency department outcomes

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 (± SD)				
Mean age	Female sex mean age		Male sex mean age	
45.94±16.7	46.74±17.1		44.93±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.

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

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