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Approach to Earthquake Victims at Emergency Services: A Review and Analysis of Current Practices

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ABSTRACT

Earthquakes are natural catastrophic phenomena that cause huge destruction to human society, causing loss of lives, mass injuries, and property damage. In the last decades, there have been a series of major earthquakes that had severe impacts on populations, notably those in Turkey, Iran-Iraq, Nepal, China, and Haiti. This review was undertaken with searches of indexed online databases such as PubMed, Google Scholar, Scopus, and Web of Science (core collection) for existing literature, guidelines, protocols, and best practices to diagnose and treat earthquake victims in emergency settings. Timely diagnosis and treatment of traumatic injuries and related conditions such as Crush syndrome and rhabdomyolysis after earthquakes are imperative to provide the best chances of survival to patients. Possible later complications such as neurovascular events and infections may contribute to reduced mortality and morbidity rates and should be addressed accordingly. Improved communication, collaboration between different healthcare departments, and coordination between healthcare facilities in the immediate disaster zone can help optimize resources and minimize delays in diagnosis, treatment, and transport of patients. Combined with well-established triage protocols and a dedicated team of physicians from multiple disciplines, emergency departments should prioritize the allocation of limited resources to ensure that patients with urgent and life-threatening injuries receive timely and appropriate care. Timely diagnosis and treatment of traumatic injuries and related conditions such as Crush syndrome and rhabdomyolysis after earthquakes are imperative to provide the best chances of survival to patients.

Keywords: Earthquakes, Turkey, emergency, Crush syndrome, rhabdomyolysis

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Introduction

Earthquakes are natural catastrophic phenomena that cause huge destruction to human society, causing loss of lives, mass injuries, and property damage. In the last decades, there have been a series of major earthquakes that had severe impact on populations, notably those in Turkey [2023, MW 7.6 (moment magnitude scale), Kahramanmaraş], Iran-Iraq (2017, MW 7.6, Kermanshah), Nepal (2015, MW 7.8, Ghorka), China (2008, MW, 8.8 Sichuan), Turkey (2020, MW 6.7, Elazığ), and Haiti (2010, MW 7.0, Port Au Prince). In some of these, the loss of lives was documented to have been in

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thousands or even more. Emergency care for earthquake-related traumatic injuries has long been a key part of disaster medicine, as such catastrophes necessitate urgent treatment of require tens of thousands of traumatically injured victims within hours. Survivors face numerous risks in a critical time period that can best be depicted as "hours to days", they could be trapped in rubble, crushed under falling debris, suffering from severe limb injuries that can lead to amputations, head injury, or suffocation, while facing the possibility of secondary disasters like fire or flash flooding. Overwhelmed emergency systems, limited resources, and fragile infrastructure often impair emergency response in large scale events that cause mass casulties. Therefore, early recognition of life-threatening conditions among earthquake survivors and initiating treatment in a timely manner remains the main focus for disaster response. This review aims to discuss some important aspects of emergency care of earthquake survivors who were referred to emergency departments (EDs) in the days following an earthquake while providing examples from across various studies based on major earthquakes across the globe.

This review was undertaken with searches of indexed online databases such as PubMed, Google Scholar, Scopus, and Web of Science (core collection) for existing literature, guidelines, protocols, and best practices to diagnose and treat earthquake victims in emergency settings. Keywords "earthquake, emergency, triage, trauma, post-earthquake" were used. Search strategies included reviewing all titles and abstracts of potentially relevant articles and/or examining the full texts of selected references. Available literature on emergency preparedness and disaster planning before, during, and after major earthquakes, epidemiological studies on the incidence and distribution of injuries caused by earthquakes, and the role of primary, secondary, and tertiary care providers in earthquake-affected regions were also included.

1. Epidemiology and Demographics

In the wake of a major earthquake, demographic variables can have a considerable impact on the approach to patients in the ED. Age, gender, and socioeconomic status can influence the severity of injuries, response to treatment, and prognosis. For instance, older individuals may be more susceptible to fractures and other age-related injuries, whereas females are at a risk of reproductive and gynecological complications (1). In addition, lower income areas tend to have limited access to medical care, which may exacerbate pre-existing conditions and increase the mortality rate. Therefore, it is crucial for emergency personnel to be aware of these potential differences and adjust their treatment plans accordingly.

According to several studies, there has been a marked difference in the number of injuries between genders. In the aftermath of the Wenchuan earthquake in 2008, 50.4% (n=1148) of the 2,278 registered survivors were women (2). Similarly, following the Kathmandu earthquake in 2015, 53% (n=883) were females among the total of 1,668 patients included in study (3). In the case of the 2020 Samos earthquake, the percentage of men and women (i.e., 39.5% vs. 60.5%, respectively) was further skewed toward female gender (4). Again, females were shown to be more prone to injuries during earthquakes in Mexico City (2017), Kahramanmaraş, and Haiti (2010) (Doocy) according to various studies and databases (5,6,7). Gender appears to play a role in determining the incidence and distribution of injuries caused by earthquakes, and admissions to EDs.

Elderly people may find it difficult to leave their homes after an earthquake because they may not be able to react quickly. Older persons may also have additional medical conditions, which makes them prone to environmental exposure and puts them at a greater risk of hemodynamic instability following the disaster. However, statistical data suggest that while older individuals are potentially at greater risk of injuries, they are not one of the age groups with a higher overall frequency of emergency care presentations. Only 5.3% of the 80.2% of victims who were admitted as survivors to the emergency services in the wake of the 2023 Kahramanmaraş earthquake were elderly, and the elderly patient ratio was 7.6% among the deceased patients (6). Additionally, after the 2020 Erzincan-Elazığ earthquake in Turkey, which occurred at night, people between 18 and 59 years old were found to be the most injured. The mean age of patients admitted to the ED of a university hospital following the Elazığ-Turkey earthquake was 37.3 (8), and the age group between 18 and 59 was found to be the most severely injured during the 2010 Haiti earthquake (7).

Pediatric patients are also at a higher risk of injuries compared with adults, according to various studies. Following the earthquake in Haiti, 53% of patients were under the age of 20, and 25% were under the age of five; 25% of patients in India were under the age of 17 (9) while 25% of patients in the aftermath of 2001 earthquake in Gujarat, India were under the age of 17 (10). Children may have an increased risk of respiratory injuries because of their smaller airways and reduced chest wall compliance. Despite their smaller body weight and size, injury patterns in the pediatric population have shown a significant incidence of fracture-related injuries (30.6%) and wounds, as well as frequently reported

crush injuries. The approach to pediatric victims may require teaming up with general pediatricians and child health specialists as well as pediatric trauma surgeons (11).

2. Triage, Organization, and Initial Assessment

Earthquakes often create mass casualties that can overwhelm the response capacity of health facilities and healthcare personnel. Effective management of resources is imperative to minimize delays and further losses. To achieve the best results, a post-disaster medical rescue effort must be well organized and coordinated (12). During the first hours and days immediately following a disaster, emergency rooms (ERs) face several challenges. They need to prioritize treatment for those who are most in need; perform rapid diagnosis and appropriate decision-making; decide what kinds of interventions could help patients; and make arrangements for transportation of the patients to appropriate care centers while considering whether there is adequate equipment, medications, and staff members to respond to and care for patients.

Research shows that there are issues with emergency services communication systems, a shortage of emergency vehicles, and a higher incidence of airport closures after earthquakes with magnitudes greater than six (13). Due to phone line congestion following the Niigata Chuetsuoki earthquake, emergency calls on the day of the earthquake could not be fully attended to until approximately 12:00 hours. Subsequently, between 12:00 hours and 17:00 hours, a sizable percentage of the vehicles had to be set aside for use in hospital transfers; it was not until 18:00 hours that most ambulances could again be dispatched to emergency scenes (14). Further, rescue and medical personnel may become victims themselves, and local healthcare facilities can be damaged by the earthquake. All medical facilities within a 75-km radius of the epicenter of the 7.3-Mw earthquake were destroyed following the 2017 Kermanshah earthquake in Iran (15). In Hatay, Turkey, several private hospitals as well as two tertiary hospitals and a district public hospital sustained significant damage as a result of the 2023 Kahramanmaraş earthquake (16). To mitigate these situations, some steps should be taken prior to a disaster, such as preparing disaster plans, conducting periodical trainings and simulations, and setting up contingency arrangements with other facilities for worst-case scenarios. According to Schultz et al. (17), the distance of a hospital from the epicentre within the immediate disaster zone cannot effectively estimate the danger of damage to that facility. As a result, direct patient transportation from the disaster area to a secondary hospital could be beneficial. This precaution may also help ease the burden of hospitals within the immediate vicinity of the earthquake, since the difference in hospital arrival time is associated with mortality, with the mean time of emergency service admission being later (>9 hours) in survivors compared with non-survivors, which can be attributed to better capacity to provide care to patients in the latter days of an emergency response (4). China and Japan, two Asian countries with a long history of major earthquakes, seem to have successfully implemented pre-hospital disaster planning during major post-earthquake rescues. The Chinese Government's response to disasters is defined by a militarily proactive and highly centralized command structure. The Chinese Government set up an earthquake relief headquarters within two hours of the Wenchuan earthquake, and the Provincial Health Department coordinated the logistics of the operation, served as a strategic base of operation, prevented shortages and inappropriate use of local resources, and ensured cooperation. Medical rescue forces from the rest of China were uniformly deployed by this department (12). A disaster medical care system that utilizes hospitals as disaster management centers was developed by the Japanese Government as a result of lessons learned from prior disasters: multiple main disaster management hospitals were established in each prefecture, one of which was assigned to each municipality (18).

In disaster scenarios, a structured triage system that is easy to implement and adhere to is key. ED is where the medical chain from diagnosis to treatment begins for all victims during a disaster; accurately evaluating patients to determine the best course of action according to their needs and then allocating available resources according to the priority of their conditions is crucial. While a rapid and accurate method of triaging patients is critical in disaster settings, there is no golden rule for deciding who receives priority treatment. According to research, even in the aftermath of the same disaster, some patients were prioritized based on their medical needs (19), while others were prioritized based on a mix of patient needs and the imperative to make the best possible use of available resources, as in the case of the 2021 Haiti earthquake (20). Most of the times, a basic triage approach (START) is employed as in the multicentered, cross-sectional study by Uz et al. (21) regarding the 2020 Aegean Sea-İzmir earthquake victims: patients are divided into four groups according to their condition: green means a minor injury that is not urgent, yellow implies a slight injury that might be delayed, red indicates a serious injury, and black indicates death. According to their findings, patients with the yellow triage code presented most frequently during the first hour, and patients with the black triage code were most often brought in after 24 hours. The majority of patients

(55%, n=103) were entrapped under debris for longer than 24 hours, and they had the highest mortality rate (21).

According to a study that provided an overview of the hospital triage procedure used for patients evaluated and treated at Sichuan University's West China Hospital, earthquake victims were assigned by an emergency professor to either an immediate treatment area, a secondary priority treatment area, or a minor treatment area based on the extent of their injury upon arrival to the ED. Their triaging system was essentially similar to that of the four groups: resuscitation or emergency treatment, urgent treatment, delayed treatment, and minor injuries (2). Depending on the severity of the injuries, waiting durations varied, which underlines the importance of correct assessment and categorization of patients, since a misassignment can significantly affect their prognosis. The same triage procedures were utilized in a hospital following the 2017 earthquake in Mexico City: administrative staff outside the hospital classified patients using a similar system-color codes of green, yellow, red, and black-to identify them. Emergency medical teams were assembled in the waiting area and included a nurse, an intern, and a resident in surgery or orthopedic trauma (5). Although the triage process may vary, it is vital to improve emergency response by assembling teams of medical professionals from different specialties to handle large-scale casualties. Nie et al. (2), reported that ED teams were established following the Sichuan earthquake, including general surgeons, orthopedic surgeons, plastic surgeons, neurosurgeons, and pediatric surgeons. A senior emergency medicine physician made the final triage decisions for each patient, and on rare occasions, the senior physicians' opinion would differ from the initial triage assessment. The final accuracy rate (1984/2229) was 89.0%, which was an acceptable ratio (2). Again, a type 3 Emergency Medical Team-which is capable of offering in-patient referral surgical surgery as well as intensive care services-was assembled within 80 hours after the earthquake in Kathmandu (22). Establishment of a well-trained, coordinated, and equipped emergency medical team is imperative in ensuring the timely diagnosis and treatment of earthquake victims. The composition and capabilities of these teams should be tailored to the local resources and needs of the affected region. However, surgically trained professionals, particularly in the fields of orthopedics and neurosurgery, should be included as their expertise can be crucial in disaster situations.

3. Injuries and Trauma Management

The primary challenge emergency health care providers encounter in an earthquake disaster situation is the presentation and management of injuries and their variety, since there are many ways that people may be hurt in an earthquake, such as being crushed by fallen debris, falling from high buildings, and being struck by flying objects. Patients should be thoroughly assessed primarily for signs of extremity fractures, internal organ damage, impaired brain function, and spinal cord injuries as these are shown to be the main findings of both life-threatening and disabling injuries following an earthquake (23). However, assessment of earthquake survivors is often impaired by the limited availability of diagnostic modalities and resources in EDs in the setting of a crowded ER during the aftermath of the disaster. According to Uz et al. (21), computed tomography (CT) and laboratory were the most frequently used resources in the first hour during the 2020 Aegean Sea earthquake, yet performing dozens of CT scans at the same time was challenging. Some patients had to be evaluated solely on a physical examination, foregoing imaging tests. Many patients received plaster splints and were discharged without undergoing any imaging modalities, such as X-ray scans and joint tomography, and were referred to outpatient clinics (21). Yitzhak et al. (22), also mentioned a lack of advanced diagnostic instruments, such as CT scans, as one of the challenges during the diagnosis and treatment of Kathmandu earthquake survivors, along with a lack of resources, insufficient intensive care unit beds, and team accommodation. These difficulties facilitate the necessity of portable units, such as portable ultrasound devices. E-FAST has been successfully used in the emergency setting following the earthquake and is an essential instrument for identifying serious injuries that may pose a serious risk of mortality (21). Besides being a quick and cost effective tool with high sensitivity and specificity for diagnosing conditions ranging from simple fluid collection in the pericardium to penetrating thoracic trauma, portable ultrasound devices are employed during several invasive operations. After the 2010 Haiti earthquake, anesthesiologists reported using a portable ultrasound scanner to perform ultrasound-guided regional anesthesia for pre-operative analgesia. This technique helped address unclear surface signs caused by trauma while providing necessary muscle relaxation (24).

While patients with multiple injuries can comprise up to 26.7%-56.7% of all individuals injured following an earthquake (25,26), the most common identifiable site of trauma was shown to be the lower extremities in multiple injury studies and across different earthquakes (4,8,23,27,28,29,30,31). Timely surgical intervention must be provided to patients with severe leg injuries that might have compromised blood flow due to compartment syndrome, hematomas, or vascular injuries. On rare occasions, amputation of injured limbs may be performed to prevent the development of sepsis and

subsequent multi-organ failure. Turgut et al. (32) observed a direct correlation between the time spent under debris and the severity of compartment syndrome, the need for emergency fasciotomy, and amputations. Similar findings were reported by Tahmasebi et al. (33), who demonstrated a correlation between the incidence of compartment syndrome and the length of time spent under rubble. However, there is a disagreement among physicians over whether fasciotomy is appropriate for patients who have suffered crush injuries. To increase circulation and stop muscle necrosis, supporters of the approach claim that injured limbs should be swiftly decompressed. Others argue that the risk of infection is too high to perform the procedure in an emergency situation (34). According to Michealson (35), closed crush injuries should only be managed by fasciotomy if distal gangrene begins to develop. Likewise, there is controversy regarding the amputation of limbs in patients with Crush syndrome due to the possibility of myoglobin and potassium leakage from necrotic tissue during the procedure (36).

Immediate debridement and irrigation of dirty wounds alongside administration of antibiotics should be performed as early as possible in the ED following an earthquake. This protocol is vital in preventing wound complications such as infections and may save patients from developing systemic complications, sepsis, and even possible amputation in some circumstances. Yitzhak et al. (22) stated that orthopedic surgeries were typically conducted for wound debridement as the primary diagnosis following the 2015 Nepal earthquake. Two distinct studies also reported that wound debridement accounted for a significant fraction of the surgical procedures performed following the Pakistan earthquake (29,37). Open fractures carry a particular risk of infection and require immediate treatment starting in the ED. Antibiotics are given to prevent the development of conditions such as osteomyelitis, while stabilizing the fracture with external fixators can help to ensure proper alignment during healing and provide structural support. The mortality rate for crushing injuries with open wounds was found to be higher after the 2020 Aegean Sea-İzmir earthquake than it was for crushing injuries without open wounds (21), and the reported range of open fracture proportions during earthquakes is 32%-54% (38).

While not as frequent as limb injuries, head injuries can be highly lethal and often require urgent management in the ED. According to a review of 25 studies, the median frequency of brain injuries was 16.6%, placing them third among patients who were earthquake victims. The majority of patients with head injuries (59.1%) had contusions or lacerations, 32.3% had skull fractures, and 9.5% had epidural hematomas. The most frequent cerebral hemorrhage caused by an earthquake was epidural hematoma (23). The mean percentage of inpatients who underwent major surgery after suffering a head injury was 15.5%. Five patients who underwent craniotomies more than 90 min after the onset of anisocoria all passed away, emphasizing the significance of timely surgical intervention in individuals exhibiting symptoms. According to Aurangzeb et al. (39), single burr hole surgery is reliable and has provided positive results for many patients with earthquake-related epidural hematomas. Preventing unnecessary delays in treating patients with a suspected brain injury is crucial to the management of patients with potentially fatal intracranial injuries. Spinal cord injuries can also occur in earthquake-related trauma and should be considered as part of the initial assessment in EDs. During the Kermanshah earthquake, 120 patients were disabled and 18 patients sustained spinal cord injury (15). According to one study, mortality is the most common outcome for quadriplegics (40). The majority of spinal injuries are thoracolumbar in origin, with the lumbar spine being the most commonly damaged (41). Earthquake-related thoracic injuries have been found to be a significant predictor of mortality in some earthquakes, despite being fewer and more likely to be mild (odds ratio: 375, p=0.004) (42). In a different Chinese investigation examining the impacts of the 2008 earthquake, 21% of patients with chest injuries experienced respiratory failure, necessitating mechanical ventilation (43).

Approaches to earthquake survivors who are severely injured and require immediate assistance and treatment in the ED are contingent on a range of factors. Fractures, Crush syndrome, head and neck injuries, and abdominal and chest injuries are commonly encountered in these patients, and their treatment requires prompt recognition and swift action. Patients with head injuries must undergo immediate neuroimaging, and epidural hematomas must be managed by emergency surgical evacuation. In the presence of extremity injuries, bleeding control, wound debridement, infection prevention, and limb stabilization should be addressed. Patients with compartment syndrome should be identified early and evaluated for urgent fasciotomy or amputation. Pelvic fractures should be appropriately immobilized. Patients with chest injuries must receive early resuscitative measures, such as chest decompression and tube thoracostomy, if necessary. Regarding the need for sedation, general anesthesia was the preferred anesthetic method following the Aegean Sea earthquake (44), and ketamine was successfully used to induce and maintain anesthesia in earthquake survivors who were receiving inotropic support

and had unstable hemodynamics (4). Despite the limited resources available, healthcare professionals in emergency settings need to prioritize the management of these patients and provide a coordinated approach along with surgery specialty physicians to ensure the best possible outcomes.

4. Rhabdomyolysis, Kidney Failure, and Other Complications

Trauma experienced by patients during an earthquake can lead to metabolic disorders that require prompt recognition and treatment. Hyperkalemia, hypophosphatemia, and other electrolyte disorders following rhabdomyolysis and renal function disorders are frequently encountered in earthquakes, along with secondary issues such as aggregation of chronic comorbidities and increased risk for spread of infectious diseases. These subsequent complications lead to additional morbidity and mortality, and initiating treatment of these conditions in the emergency setting is paramount.

After significant earthquakes, there is a documented frequency of 2-15% of Crush syndrome, which can be described as a crush injury with systemic complications. Acute renal failure (ARF) is thought to develop in approximately half of Crush syndrome patients, and approximately half of these individuals are reported to require dialysis (45). It is a type of traumatic rhabdomyolysis that occurs when a muscle group is subjected to prolonged, continuous pressure, which leads to severe necrosis. After the pressure on the crushed body part is released, potassium, phosphorus, and myoglobin are released from the injured areas, while calcium and sodium permeate into the necrotized muscle. Impairment of perfusion and intratubular blockage by myoglobin and uric acid cause subsequent acute renal damage. ARF, hyperkalemia, acidosis, and hypovolemic shock can all be fatal. Following the Wenchun earthquake, 41.6% of patients with Crush syndrome experienced acute kidney injury within 3 days, and 67% of those patients died, highlighting the significance and critical nature of this complication (46). Use of urine dipsticks for screening both myoglobin and rhabdomyolysis while still triaging earthquake victims is advised due to the prevalence of crush injury and its high mortality rate (42). The primary causes of death for patients with crush injuries in the first five days following an earthquake are known to be hypovolemia and hyperkalemia, which both should be addressed urgently in the ED (47), since along with oliguria they can precipitate cardiac arrhythmias and arrest (48). Systolic hypotension on admission, female sex, and peak blood creatine kinase values greater than 20.000 U/L all shown to increase the risk for mortality in patients with ARF (49). Even if a patient's vital signs initially appear normal, early, aggressive fluid resuscitation via intravenous (IV) fluids in large quantities is essential to prevent and treat ARF in the majority of crush injury patients. Rhabdomyolysis treatment consists of an initial IV fluid infusion of up to 1.5 L/h followed by IV fluid rehydration or 500 mL/h saline solution alternated every hour with a goal urine output of 200 mL/h (50). Emergency fasciotomy should be considered if compartment syndrome is the primary cause. Potassium concentrations and electrocardiography changes should be monitored frequently, and potassium-containing intravenous solutions should be avoided if possible.

ARF or severe complications of Crush syndrome in patients with crush injuries can be prevented by intensive fluid therapy, alkalinization, and forced diuresis when necessary. It has been proposed that the development of myoglobinuric ARF can be avoided if the people buried under the wreckage are rescued within the first 6 hours and treated accordingly (51). However, on some occasions, dialysis is required because of severe hyperkalemia, kidney failure that can not be managed by conventional treatment, and the necessity to address abnormalities in pH and electrolytes. Sarı et al. (31) observed that among adult survivors with Crush syndrome following the 2023 Kahramanmaraş earthquake, 26.6% only required fluid therapy, whereas 20.7% needed renal replacement therapy (hemodialysis). Rhabdomyolysis developed in 15.9% (32) of the patients who survived the 2020 Aegean Sea earthquake, and four (1.9%) of these patients underwent hemodialysis in the ER because of ARF (21). Çağıran et al. (4) reported that in the aftermath of the same earthquake, Crush syndrome/ARF developed in 8.55% (n=13) of the surviving patients, with dialysis being utilized in 1.32% (n=2). Regarding the 43,953 patients that were transferred to reference hospitals following the Marmara earthquake, 639 (1.5%) of them had renal failure, and 477 of these patients (74.6%) required hemodialysis (42). Patients with oliguric renal failure could be given the highest priority if dialysis needs to be prioritized, and those with hyperkalemia could be treated medically and renal replacement therapy could be delayed among these patients (52).

In addition to the severe traumatic injuries and injury-related health issues mentioned earlier, there are other potential short- and long-term complications and health risks that accompany the period following a major earthquake. Patients who are trapped under debris or debris for extended periods of time face significant health risks from environmental exposure, such as hypothermia. Survivors are at an elevated risk of contracting respiratory diseases such as pneumonia and influenza. Disruption of water and sanitation services, as well as contamination of food and drink, may also

lead to epidemics of gastrointestinal and water-borne illnesses (53). Psychiatric disorders, including post-traumatic stress disorder, depression, and anxiety, may emerge shortly after an earthquake and may need to be evaluated and managed by emergency services. Cardiovascular diseases, such as hypertension and myocardial infarction, can also occur as a result of emotional and physical strain and difficulty in accessing patients' routine treatments.

There was a reported change in the healthcare requirements of survivors after the initial earthquake period. While the majority of injuries sustained in the aftermath of the Wenchun earthquake were traumatic in origin, upper respiratory tract infections, enteritis, and skin illnesses progressively surfaced after a week (12). The increased frequency of respiratory diseases, gastrointestinal disorders, skin issues, eye infections, and urinary tract infections was partially related to unsanitary conditions (54). While no specific disease epidemic was noted after approximately 8,000 people received diphtheria and tetanus vaccinations following the Kermanshah earthquake, the city's accumulated waste blocked the waterways and accumulated around the shelters, which led to an increase in a number of diseases, including cholera (15). In addition to environmental concerns, issues from infections following delayed presentations of earthquake-related injuries were common due to the lack of medical treatment (55,56). Following the 2005 Pakistan earthquake, many of the treated patients with extremity fractures and deploying of extremities were found to have purulent discharges three weeks later (57). Bartels and VanRooyen (58) described a third peak in deaths that occurred days to weeks after the earthquake and attributed it to sepsis, multisystem organ failure, and disseminated intravascular coagulation, stating that these patients have the greatest potential for survival. Emergent decontamination of the affected area, cleaning of wounds, and administration of antibiotics can help to prevent the spread of infectious diseases and reduce the risk of secondary bacterial infections. Studies on earthquakes in Japan, Pakistan, and Haiti have shown that increasing the number of specialists in internal medicine pediatrics and infectious diseases can reduce the complications and mortality related to delayed rescue, and collaborating with physicians of the mentioned specialties in the ED may help to provide comprehensive care for these patients (59).

Following an earthquake, an increase in patients presenting to the hospital with cardiovascular diseases and hypertensive cardiocerebral issues has been noted (60). Acute myocardial infarction (14.5% vs. 22.8%; p=0.028), elevation of blood pressure (10% vs. 21.8%, p=0.001), and paroxysmal arrhythmias treated with electrocardioversion (0.9% vs. 4.5%, p=0.022) were significantly more common in a subgroup analysis of patients treated in hospitals located within 20 km of the epicenter according to Babić et al. (61). Again, after the 1994 earthquake in California, USA, the number of patients admitted with acute myocardial infarctions increased by 35% in the week following the disaster (62). When compared with the same period in the previous year, the rate of admission for acute myocardial infarction increased considerably in the six weeks following the earthquake in Taiwan (63). Patients with high blood pressure may also have adverse outcomes from earthquakes. The mean systolic blood pressure was found to be 14-16 mmHg higher and the mean diastolic blood pressure was 6-10 mmHg higher than the baseline values in elderly patients following the 1995 earthquake in Japan (64). Earthquakes also led to an increase in the mortality of cerebrovascular diseases. The number of fatal strokes among the elderly increased in the three months following the 1995 earthquake in Japan (58 stroke deaths after the earthquake vs. 31 in the same period the previous year) (65). Increased risk of these complications post-earthquake, including cardiovascular and cerebrovascular problems, may be associated with stress (both physical and physiological), subsequent excarnation of underlying health conditions, inability to access regular medication, and poor living conditions in the aftermath of a disaster. Identifying and monitoring earthquake survivors who are at high risk for these complications, managing unregulated blood pressure issues, and performing screening and diagnostic tests such as electrocardiograms, echocardiography, and cerebral imaging modalities are all essential measures that can be implemented in the ED.

Conclusion

In conclusion, overall, the experiences from past disasters suggest that emergency services need to be better prepared for unique challenges when treating earthquake-related traumatic injuries and their complications. Improved communication, collaboration between different healthcare departments, and coordination between healthcare facilities in the immediate disaster zone can help optimize resources and minimize delays in diagnosis, treatment, and transport of patients. When imaging modalities cannot meet the demand, portable devices such as E-FAST have shown promise in helping to identify critical injuries and guide clinicians. Combined with well-established triage protocols and a dedicated team of physicians from multiple disciplines, EDs should prioritize the allocation of limited resources to

ensure that patients with urgent and life-threatening injuries receive timely and appropriate care. Timely diagnosis and treatment of traumatic injuries and related conditions such as Crush syndrome and rhabdomyolysis after earthquakes are imperative to provide best chances of survival to patients. Possible later complications such as neurovascular events and infections may contribute to reduced mortality and morbidity rates and should be addressed accordingly.

Ethics

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Authorship Contributions

Concept: Ö.Y., S.D., A.A., Design: Ö.Y., S.D., A.A., Data Collection or Processing: Ö.Y., S.D., A.A., Analysis or Interpretation: Ö.Y., S.D., A.A., Literature Search: Ö.Y., S.D., A.A., Writing: Ö.Y., S.D., A.A.

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