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Original Article

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Post-Earthquake Realities: A Study on the Challenges of Relocated Hemodialysis Patients Following the Kahramanmaraş Earthquake

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ABSTRACT

Background: In February 2023, Türkiye experienced 2 significant earthquakes, measuring 7.4 and 7.3 on the Richter scale and impacting 11 provinces. This study was performed to investigate the experiences of patients undergoing hemodialysis treatment in earthquake-affected areas who were relocated to alternative centers, with a focus on assessing the medical challenges that emerged thereafter.

Methods: This study included 181 hemodialysis patients (71 females, 110 males) from 11 earthquake-affected provinces who were transferred to different dialysis centers because of infrastructure and superstructure damage at their original treatment facilities.

Results: The predominant reason for relocation was damage to personal residences, reported by 77.4% of patients. Notably, 59.4% resumed hemodialysis with a delay of at least 1 day. Emergency complications were observed in 24.6% of patients, with hypervolemia (11.7%) being the most common. At the time of reporting, 23.1% of patients continued treatment at the relocated centers, while 78.8% expressed intent to return to their original facilities. Importantly, only 1 patient was reported to have died during the study period, highlighting the overall resilience of this population.

Conclusion: Hemodialysis patients are particularly vulnerable to the impacts of earthquake-related disruptions. Dialysis centers in high-risk regions must adhere to construction standards that ensure operational resilience. Additionally, prioritizing the transfer and medical coordination of hemodialysis patients during disasters is essential to maintaining continuity of care and minimizing health risks.

Keywords: Disaster, earthquake, hemodialysis, dialysis

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INTRODUCTION

Major disasters—both natural and man-made—have devastating effects that disrupt every aspect of life, with particularly severe consequences for individuals with chronic illnesses requiring continuous treatment. Studies show that 25-40% of people in disaster-affected regions, such as those impacted by Hurricanes Katrina and Rita, have at least one chronic condition.[1] Among these, patients undergoing hemodialysis are especially vulnerable because of their dependence on specialized treatment centers and the risk of life-threatening complications if timely care is interrupted.[2] Natural disasters, such as Hurricane Katrina in 2005, have been shown to significantly disrupt dialysis schedules, with patients missing sessions at rates five to seven times higher than usual.[3] Such interruptions increase the risk of serious conditions—including hyperkalemia, hypervolemia, and metabolic acidosis—which can develop rapidly without regular access to dialysis.[4] Man-made disasters, such as armed conflicts, present similarly complex challenges for patients dependent on chronic hemodialysis because of infrastructure damage, transportation barriers, and disruptions in electricity and clean water supplies.[5]

On February 6, 2023, Türkiye experienced the devastating Pazarcık–Elbistan earthquake, measuring 7.4 and 7.3 on the Richter scale. Affecting 11 provinces, the disaster exemplifies the significant challenges healthcare systems face in the aftermath of such events. Official figures estimate that 14 013 196 people—16.4% of the national population—were affected, with more than 50 783 lives lost and more than 122 000 injured. The earthquake caused extensive infrastructure damage across 350 000 km^2, with more than 35 000 buildings destroyed, approximately 300 000 damaged, and more than 2 million households facing housing problems. The disaster also triggered more than 40 000 aftershocks, further compounding the impact and leading to the displacement of over 2 million individuals.[6]

Given the scale of disruption caused by disasters, understanding the extent to which hemodialysis treatments are affected is critical. The field of "disaster nephrology" has emerged in response to these challenges, offering strategies to mitigate the risks faced by patients requiring chronic kidney replacement therapy.[7] This study aims to examine the disruption of dialysis services for patients in the 11 provinces affected by the Pazarcık–Elbistan earthquake. Additionally, it explores the medical complications that arose during and after the transfer of hemodialysis patients to alternative treatment centers in the disaster's aftermath.

MAIN POINTS

- **Existing Knowledge:** In the context of an earthquake or other disaster, it's crucial to recognize that the continuity of dialysis treatment may be disrupted. Establishing emergency preparedness within the dialysis community is vital to ensure the uninterrupted provision of patient care. Factors such as power outages, damaged infrastructure, and impassable roads can pose significant challenges to relocating patients to alternative facilities.
- **Novel Contribution:** While there have been some studies addressing this issue, the number of investigations about the post-earthquake experiences of patients, particularly those undergoing displacement, remains limited. Given the authors' country's susceptibility to earthquakes, this research provides valuable insights that can guide the authors' preparedness efforts for future seismic events.
- **Potential Significance:** This study contributes to the evolving field of "disaster nephrology," furnishing practical guidance for healthcare professionals and disaster response teams. This knowledge can aid in better preparing for and supporting hemodialysis patients during critical periods, enhancing overall disaster response strategies.

MATERIAL AND METHODS

Study Design

This retrospective multicenter study aimed to explore the post-earthquake experiences of hemodialysis patients who survived the Pazarcık–Elbistan Earthquake, which occurred on February 6, 2023. The study included a cohort of hemodialysis patients from the 11 provinces affected by the disaster, who were later transferred to other dialysis centers.

Participants

The study population consisted of adult hemodialysis patients aged 18 years or older who were residing in the earthquake-affected region at the time of the disaster. These patients were receiving treatment at both public and private hemodialysis centers.

Data Collection

Data collection was conducted using a questionnaire initially developed for a study on hemodialysis patients displaced from Ukraine due to the Russia–Ukraine War.[8] This questionnaire was revised and adapted for use on Google Forms platform.[9] The modified version consisted of 26 questions, included an introductory page outlining the study methods for participants. The first section of the questionnaire gathered demographic data. The second section addressed the effects of the earthquake on patients and hemodialysis facilities, including trauma, electrical disruptions, and other related issues. The third section focused on how patients relocated to other cities. The fourth section examined medical problems, complications, emotional stress, and communication challenges. The fifth and final section included questions about the patients' current status at the receiving centers. Three months after the earthquake, the survey was distributed via email to all members

of the Turkish Society of Nephrology and the Association of Dialysis Physicians. It was administered to patients through medical staff in dialysis centers. A total of 18 dialysis centers from 12 different cities participated in the study. Marmara University School of Medicine Clinical Investigation Ethics Committee approved the research project under protocol number 09.2023.584.

Statistical Analyses

All analyses were performed using the Statistical Package for the Social Sciences for Windows, version 20.0 (IBM SPSS Corp.; Armonk, NY, USA). Descriptive statistics were calculated for all numeric variables, including means, medians, standard deviations, and minimum and maximum values, along with proportions for all categorical variables.

RESULTS

This study collected information on 181 hemodialysis patients who were transferred to 18 different dialysis centers across 12 cities. Data collection occurred between 107 and 491 days after the earthquake (average of 194 days). Among all patients, 39.2% were female, and their mean age was 58.9 ± 14.6 years. The mean dialysis vintage was 55.9 ± 19.6 months (Table 1).

In total, 37.6% of patients were transferred from Hatay to other centers, followed by 18.2% from Kahramanmaraş, and 14.9% from Malatya. Among the cohort, 6.1% had been trapped under rubble and were rescued after an average of 10.9 hours. Only 1 patient sustained life-threatening injuries, requiring amputation due to crush syndrome. Additionally, 77.4% of patients reported damage to their homes, while 42.1% noted damage to the dialysis centers where they received treatment after the earthquake. Furthermore, 29.8% of patients reported experiencing power and water outages (Table 2).

Table 1. Demographic and Clinic Data

Age (years SD)		58.9 ± 14.6
Gender (Female %)		39.2
Etiology of End Stage Kidney Disease (ESKD) (%)	Diabetes	36.9
	Hypertension	33.8
	Uropathies	5.6
	Polycystic kidney disease	5.6
	Glomerulonephritis	5
	Others	13.1
City (%)	Hatay	37.6
	Malatya	18.2
	Kahramanmaraş	14.9
	Gaziantep	13.8
	Adıyaman	7.2
	Others	8.3
Hemodialysis (HD) duration (months SD)		55.9 ± 19.6
HD sesion number (%)	3 per week	87.7
	2 per week	11.1
	>3 per week	1.2
Vascular access (%)	Arteriovenous fistula	74.4
	Permanent catheter	13.8
	Transient catheter	6.1
	Arteriovenous graft	1.8

SD, standart deviation.

Table 2. Questions About the Aftermath Earthquake

	Response	%	(n)
"Has the patient been trapped under rubble?"	Yes	6.1	161
	No	93.9	
"Did the patient sustain any injuries in the aftermath of the earthquake?"	Yes	13.3	111
	No	86.7	
"What was the reason for the patient's relocation from the dialysis center in the earthquake zone?"*	Home Damage	77.4	164
	Dialysis Center Damage	42.1	
	Power Outage	15.2	
	Water Shortage	14.6	
	Staff Shortage	6.7	
	Other Reasons	14.6	
"Did any issues occur with the patient's vascular access route aftermath earthquake?"	Yes	8.6	162
	No	91.4	

*Multiple-choice question.

Transportation to other centers was facilitated by relatives for 67.7% of the patients, and 68.6% began living in their relatives' homes. A total of 60.8% were transferred to dialysis centers located in the cities where their relatives resided. Following the earthquake, 40.6% of the patients did not miss a dialysis session, while 31.9% experienced delays of three or more days. Additionally, 8.6% of patients reported problems with vascular access during this period (Table 3).

A total of 62.3% of patients remained in contact with their primary treatment center. No emergency conditions were reported in 79.2% of patients at the centers to which they were transferred; the most common emergency condition was hypervolemia, occurring in 11.7% of patients. High dialysis session frequency was maintained for 97.5% of patients. Additionally, 63.7% of patients did not have any documentation detailing their previous treatments, and 48.4% did not have their medications with them at the time of transfer. However, 96.8% of patients reported no issues in obtaining their medications after relocation. Approximately 90% of patients indicated that their fluid intake and dietary compliance had not worsened compared with their pre-earthquake levels. Only 14.5% were receiving psychological support. Among those still receiving care at the transfer center, 23.1% intended to continue treatment there, while 78.8% planned to return to their primary center (Table 4).

DISCUSSION

Patients undergoing maintenance hemodialysis represent a particularly vulnerable population during seismic events such as earthquakes, where disruptions to infrastructure and healthcare systems pose significant challenges. In the cities affected by the February 2023 earthquake, there were approximately 8,000 hemodialysis patients, and it is estimated that approximately 1,000 were transferred to other centers due to the earthquake's impact. In this study, the authors' goal was to identify the challenges faced by patients undergoing maintenance hemodialysis who were required to relocate to different facilities, as well as to examine the clinical issues encountered during this process.

The intensity of a high-magnitude earthquake can lead to partial or complete destruction of medical facilities.[10] In this study, 42.2% of patients reported that their dialysis center was so incapacitated, it could no longer be used. Additionally, electricity and water supply systems are often disrupted following earthquakes;[11] in the authors' findings, 15.2% and 14.6% of patients experienced electricity and water outages, respectively, in the affected areas. These results highlight the critical importance of maintaining the functionality of dialysis facilities to ensure uninterrupted care for patients undergoing maintenance hemodialysis. Investments in earthquake-resistant infrastructure and the integration of backup power systems can significantly reduce disruptions caused by structural damage or power failures.[11] One of the most frequently reported reasons for dialysis units being inoperable was the toppling of water treatment tanks. In earthquake-prone areas, securing these systems may offer a simple yet effective solution.[12] Furthermore, strategically locating dialysis centers in regions less susceptible to seismic activity could improve overall resilience. In addition to facility damage, 77.4% of patients reported damage to their homes as a key reason for relocation. Recognizing the impact of home damage on patients' ability to transport essential medications is also crucial. Contingency plans should address the challenges patients face when their living environments are compromised.[13]

The prompt and secure relocation of patients undergoing maintenance hemodialysis to alternative treatment centers is a crucial element of earthquake preparedness. Planning, rescue coordination, and flexibility are essential for rapid, reliable,

Table 3. Question About Relocation Period

		%	Response (n)
"Why did the patient come to your unit?"	The city where their relatives live	60.8	158
	Referral by government	27.2	
	The nearest center	12	
"How did the patient reach your unit? Through which organizations?"	With relatives	67.7	158
	Ownself	15.8	
	Referral by government	12	
	Others	4.5	
"Where is the patient staying?"	With relatives	68.6	156
	Rent	25.6	
	Hostage	5.8	
	Hotel	0.6	
"Was there any communication or language barrier with the patient?"	Yes	6.3	160
	No	93.7	

Table 4. Questions About After Relocation

	Response	%	(n)
"Is the patient in contact with their own center?"	Yes	62.3	162
	No	37.7	
"How many days was the last dialysis session delayed?"	0	40.6	160
	1	10.6	
	2	19.6	
	3	14.4	
	4	5.6	
	5	6.3	
	>5	2.9	
"Was there a nephrological emergency when the patient arrived at your unit?"	Acidosis	1.3	154
	Hyperkalemia	0	
	Hypervolemia	11.7	
	Others	7.5	
	None	79.2	
"Has the number of dialysis sessions been reduced after the earthquake?"	Yes	2.5	162
	No	97.5	
"Did the patient have a medical report, including a dialysis prescription, when being admitted to your unit?"	Yes	36.3	157
	No	63.7	
"Did the patient have the medications when being admitted to your unit?"	Yes	51.6	155
	No	48.4	
"After being admitted to your unit, were there any issues with supplying the patient's medications?"	Yes	3.2	157
	No	96.8	
"How was the patient's diet compliance compared to before the earthquake?"	Very good	17.4	155
	Good	32.9	
	Medium	38.1	
	Bad	9	
	Very bad	2.6	
"Has the patient received or is the patient receiving psychological support?"	Yes	14.5	159
	No	85.5	
"Will the patient continue their dialysis treatment in your unit?"	Yes	23.1	160
	No	76.9	
"If not, where will the treatment continue?"*	Return to own center	78.8	118
	Another center in same city	11	
	To another city	10.2	

*Only those who answered no to the previous question answered.

and manageable patient transfers. This approach was successfully implemented during the L'Aquila earthquake in Italy (2009), where patients were moved to neighboring units and a provisional dialysis center was established.[2] Similarly, the positive outcomes following the New Zealand earthquake were attributed to well-coordinated efforts and established emergency planning guidelines.[14] In this study, when participants were asked about their means of transfer to other centers, 67.7% reported relying on relatives, 15.8% used their own transportation, and fewer than 15% were transferred via state-provided

transport. These findings highlight the need for well-defined protocols for patient relocation, including coordination with transportation services and neighboring healthcare facilities, to improve the efficiency of such transfers. Additionally, a majority of patients (68.6%) reported staying with their relatives. While the transfer process itself is essential, systematic planning for patient accomodation is equally important. From this perspective, pre-planning the use of guesthouses, school dormitories, or hotels could help meet the housing needs of patients who must relocate to another city after a disaster. It is also important to recognize that logistical challenges may make patient transfers impossible in some situations. In such cases, alternative treatment methods—such as peritoneal dialysis or portable hemodialysis machines—can be employed to provide life-sustaining care.[15,16]

Managing medical records and medications for patients transferred to other centers due to an earthquake is a significant challenge. Effective strategies are essential to ensure continuity of care and proper resource allocation during such disasters. Utilizing standardized patient encounter forms and centralized data collection points can streamline patient tracking and care coordination during emergencies.[17] Furthermore, the Health Information Services should have pre-planned strategies for retrieving and allocating medical records in disaster situations.[18] In this study, 63.7% of patients reported not having a medical report containing details of their treatment history or hemodialysis prescription. Additionally, 37.7% stated they were not in contact with their previous center. Fortunately, the authors' country has a national online database (E-Pulse system), which stores all patients' health data and is accessible to healthcare professionals with the individual's consent. This system enabled access to the necessary information regarding patients' treatment processes, ensuring the continuation of healthcare services without interruption. Remote management of hemodialysis patients has been shown to be both feasible and safe, supporting timely physician reviews and reducing the need for physical visits.[19] Telemedicine applications, which became more widespread during the coronavirus disease (COVID-19) pandemic,[20] have also emerged as important support tools in the aftermath of disasters. In fact, telemedicine has proven to be a vital means of maintaining continuity of care for hemodialysis patients by enabling remote consultations and monitoring—an approach that was especially critical during the COVID-19 pandemic, when access to physical healthcare facilities was significantly restricted.[21,22] Moreover, a telemedicine-based breastfeeding counseling program was implemented in disaster-affected regions following the earthquake in Türkiye on February 6, successfully addressing breastfeeding challenges.[23] Given the shortage of healthcare workers (including physicians) during earthquakes, these technologies allow professionals to remotely assess patients' conditions, provide guidance, and adjust treatment plans, thereby reducing the need for immediate physical transfers after seismic events.

Ensuring a consistent supply of medications and dialysis equipment is crucial for the well-being of patients undergoing maintenance hemodialysis. In this study, 48.4% of patients reported being unable to bring their medications with them during their transfer to another center. This issue can be partly attributed to the fact that 77.4% of patients had sustained damage to their homes. Understandably, in times of crisis, such details may be overlooked. Therefore, the establishment of robust contingency plans for securing and distributing essential supplies in the aftermath of earthquakes is imperative. Moreover, educating patients about emergency response plans is essential to help mitigate risks during natural disasters.[24] Encouragingly, 96.2% of patients reported no issues in obtaining medications after relocation. Immediate networking between dialysis units across Türkiye and coordination of needs through the previously established Renal Disaster Task Force of the Turkish Society of Nephrology played a key role in this positive outcome. Collaboration with pharmaceutical and medical supply companies to develop resilient supply chain strategies can help further prevent shortages during times of crisis.[25] Additionally, fostering a sense of community among patients promotes mutual support during difficult times. A collaborative approach involving healthcare professionals, emergency responders, and community stakeholders is essential to strengthen the overall resilience of patients.[25]

Additionally, the logistical challenges posed by disasters—including difficulty accessing treatment centers and missed dialysis sessions—contribute significantly to the elevated risk of medical complications.[26,27] In this study, 59.4% of patients missed at least one dialysis session, with 29.8% experiencing a lapse of three or more days in their dialysis schedule. The vulnerability of hemodialysis patients is heightened during seismic events, presenting a complex array of challenges. Disruptions in dialysis regimens due to earthquakes may lead to the accumulation of potassium, fluid overload, and acid–base imbalances, all of which carry serious risks for individuals with compromised renal function. Specifically, 11.7% of patients exhibited hypervolemia, and 1.3% experienced complications related to acidosis. Addressing the medical complexities of these conditions, along with developing strategies to reduce the impact of missed dialysis sessions, is essential for tailoring disaster-preparedness protocols to the specific needs of hemodialysis patients in earthquake-prone regions.[13] Furthermore, empowering maintenance hemodialysis patients with knowledge about earthquake preparedness is a proactive and effective strategy.[28] Providing educational resources on assembling emergency kits, understanding evacuation procedures, and recognizing early signs of medical distress equips patients to take an active role in safeguarding their health. Establishing networks for sharing best practices and lessons learned from previous seismic events can further strengthen preparedness and response efforts.[29,30] In addition, offering education and training for both healthcare providers and patients—through regular

drills and simulations—can improve familiarity with protocols and enhance performance under stressful conditions.[31]

The study has several limitations, including its retrospective design, potential recall bias, exclusion of some relocated patients, and the absence of an assessment of the long-term consequences of relocation. Despite these limitations, the study's strength lies in its ability to highlight the transfer processes and medical challenges faced by patients during the post-earthquake period, offering valuable insights and practical suggestions. With the anticipation of future earthquakes, the study's recommendations serve as a guide for strategic preparedness, promoting a tailored and rational approach to future planning.

In conclusion, safeguarding maintenance hemodialysis patients during earthquakes requires a comprehensive and multidimensional strategy. By addressing infrastructure vulnerabilities, refining patient transfer protocols, embracing telehealth solutions, ensuring a robust supply chain, promoting patient education, and fostering interdisciplinary collaboration, healthcare systems can more effectively manage the complexities of seismic events and protect the well-being of this vulnerable population. These findings underscore the importance of a thorough and adaptable approach to disaster preparedness in the context of hemodialysis care, taking into account the unique vulnerabilities and needs of patients in earthquake-prone regions.

Data Availability Statement: All relevant data was presented in the manuscript.

Ethics Committee Approval: Ethical committee approval was received from the Ethics Committee of Marmara University School of Medicine (Approval No: 09.2023.584, Date: 05.09.2023).

Informed Consent: Informed consent was obtained from the participants who agreed to take part in the study.

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