Evacuating Patients with Ongoing Dialysis

Sharafaldeen Bin Nafisah and Salem Alammi

Abstract—**Introduction:**

Efficient planning is crucial for the safe evacuation of dialysis patients during a disaster. The lack of evidence-based approaches for evacuating these patients highlights the need to explore the associated challenges and develop a comprehensive plan to address the unique vulnerabilities of this cohort.

Methods:

Information was gathered using three methods: First, a thorough literature search was conducted. Secondly, a focus group was established, comprising experts in nephrology, biomedical engineering and safety engineering, as well as senior dialysis nurses. Finally, the research team visited a dialysis centre to examine the dialysis machines and engage in discussions regarding evacuation plans.

Results:

Three procedures were identified to promptly release patients from a dialysis machine: the 'clamp and cut' method, the 'clamp and cap' method, and the hand crank method. Factors such as the size and weight of the dialysis machine, battery life, and potential blood loss resulting from immediate interruption of the dialysis process were noted as important considerations.

Conclusion:

It is essential that dialysis patients be recognised as a vulnerable group, and that time and effort be invested in the design of an evacuation plan specific to their needs. Furthermore, it is imperative for dialysis centre staff to be knowledgeable about when to evacuate and what actions to take to ensure a safe and effective evacuation process.

Index Terms—**disasters, disaster planning, dialysis, haemodialysis units, hospital, renal dialysis**

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I. BACKGROUND

During emergencies such as electricity/power outages, fires, water shutdowns, or imminent threats to site or patient safety, immediate evacuation becomes imperative [1]. However, disaster evacuation policies often overlook a specific group of patients — those undergoing dialysis [2]. This oversight may be attributed to the infrequency of such events, or to the prioritisation of critically ill and intubated patients in larger hospitals. Nevertheless, dialysed patients require special attention due to their unique vulnerabilities that extend beyond their health status.

Once the dialysis process is initiated, patients become immobile and reliant on the machine for a duration of 2-6 hours. The necessity of a power supply, as well as a water source for haemodialysis, further restricts their mobility. From a physiological standpoint, any sudden interruption of an ongoing dialysis procedure can lead to hypovolaemia as blood and fluids have already been transferred from the patient to the machine [3]. Given that patients with end-stage renal disease frequently experience anaemia, failure to return the blood to the patient prior to ending the dialysis session can result in symptomatic anaemia.

Effective evacuation planning for such cases requires the consideration of three key factors: the patients' vulnerabilities, the evacuation setting, and the patients' destination. These factors are connected and interdependent, thus requiring a comprehensive approach involving patients, caregivers, emergency medical services, and disaster planners. While discussions have taken place concerning the evacuation of various patient groups, there remains a dearth of guidance regarding the appropriate course of action for patients undergoing dialysis during an evacuation. The objective of this discussion, therefore, is to address the evacuation of dialysed patients and develop evidence-based evacuation plans. By taking into account the specific needs and vulnerabilities of

these patients, we can ensure their safety and well-being in emergency situations.

II. METHODS

This is a qualitative study, including a focus group discussion, conducted in Saudi Arabia from July to August, 2023. To address the research question, three methods were employed: a literature search, the establishment of a focus group, and site visits to a dialysis centre. The focus group interviews, facilitated by the researcher, aimed to gather in-depth insights and understand the participants' experiences and perspectives. Field observations were also conducted to observe and document the context and interactions related to the research question. The collected data were then thematically analysed.

The literature search was conducted using the PubMed database, with the keywords 'uninterrupted dialysis', 'evacuation', and 'dialysis patient during a disaster'. Additionally, protocols and policies related to the topic were screened for relevant information.

The enrolment criteria for the focus group were their assigned roles at the dialysis centre, their assigned roles in safety/engineering, and their assigned roles in the event of evacuation.

For the research team's visit to a dialysis centre, the city's largest dialysis facility was chosen due to its surge capacity of 600 dialysis beds, and also being a referral centre for other hospitals. The team also visited the dialysis ward of a tertiary hospital to compare dialysis machines and assess competency and training. The site selection was based on bed capacity, dialysis services provided, and the potential significance of an interruption to dialysis services in that centre. An evacuation demonstration was given to illustrate how to interrupt dialysis; verbal consent was obtained from the patient.

III. RESULTS

Literature Search:

Of 527 results using the specified keywords, five references were identified, including a guideline, a recorded lecture, and pamphlets from medical centres [4-8]. One article was in pre-press and therefore unobtainable. These available resources provided information on various manoeuvers employed in the event of immediate evacuation. Such procedures aim to minimise downtime and ensure smooth patient transitions to safer locations, thereby maintaining continuity of care and reducing adverse effects during unforeseen events [9].

One critical technique identified in the literature is the 'clamp and cut' procedure, used during haemodialysis emergencies, which involves immediately clamping and cutting the dialysis lines [10]. The procedure is performed using the emergency kit available at the patient's chairside machine.

Another manoeuver highlighted in the literature is the 'clamp and cap' procedure. This technique involves temporarily sealing the dialysis lines, using specialised caps, to maintain the system's integrity and prevent contamination or clot formation [11].

Additionally, the hand crank method serves as an alternative technique for sustaining dialysis treatment in the absence of power. This method involves manually operating the hand crank of the dialysis machine to maintain blood flow and prevent clotting until power is restored or the issue is resolved [11]. By employing the hand crank method, healthcare providers can ensure uninterrupted therapy for patients until the situation has been resolved.

Focus group:

In the interest of diversity, the focus group consisted of five people: experts in nephrology, biomedical engineering and safety engineering, as well as senior dialysis nurses. Participation was voluntary. Semi-structured interviews were conducted, the topic identified in advance, as illustrated in Table 1. Several interviews of approximately 20 minutes were held at different times to explore opinions and insights regarding the subject matter.

Our content analysis shed light on the specific challenges and considerations that need to be addressed when developing effective evacuation plans for dialysis patients. The focus group discussions identified several challenges associated with the evacuation of this patient group, one major challenge being the lack of specific evacuation plans for dialysis centres. The group emphasised the need for detailed protocols that address the unique needs and vulnerabilities of dialysis patients during emergency situations.

The discussions also highlighted the importance of considering factors such as the connection of the dialysis machine to a water source, and the battery

Table 1. Interview Topics, Identified In advance.

Topic	Sub-topic
Existing disaster plans	Plans for patients with ongoing dialysis
Dialysis interruption	Theories and practical steps for immediate interruption
Competency	Education and training

life of the machine. Furthermore, the exact process of immediately interrupting dialysis, with or without waiting for the blood return, was discussed as an area that requires clear guidelines.

Identifying suitable destinations for evacuation was another significant challenge identified by the focus group. Establishing memoranda of understanding (MOU) with other centres that can provide dialysis services was recognised as an important step in ensuring appropriate care for evacuated patients.

Site visit:

Several challenges were identified during the site visit, including the size and weight of the dialysis machines, which could potentially hinder navigation through emergency evacuation routes. Additionally, a question arose regarding the capacity of ambulances to accommodate both the heavy machine and the patient when evacuating. Furthermore, considerations were raised regarding the possibility of using dedicated vehicles to transport the machines to the respective alternative facilities.

Education and training emerged as an essential component of safe and successful evacuation. The manoeuvres employed to immediately interrupt dialysis were explored, and are illustrated in Figures 1 and 2.

IV. DISCUSSION

The evacuation of a dialysis patient involves similar principles to that of other patients, with certain notable differences. One key distinction is the need to evacuate the patient along with their dialysis machine, as this machine is essential for the patient's survival. While patient safety is the priority, the importance of machine mobilisation should not be underestimated. Factors such as the weight, size, and mobility of the machine, as well as the width of emergency doors and the capacity of ambulances to transport both machine and patient, must be taken into account. The choice between vertical and horizontal evacuation must also be considered, particularly when elevators are not designed to accommodate patients with their machines. While it may be relatively simple to relocate patients to a non-affected area within the same facility, challenges arise when evacuation to external facilities is necessary. In such cases, efforts should be made to plan for the continuity of care, ensuring that patients who cannot timeously receive their regular dialysis are provided with appropriate support.

In situations where immediate evacuation is imminent, a benefit/risk assessment mindset should be adopted. It is important to acknowledge that interrupting dialysis, be it haemodialysis or continuous renal replacement therapy (CRRT), will result in anaemia and hypovolaemia due to the approximately 300 ml of blood inside the dialysis machine [12]. In order to address this issue, it is important to establish mitigation strategies for use during immediate evacuations. One such strategy is to wait for the blood to return to the patient using the installed batteries (in case of a power outage). This allows a 10-minute period for the blood to return to the patient, the same period providing a window of time for safe mobilisation to the ambulance in situations where site safety concerns necessitate emergency evacuation. If the ambulance is not designed to accommodate the dialysis machine, the en-route period is sufficient for the blood to return to the patient. In cases where the batteries are not functioning, a hand crank can be used to manually return the blood to the patient. Healthcare providers should be trained in the proper use of the hand crank and should practice this method regularly, during drills, to ensure readiness for such emergencies.

In addition to these measures, it is essential to conduct regular drills to simulate and practice evacuation procedures. This allows healthcare providers to become familiar with the necessary steps and enables them to efficiently execute the evacuation process in the event of a real emergency. Regular drills and practice sessions that incorporate the 'clamp and cut', 'clamp and cap', and hand crank methods are essential for healthcare providers to develop adequate and timely proficiency in these techniques.

Figure. 1. The clamp and cap procedure: The dialysis line is clamped using the clips (black arrows) and closed using the caps (white arrows).

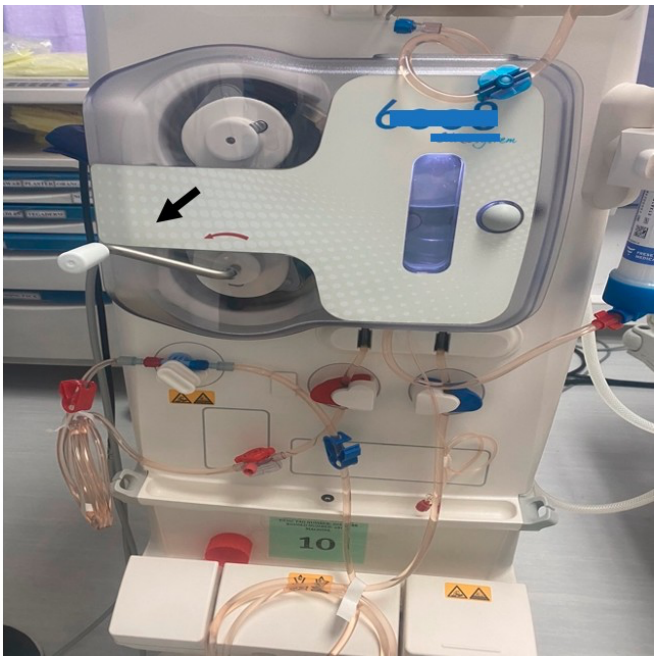

Figure 2. The hand crank method, whereby blood can be manually returned to the patient in the event of a power outage without backup batteries.

Such training enhances their preparedness to handle emergency situations safely and effectively [13]. It is crucial that healthcare facilities prioritise comprehensive training programs that cover all three methods to ensure readiness for various emergency scenarios.

In addition to the above, it is important to address the needs of regular dialysis patients who may require urgent dialysis due to conditions such as fluid overload and hyperkalemia [14]. For these patients, a specific plan should be in place for the completion or initiation of dialysis after evacuation. Factors such as missed or delayed dialysis sessions should be taken into account, as some patients may depend on dialysis for their survival [15]. Planners should also consider the spectrum of severity among patients, including those with severe uraemia who may have a decreased level of consciousness. Stable and unstable patients should be considered, with provisions made for invasive procedures such as intubation, if necessary. It is also important to note that paediatric patients may be on peritoneal dialysis rather than haemodialysis [16]. However, this paper focuses on planners addressing the needs of stable adult dialysis patients.

When choosing a destination for evacuation, it is vital to consider the availability and accessibility of a dialysis machine or, at the very least, a dialysis emergency bag with compatible medical supplies [17]. Such bags may be required in extreme cases and should be included in the evacuation plan. Where it is possible to transfer patients to other facilities with dialysis centres, priority should be given to those who have not completed their session or are experiencing symptoms. It may be necessary to bypass other hospitals that are not ideal for this particular patient group. The use of private sector dialysis machines, whether within their own facilities or moved to other locations, requires early agreements, financial considerations, and technical measures [18]. Staff members accompanying evacuated patients must also be knowledgeable about operating different machines, and must be able to be assigned to other facilities [18].

Another important consideration involves the evacuation of a large number of patients from a dialysis centre [19]. In such situations, a mass casualty incidents protocol should be followed, prioritising those with a severe need for dialysis to receive treatment first. Prioritisation can be based on venous blood gas, vital signs, ECG, and clinical judgment. If there is a need to dialyse multiple patients immediately, we believe a two-hour dialysis session can

ensure a fair allocation of scarce resources, along with additional measures such as treatment for hyperkalemia.

Effective communication plays a crucial role in coordinating transport and preparing alternative facilities. These facilities should have dialysis machines ready and dialysis nurses standing by. Often, when patients are transferred to new facilities, there is a policy of requesting laboratory tests such as hepatitis screens. This issue can be addressed by ensuring that accessible documentation is shared between the evacuated facility and the receiving facilities. To facilitate this, a MOU can be agreed during the planning phase, outlining the sharing of documentation through a mutual point.

V. CONCLUSION

Knowledge and use of the 'clamp and cut', 'clamp and cap', or hand crank methods in the evacuation of haemodialysis patients is crucial for ensuring patient safety and efficient emergency response. Dialysis centre staff need to know when to evacuate, and how to do so effectively. The competency of dialysis nurses in operating dialysis machines entails practical knowledge of the procedure for emergency interruption; it is therefore paramount that these skills are checked periodically during drills and hands-on exercises. Regular drills and training (habitual or as part of facility accreditation) can improve proficiency, reinforce knowledge and enhance awareness about these emergency procedures, ultimately improving patient outcomes during unexpected events. Learning about specific and different machines within the facility is also imperative.

There are several recommendations that we believe are integral to the successful evacuation of patients with ongoing dialysis. These include identifying dialysis patients as special segment in every evacuation plan; exploring, through drills and tabletop exercises, the knowledge and skills related to immediate, emergency discontinuation of dialysis; and ensuring the transfer of knowledge and experience of the required procedural techniques, including hand crank operation.

Moreover, biomedical engineering, safety engineering and facility design must be incorporated into evacuation plans, and scenarios must be explored in which the dialysis machine is evacuated with the patient, be it a vertical or horizontal evacuation. Overall, to formulate effective plans requires consideration of the facility design, the type of dialysis machine and the ambulance design, as well as the existence of MOUs with other facilities for evacuation events. Effective and timely communication is also key in any evacuation.

VI. LIMITATIONS

This study is limited by the small size of the focus group used, the fact that software was not used for coding the interview data, the lack of repeated interviews, and the fact that transcripts were not returned to the participants for comments.

VII. REFERENCES

[1] Sawin DA, Loeper R, Hymes JL. Emergency Response to Natural Disasters: The Experience of Fresenius Medical Care. Kidney Int Rep. 2023 Feb 1;8(3):392-396. Doi: 10.1016/j.ekir.2023.01.038. PMID: 36938098; PMCID: PMC10014378.

[2] Kelman J, Finne K, Bogdanov A, et al. Dialysis care and death following Hurricane Sandy. Am J Kidney Dis. 2015;65(1):109–115

[3] Douvris A, Zeid K, Hiremath S, Bagshaw SM, Wald R, Beaubien-Souligny W, Kong J, Ronco C, Clark EG. Mechanisms for hemodynamic instability related to renal replacement therapy: a narrative review. Intensive Care Med. 2019 Oct;45(10):1333-1346. doi: 10.1007/s00134-019- 05707-w. Epub 2019 Aug 12. PMID: 31407042; PMCID: PMC6773820.

[4] Home dialysis: what to do during a power outage [Internet]. Cincinnati Home Dialysis Blog. 2021 [cited 2023 Sep 12]. Available from: https://www.cincinnatihomedialysis.com/blog /home-dialysis-power-outage/

[5] Northwest Kidney Center. Dialysis Connection. 2015 [cited 2023 Sep 12]. Get prepared to handle an emergency. Available from: https://www.nwkidney.org/wp-content/uploads/2015/10/DialysisConnection_Fall2015.pdf

[6] Emergency Preparedness For Dialysis Facilities: A Guide for Chronic Dialysis Facilities [Internet]. Centers for Medicare & Medicaid Services; [cited 2023 Sep 12]. Available from: https://www.cms.gov/medicare/end-stage-renal-disease/esrdnetworkorganizations/downloads/emergencypreparednessforfacilities2.pdf

[7] Circle Protocol for Temporary Interruption of Dialysis [Internet]. BC Renal; 2018 [cited 2023 Sep 12]. Available from: http://www.bcrenal.ca/resource-gallery/Documents/HD_Circle_Protocol_for_Temporary_Interruption_of_Dialysis.pdf

[8] Liossatou A. Dialysis disaster evacuation plan – Emergency dialysis patients' self-disconnection through 'Clamp & Cut' procedure [Internet]. 47th EDTNA/ERCA International Conference Genoa; 2018 Sep 15 [cited 2023 Aug 5]; Italy. Available from:https://www.edtnaerca.org/resource/edtna/files/2018-genoa-presentations/O-62-Anastasia-Liossat ou.pdf

[9] Clark W, Na L, Rosansky S, Sontrop J, Macnab J, Glassock RJ. Association between estimated glomerular filtration rate at initiation of dialysis and mortality. CMAJ. 2016;188(10):E493-E501.

[10] Foley RN, Gilbertson DT, Murray T, Collins AJ. Long interdialytic interval and mortality among patients receiving hemodialysis. N Engl J Med. 2009 Jul 23;361(4):369-380.

[11] National Kidney Foundation. Dialysis emergency preparedness guidelines [Internet]. 2019 [cited 2023 Sep 12]. Available from:

https://www.kidney.org/sites/default/files/Dialysi s%20Emergency%20Preparedness%20Guidelines%20FINAL3.pdf.

[12] Ronco C, Marchionna N, Brendolan A, Neri M, Lorenzin A, Martínez Rueda AJ. Expanded haemodialysis: from operational mechanism to clinical results. Nephrol Dial Transplant. 2018 Oct 1;33(suppl_3):iii41-iii47. doi: 10.1093/ndt/gfy202. PMID: 30281134; PMCID: PMC6168809.

[13] Baetzner AS, Wespi R, Hill Y, Gyllencreutz L, Sauter TC, Saveman BI, Mohr S, Regal G, Wrzus C, Frenkel MO. Preparing medical first responders for crises: a systematic literature review of disaster training programs and their effectiveness. Scand J Trauma Resusc Emerg Med. 2022 Dec 24;30(1):76. doi: 10.1186/s13049-022-01056- 8. PMID: 36566227; PMCID: PMC9789518.

[14] Howard D, Zhang R, Huang Y, et al. Hospitalization rates among dialysis patients during Hurricane Katrina. Prehosp Disaster Med. 2012;27(4):325–329.

[15] Kutner NG, Muntner P, Huang Y, et al. Effect of Hurricane Katrina on the mortality of dialysis patients. Kidney Int. 2009;76(7):760–766.

[16] United States Renal Data System. 2017 USRDS annual data report: Epidemiology of kidney disease in the United States. National Institutes of Health, National Institute of National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2017.

[17] Lempert KD, Kopp JB. Renal Failure Patients in Disasters. Disaster Med Public Health Prep. 2019 Aug;13(4):782-790. doi: 10.1017/dmp.2018.142. Epub 2019 May 6. PMID: 31057134; PMCID: PMC6897549.

[18] Koshiba T, Nishiuchi T, Akaihata H, et al. Evaluating the Imbalance Between Increasing Hemodialysis Patients and Medical Staff Shortage After the Great East Japan Earthquake: Report From a Hemodialysis Center Near the Fukushima Nuclear Power Plants. Ther Apher Dial. 2016;20(2):127–134.

[19] Dossabhoy NR, Qadri M, Beal LM. Nephrologic Impact of Hurricanes Katrina and Rita in Areas Not Directly Affected. J La State Med Soc. 2015;167(6):254–256