Review Article

JHSMR Journal of Health Science and Medical Research

Dialysis Management during Flooding Disasters: Operational Strategies and Lessons Learned from Songklanagarind Hospital

Atthaphong Phongphithakchai, M.D., Suntornwit Praditaukrit, M.D., Sirihatai Konwai, M.D., Suwikran Wongpraphairot, M.D., Ussanee Boonsrirat, M.D., Pornpen Sangthawan, M.D., Phongsak Dandecha, M.D.

Division of Nephrology, Department of Internal Medicine, Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla 90110, Thailand.

Received 26 February 2026 ● Revised 30 September 2026 ● Accepted 16 October 2026 ● Published online 9 November 2026

Abstract:

Flooding disasters are a major threat to the continuity of dialysis services, leading to disruptions in infrastructure, transportation, water supply, electricity, and the healthcare workforce. Dialysis care is particularly vulnerable because kidney replacement therapy is time-sensitive and dependent on complex technical systems and trained personnel. Previous disaster experiences have demonstrated increased healthcare utilization and adverse outcomes when maintenance hemodialysis is interrupted. This narrative review summarizes key principles for dialysis management during flooding disasters across preparedness, response, and recovery phases, with primary emphasis on maintenance hemodialysis and hospital-based kidney replacement therapy, and a focused discussion of peritoneal dialysis. We also present an operational case experience from Songklanagarind Hospital during regional flooding in November 2025, where services were reorganized into a dual-track model consisting of acute inpatient kidney replacement therapy and triage-based outpatient maintenance hemodialysis. Nephrologists and dialysis nurses coordinated clinical prioritization and operational continuity in order to support dialysis delivery under severe logistical constraints.

Keywords: dialysis service continuity, disaster preparedness, flood disaster, healthcare system resilience, maintenance hemodialysis

This paper is part of the "Hat Yai Flooding 2025" collection

Contact: Atthaphong Phongphithakchai, M.D.
Division of Nephrology, Department of Internal Medicine, Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla 90110, Thailand.
E-mail: ton331@hotmail.com

J Health Sci Med Res 2026;44(6):e20261499
doi: 10.31584/jhsmr.20261499
www.jhsmr.org

© 2026 JHSMR. Hosted by Prince of Songkla University.
This is an open access article under the CC BY-NC-ND license (http://www.jhsmr.org/index.php/jhsmr/about/editorialPolicies#openAccessPolicy).

Introduction

Flooding is among the most frequent natural disasters worldwide and is projected to increase in both frequency and severity as a result of climate change. Healthcare systems are particularly vulnerable to flooding because they depend on uninterrupted electricity, clean water supply, transportation networks, and specialized personnel. Dialysis services represent one of the most disaster-sensitive components of healthcare delivery, as even short interruptions in kidney replacement therapy may result in life-threatening complications such as hyperkalemia, volume overload, metabolic acidosis, and uremic symptoms[1-4].

Observational studies following major disasters, including Hurricane Katrina, have consistently shown that missed dialysis sessions are associated with increased emergency department visits, hospitalizations, and mortality among patients receiving maintenance hemodialysis (HD)[1,2]. These observations underscore the need for disaster-specific dialysis management strategies that go beyond routine contingency planning and address operational realities during flooding events.

Review methods

This narrative review was informed by a structured search of PubMed/MEDLINE and relevant guidance from governmental and professional organizations. Search terms included combinations of "dialysis," "hemodialysis," "peritoneal dialysis," "kidney replacement therapy," "disaster," "flood," "hurricane," "earthquake," "emergency preparedness," "water supply," and "dialysis facility." We prioritized original studies describing dialysis-related outcomes after major disasters, reviews of disaster nephrology, and authoritative guidance addressing emergency preparedness, dialysis water safety, and facility recovery. Reference lists of relevant articles were also reviewed. Because the objective was to integrate published evidence with practical operational lessons rather than estimate pooled effects, study selection and synthesis were narrative rather than systematic.

Why flooding uniquely threatens dialysis care

Flooding affects dialysis services through multiple, often simultaneous, mechanisms. Water intrusion can damage dialysis machines, reverse osmosis (RO) systems, electrical panels, and supply storage areas, while post-flood contamination and mold can delay safe reopening. Dialysis services also depend on stable electricity and dialysis-quality water; restoring municipal utilities alone does not establish hemodialysis readiness. Before use, affected water-treatment components and dialysis distribution systems require structured inspection, cleaning/disinfection as indicated, and water-quality verification according to applicable standards and manufacturer guidance[5,6].

Transportation disruption is another critical factor. Flooded or damaged roads can prevent patients from reaching dialysis facilities, leading to delayed or missed treatments. Reports after Hurricane Katrina and Hurricane Maria describe increased healthcare utilization, inability to reach treatment centers, supply limitations, and the need for contingency transfer and preemptive planning[2,7]. Natural disasters can also disrupt electricity, water, staffing, consumables, and communication simultaneously. Critically ill patients with urgent kidney replacement therapy indications cannot safely defer treatment, but the modality used must be matched to clinical need and available infrastructure. Together, these vulnerabilities indicate that flood preparedness for dialysis services must integrate engineering, infection control, logistics, staffing, transport, communication, and clinical decision-making.

Preparedness before floods: a continuity-first approach

1. Risk assessment and continuity of operations

Dialysis units should explicitly define essential functions, including safe water supply, electrical power,

trained staff availability, dialysis consumables, transportation pathways, and communication channels. Planning should incorporate loss-of-function scenarios, an emergency water supply plan, predefined mitigation strategies, inter-facility agreements, and thresholds for reducing or relocating services[5,8,9]. Nephrologists, dialysis nurses, engineering personnel, infection-control teams, administrators, and emergency coordinators should be involved in preparedness planning.

2. Patient-focused preparedness

Patient preparedness should include an up-to-date dialysis prescription and medication list, primary and alternative contacts, emergency diet and fluid-restriction instructions, and knowledge of alternative dialysis facilities or shelters[4,7,9]. Dialysis centers should maintain an emergency patient registry with current contact information, alternative contacts, and sufficiently precise home-location information, subject to local privacy requirements.

3. Communication redundancy, patient localization, and early relocation

Preparedness should assume that mobile telephone networks, internet services, and electricity may fail simultaneously. Predetermined evacuation or meeting points, coordination with community health volunteers, emergency medical services, local authorities, and rescue organizations, and early relocation of clinically or logistically vulnerable patients should be considered when severe flooding is predictable. Satellite-based communication, including low-Earth-orbit satellite internet, may provide an additional backup layer for hospitals, dialysis centers, command centers, shelters, and rescue coordination teams when terrestrial networks fail; however, its usefulness depends on power, equipment, service coverage, trained personnel, and an adequate view of the sky[7,9].

4. Preemptive rescheduling and front-loading scheduled dialysis

When a major disruption is reasonably anticipated, selected patients may be rescheduled earlier or scheduled dialysis may be front-loaded before access deteriorates[7,9]. This approach should be individualized according to time since the previous treatment, potassium and volume status, residual kidney function, comorbidities, and the expected duration of disruption; it should not be applied indiscriminately.

Response during flooding: a dual-track service model

A practical response to flooding disasters can divide operations into two parallel tracks: acute inpatient kidney replacement therapy and outpatient maintenance hemodialysis. The tracks share command, staffing, and resource oversight but use separate clinical pathways (Table 1 and Figure 1).

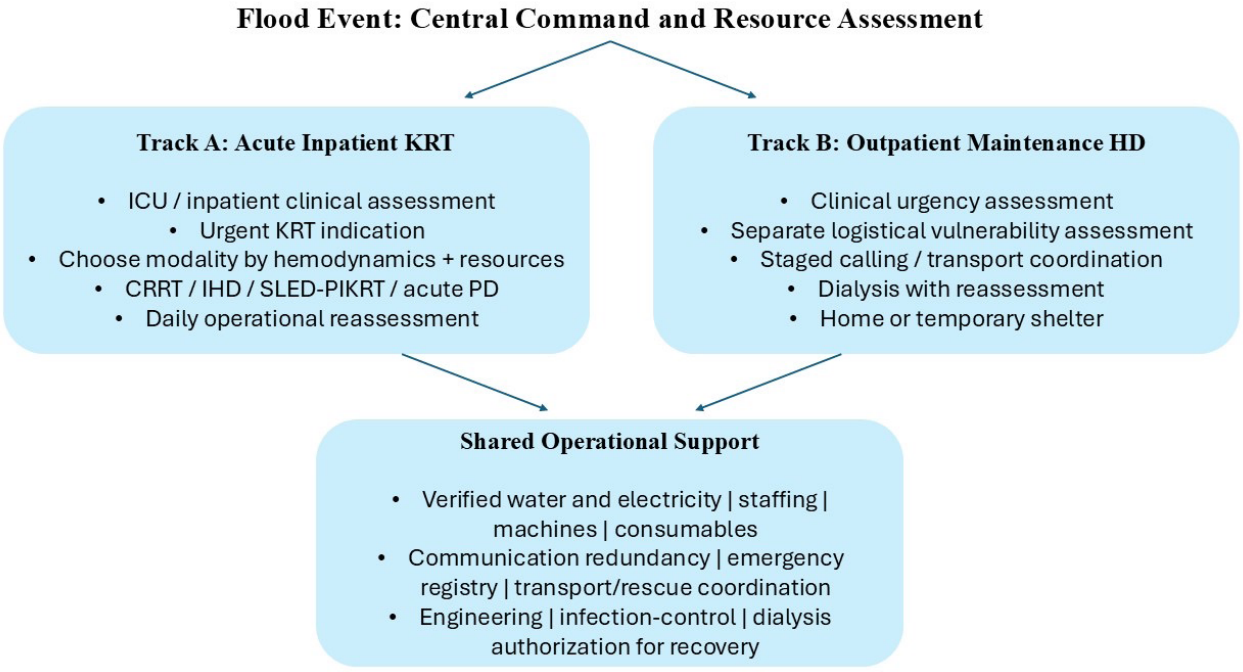
Lane A: inpatient acute dialysis

The primary goal of acute inpatient kidney replacement therapy is prevention of immediate morbidity and mortality. A defined command structure and daily operational huddles should coordinate bed capacity, staffing, consumables, machines, water, and electricity. Modality selection should be individualized rather than based on a single preferred technique. continuous renal replacement therapy (CRRT) may be appropriate for patients with marked hemodynamic instability or a need for gradual fluid and solute removal when machines, trained staff, electricity, and consumables are available. Intermittent HD can treat stable ICU or ward patients efficiently when dialysis-quality water and electrical infrastructure are verified. sustained low-efficiency dialysis (SLED) or other prolonged intermittent therapies may provide an intermediate option, while acute peritoneal dialysis (PD) may be considered in selected settings when extracorporeal resources or water infrastructure are constrained, and appropriate expertise and supplies are available[9,10].

Table 1 Division of dialysis services during flooding disaster: inpatient acute care and outpatient triage system

Component	Inpatient acute dialysis (IPD Track)	Outpatient dialysis (OPD Track)
Primary objective	Life-saving renal support for critically ill patients	Continuity of maintenance hemodialysis
Location	ICU and inpatient wards	Dialysis center
Patient population	Hemodynamically unstable ICU patients; urgent inpatient cases	Stable chronic hemodialysis patients
Dialysis modalities	CRRT, intermittent HD, SLED/PIKRT, or acute PD according to clinical status and resources	Intermittent HD, PD managed through a separate contingency pathway
Team structure	Dedicated ICU dialysis team (CRRT+HD)	Dedicated triage and OPD dialysis team
Decision-making	Daily multidisciplinary operational huddle; nephrologist-led clinical decisions	Centralized triage with nephrologist confirmation of priority
Resource priority	Clinical urgency, machines, consumables, trained staff, power, and water	Dialysis slots, verified water/power, staffing, transport, and communication
Flexibility strategy	Modality adaptation according to hemodynamics and resource availability	Staggered shifts, selected temporary dose adaptation with reassessment
Disaster-specific focus	Hemodynamic stability, fluid control, metabolic safety	Missed-session prevention, patient flow control

CRRT=continuous renal replacement therapy, HD=hemodialysis, PD=peritoneal dialysis, PIKRT=prolonged intermittent kidney replacement therapy, SLED=sustained low-efficiency dialysis, OPD=outpatient department, IPD=inpatient department, ICU=intensive care unit



CRRT=continuous renal replacement therapy, HD=hemodialysis; PD=peritoneal dialysis, PIKRT=prolonged intermittent kidney replacement therapy, SLED=sustained low-efficiency dialysis, ICU=intensive care unit, KRT=kidney replacement therapy

Figure 1 Parallel dual-track dialysis response during the flooding disaster at Songklanagarind Hospital

Dialysis under water, electricity, and supply constraints

Conventional HD should not be initiated or expanded when the safety of the water supply, RO system, or electrical infrastructure is uncertain. Capacity should be matched to verified water availability and quality, reliable power, functioning machines, staffing, and consumable stocks. During a municipal water interruption, an emergency water supply plan and, where locally permitted, appropriately managed alternative water sources may be required. Following restoration, pretreatment filters, carbon tanks, softeners, RO membranes, and distribution loops should be inspected, serviced, flushed, cleaned or disinfected as indicated, and dialysis water should meet applicable microbiological, endotoxin, and chemical standards before routine use[5,6].

Lane B: outpatient maintenance dialysis

The outpatient maintenance hemodialysis track aims to preserve safe access while prioritizing patients at greatest risk from delay. Clinical urgency and logistical vulnerability should be assessed separately (Table 2). Clinical assessment should consider the symptoms of pulmonary edema or uremia, suspected or documented hyperkalemia, time since the last dialysis session, interdialytic weight gain, blood pressure (BP)/hemodynamic stability, residual kidney function, and recent acute illness. Logistical assessment should consider road access, transportation, caregiver availability, communication reliability, housing safety, and shelter needs. Age alone should not determine priority. The dialysis nurse or triage clinician should reassess patients at each contact and immediately before treatment; new dyspnea, chest pain, weakness or arrhythmia suggestive of hyperkalemia, altered mental status, severe hypertension, or other clinical deterioration should trigger urgent nephrologist review and emergency/inpatient assessment when indicated. Final prioritization should be confirmed by the responsible nephrologist with the dialysis team.

Temporary dialysis-dose adaptation during severe capacity constraints

There is no universal preference for shortening treatment duration versus reducing treatment frequency. If infrastructure remains safe but dialysis slots are limited,

Table 2 Clinical urgency and logistical vulnerability framework for outpatient hemodialysis during flooding

Triage domain	Criteria	Examples	Action
Clinical urgency–high	High risk from delay	Dyspnea/pulmonary edema; suspected/documented hyperkalemia; uremic symptoms; prolonged interval since last dialysis; marked interdialytic weight gain; unstable BP or recent acute illness	First available safe treatment; urgent nephrologist review; emergency/inpatient escalation if unstable
Clinical urgency–intermediate	Clinically stable but limited tolerance for delay	Moderate interdialytic weight gain; approaching usual treatment interval, relevant comorbidity without acute symptoms	Early scheduled treatment; reassess at each contact and immediately before dialysis
Clinical urgency–lower	Stable with low immediate risk	No acute symptoms; stable volume status; residual kidney function when present	Later calling round or short deferral with explicit reassessment plan
Logistical vulnerability	Assessed separately from clinical urgency	Inaccessible road/home; unreliable transport or communication; no caregiver; unsafe housing; shelter need	May move patient earlier for transport opportunity, evacuation, transfer, or shelter, age alone is not a priority criterion

temporary session shortening may allow more patients to receive treatment; extending the interdialytic interval may be considered only in carefully selected, clinically stable patients. Either strategy requires individualized assessment and a defined reassessment plan. Treatment should not be shortened or deferred solely for operational convenience in patients with severe or suspected hyperkalemia, pulmonary edema or significant volume overload, severe metabolic abnormalities, uremic symptoms, hemodynamic instability, or other urgent dialysis indications. Patients receiving an abbreviated session should be reassessed after treatment and reprioritized according to the residual symptoms, volume status, laboratory findings when available, and the anticipated time to the next safe treatment.

Patients unable to reach the dialysis unit

For patients unable to travel because of submerged roads, strong currents, inaccessible residences, or loss of transport, teams should use the emergency registry and alternative contacts, coordinate with community health volunteers and rescue organizations, identify safe collection or evacuation points, and arrange transfer to an accessible dialysis facility where feasible. When severe flooding is predictable, early relocation of high-risk or highly transport-dependent patients may be safer than attempting rescue after roads become impassable[7,9].

Peritoneal dialysis during flooding disasters

PD does not require an HD water-treatment system or vascular access, but disasters create distinct vulnerabilities, including interruption of dialysate delivery, unsafe storage, loss of electricity for automated PD, contaminated living environments, and difficulty maintaining aseptic technique. Patients using automated PD may require a contingency plan for manual exchanges when feasible, while those whose homes are unsafe may need a clean alternative treatment location or temporary modality transfer. In a multicenter report after the 2023 Kahramanmaraş earthquake, PD patients experienced power and water shortages, treatment delays, modality changes, displacement, and post-disaster peritonitis, underscoring the need for supply continuity and infection-prevention planning[11].

Case vignette: flood response at Songklanagarind Hospital (November 2025)

During regional flooding in November 2025, Songklanagarind Hospital, Prince of Songkla University, implemented a dual-track dialysis operations model based on the framework described above. The account below is a descriptive operational case experience rather than a prospective outcomes study.

1. Division into inpatient and outpatient workflows

In the inpatient track, a dedicated ICU dialysis structure was established with CRRT and intermittent HD capability, and the modality was selected according to clinical condition and resource availability. This structure was intended to support coverage, troubleshooting, and the prioritization of unstable patients under nephrologist leadership.

In the outpatient track, a dedicated triage team sorted chronic hemodialysis cases and allocated patients into three staged calling rounds (“three waves”) to reduce crowding, match transportation feasibility, and distribute workload throughout the day.

2. Staged calling rounds

The staged approach was designed to limit congestion in constrained waiting areas and permit dynamic reprioritization as information changed, including road closures, patient symptoms, transport feasibility, staffing, and machine availability. Because detailed patient-level operational counts were not prospectively collected in a standardized disaster registry, reliable numbers of scheduled, completed, delayed, shortened, transferred, and

missed treatments and event-specific complications cannot be reported retrospectively without risk of misclassification. We therefore present this experience as an operational description and avoid attributing clinical effectiveness to the model.

3. Temporary shelter after dialysis

Temporary post-dialysis sheltering was made available for patients unable to safely return home because of transportation barriers or unsafe housing access. This provided a safer disposition option and allowed clinical reassessment if symptoms developed.

4. Recovery phase: safe reopening and normalization

After floodwaters recede, the resumption of dialysis should be rapid but conditional on first verifying its safety. Before reopening or expanding HD capacity, the facility should assess structural and electrical safety, inspect the water source and treatment train, change or service pretreatment components as indicated, regenerate softeners, backwash carbon tanks, clean/disinfect RO membranes and the dialysis distribution loop as appropriate, flush the system, and verify dialysis-water quality against applicable chemical, microbiological, and endotoxin standards and manufacturer requirements[5,6]. Dialysis machines exposed to water damage should not be returned to service until inspected and cleared according to manufacturer and engineering guidance. Reopening should be authorized through the institution's responsible dialysis, engineering/facilities, infection-control, and safety processes. Backlog management should continue with dynamic triage and monitoring for complications of delayed dialysis, followed by a structured after-action review.

Limitations

This article is a narrative review and descriptive operational report. The literature search was structured but not systematic, and formal risk-of-bias assessment was not performed. The Songklanagarind Hospital experience was not designed as a prospective disaster registry; complete treatment counts, resource-use metrics, and patient-level outcomes were not consistently captured in a form suitable for retrospective quantitative analysis. The proposed framework should therefore be interpreted as a practical model requiring adaptation to local infrastructure, staffing, disaster type, and regulatory requirements rather than evidence of comparative effectiveness.

Conclusion

Flooding disasters pose a serious threat to dialysis service continuity. A continuity-first, dual-track approach can organize acute inpatient kidney replacement therapy and outpatient maintenance hemodialysis while preserving separate clinical pathways and shared operational oversight. Modality selection, dialysis-dose adaptation, patient prioritization, communication, transport, shelter, and reopening decisions should be individualized according to clinical urgency and verified resource availability. The Songklanagarind Hospital experience illustrates one operational approach that may inform local preparedness planning but requires adaptation and prospective evaluation in other settings.

Funding sources

No specific funding was received for this narrative review and operational report.

Conflict of interest

The authors declare no conflicts of interest related to this manuscript.

Author contributions

All authors contributed to the conception of the operational framework, interpretation of the flood response experience, critical revision of the manuscript, and approval of the final version.

Data availability

No research dataset was generated for this narrative review. Detailed patient-level disaster operational data are not presented because they were not prospectively collected in a standardized research registry.

Ethics statement

This manuscript is a narrative review and descriptive operational report and does not report individual-level patient data.

References

1. Kopp JB, Ball LK, Cohen A, Kenney RJ, Lempert KD, Miller PE, et al. Kidney patient care in disasters: lessons from the hurricanes and earthquake of 2005. Clin J Am Soc Nephrol 2007;2:814-24.
2. Anderson AH, Cohen AJ, Kutner NG, Kopp JB, Kimmel PL, Muntner P. Missed dialysis sessions and hospitalization in hemodialysis patients after Hurricane Katrina. Kidney Int 2009;75:1202-8.
3. Kenney RJ. Emergency preparedness concepts for dialysis facilities: reawakened after Hurricane Katrina. Clin J Am Soc Nephrol 2007;2:809-13.
4. Murakami N, Siktel HB, Lucido D, Winchester JF, Harbord NB. Disaster preparedness and awareness of patients on hemodialysis after Hurricane Sandy. Clin J Am Soc Nephrol 2015;10:1389-96.
5. Centers for Disease Control and Prevention. Guidance for Healthcare Water System Repair and Recovery Following a Boil Water Alert or Disruption of Water Supply. Atlanta: CDC; 2024.
6. Centers for Disease Control and Prevention. Water Use in Dialysis. Atlanta: CDC; 2024.
7. Bonilla-Félix M, Suárez-Rivera M. Disaster management in a nephrology service: lessons learned from Hurricane Maria. Blood Purif 2019;47:199-204.
8. Dent L, Finne K, Lurie N. Progress in emergency preparedness for dialysis care 10 years after Hurricane Katrina. Am J Kidney Dis 2015;66:742-4.
9. Sever MŞ, Vanholder R, Lameire N. Disaster preparedness for people with kidney disease and kidney healthcare providers. Curr Opin Nephrol Hypertens 2024;33:613-20.
10. Kidney Disease: Improving Global Outcomes (KDIGO) Acute Kidney Injury Work Group. KDIGO Clinical Practice Guideline for Acute Kidney Injury. Kidney Int Suppl 2012;2:1-138.
11. Sahutoglu T, Danis R, Pembegul I, Ozturk I, Huzmeli C, Tugcu M, et al. Resilience and challenges of peritoneal dialysis survivors in the aftermath of the 2023 Kahramanmaraş earthquake. Ther Apher Dial 2024;28:648-56.