

Disaster Preparedness and Response for Technology-Dependent Patients in Low- and Middle-Income Countries: A Scoping Review

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Abstract

Background

Technology-dependent patients requiring life-sustaining interventions such as dialysis, oxygen therapy, insulin, or home mechanical ventilation are particularly vulnerable during disasters because disruptions to healthcare services, electricity, and supply chains can interrupt essential treatment. Evidence on disaster preparedness for these populations in low- and middle-income countries (LMICs) remains fragmented.

Objective

To map the existing evidence on disaster preparedness, response, and continuity of care for technology-dependent patients in LMICs and identify research gaps.

Methods

A scoping review was conducted following the Arksey and O'Malley framework and reported according to the PRISMA-ScR guideline. PubMed, Scopus, PsycINFO, and Google Scholar were searched for studies published between 2010 and 2026. Eligible studies were screened independently by two reviewers, data were charted using a standardized form, and findings were synthesized narratively.

Results

A total of 1,609 records were identified, with 10 studies meeting the inclusion criteria. Most evidence focused on dialysis ($n = 7$), particularly in Asia-Pacific and humanitarian settings. One study examined insulin-dependent diabetes care during humanitarian crises, while evidence on oxygen therapy and mechanical ventilation was scarce and largely limited to COVID-19-related contexts. No study specifically investigated home mechanical ventilation in LMIC disaster settings. Across studies, common preparedness strategies included emergency planning, patient education, backup power systems, interfacility coordination, and telemedicine. Major evidence gaps included limited primary research, underrepresentation of LMIC settings, and a lack of evidence for several technology-dependent populations.

Conclusion

Evidence on disaster preparedness for technology-dependent patients in LMICs is limited and uneven across technologies. More context-specific primary research is needed to strengthen continuity of life-sustaining care during disasters.

1. INTRODUCTION

The number of people who rely on life-sustaining medical technologies continues to increase worldwide. An estimated 2.6 million people received kidney replacement therapy in 2010, with projections rising to 5.4 million by 2030 (1). Around 900 million people currently use assistive technologies globally, and this figure is expected to reach 1.3 billion by 2050 (2). Technologies such as dialysis machines, oxygen concentrators, insulin delivery systems, and home mechanical ventilators enable people with chronic conditions to survive and maintain independence. At the same time, they create dependence on uninterrupted access to electricity, clean water, specialized supplies, and skilled healthcare services.

Technology-dependent patients represent a heterogeneous population with diverse clinical needs. This population includes individuals receiving renal replacement therapy for end-stage kidney disease, people with chronic respiratory diseases requiring oxygen therapy, individuals with type 1 diabetes who rely on refrigerated insulin, and those using home mechanical ventilation because of neuromuscular or chronic respiratory disorders (3, 4). The level of reliance ranges from intermittent use of a single device to continuous dependence on multiple technologies (3, 5, 6). Regardless of the technology involved, interruption of treatment or equipment can rapidly become life-threatening.

Even under normal conditions, caring for technology-dependent patients places considerable demands on health systems. Management extends beyond clinical treatment to include patient education, psychosocial support, specialized equipment, reliable supply chains, and coordinated multidisciplinary care (3, 6, 7). Even in high-income countries, these services are frequently fragmented. Patients report

shortages of qualified nurses, transportation barriers, high caregiver burden, and persistent safety concerns (8–10). These existing challenges leave little capacity to absorb the additional disruptions caused by disasters.

Disasters can disrupt every component of the care pathway for technology-dependent patients. Earthquakes, floods, hurricanes, armed conflicts, and infrastructure failures interrupt electricity, damage healthcare facilities, disrupt supply chains, and reduce the availability of trained healthcare personnel (3, 11). The consequences can be immediate and severe. Following the 2011 Tohoku earthquake and tsunami in Japan, 314 dialysis facilities became non-functional, requiring more than 10,000 patients to be transferred to alternative centers (11). During the 2017 Pohang earthquake in South Korea, a power outage interrupted an ongoing hemodialysis session and necessitated emergency evacuation using manual reinfusion procedures (12). In conflict settings such as Syria, Sudan, and Gaza, interruptions in dialysis services, shortages of essential consumables, and damaged health infrastructure have resulted in repeated treatment disruptions and preventable deaths (13–15).

These risks are particularly pronounced in low- and middle-income countries (LMICs), where disasters frequently occur against a backdrop of fragile health systems. The Asia-Pacific region accounts for approximately 81.5% of global disaster casualties (11), while sub-Saharan Africa, South Asia, and Latin America continue to experience recurrent natural hazards alongside constrained health system capacity (13, 16). In many of these settings, unreliable electricity, limited access to clean water, shortages of trained healthcare workers, and fragile supply chains magnify the effects of disasters. Armed conflicts, which increasingly affect many LMICs, further weaken already overstretched health systems and compromise the continuity of essential care (13, 14).

Recent evidence suggests that disaster preparedness for technology-dependent populations remains insufficiently integrated into health systems in LMICs. A scoping review by Gosling et al. (17) found that rehabilitation and assistive technology receive limited attention in disaster preparedness and response because of low awareness, workforce shortages, and underdeveloped health systems. Similarly, Myhre et al. (18) reported that while climate-resilient health system research increasingly addresses workforce capacity and service delivery, comparatively little attention has been paid to maintaining access to essential medicines and medical technologies during disasters. Together, these findings suggest that continuity of care for technology-dependent patients remains an underexplored component of disaster preparedness in resource-limited settings.

Although the vulnerability of technology-dependent patients during disasters is well recognized, evidence from LMICs remains limited. Prasser et al. (3) synthesized the disaster-related care needs of technology-dependent patients and identified three interrelated domains: clinical and supportive care, medical aids and supplies, and access to essential services. However, the review was based almost entirely on evidence from high-income countries, predominantly the United States, and the authors acknowledged that the findings may have limited applicability to other settings. Similar evidence gaps have been reported for diabetes management during humanitarian crises in LMICs, where most available studies were conducted in relatively stable settings rather than acute emergencies (19). Likewise, Gray et al. (11) noted that although considerable evidence exists on dialysis care during disasters in the Asia-Pacific region, much of it originates from high-income countries such as Japan, with comparatively little evidence from LMICs.

Whether and how the needs of technology-dependent patients are addressed during disasters in LMICs therefore remains unclear. This evidence gap is important because many of the world's most disaster-prone regions are also those with the least resilient health systems. Understanding the current evidence on disaster preparedness, emergency response, and continuity of care is essential for developing policies and interventions that are both equitable and feasible within resource-constrained settings. Therefore, this scoping review aims to map the existing evidence on disaster preparedness, response, and continuity of care for technology-dependent patients in LMICs and to identify priority knowledge gaps for future research. The review focuses on four technology categories: renal replacement therapy, oxygen therapy, insulin-dependent diabetes care, and home mechanical ventilation. By synthesizing the available evidence and highlighting areas where research is lacking, this review provides a foundation for strengthening disaster preparedness policies and informing future research to improve the continuity of life-sustaining care for technology-dependent populations in low-resource settings.

2. METHODS

2.1 Study Design

This scoping review was conducted in accordance with the methodological framework proposed by Arksey and O'Malley (20) and is reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) (21). A review protocol was not prospectively registered because of the iterative nature of the review process. A scoping review was considered the most appropriate approach because the review sought to map the breadth of available evidence on disaster preparedness for technology-dependent patients in low- and middle-income countries (LMICs), identify key concepts, and highlight gaps in the existing

literature rather than evaluate intervention effectiveness or study quality. In keeping with accepted guidance for scoping reviews, no formal quality appraisal of included studies was undertaken.

2.2 Eligibility Criteria

Eligibility criteria were developed using the Population, Concept, and Context (PCC) framework recommended by the Joanna Briggs Institute. Studies were eligible if they involved technology-dependent patients requiring renal replacement therapy (dialysis), oxygen therapy, insulin-dependent diabetes management, or home mechanical ventilation; addressed disaster preparedness, disaster response, or continuity of care; and were conducted in, or directly relevant to, LMICs as classified by the World Bank. We included quantitative, qualitative, mixed-methods, review studies, case reports, and practice guidelines that contained empirical evidence or specific recommendations relevant to the review question. Editorials, opinion articles, letters, conference abstracts without sufficient data, and publications published before 2010 or in languages other than English were excluded. Full eligibility criteria are presented in Table 1.

Table 1
Eligibility Criteria

Criterion	Inclusion Criteria	Exclusion Criteria
Population	Technology-dependent patients requiring dialysis, oxygen therapy, insulin-dependent diabetes care, or home mechanical ventilation	Studies not involving technology-dependent patients or not addressing the specified technologies
Concept	Disaster preparedness, disaster response, disaster recovery, or continuity of care during natural disasters, humanitarian emergencies, armed conflicts, or public health emergencies	Studies unrelated to disasters or continuity of care
Context	Low- and middle-income countries (LMICs) as classified by the World Bank, including multi-country studies with LMIC-specific findings	Studies conducted exclusively in high-income countries without LMIC-specific data
Study design	Primary research (quantitative, qualitative, mixed methods), systematic reviews, scoping reviews, narrative reviews, case reports, case series, guidelines, and reports containing empirical evidence or practice recommendations	Editorials, opinion pieces, commentaries, letters, conference abstracts without sufficient data, and studies lacking relevant empirical evidence
Publication period	Published between January 2010 and July 2026	Published before 2010
Language	English	Non-English
Availability	Full-text articles available	Full text unavailable

2.3 Information Sources and Search Strategy

The literature search was conducted on 01 March 2026 using four electronic databases (PubMed, PsycINFO, Scopus, and Google Scholar). The search strategy was developed using the PCC framework and combined controlled vocabulary, where available, with free-text terms related to technology-dependent patients, disasters, and LMICs. Search terms included dialysis, oxygen therapy, ventilators, insulin, disaster preparedness, humanitarian crises, conflict, continuity of care, and LMIC-related terms. Database-specific search strategies were adapted according to indexing requirements. For Google Scholar, the first 200 records sorted by relevance were screened. Searches were limited to studies published between 2010 and 2026. The complete search strategies for all databases are provided in Supplementary Material.

2.4 Study Selection

All retrieved records were imported into Rayyan for screening, and duplicate records were removed before study selection. Two reviewers (P.R.I & A.O.A) independently screened titles and abstracts against the predefined eligibility criteria. Potentially relevant articles underwent full-text assessment by the same reviewers. Disagreements were resolved through discussion and consensus, with consultation from a third reviewer (C.H.U) when necessary. Before formal screening commenced, both reviewers independently screened a sample of 50 records to calibrate the eligibility criteria and ensure consistent application throughout the review.

2.5 Data Charting

A standardized data-charting form was developed by the review team and pilot-tested on five included studies before full data extraction. Following refinement, five reviewers (A.O.A, E.B, E.U.O, M.I.A & M.A.A) independently extracted data using an iterative approach consistent with current guidance for scoping reviews (22). Extracted information was organized in a structured spreadsheet using Google Sheets. Any discrepancies between reviewers were resolved through discussion or consultation with a sixth reviewer (A.S.F).

2.6 Data Items

Data extracted from each study included author, year of publication, country or region, World Bank income classification, study design, technology category, disaster type, disaster phase (preparedness, response, or recovery), key findings, disaster preparedness or response strategies, and research gaps identified by the authors.

2.7 Data Synthesis

Extracted data were synthesized using descriptive summary and basic content analysis, as recommended for scoping reviews (22) (Pollock et al., 2023). Studies were grouped according to technology category, including dialysis, oxygen therapy, insulin-dependent diabetes care, and home mechanical ventilation. Findings were then coded to identify recurring concepts related to disaster preparedness, disaster response, continuity of care, and reported evidence gaps. Results are presented using narrative synthesis supported by summary tables.

3. RESULTS

3.1 Study Selection

The study selection process is presented in Fig. 1. The database search identified 1,609 records, comprising 276 from PubMed, 1,052 from PsycINFO, 81 from Scopus, and 200 from Google Scholar. After removing 287 duplicate records, 1,322 records remained for title and abstract screening. Following screening, 1,286 records were excluded because they did not meet the eligibility criteria. The full texts of 36 articles were retrieved and assessed for eligibility.

Of the 36 full-text articles assessed, 26 were excluded. The most common reasons for exclusion were studies conducted exclusively in high-income countries (n = 8), absence of technology-dependent populations (n = 5), lack of a disaster preparedness or disaster response focus (n = 4), publication type (editorials, commentaries, conference abstracts, or letters without empirical data) (n = 4), unavailable full text (n = 2), duplicate publications or overlapping datasets (n = 2), and publication outside the predefined study period (n = 1). Ultimately, 10 studies met the eligibility criteria and were included in this scoping review (Fig. 1).

3.2 Characteristics of Included Studies

The characteristics of the included studies are summarized in Table 2. The studies were published between 2015 and 2025, reflecting increasing research interest in disaster preparedness for technology-dependent populations over the past decade.

Geographically, the studies represented diverse settings, including the Asia-Pacific region, the Middle East, sub-Saharan Africa, Europe, and global humanitarian contexts. Several studies addressed multiple countries, particularly those examining armed conflicts or humanitarian emergencies.

Dialysis was the most frequently investigated technology, accounting for seven of the ten included studies. One study focused primarily on insulin-dependent diabetes management during humanitarian crises, one examined oxygen therapy within the context of the COVID-19 pandemic, and one evaluated ventilation strategies in an LMIC intensive care setting. No study specifically investigated disaster preparedness for patients receiving home mechanical ventilation.

The disasters examined included earthquakes, floods, tsunamis, armed conflict, humanitarian crises, austere environments, and the COVID-19 pandemic. Most studies addressed the response phase, while fewer considered preparedness or post-disaster recovery (See Table 3). Study designs included narrative reviews, systematic reviews, scoping reviews, case reports, and case series (Table 2).

Table 2
Characteristics of Included Studies

Study	Country/Region	World Bank Classification	Technology Category	Disaster Type	Disaster Phase	Study Design	Study Population
Yoo et al. (12)	South Korea	High-income country	Haemodialysis	Earthquake	Preparedness, Response	Case report/Review	Adult haemodialysis patients
Gorbatkin et al. (23)	Ghana, Nigeria, Tanzania, Afghanistan, Iraq	LMIC	Peritoneal dialysis	Conflict, disasters, austere environments	Response	Case series/Review	Patients with acute kidney injury
Luyckx et al. (13)	Global	Mixed	Dialysis	Humanitarian crises, conflict	Preparedness, Response, Recovery	Narrative review	Dialysis-dependent populations
Sever et al. (14)	Global	Mixed	Paediatric dialysis and transplantation	Earthquakes, floods, conflict	All phases	Review	Children with kidney disease
Gray et al. (11)	Asia-Pacific	Mixed	Haemodialysis and peritoneal dialysis	Earthquake, tsunami, cyclone, flood	All phases	Review	Chronic dialysis patients
Song & Lee (19)	Middle East, Africa, Asia	LMIC	Insulin-dependent diabetes care	Humanitarian crises	Response, Recovery	Systematic review	People living with diabetes
Sandal et al. (16)	Global	Mixed	Dialysis and transplantation	Natural disasters, conflict	All phases	Scoping review	Kidney care systems
Relan et al. (24)	Global (23 LMICs, all WHO regions)	LMIC	Oxygen therapy / respiratory support	COVID-19 pandemic	Response	Prospective observational cohort study	Hospitalised COVID-19 patients requiring oxygen or respiratory support
Abdellatif (25)	Global	LMIC focus	Dialysis	Humanitarian crises	Preparedness, Response	Review	Dialysis patients
Thomas et al. (26)	Iraq	LMIC	Non-invasive ventilation	COVID-19	Response	Review/Case report	Critical care patients

Table 3
Summary of Key Findings, Preparedness Strategies, and Knowledge Gaps

Study	Key Challenges	Preparedness/Response Strategies	Principal Findings	Knowledge Gaps
Yoo et al. (12)	Power outages; reverse osmosis water failure; interrupted dialysis	Emergency boxes, Clamp-and-Cap protocol, backup generators, UPS, disaster drills, patient education	Rapid emergency procedures prevented mortality and maintained dialysis continuity	Limited national regulations and emergency nutrition guidance
Gorbatkin et al. (23)	Electricity shortages; limited dialysis equipment	Improvised catheters, locally prepared dialysate, manual peritoneal dialysis, clinician training	Peritoneal dialysis provided a feasible life-saving alternative where haemodialysis was unavailable	Limited evidence on long-term outcomes
Luyckx et al. (13)	Resource scarcity; ethical dilemmas; inequitable access	Ethical triage, stakeholder engagement, crisis standards of care, international collaboration	Disaster preparedness is both a clinical and ethical responsibility	Limited empirical evidence from fragile settings
Sever et al. (14)	Infrastructure damage; medication shortages; workforce shortages	National coordination, caregiver education, telemedicine, modality switching, emergency planning	Children require disease-specific disaster preparedness strategies	Limited paediatric evidence
Gray et al. (11)	Facility destruction; water shortages; patient displacement	Disaster checklists, backup power, emergency communication systems, increased use of peritoneal dialysis	Peritoneal dialysis showed greater resilience than facility-based haemodialysis	Limited evidence for floods and cyclones
Song & Lee (19)	Drug shortages; insulin affordability; poor adherence	mHealth, task shifting, psychosocial support, multidisciplinary care	Community-based interventions improved diabetes care during humanitarian crises	Little evidence during sudden-onset disasters
Sandal et al. (16)	Lack of coordinated disaster planning	ABC preparedness framework, DIAL response model, ARC recovery model, telemedicine	Proposed a comprehensive disaster management roadmap for kidney care	Limited implementation studies
Relan et al. (24)	Substantial cross-country variation in oxygen and respiratory support access, compounded by unreliable electricity and facility-level infrastructure fragility, with the lowest access in the African region	Strengthening oxygen supply chains and backup electricity infrastructure to sustain respiratory support capacity during health emergencies	Reduced oxygen availability was significantly associated with higher mortality among hospitalised COVID-19 patients across 23 LMICs	Evidence remains pandemic-derived rather than disaster-specific; oxygen-dependent patient preparedness in non-pandemic disaster settings is still unexamined
Abdellatif (25)	Interrupted kidney care during conflict	International collaboration, advocacy, preparedness planning	Kidney care remains insufficiently represented in humanitarian policy	More LMIC implementation research required
Thomas et al. (26)	Staff shortages; limited equipment; disrupted supply chains	Non-invasive ventilation protocols, staff training, resource adaptation	Non-invasive ventilation can be safely implemented in resource-limited critical care settings	Limited evidence on long-term ventilation outcomes

3.3 Findings by Technology Category

The available evidence was unevenly distributed across the four technology categories. Dialysis accounted for most of the evidence, whereas oxygen therapy, insulin-dependent diabetes care, and ventilation were represented by few studies. No eligible study specifically examined home mechanical ventilation in LMIC disaster settings.

3.3.1 Renal Replacement Therapy (Dialysis)

Seven studies examined disaster preparedness and continuity of dialysis care (11, 12, 13, 14, 16, 23, 25). Most evidence originated from earthquake-prone regions in the Asia-Pacific and from humanitarian or conflict settings (11, 12, 14).

Gray et al. (11) documented the disruption of dialysis services following the 2011 Tohoku earthquake and tsunami in Japan, during which 314 dialysis facilities became non-functional and 10,906 patients required transfer to alternative centers. The review identified disruption of electricity and water supplies as the principal causes of service interruption and reported that patients receiving peritoneal dialysis generally experienced fewer treatment interruptions than those receiving hemodialysis because treatment could continue at home.

Similarly, Yoo et al. (12) described the management of hemodialysis services during the 2017 Pohang earthquake in South Korea. Fifteen patients receiving dialysis were safely evacuated after failure of the reverse osmosis water system following a power outage. The study proposed practical preparedness measures including emergency supply boxes, backup generators, manual blood reinfusion procedures, regular disaster drills, and patient education.

Evidence from austere environments suggested that peritoneal dialysis represents a feasible alternative when conventional hemodialysis infrastructure is unavailable. Gorbatkin et al. (23) reported successful use of improvised peritoneal dialysis following earthquakes and in conflict settings using locally available equipment and intravenous fluids to prepare dialysate.

Three studies focused primarily on humanitarian emergencies and armed conflict. Luyckx et al. (13) highlighted major inequities in access to dialysis during conflicts in Ukraine, Sudan, and Gaza and emphasized transparent resource allocation, ethical triage, and international collaboration. Sever et al. (14) described the additional challenges faced by pediatric dialysis and transplant patients, recommending comprehensive disaster planning, caregiver education, telemedicine, and flexible dialysis strategies. Sandal et al. (16) proposed a comprehensive disaster risk reduction and management framework centered on preparedness, coordinated emergency response, and structured recovery planning. Abdellatif (25) further emphasized disaster preparedness, international partnerships, and strengthening local nephrology services as priorities for humanitarian nephrology.

3.3.2 Oxygen Therapy

Evidence relating to oxygen therapy was limited to a single study. Relan et al. (24) conducted a prospective observational cohort study of hospitalized COVID-19 patients across 23 LMICs spanning all WHO regions, assessing facility-level sources of oxygen and electricity alongside respiratory support capacity. The study found that availability and use of oxygen support options varied substantially between countries and was significantly lower in the African region, with mortality associated with reduced access to oxygen. These findings highlight the vulnerability of oxygen-dependent patients when health system infrastructure, including electricity supply, is disrupted or under-resourced.

3.3.3 Insulin-Dependent Diabetes Care

Only one study specifically examined disaster-related diabetes care in LMICs. Song and Lee (19) reviewed 19 studies of diabetes management during humanitarian crises and identified several interventions associated with improved continuity of care, including mobile health technologies, task-shifting to nurses and community health workers, psychosocial support, provision of glucometers, and multidisciplinary care. Common barriers included interrupted insulin supply, high out-of-pocket costs, treatment complexity, and poor adherence to clinical guidelines. The review also highlighted the limited evidence available from acute disaster settings.

3.3.4 Ventilation

Evidence relating to ventilation was also limited. Thomas et al. (26) described the use of non-invasive ventilation during the COVID-19 response in Baghdad, Iraq, outlining challenges related to equipment shortages, workforce limitations, and resource constraints. Together with the findings of Relan et al. (24), the available evidence suggests that respiratory support services are particularly vulnerable during public health emergencies in LMICs, with inequities in oxygen access compounding the risk for technology-dependent patients. No included study specifically investigated disaster preparedness for patients receiving home mechanical ventilation, representing an important gap in the current evidence base.

3.4 Evidence Map

The distribution of evidence across technology categories is summarized in Table 4. Dialysis accounted for most available evidence and covered multiple disaster types, including earthquakes, armed conflict, humanitarian crises, and austere environments. Evidence for oxygen therapy, insulin-dependent diabetes care, and ventilation was considerably more limited, while no eligible study addressed home mechanical ventilation. This uneven distribution highlights substantial differences in the maturity of the evidence across technology-dependent populations.

Table 4
Summary of Evidence by Technology Category

Technology Category	Included Studies (n)	Evidence Base	Geographic Focus	Disaster Contexts
Dialysis (haemodialysis and peritoneal dialysis)	7	Most extensively studied. Evidence includes reviews, case reports, and scoping reviews addressing preparedness, response, and recovery.	Asia-Pacific, Middle East, global humanitarian settings	Earthquakes, tsunamis, floods, armed conflict, humanitarian crises, austere environments
Oxygen therapy	1	Single multicountry cohort study showing marked inequity in oxygen and respiratory support access across LMICs, with mortality linked to availability of oxygen; not disaster-specific but demonstrates infrastructure vulnerability relevant to preparedness	Global LMIC settings	COVID-19 pandemic
Insulin-dependent diabetes care	1	Limited evidence focused primarily on continuity of care during humanitarian crises.	Middle East, Africa, Asia	Humanitarian emergencies and protracted crises
Mechanical ventilation (hospital-based)	1	Limited evidence describing the use of non-invasive ventilation in resource-constrained emergency settings.	Iraq	COVID-19 pandemic
Home mechanical ventilation	0	No eligible studies identified.	None	None

3.5 Disaster Preparedness and Response Strategies

Across the included studies, several preparedness and response strategies were consistently identified (Table 5). Frequently reported preparedness measures included emergency response plans, staff training and disaster simulations, patient education, backup power systems, emergency supply kits, and communication protocols. Peritoneal dialysis emerged as an important alternative to hemodialysis in resource-constrained disaster settings because of its reduced dependence on electricity and water infrastructure.

Communication and coordination were also recurring themes. Studies highlighted telemedicine, patient information systems, regional coordination networks, and partnerships between health facilities as mechanisms for maintaining continuity of care during disasters. Resource management strategies included stockpiling essential supplies, flexible dialysis scheduling, modality switching, and surge-capacity planning.

Several studies additionally emphasized ethical decision-making during disasters, including transparent triage processes, equitable resource allocation, and psychosocial support for both patients and healthcare workers.

Table 5
Disaster Preparedness and Response Strategies Identified Across Included Studies

Preparedness Domain	Strategies Identified	Supporting Studies
Preparedness planning	Development of emergency preparedness plans; emergency supply kits ("Emergency Box"); Clamp-and-Cap procedures; routine disaster drills; patient and caregiver education; backup power systems (generators and UPS); emergency dietary guidance	Yoo et al. (12); Gray et al. (11); Sever et al. (14); Sandal et al. (16)
Alternative treatment approaches	Increased use of peritoneal dialysis in disaster settings; improvised peritoneal dialysis using locally available materials; modality switching where haemodialysis is unavailable; adaptation of non-invasive ventilation in resource-limited settings	Gorbatkin et al. (23); Gray et al. (11); Thomas et al. (26); Sever et al. (14)
Communication and information systems	Patient-held medical records; dialysis information cards; emergency communication networks; telemedicine; information-sharing systems among healthcare facilities and emergency responders	Yoo et al. (12); Sandal et al. (16); Sever et al. (14)
Resource management	Stockpiling essential medicines and consumables; flexible dialysis scheduling; rationing when necessary; surge capacity planning; workforce redeployment; supply chain coordination	Sandal et al. (16); Luyckx et al. (13); Sever et al. (14); Abdellatif (25)
Ethical and policy frameworks	Transparent triage processes; crisis standards of care; stakeholder engagement; equitable resource allocation; preparedness as an ethical responsibility	Luyckx et al. (13); Sandal et al. (16); Abdellatif (25)
Psychosocial and patient support	Psychosocial support for patients and caregivers; management of staff burnout and moral distress; multidisciplinary care; community-based support	Song & Lee (19); Sandal et al. (16); Sever et al. (14); Luyckx et al. (13)
Coordination and collaboration	National and regional coordination mechanisms; multidisciplinary disaster task forces; international collaboration; partnerships between governments, professional societies, humanitarian organisations, and healthcare facilities	Gray et al. (11); Sandal et al. (16); Luyckx et al. (13); Abdellatif (25)

4. DISCUSSION

This scoping review mapped the available evidence on disaster preparedness, response, and continuity of care for technology-dependent patients in low- and middle-income countries (LMICs). Despite the growing global population requiring life-sustaining medical technologies, only ten studies met the eligibility criteria, highlighting a limited and uneven evidence base across technologies and regions. The literature was dominated by dialysis, whereas evidence relating to oxygen therapy, insulin-dependent diabetes care, and mechanical ventilation was sparse. Notably, no eligible study specifically addressed home mechanical ventilation in LMIC disaster settings. These findings suggest that current preparedness efforts have evolved around specific clinical priorities rather than a comprehensive health systems approach capable of addressing the diverse needs of technology-dependent populations.

The predominance of dialysis is consistent with previous reviews, including Prasser et al. (3), who similarly identified renal replacement therapy as the most extensively studied technology-dependent population during disasters. Our findings demonstrate that this pattern persists in LMICs despite a much smaller evidence base. Hemodialysis is particularly vulnerable to disasters because it depends on uninterrupted electricity, water treatment systems, specialized consumables, transportation, and trained personnel. Consequently, service disruptions rapidly become life-threatening and are more likely to be documented than interruptions affecting other technologies. As the global burden of kidney failure continues to rise, with an estimated 5.4 million people projected to require kidney replacement therapy by 2030 (1), strengthening disaster preparedness for this population remains a public health priority.

Across the included dialysis studies, infrastructure failure consistently emerged as the primary cause of treatment interruption. Gray et al. (11) described how the 2011 Tohoku earthquake and tsunami rendered more than 300 dialysis facilities non-functional and necessitated the transfer of over 10,000 patients, while Yoo et al. (12) reported emergency evacuation following disruption of dialysis services during the Pohang earthquake. Similar vulnerabilities were observed in conflict-affected settings, where destruction of health facilities, shortages of dialysis consumables, interruptions to electricity and water supplies, and displacement of healthcare workers resulted in delayed or missed treatment (13, 14, 25). Despite differences in disaster type, the underlying threats were remarkably consistent, indicating that continuity of dialysis depends less on the nature of the hazard than on the resilience of health systems. Correspondingly, preparedness strategies identified across the studies included emergency response plans, backup power and water supplies, regional referral networks, stockpiling of consumables, disaster simulation exercises, and patient education. Sandal et al. (16) further proposed a comprehensive disaster risk reduction framework spanning preparedness, response, and recovery, while Gorbatkin et al. (23) demonstrated the feasibility of improvised peritoneal dialysis when conventional hemodialysis was unavailable. Collectively, these findings emphasize that flexibility in

treatment delivery, together with coordinated infrastructure and service planning, is essential for maintaining continuity of care during disasters.

Evidence for other technology-dependent populations was considerably more limited. Only one study examined insulin-dependent diabetes care in humanitarian settings (19), while oxygen therapy and ventilatory support were represented largely by studies conducted during the COVID-19 pandemic (24, 26, 27). The complete absence of studies on home mechanical ventilation represents one of the most important findings of this review. Patients dependent on long-term ventilation share many of the vulnerabilities experienced by dialysis patients, including reliance on electricity, specialized equipment, consumable supplies, and caregiver support, yet they remain largely invisible within the disaster literature. This disparity likely reflects differences in service delivery rather than differences in vulnerability, as hemodialysis is concentrated in specialized facilities whereas home ventilation, oxygen therapy, and insulin management are delivered across dispersed community settings where disruptions are less systematically documented.

The limited evidence for oxygen therapy, mechanical ventilation, and insulin-dependent diabetes also reflects broader health system inequities across LMICs. Oxygen shortages during the COVID-19 pandemic exposed longstanding weaknesses in procurement systems, biomedical engineering capacity, equipment maintenance, and infrastructure, while continuity of insulin therapy depends on reliable medicine supply chains, refrigeration, glucose monitoring, and multidisciplinary care. Existing evidence, however, largely originates from protracted humanitarian settings rather than sudden-onset disasters, leaving important knowledge gaps regarding preparedness for earthquakes, floods, and similar emergencies. Given the increasing prevalence of diabetes and chronic respiratory diseases across many LMICs, these gaps represent important public health concerns rather than merely research deficiencies.

A marked geographical imbalance was also evident. Although LMICs experience a disproportionate burden of disaster-related morbidity and mortality, relatively few studies originated from sub-Saharan Africa, South Asia, or Latin America. Instead, most evidence came from earthquake-prone regions of Asia and conflict-affected areas of the Middle East. Similar regional disparities have been reported by Gosling et al. (17) and Myhre et al. (18), suggesting that evidence from many highly vulnerable settings remains scarce. Consequently, the transferability of existing preparedness strategies to other LMIC contexts remains uncertain, underscoring the need for locally generated evidence to inform context-specific disaster planning.

Beyond individual technologies, this review demonstrates that continuity of care for technology-dependent patients depends fundamentally on resilient health systems. Across the included studies, successful preparedness relied on robust infrastructure, reliable supply chains, coordinated referral networks, effective communication systems, and preparedness planning before disasters occurred. These findings align with the broader concept of health system resilience, which emphasizes the capacity to anticipate, absorb, adapt to, and recover from shocks while maintaining essential services. Importantly, many barriers reported during disasters—including fragile supply chains, workforce shortages, inadequate infrastructure, poor referral systems, and financial constraints—reflect pre-existing health system weaknesses that become amplified during emergencies. Disaster preparedness should therefore be integrated into routine chronic disease management through measures such as patient registries, emergency communication systems, disaster education, backup power, stockpiling of essential supplies, and regional referral agreements, rather than being implemented only after disasters occur.

The review also highlights opportunities to strengthen preparedness through digital health and data-driven approaches. Although none of the included studies evaluated predictive analytics, emerging evidence suggests that data-driven surveillance can support early outbreak detection (29), while machine learning approaches are being explored for broader health-system planning applications, including insurance coverage modelling (28) and integrated health/agricultural monitoring systems (30), though the latter's direct relevance to disaster response is not yet established.

Similar approaches could facilitate identification of patients dependent on dialysis, oxygen therapy, insulin, or home ventilation, enabling targeted preparedness, prioritized evacuation, and continuity planning before infrastructure failures occur. However, their successful implementation will require stronger patient registries, interoperable health information systems, reliable communication networks, and greater investment in digital health infrastructure.

Another important finding is the limited representation of patient and caregiver perspectives. Most studies approached disaster preparedness from organizational or healthcare provider perspectives, with comparatively little attention to the experiences of those directly affected. Greater involvement of patients, families, and community organizations could improve the feasibility and acceptability of preparedness strategies by incorporating practical knowledge of home-based care, transportation, emergency decision-making, and continuity planning. Future research should therefore prioritize prospective evaluations of preparedness interventions in diverse LMIC settings, particularly for home mechanical ventilation, long-term oxygen therapy, and insulin-dependent diabetes care. Studies should also

examine implementation, cost-effectiveness, and sustainability of preparedness strategies while integrating perspectives from patients, caregivers, and multidisciplinary stakeholders.

This review has several limitations. Although a comprehensive search strategy was employed across multiple databases, relevant studies published in languages other than English or indexed outside the selected databases may have been missed. Consistent with scoping review methodology, formal quality appraisal was not undertaken because the objective was to map the available evidence rather than evaluate intervention effectiveness. The small number of eligible studies and their concentration within specific technologies and geographical regions also limit the generalizability of the findings. Nevertheless, these limitations primarily reflect the immaturity of the evidence base and reinforce the need for more rigorous primary research across diverse LMIC settings.

5. CONCLUSIONS

This scoping review reveals a substantive but uneven evidence gaps at the intersection of technology dependence, disaster response, and low-resource settings. Dialysis is relatively well-studied, with evidence from Asia-Pacific earthquake settings and conflict-affected regions. Home mechanical ventilation and insulin-dependent diabetes care are critically under-researched. The geographic distribution of evidence is also uneven, with little research from South Asia, sub-Saharan Africa, or Latin America. Low- and middle-income countries bear the greatest burden of disasters yet have the weakest health systems. Strengthening disaster preparedness for technology-dependent patients in these settings requires urgent investment in primary research, context-specific guidelines, and health system strengthening. The roadmap developed by Sandal et al. (16) provides a framework that can guide these efforts, but its implementation in LMIC settings requires adaptation, evaluation, and support. The integration of technology-dependent patient populations into disaster preparedness and response plans is an ethical imperative. As Luyckx et al. (13) argue, preparedness is both a clinical and ethical responsibility. The global kidney community and other professional societies must advocate for equitable, context-sensitive policies that protect the world's most vulnerable populations during disasters. To address the complex care needs of technology-dependent patients during disasters, a complementary strategy that combines structural preparedness, professional adaptability, and user participation is required. As nurses play an important role in care delivery for technology-dependent patients across settings, their involvement can help mitigate care gaps when existing plans fall short in the event of a disaster. To further strengthen the evidence base, future studies should employ study designs that allow for both empirical depth and practical transferability, and should include underrepresented populations and regions. Given the current situation of declining global health funding, the need for scalable, context-specific solutions has never been more pressing.

Supplementary Table S1. Complete Electronic Search Strategies

PubMed	((dialysis[tiab] OR haemodialysis[tiab] OR hemodialysis[tiab] OR "oxygen concentrator"[tiab] OR "oxygen therapy"[tiab] OR ventilator*[tiab] OR "home mechanical ventilation"[tiab] OR insulin[tiab]) AND (disaster*[tiab] OR emergenc*[tiab] OR humanitarian[tiab] OR displacement[tiab] OR flood*[tiab] OR earthquake*[tiab] OR conflict*[tiab] OR "power outage"[tiab] OR preparedness[tiab] OR "continuity of care"[tiab]) AND ("low- and middle-income countr*[tiab] OR LMIC*[tiab] OR "developing countr*[tiab] OR Africa[tiab] OR Asia[tiab] OR "Latin America"[tiab] OR "sub-Saharan Africa"[tiab] OR "developing countries"[Mesh]))
PsycINFO	TI,AB(dialysis OR haemodialysis OR hemodialysis OR "oxygen concentrator" OR "oxygen therapy" OR ventilator* OR "home mechanical ventilation" OR insulin) AND TI,AB(disaster* OR emergenc* OR humanitarian OR displacement OR flood* OR earthquake* OR conflict* OR "power outage" OR preparedness OR "continuity of care") AND TI,AB("low- and middle-income countr*" OR LMIC* OR "developing countr*" OR Africa OR Asia OR "Latin America" OR "sub-Saharan Africa" OR "developing countries")
Scopus	TITLE-ABS-KEY(dialysis OR haemodialysis OR hemodialysis OR "oxygen concentrator" OR "oxygen therapy" OR ventilator* OR "home mechanical ventilation" OR insulin) AND TITLE-ABS-KEY(disaster* OR emergenc* OR humanitarian OR displacement OR flood* OR earthquake* OR conflict* OR "power outage" OR preparedness OR "continuity of care") AND TITLE-ABS-KEY("low- and middle-income countr*" OR LMIC* OR "developing countr*" OR Africa OR Asia OR "Latin America" OR "sub-Saharan Africa" OR "developing countries")
Google Scholar	(dialysis OR oxygen OR ventilator OR insulin) AND disaster AND (LMIC OR Africa OR Asia OR "developing countries")

AUTHORS' CONTRIBUTIONS

P.R.I.: Conceptualization, Supervision, Methodology, Investigation, Data curation, Formal analysis, Validation, Writing – original draft, Writing – review & editing.; E.B.: Investigation, Data curation, Validation, Writing – review & editing; M.A.A.: Methodology, Validation, Supervision, Writing – review & editing; A.O.A.: Methodology, Investigation, Data curation, Formal analysis, Writing – original draft, Visualization, Project administration; E.U.O.: Investigation, Validation, Data curation, Writing – review & editing; M.I.A.: Supervision, Methodology, Data curation,

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Declarations

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

CLINICAL TRIAL NUMBER

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

COMPETING INTERESTS

The authors declare no competing interests

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P.R.I.: Conceptualization, Supervision, Methodology, Investigation, Data curation, Formal analysis, Validation, Writing – original draft, Writing – review & editing.; E.B.: Investigation, Data curation, Validation, Writing – review & editing; M.A.A.: Methodology, Validation, Supervision, Writing – review & editing; A.O.A.: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing – original draft, Visualization, Project administration; E.U.O.: Investigation, Validation, Data curation, Writing – review & editing; M.I.A.: Supervision, Methodology, Data curation, Writing – review & editing; A.S.F.: Methodology, Validation, Writing – review & editing; C.H.U.: Methodology, Validation, Writing – review & editing.

DATA AVAILABILITY

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Figures

Figure 1. PRISMA 2020 flow diagram of study selection.

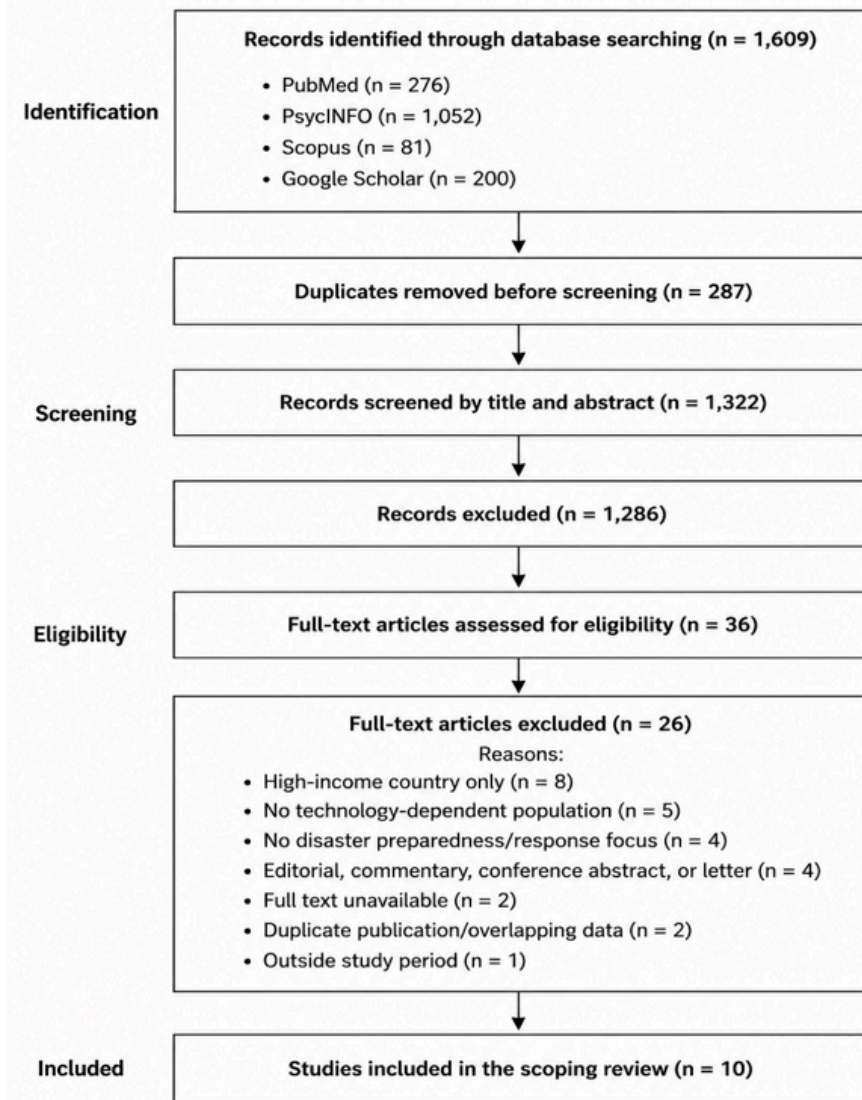


Figure 1

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