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Review article

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Disasters and kidney care: pitfalls and solutions

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Abstract

Patients with kidney disease, especially those with kidney failure, are particularly susceptible to the adverse effects of disasters because their survival depends on functional infrastructure, advanced technology, the availability of specific drugs and well-trained medical personnel. The risk of poor outcomes across the entire spectrum of patients with kidney diseases (acute kidney injury, chronic kidney disease and kidney failure on dialysis or with a functioning transplant) increases as a result of disaster-related logistical challenges. Patients who are displaced face even more complex problems owing to additional threats that arise during travel and after reaching their new location. Overall, risks may be mitigated by pre-disaster preparedness and training. Emergency kidney disaster responses depend on the type and severity of the disaster and include medical and/or surgical treatment of injuries, treatment of mental health conditions, appropriate diet and logistical interventions. After a disaster, patients should be evaluated for problems that were not detected during the event, including those that may have developed as a result of the disaster. A retrospective review of the disaster response is vital to prevent future mistakes. Important ethical concerns include fair distribution of limited resources and limiting harm. Patients with kidney disease, their care-givers, health-care providers and authorities should be trained to respond to the medical and logistical problems that occur during disasters to improve outcomes.

Sections

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Key points

- The numbers of man-made and natural disasters are increasing, with the greatest adverse effects in vulnerable populations, including older people, women, children and patients with non-communicable diseases (NCDs).
- Among patients with NCDs, those with kidney failure require special attention because their survival during disasters depends upon functional infrastructure, advanced technology, the availability of specific drugs and well-trained medical personnel.
- Although displacement during disasters may be preferred by some patients, additional problems that occur when travelling and/or in the new environment may have a negative impact on their prognosis.
- Disaster-associated risks for patients with kidney disease may be mitigated by pre-disaster preparedness and training of various stakeholders, including the patients themselves.
- Patients with acute kidney injury, chronic kidney disease or kidney failure should be evaluated after a disaster to identify any problems that were not detected during the disaster.
- Retrospective analysis of the disaster response is necessary to identify and learn from mistakes and to avoid these during future events.

Introduction

Disasters result in "serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses"[1]. Natural disasters (including earthquakes, hurricanes and pandemics) and man-made disasters (such as wars, terrorist attacks and nuclear plant accidents) with devastating effects have been experienced within the past 20 years or are still ongoing, and include the COVID-19 pandemic, flooding in Pakistan, wildfires and hurricanes in the USA, the Syrian and Russian–Ukrainian wars and many others.

Although some regions worldwide are at higher risk than others, none is exempt from disasters. Between 2001 and 2020, an average of 347 natural disasters (excluding biological and extraterrestrial events) occurred per year. These disasters affected 193.4 million people and resulted in 61,212 deaths and US $153.8 billion in economic losses[2]. In 2020, the number of active conflicts reached a record high since World War II and in 2022, more than one billion individuals were at risk[3,4]. The COVID-19 pandemic demonstrated that biological disasters may be the most dangerous of all. As of 31 May 2023, 767,364,883 cases of COVID-19 had been confirmed, with 6,938,353 deaths directly attributed to the disease[5]. In 2020–2021, an estimated 18.2 million people died as a result of the collateral effects of the pandemic[6].

Disasters may cause extensive medical problems, some of which are disaster-specific; for example: increased risk of crush syndrome after earthquakes and other destructive events; drowning after floods, typhoons and tsunamis; and gunshot wounds during wars[7]. However, other health risks increase uniformly with all types of disasters. These risks include acute illnesses (including acute myocardial infarction, stroke and seizures) and acute exacerbations of pre-existing non-communicable diseases (NCDs), including acute flares of chronic obstructive pulmonary disease and asthma[8], hyperglycaemic or acidotic coma in patients with diabetes[9], disrupted blood pressure control in those with hypertension[9,10], and relapse of cancer owing to treatment interruptions[11,12]. Medical complications are more prominent in vulnerable patients, including those with low socioeconomic status, members of minority ethnic groups, those who are older or frail, women, children and those with NCDs[7,12–24] (Table 1). For example, poorly controlled NCDs were responsible for at least 30% of deaths after Hurricane Irma and Hurricane Maria in the Caribbean in 2017 (refs. 23,25).

Among patients with NCDs, those with advanced kidney disease are at particularly high risk during and after disasters because their survival depends on functional infrastructure, timely access to advanced medical technology, availability of specific drugs and well-trained personnel[26]. The burden, morbidity and mortality of NCDs and kidney diseases are even greater in low-income and middle-income countries than in high-income countries owing to poverty, and socioeconomic and logistical factors[27,28], which are exacerbated in the case of disasters[29].

The 2023 World Kidney Day theme was "kidney health for all: preparing for the unexpected, supporting the vulnerable", which focused on the substantial impact of disastrous events on patients with kidney disease[30]. This campaign encouraged the adoption of integrated strategies that prioritize prevention, early detection and management of patients with kidney diseases and other NCDs during disasters[30]. In this Review, we discuss the medical and logistical problems that are faced by patients with kidney disease and their care-givers during mass disasters and suggest pragmatic approaches to prevent or minimize risks to these patients during these events.

Disaster nephrology

The link between disasters and kidney disease was first noted during the London Blitz in 1941, when the first modern description of crush-related acute kidney injury (AKI) was published[31]. The term 'renal disaster' was coined following the Spitak earthquake in Armenia in 1988, after which 600 patients with crush-related AKI were reported, almost all of whom died due to the scarcity of dialysis infrastructure[32,33]. The concept of 'seismonephrology' or 'earthquake nephrology', which underlines the occurrence of AKI in people who are rescued from collapsed buildings[34], emerged after the Marmara earthquake in Turkey in 1999, which resulted in crush-related AKI in 639 patients[35]. However, other forms of disasters may also impact kidney health and disrupt the care of patients on maintenance dialysis and transplant recipients; thus, the more encompassing term 'disaster nephrology' was introduced in 2015 (ref. 36).

Despite extensive literature on the topic[36] (Supplementary Table 1), general awareness and knowledge of kidney-related problems during disasters remain disappointing, probably because patients with kidney disease constitute a relatively small proportion of people who are affected by disasters[36]. Nevertheless, kidney-related problems in disasters are extensive because in addition to the highly visible effects on people with AKI and kidney failure, substantial harms are experienced by the much larger group of people with chronic kidney disease (CKD) who are not dependent on kidney replacement therapy (KRT). Patients with AKI and across the entire spectrum of CKD are therefore at high risk of adverse outcomes, including limited access to kidney care[37], hospitalization, respiratory failure and death during disasters[38–40].

Acute kidney injury

The reported incidence of AKI during disasters depends on recording accuracy, diagnostic efficacy, logistical capacity, disaster type and population characteristics[41]. Following the Kobe earthquake in Japan

Table 1 | Vulnerable groups and major reasons for their increased risks during mass disasters[7,12–24]

Group	Potential reasons for vulnerability
Low socioeconomic status	High risk of acute and chronic diseases
	Increased threats due to risky living areas and low-quality housing
	High degree of health illiteracy and limited access to health-care services
	Challenges relating to displacement owing to financial restraints
Minority ethnic groups	Poverty, poor housing, low income and language barriers
	Living in overcrowded households
	Potentially lower levels of education than the general population
Older people	Limited self-preservation skills owing to reduced physical performance
	Disability, delayed diagnosis and increased risk of morbidity and mortality owing to atypical symptomatology and comorbidities
	High rates of long-term sequelae
Frail people	Limited self-preservation skills owing to reduced physical performance
	Limited ability to cope with disaster-related medical problems
	Skeletal disorders reduce capacity to flee homes in dangerous situations
Children	Limited self-preservation skills and dependence on their parents or guardians for survival
	Increased risk of polytrauma compared with adults
	Higher risk of injury from explosions, irradiation and exposure to chemical and airborne toxins compared with adults
Women	Lower physical capacity than men to survive during destructive disasters
	Higher stress levels within the family context and less economic and social rights than men in some regions
	Higher risk of domestic and sexual violence than men
	Higher risk of malnutrition than men in some regions
	Lower priority than men during rescue efforts in some regions
Patients with neurocognitive disorders[a]	Limited self-preservation skills due to reduced perception of threats compared with those with normal mental function
	Disability and poor physical performance in patients with dementia
	No concrete plans for evacuation in an emergency
	Inability to cope with disaster-related medical problems
Patients with non-communicable diseases	Difficulty in accessing medication and acute care services
	Non-adherence to treatment, inability to meet dietary requirements
	Increased susceptibility to stress, neuroendocrine and immune disruptions
	High risk of surgical or medical emergencies
	Need for functional infrastructure, advanced technology and availability of well-trained personnel for survival[b]

[a]Including, but not limited to, those with reduced mental functions, psychiatric illness or dementia. [b]Patients with kidney failure who require dialysis or transplantation are one of the highest risk groups because they are at high risk of life-threatening complications if their treatment is interrupted or if they cannot obtain immunosuppressants or other critical medications.

in 1995, 7.4% of 2,718 patients with earthquake trauma had AKI[42]. After the Marmara earthquake, the incidence of AKI was 12.0% among hospitalized patients, but only 1.5% among victims at large[35]. In Southeast Turkey, two catastrophic earthquakes (measuring 7.7 and 7.6 on the Richter scale) occurred within 13 h of each other on 6 February 2023, and resulted in the highest number of cases of crush injuries recorded to date. Preliminary data suggest that >2,000 people sustained crush injuries during these earthquakes, of whom >1,000 required dialysis support (S. Ozturk, personal communication). During the COVID-19 pandemic, AKI was a common and life-threatening complication. A study of critically ill patients with COVID-19 who were admitted to the intensive care units of 67 US hospitals found wide variation in the incidence of COVID-19-associated AKI (7.5–44.6%), with an overall mortality of 63.3% among patients who received KRT during a median follow-up of 17 days[43].

Both traumatic and non-traumatic aetiologies have a role in disaster-associated AKI. The main aetiologies of traumatic prerenal AKI include bleeding due to gunshot wounds or penetrating injuries and third spacing of plasma water in the compartments of crushed extremities during armed conflicts, earthquakes and other destructive events. Extreme dehydration due to inability to access fluid (for example, in people who are trapped in confined spaces) is a non-traumatic aetiology of AKI. In protracted or severe hypovolaemia or shock, intrinsic AKI may develop because of ischaemic acute tubular necrosis (ATN).

In patients with crush injuries, rhabdomyolysis-induced intrinsic AKI may develop subsequent to prerenal AKI if immediate treatment is not initiated[44]. Many other pathogenetic factors have roles in the pathogenesis of rhabdomyolysis-induced AKI, including tubular obstruction by uric acid and myoglobin casts, direct tubular toxicity of myoglobin and free radical production catalysed by iron that is released as a result of degradation of intratubular myoglobin[45,46]. In addition, exposure to noxious gases or agents during disasters may cause nephrotoxic ATN[41].

Another frequent cause of intrinsic AKI is mismatched blood transfusions. Following the Armenian earthquake, 6 of 15 patients who were recovering from crush injuries developed a second episode of AKI and two of these patients died due to severe transfusion reactions[47]. During floods, infections such as malaria[48] and leptospirosis[49] are major causes of AKI. However, the most frequent infectious cause of intrinsic AKI following disasters is sepsis, mainly owing to unhygienic conditions, infected wounds and suboptimal medical care[50]. In the Marmara earthquake, 80 of 323 (24.8%) patients with crush-related AKI who underwent a fasciotomy developed sepsis and 27% of patients with sepsis died[51]. Postrenal AKI is not common during disasters and is almost always due to supra-vesical or infra-vesical obstruction after pelvic trauma[44].

Outcomes in patients with AKI depend on the underlying aetiology and the circumstances of the disaster. AKI mortality was 53% during the Korean War in 1950–1953 (ref. 52) and around 40% among dialysed patients with crush-related AKI in the Iran earthquake in 1990 (ref. 53) and in the Kobe earthquake in Japan in 1995 (ref. 42). More recently, AKI mortality was 22% among US service members injured in the Iraq and Afghanistan wars between 2012 and 2013 (ref. 54) and 15–20% among patients injured in the Chi-Chi earthquake in Taiwan and the Marmara earthquake in Turkey in 1999 (refs. 55–57). Despite these improvements, the prognosis of patients with AKI following disasters still remains unfavourable, particularly in those with polytrauma, severe AKI, delayed diagnosis, repeated need for surgery and limited therapeutic possibilities[41].

AKI may lead to CKD in the long term. A retrospective cohort study including 3,846 US military personnel who were critically injured in conflicts in Iraq or Afghanistan, found that AKI was associated with a 66% increase in the incidence of hypertension and a nearly fivefold increase in the incidence of CKD compared with historical data for the overall US military population[58]. Progression to CKD was also reported to occur in 16% of survivors of COVID-related AKI, increasing to 44% among those whose serum creatinine levels did not recover to <1.5 times the baseline value by 3 months after hospital discharge[59].

CKD and kidney failure

Patients with CKD not on KRT, those with kidney failure on haemodialysis or peritoneal dialysis and transplant recipients can all be adversely affected by disasters. During disasters, many medical factors contribute to adverse outcomes among these patients[9,10,12,21,26,36,41,44,60–67] (Box 1). However, non-medical factors such as the type, severity and duration of the event, the disaster preparedness, training and awareness of relevant parties (including patients, care-givers, health-care personnel, rescuers and policy makers), and the pre-disaster status of the health-care system also influence prognosis.

CKD not requiring KRT. The prevalence of CKD is very high and increasing worldwide; 10.4% of men and 11.8% of women have the disease[68]. If preparedness is adequate, patients with CKD who do not require KRT may remain stable following disasters with short durations. However, this is not always the case and such patients

Box 1

Factors that contribute to the adverse outcomes of patients with kidney diseases during disasters

- Patient follow-up may be suboptimal due to damage to basic infrastructure (such as electricity, tap water, transportation and communication) and health-care infrastructure (such as hospitals, laboratories, dialysis units and imaging equipment) as well as a shortage of highly specialized medical personnel[61,63].
- Suboptimal management of underlying aetiologies of kidney disease (including diabetes mellitus[9], hypertension[9,10] and glomerulonephritis[41,44]) may negatively affect the clinical course, especially in protracted disasters[12,26,62].
- Kidney dysfunction and uraemia-related immune deficiency may increase infection risk during pandemics, in closed communities such as shelters or refugee camps[21] and/or during hospital visits.
- In patients with CKD who require immunosuppressive treatment, discontinuation of this treatment owing to lack of availability may cause rapid deterioration of kidney function, whereas sustained treatment may increase the risk of severe infections during pandemics or in unhygienic conditions[26,60,63,65].
- In transplant recipients, lack of immunosuppressants may result in graft failure[64].
- Even short interruptions in treatment may be fatal for patients on dialysis[61].
- Reduced physical performance, frailty and gait disorders in patients with advanced CKD[66] may interfere with their ability to flee their homes, especially if they reside on upper floors[67].
- Disaster preparedness plans created by health policymakers usually neglect patients with kidney disease because of lack of awareness of kidney disease and the relatively low number of patients with kidney failure[36].
- Many patients with CKD are not diagnosed until an advanced stage of disease is reached; thus, data on the impact of disasters on patients with earlier stages of CKD are lacking.

CKD, chronic kidney disease.

may be at increased risk of rapid disease progression. For example, 5 years after the Great East Japan earthquake, which occurred in 2011, a significant increase in the number of dialysis initiations was reported[69]. This increase was sustained for a decade and associated with an increase in hypertensive renal disease in particular. Several factors, including disaster-associated activation of the sympathetic nervous system, non-adherence with dietary recommendations and inability to obtain antihypertensive medications, may interfere with adequate control of blood pressure and consequently lead to rapid deterioration in kidney function and need for dialysis initiation[69].

Haemodialysis. During disasters, logistical problems, such as interruptions of water and electricity supplies and disruption of infrastructure and communication, may result in several dialysis sessions being missed. Following the Marmara earthquake, many patients received dialysis only once or twice a week for several weeks[70]. During Hurricane Katrina in 2005, missed dialysis sessions were associated with higher odds of hospitalization compared with continued regular treatment[71]. Following Hurricane Sandy in 2012, increases in hospitalizations and in 30-day mortality were noted among patients on dialysis[72].

Detrimental effects of climate change on patients on dialysis were observed following Winter Storm Uri, which resulted in an onslaught of snow, ice and sub-freezing temperatures in Texas, USA, in 2021. Widespread power outages and frozen pipes resulted in water supply problems, and closure of almost all outpatient dialysis units, causing many patients to miss dialysis sessions[73].

During the COVID-19 pandemic, increased demand owing to the dialysis requirements of patients with COVID-related AKI and limited capacity owing to a shortage of dialysis materials and personnel resulted in a deficiency of haemodialysis provision[43]. Delays in arteriovenous fistula surgery, transportation problems and a shortage of personal protective equipment also contributed to disruption of haemodialysis services[60]. A web-based survey found that these problems were more severe in settings with lower resources, and missed treatments were noted in up to half of the surveyed facilities in Africa, Latin America, the Middle East and South Asia[74,75]. Mortality was high not only among patients on dialysis[76] but also among the staff of haemodialysis centres, with some centres in Africa and South Asia reporting ≥50% staff mortality[75].

In addition to underdialysis, suboptimal follow-up and diet may contribute to interdialytic and intradialytic complications during and after disasters[26,77,78]. Unavailability of medications (for example, erythropoiesis-stimulating agents, antihypertensives, phosphate binders, vitamin D preparations and iron)[61,79] may exacerbate comorbidities, especially in protracted disasters. Psychological problems and non-adherence to therapy[80] may also worsen during disasters and trigger complications. Finally, work overload, burnout, panic and extensive stress among dialysis personnel may result in suboptimal health-care provision and potentially even malpractice[62,81,82]. Consequently, the mortality of patients on maintenance haemodialysis during disasters is very high. During the 1992-1995 war in Bosnia and Herzegovina, the annual mortality of patients on maintenance dialysis increased from 10.3% in 1991 to 41% in 1993–1994 (ref. 83). In the Syrian war, lack of access to dialysis, outdated technology and a shortage of medications and nephrologists has contributed to unfavourable outcomes among patients with kidney failure[62]. In the Russian–Ukrainian conflict, shelling of health-care facilities — including dialysis centres — has made dialysis impossible for most of the time in many places. Power outages, cold weather, severe food shortages and a lack of tap water and basic supplies have also resulted in critical disruptions of dialysis services[79,84].

A specific problem arises when patients are connected to haemodialysis machines at the moment of a disaster (for example, bombardment, earthquake tremors or flooding). Dialysis staff may not be able to disconnect all patients simultaneously, which may cause the patients to panic and self-disconnect, potentially resulting in extensive bleeding, subsequent hypotension and shock and fistula problems[26].

Peritoneal dialysis. During and after disasters, patients on peritoneal dialysis may be unable to obtain adequate supplies of dialysis solution[85–88], which may result in underdialysis and subsequent hypervolaemia, electrolyte disturbances, heart failure and hypertension[88,89]. Destruction or shelling of warehouses or disruption in transportation may interrupt delivery of the necessary supplies. Patients may be forced to live in crowded shelters or camps where unsanitary conditions may increase the risk of peritonitis and also exit-site and tunnel infections[21,90].

Some patients on continuous ambulatory peritoneal dialysis (CAPD) need help from relatives or care-givers to do exchanges; if these people are not available, the performance of peritoneal dialysis becomes problematic. For patients receiving automated peritoneal dialysis (APD), lack of electricity may interfere with treatment[26] and, similar to patients on haemodialysis, hurried disconnection at the moment of a disaster may lead to catheter injury or dislocation or peritoneal contamination[88].

Outcomes among patients on peritoneal dialysis following disasters seem to be more favourable than those among patients on haemodialysis; thus, peritoneal dialysis has been recommended as the chronic dialysis modality of choice in disaster-prone areas[91,92]. However, a survey of the global impact of the COVID-19 pandemic on peritoneal dialysis services showed that major disruptions in supplies occurred, particularly in Africa and South Asia[93]. A decline in routine follow-up and training of new patients and an increase in telehealth consultations was noted. Mortality due to COVID-19 was very high (>50%) among patients on peritoneal dialysis in some regions, such as the Middle East[93].

Kidney transplantation. Both incident transplantation activity and the outcomes of previously transplanted recipients may be adversely affected by disasters, mainly as a result of chaotic and unhygienic conditions, disruption of general and health-care infrastructure and shortages of experienced medical personnel and immunosuppressive medications (Box 1).

The number of transplantation procedures may decrease even after short-term disasters, and even in high-income countries. For example, after Hurricane Katrina, kidney transplantations in Louisiana, USA, declined by 21% mainly due to chaos and panic, closure of two of three major transplant centres in New Orleans, shortage of medical supplies, inefficiency and burnout of medical personnel, a decrease in the number of deceased donors owing to limited availability of intensive care unit (ICU) beds and restrictions on organ transport[81].

The frequency of transplantation surgery declines even more dramatically in protracted disasters. During the Syrian war, a 20% annual decrease in kidney transplantation was reported between 2011 and 2015 (ref. 94). Moreover, during the first wave of the COVID-19 pandemic, living donor kidney transplantation was put on hold in 67% of North American and 91% of European centres[95], whereas, in France, deceased donor transplantation was reduced by up to 90.6%[96].

The care of transplant recipients is adversely affected by unhygienic conditions, inadequate nutrition, dehydration, unavailability of immunosuppressive drugs, shortage of experienced personnel, failure to perform clinical, biochemical and immunological follow-up, and unavailability of allograft biopsies[81,94,97]. Following disasters, overall outcomes among kidney transplant recipients are unfavourable, although considerable variation exists.

A meta-analysis showed that transplant recipients with COVID-19 have a significantly higher risk of intensive care unit admission than patients with COVID-19 who were not transplant recipients[98]. During the first wave of the COVID-19 pandemic, COVID-19-related mortality was also considerably higher among transplant recipients than among patients on haemodialysis[40]. This high mortality was mainly attributed to immunosuppression, comorbidities and suboptimal health care[99]. Immunosuppressive treatment in patients with, or at risk of, COVID-19 is a 'double-edged sword', because patients who are immunocompromised have reduced resistance to infection, faster progression of COVID-19 and higher mortality; however, immunosuppression might also have a beneficial effect by interfering with the systemic inflammatory response syndrome that is triggered by SARS-CoV-2 (ref. 100). Interaction of antiviral drugs with immunosuppressants[101] and increased risk of rejection when immunosuppression is reduced are other major concerns[102,103]. Variables such as the clinical status of the patient, laboratory findings, previous immunosuppression, allograft function and most importantly disease severity must be considered when making decisions regarding modifications of immunosuppressive treatment strategy in transplant recipients with COVID-19 (ref. 101).

Mental health conditions

Many individuals who are affected by disasters experience mental health conditions that are triggered by losses, trauma, continuous danger and constrained social and living conditions[104]. These mental health conditions may be particularly pronounced among patients with NCDs[105]. Worsening mental health after disasters is frequent among patients with kidney disease, who have various psychological problems at baseline and face daily existential challenges during disasters[106]. After Hurricane Katrina, 24% of 391 patients on dialysis reported symptoms consistent with post-traumatic stress disorder (PTSD), whereas 46% experienced depression, which was associated with higher risks of hospitalization and all-cause and cardiovascular disease mortality in the year following the disaster[107].

Health-care providers may also suffer from extensive stress, mental health conditions and burnout, mainly due to concerns about their own safety, medical supply shortages and everyday family responsibilities in addition to their high workload[82]. Following the Kobe earthquake in Japan in 1995, increased risk of somatic symptoms, sleep disturbances, anxiety and social dysfunction were frequent among nurses[108]. A systematic review and meta-analysis showed that during the COVID-19 pandemic, insomnia, anxiety, PTSD, depression and stress increased among physicians and nurses, especially among older staff[109]. These problems may be even more prominent among nephrology professionals, whose workload increases considerably during disasters and who face demanding working conditions even under normal circumstances[110]. During the COVID-19 pandemic, the availability of mental health support services for staff varied worldwide, with the highest provision in North America and the Caribbean (84%) and the lowest in South Asia (25%). However, staff members were often unaware of these services[75].

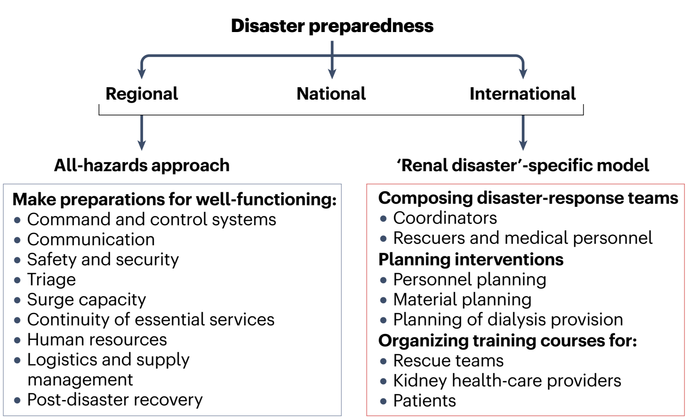

Fig. 1 | Main elements of the disaster response in 'disaster nephrology'. Disaster response and relief preparedness is needed at the regional, national and international levels[44,114]. At each level, consideration of the principles of an 'all-hazards approach', which applies to all types of disasters, in combination with "disaster-specific and/or disease-specific scenarios" may result in the most effective disaster response[44,111–113]. This strategy provides continuity of essential services, well-coordinated implementation of hospital operations at every level, clear and accurate internal and external communication, swift adaptation to increased demands, effective use of scarce resources and a safe environment for health-care workers, and minimizes risks and post-disaster chaos across the spectrum of patients with kidney disease and their health-care providers.

Disaster preparedness

Disaster preparedness at the international, national and regional levels is fundamental to minimize post-disaster disorganization, chaos and disruption of health-care provision. Preparedness models that combine a comprehensive 'all-hazards' approach with a more focused disaster-specific and/or disease-specific approach may achieve the most efficient response[44,111–114] (Fig. 1). The all-hazards approach manages different disasters according to a common plan because all disasters share certain commonalities, such as problems in continuity of essential services, maintenance of hospital services, communication, adaptation to increased demands, effective use of scarce resources and creating a safe environment for health-care workers[111–113]. However, specific approaches are necessary for actions that differ according to the type of disaster or disease. A combination of the two preparedness models enables tailoring of the disaster response to the circumstances of the disaster. Technical details of disaster preparedness policies are outlined in detail elsewhere[111–113,115]. Here, we focus on risk reduction strategies on a regional level to minimize disaster-related threats to patients with kidney disease and health-care providers[115].

Composing disaster response teams

Trained and experienced disaster relief coordinators are critical to minimize disorganization and to make immediate decisions to enable effective interventions during and following disasters[26,61,62,115,116] (Table 2). Selection and training of rescuers, first responders and medical personnel, and their appropriate assignment according to personal skills and experience are essential. The most effective disaster response can be achieved by executing the tasks that are specified by the coordinator(s); however, if they cannot be reached, medical personnel should take appropriate initiatives themselves[115] (Fig. 2). Unfortunately, trained and experienced local disaster coordinators do not currently exist in many disaster-prone regions and countries[117].

Table 2 | Tasks and responsibilities of different stakeholder groups to reduce the risks to patients with kidney disease during disasters[26,61,62,115,116]

Stakeholders	Tasks and responsibilities		
	Before disasters	During disasters	After disasters
Kidney disaster relief coordinators	Create local disaster intervention scenarios and action plans Assign and train sector coordinators Create comprehensive algorithms for solutions to medical and logistical problems Organize and/or conduct translation of relevant guidelines Organize training courses and drills on disaster nephrology Advocate to include disaster medicine courses in medical and paramedic curricula and congresses Contact international organizations for collaboration in case of future disasters	Apply prespecified action plans, which are central in preventing or minimizing chaos, confusion, panic and disorganization in the early hours of the disaster	Assess the efficiency of the disaster response and identify shortcomings for future improvements Identify deficiencies in the treatment of patients with kidney disease to avoid similar mistakes in the future Inform the scientific community on patient outcomes
Kidney health-care providers	Acquire and provide training on disaster nephrology Disseminate relevant information to third parties Train staff and organize drills for management of disaster-related problems Train patients with kidney disease on disaster preparedness and personal disaster response to minimize threats and drawbacks associated with disasters	Apply predefined measures to preserve own safety Apply prespecified interventions and make dynamic changes in case of problems or inefficiency Adapt treatment protocols for those injured or affected by the disaster according to the logistical constraints Refer patients to higher level hospitals if local treatment is impossible	Evaluate local disaster response, specify shortcomings and make adaptations for improvement Screen for and treat long-term disaster-related comorbidities Inform the scientific community on patient outcomes
Patients with kidney disease	Acquire education and training on how to cope with disaster-related medical conditions Apply measures to decrease potential risks (for example, maintain medication stocks) Participate in drills on management of disaster-related problems Request updates on how to comply with disaster circumstances	Apply predefined measures to preserve own safety Take predefined measures to minimize the kidney health risks that are associated with disasters[a] Apply self-treatment protocols if attending physicians or nurses cannot be reached	Be vigilant for any changes in health status Check status of own or alternative health-care facilities for treatment possibilities

This list is not exhaustive. [a]Predefined measures to minimize kidney health risks should be specified separately for patients with chronic kidney disease who are not on kidney replacement therapy, those with kidney failure on haemodialysis and those with kidney failure on peritoneal dialysis, and kidney transplant recipients.

Planning of interventions

Dividing the country into sectors, each with an assigned local coordinator, is a pragmatic approach to organize national disaster response and support. Sector coordinators should be trained in advance to support affected areas and collaborate with the central relief coordinator. They should assess the working capacity of the local personnel, arrange allocation of supplies and personnel to support the affected region, and coordinate acceptance of disaster victims for temporary rescue dialysis or maintenance treatments. The sector coordinators should be in close contact with the central relief coordinator, who is also responsible for organizing support from abroad[46].

Personnel planning to allocate the necessary support is complex because of unpredictable shortages of staff members or their inefficiency due to panic, shock, grief, physical and/or mental injuries to themselves and/or their relatives and loss of properties[7,115]. A national directory of nephrology and dialysis units is important to identify potential sources of material and/or personnel support and for redistribution of patients. Planning and distribution of medical and dialysis supplies is problematic due to the considerable quantities and bulk required. In the Marmara earthquake, 5,137 extra haemodialysis sessions were performed in 477 patients with crush injuries[46]. The problem is further increased if damage occurs to warehouses that store dialysis supplies, necessitating external support[118].

Planning of dialysis provision under chaotic conditions, complicated by increased demand due to new cases of AKI, is the most complex intervention in renal disaster response. Such planning may be easier for foreseeable disasters, such as hurricanes, tsunamis and wars. Applying dialysis ahead of the routine schedule (prophylaxis) for patients on chronic haemodialysis, as was done before Hurricane Sandy[72] and Hurricane Ian[119] in the USA, decreases immediate post-disaster dialysis needs. If dialysis units are damaged, evacuation plans are mandatory for efficient transfer of patients to other centres[92].

Advance plans for potential interventions should be precise, and answer the questions who, what, when and how[115]. All those who will potentially be involved, including patients and their care-givers, must know in advance where they should go to seek care if their dialysis facility is not functional. A solid communication plan is essential and should consider the potential for loss of landline and mobile telephone services. Regular drills are necessary to ensure smooth execution.

Organizing training courses

Rescue team members should be trained in recognition, triage and treatment of medical problems at the site of the disaster and on safe transportation of patients. Training courses should be adapted to the anticipated disasters; for example, focusing on gunshot injuries if war is anticipated, crush syndrome for destructive disasters, and infection control measures for epidemics or pandemics.

Training of kidney health-care providers may also vary by type of anticipated disaster. Although several general principles apply to all patients, treatment principles for those with traumatic injuries (for example, crush injury) and non-traumatic injuries (for example, infection-related AKI) may diverge substantially. Dialysis nurses and technicians should be trained not only to dialyse injured patients but also to take necessary actions when a disaster occurs during ongoing dialysis sessions. Health-care providers must also be trained to protect themselves during disasters and have a plan in place for their families.

Patient education is vital not only for medical reasons but also for logistical reasons. Specific training sessions should provide information on the following: emergency patient preparedness plans; composing and updating a medication stock list and kidney-disease diet; avoiding disaster-related threats (for example, reducing the risk of contracting the disease during a pandemic or minimizing the risk of injuries during destructive disasters); and self-management strategies for medical problems if relevant medical personnel cannot be reached (Table 2).

Stockpiling of medications and supplies (for example, peritoneal dialysis solutions and immunosuppressive medications) is crucial; however, these supplies must be rotated to prevent expiry and waste in the long-term. Such measures have not yet been widely applied even in highly resourced, disaster-prone countries. Before the Great East Japan earthquake in 2011, only 62% of kidney transplant recipients had stockpiled their medications and only 44% always carried their medications with them[120]. In 2018, a US survey found that only 30% of kidney transplant recipients were well prepared for disasters[121]. Another survey showed that only 44.3% of patients on dialysis possessed a detailed medication list after the landfall of Hurricane Sandy[122]. Preparedness was worse among patients on haemodialysis than among those on peritoneal dialysis[123].

Patients on haemodialysis and APD should be trained to disconnect themselves from their dialysis machines safely, either by 'clamp and cut'[124] or 'clamp and cap' techniques[125], and be informed about alternative dialysis centres in case their usual centre is not operational. Patients who have the competences must also be prepared to assist others. Education shortly before anticipated disasters (for example, hurricanes) may facilitate preparation for transportation, informing relatives or stockpiling food and medications. If conditions do not improve, contacting alternative dialysis facilities or relocation is inevitable[115] (Fig. 2). In such cases, it would be helpful if patients have an updated copy of their complete medical history and medication list as electronic records may not be readily available.

The emergency response

The emergency response is initiated by the central disaster relief coordinator, who should be trained on relief activities and ideally should have some experience from previous disasters, which is vital to apply prespecified action plans[115]. If central coordinators become disabled owing to the disaster they should be replaced by prespecified local, and if needed, remote, backup personnel[115] (Fig. 3). Ideally, those who are responsible for coordination in a disaster should be assigned in advance, and a recognized leadership structure, with identified alternative individuals, should be in place to ensure an efficient and effective response.

Emergency response may be provided on the disaster field, in field hospitals, in tertiary care hospitals or in dialysis units. As a disparity often exists between supply and demand for health care, adjustments to usual practice may be necessary, for example decreasing the number or duration of dialysis sessions, decreasing the number of

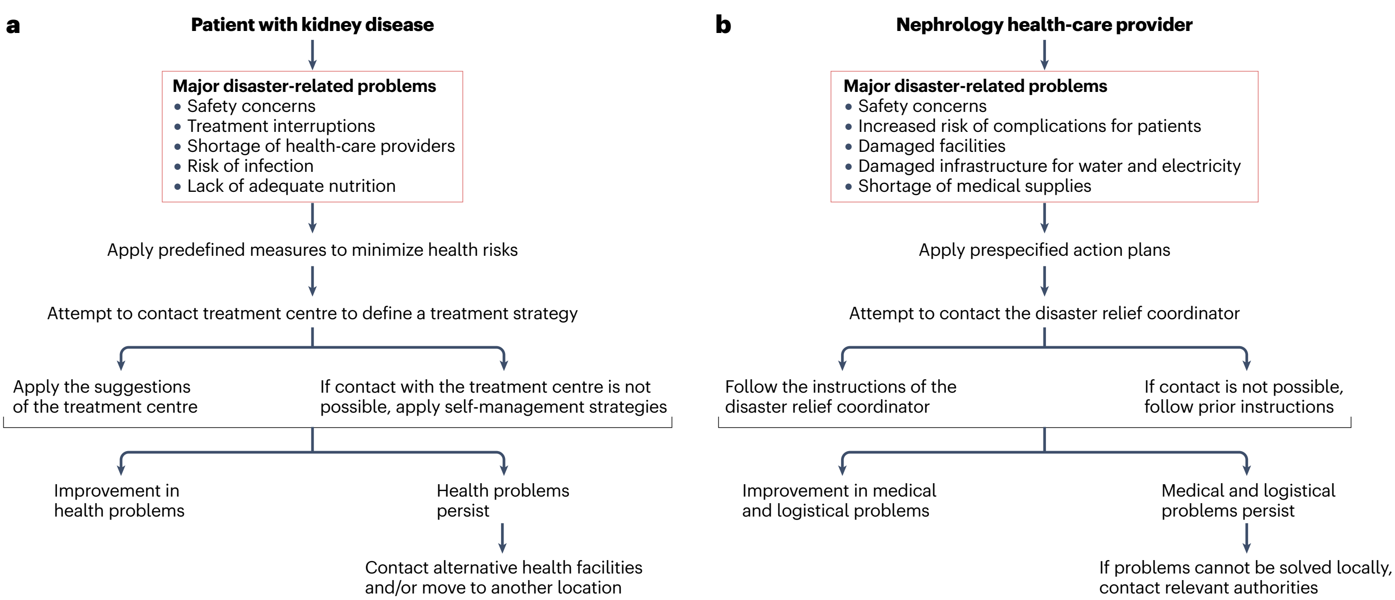

Fig. 2 | Management of disaster-related problems for patients with kidney disease and their health-care providers. a, Following a disaster, patients with kidney disease must try to contact their treatment centre to get information about their future treatment strategies. If the centre can be reached, they should follow the instructions of their health-care providers. However, if communication is impossible, patients should manage their own treatment by applying prior instructions and/or training. If health problems persist, patients should try to contact an alternative health facility or move to another region in the country or abroad. **b**, Nephrology health-care providers should apply prespecified action plans and follow the instructions of the disaster relief coordinator. If the coordinator cannot be contacted, providers should act according to their previous training or established protocols. If medical and logistical problems persist and no prospect for local improvement exists, they should contact governmental authorities, if possible[115].

immunosuppressants in transplant recipients and/or decreasing the number of follow-up visits for patients with CKD. However, such compromises in standards of care carry an increased risk of complications in the long-term[126]. Emergency response strategies may vary across the spectrum of patients with kidney diseases.

Patients with AKI

Interventions for patients with AKI depend upon the underlying aetiology. Antivirals or antibiotics and supportive therapy are the mainstays of treatment during pandemics, whereas rescue, triage, primary survey, first aid and transfer to field hospitals may be life-saving in destructive disasters. Early rehydration is critical to prevent and treat prerenal and subsequent intrinsic renal crush-related AKI and other cases of hypovolaemia[44,127–129] (Fig. 4). Point-of-care devices may enable timely detection and treatment of electrolyte disorders[116].

After initiation of emergency therapies and stabilization, patients with AKI should be transferred to higher-level hospitals with haemodialysis facilities. If transfer is impossible, local dialysis treatment, even with acute peritoneal dialysis, can be life-saving despite the risks of technical problems and infection[86,130,131].

Patients with CKD not on KRT

Medical management of the early stages of CKD during disasters may be facilitated if a private medication stock is available. Optimal treatment of underlying aetiologies (for example, diabetes, hypertension and glomerulonephritis) that may acutely worsen owing to the disaster and/or stress, is important to slow or prevent the development or progression of CKD, especially in protracted disasters, but such treatment may be impossible for logistical reasons[63]. Clinical follow-up and in-person visits may also be hindered, and telemedicine may be required. A survey of 1,164 patients during the COVID-19 pandemic in China showed that 22% utilized telemedicine, including internet consultation, instant message tools, telephone consultation and e-mail for follow-up[63]. Telemedicine may also be very useful to support inexperienced local physicians and nurses providing care during disasters[26].

Patients on haemodialysis

The disparity between supply and demand for health care during disasters is most prominent for patients on haemodialysis. To decrease the demand during the COVID-19 pandemic, dialysis frequency was sometimes reduced to twice weekly. This approach helped to reduce the risk of contracting COVID-19, to provide more space between patients, to reduce transportation needs and to mitigate personnel shortage[132,133]. However, the drawback of this approach was that it was associated with increases in systolic blood pressure, volume overload and pre-dialysis potassium levels[132]. By contrast, reducing dialysis frequency was well tolerated after the Marmara earthquake[70], possibly owing to better adherence of patients to dietary and fluid restrictions. This approach may also be better tolerated by older patients and those with lower ultrafiltration requirements and with normal pre-dialysis potassium and phosphate levels[132], but may be inappropriate for patients with a high risk of hyperkalaemia, such as those with crush injuries and/or cardiac dysfunction. To increase the number of dialysis sessions per machine, sessions can be shortened to 3 h in stable patients[134]. Combining shorter dialysis sessions with lower dialysis frequency may place patients at greater risk of adverse outcomes; therefore, they must be fully informed if this strategy is applied.

In the disaster area, patients on maintenance in-hospital haemodialysis may be referred to nearby satellite units to make space available

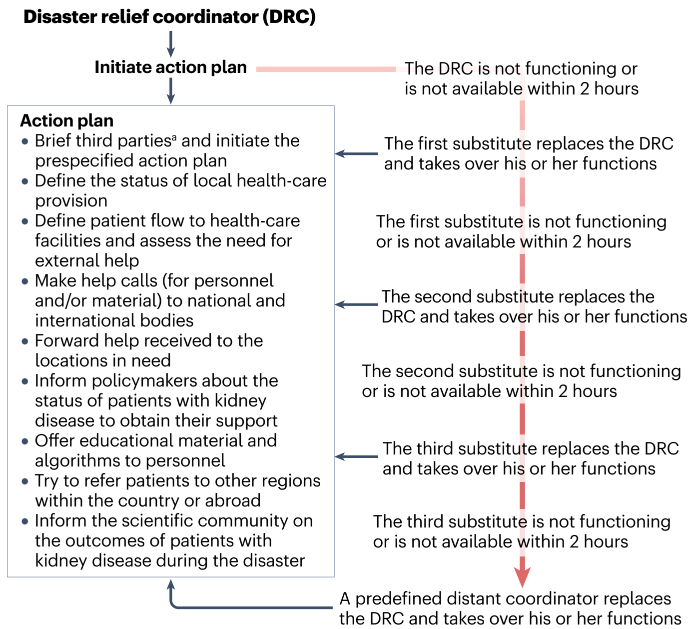

Fig. 3 | Renal disaster action plans for emergency response and organizing relief. Within the first 2 h of the disaster, the disaster relief coordinator (DRC) should brief third parties and initiate the action plan. If the DRC cannot function or is not contactable within the first 2 h, the first local substitute will be automatically assigned. If the first local substitute does not respond or cannot be reached, the second local substitute will act as the DRC. If this scenario is repeated for the third local substitute, a predefined distant coordinator (the fourth substitute) will take over the functions of the DRC. This pragmatic strategy has been effective in past disasters, particularly in the case of communication problems. Adaptations to the action plan considering the type and extent of the disaster, the status of the pre-disaster and post-disaster general and health-care infrastructure of the affected region and the country and local circumstances may be needed to achieve the most effective response. [a]Third parties include authorities, substitute DRCs, the president of the local nephrology society and the nephrology community. Adapted with permission from ref. 115.

in the hospital dialysis units for patients with complex needs, who may need urgent surgical interventions, detailed imaging techniques, close laboratory follow-up and/or ICU admission[46]. If dialysis infrastructure is intact, but a shortage of dialysis personnel exists, working hours may be increased, but this approach increases the risk of burnout and potentially even malpractice[82]. Redistributing personnel from non-functioning to functioning units and/or requesting personnel support from outside the disaster area has been very useful in several disasters[114,116,117]. If extensive damage makes dialysis impossible, evacuation of patients to other regions or abroad may be required[70,81], as was the case after Hurricane Irma[135] and Hurricane Maria[90]. If transportation is a key challenge, the only option is installation of temporary dialysis units near the disaster area, which necessitates shelter for patients and staff[135].

During disasters, home haemodialysis is associated with lower risks than in-centre haemodialysis because communication with dialysis centres, transportation and expert personnel are not required. Furthermore, home haemodialysis minimizes the risk of disease transmission during pandemics[136]. However, home haemodialysis may be disadvantageous in certain circumstances; for example, when

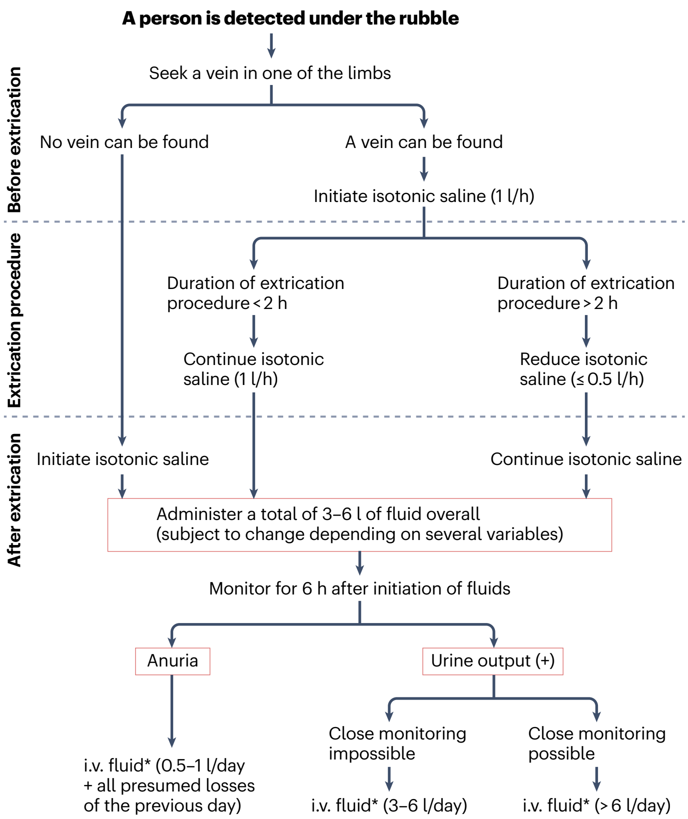

Fig. 4 | Fluid resuscitation for patients with crush injuries before, during and after extrication from rubble. After crush injury, large quantities of fluid may be sequestered in the injured muscles, resulting in compartment syndrome, hypovolaemia and hypoperfusion of the kidneys, which leads to acute kidney injury (AKI). The development of AKI can be prevented by timely administration of appropriate fluids[44,127]. Fluid volumes should be individualized, considering the time spent under the rubble, the length of the extrication procedure, volume status and urine flow, trauma pattern, environmental conditions, such as heat, demographic characteristics, such as age, and the ability to closely monitor the patient[129]. *Bicarbonate solutions (prepared by adding 50 mEq of sodium bicarbonate to 1 l of half-isotonic saline) may correct metabolic acidosis, decrease the risk of hyperkalaemia and prevent intratubular myoglobin and uric acid cast formation, but are usually not available in chaotic disaster conditions. Isotonic saline is preferred because it is effective for volume replacement, readily available and associated with a low risk of complications. The efficacy of mannitol is controversial[128], and empirical usage of potassium-containing solutions is contraindicated in patients with crush injuries. i.v., intravenous. Modified with permission from ref. 129.

electricity infrastructure is destroyed, hospitals are better able to produce electricity via generators than individual homes.

Patients on peritoneal dialysis

Peritoneal dialysis may be more practical than haemodialysis during disasters, because this modality obviates the need for regular transportation and does not depend on tap water distribution, electricity (if CAPD is used) and dedicated personnel[92]. If electricity or batteries are available, APD is even more convenient than CAPD because of a lower risk of peritonitis and higher efficiency. However, finding the ideal catheters and/or fluids may be problematic. Acute catheters improvised from sterile medical tubing (for example, nasogastric tubes or central vein catheters) and dialysate prepared from half-normal saline or Ringer's lactate may be used temporarily[86,130,131]. Reducing the number of peritoneal dialysis exchanges may be considered if there is a shortage of peritoneal dialysis solutions[26].

Patient training on exit-site and catheter care to prevent infections, as well as on self-treatment of complications, is essential, as reaching medical personnel may be impossible[86,137]. Assembling a disaster kit and having the contact information of dialysis suppliers may be useful in case of delivery problems or if patients are evacuated[138].

Kidney transplant recipients

In disaster settings, postponement of new transplantation activity is sometimes the best option[139]. A shortage of immunosuppressants for patients with functioning grafts can be managed by modifying treatment protocols[64] (for example, by changing from triple to double drug regimens while targeting higher blood levels). However, this strategy may increase the risks of rejection and drug toxicity. Training on diet, self-treatment of mild complications and infection prophylaxis are vital, especially if patients are forced to live in crowded shelters after destructive disasters. Timely transportation to other regions or countries is indicated if problems cannot be solved locally.

During disasters, the frequency of in-person hospital visits should be decreased during the first 3 months after transplantation. After 3 months, follow-up of patients by means of telemedicine technology might eliminate the need for in-person hospital visits if blood testing can be performed conveniently elsewhere[140,141]. This approach may be useful to minimize infection risk, decrease hospital workload and eliminate the need for transport during disasters[139,140].

Patients with mental health conditions

Mental health problems are prominent among patients with NCDs, especially older patients with CKD[142], and may necessitate psychological and/or psychiatric advice to differentiate between 'normal' and pathological responses, manage acute symptoms, recognize and treat psychiatric disorders in a timely manner and preserve long-term psychosocial well-being[143]. However, reaching psychiatric experts during disasters is often difficult. Psychological support by telephone was used effectively following the Fukushima disaster in Japan in 2011 (ref. 144). World Health Organization (WHO)-endorsed guidelines recommend services at a number of levels, from basic to clinical care. The latter should be provided by or under the supervision of mental health specialists[145]. Links and referral mechanisms should be established between general health-care providers, social workers, emergency relief services and mental health specialists[145].

Prevention of burnout among nephrology staff during disasters is challenging because of the increased workload and necessity to continue routine care despite shortages of medical supplies and personnel as well as personal stresses[82]. Developing an overarching plan in the pre-disaster period to optimize health-care provision may be useful. Ad hoc disaster-specific organizational measures include decreasing the workload, avoiding depletion of medical consumables and medications, motivating and commending achievements and providing a healthy and relaxed work environment[82]. Creating a good team spirit, maintaining the balance between private and professional life, training on coping with stress, allowing adequate breaks and preserving physical health may be beneficial as well[82].

The post-disaster phase

Disaster interventions do not stop when the disaster ends. Patients with acute or chronic diseases who have survived a disaster should be evaluated and treated for undiagnosed conditions, considering that: first, suboptimal treatment of NCDs during disasters increases the risk of progression and complications[12,146]; second, acute disaster-related disorders, including AKI, may progress to chronic conditions[58,59]; and third, non-urgent or silent medical problems might have been overlooked or neglected during the disaster period[26]. All of these hazards are more prominent after protracted disasters; therefore, evaluation should be performed before the end of the disaster period, if possible.

Once the situation is under control, an in-depth analysis of the activities of stakeholders during disasters should be performed (Table 2) to define approaches that could be improved in the future. Four principal questions should be considered: what was the intention, what was done, why was it done in this way, and what should be done next time?[147].

Displaced patients with kidney disease

Following a disaster, people may leave the affected area for another region within the same country (internally displaced) or to travel to another country as refugees. As of October 2022, 103 million people worldwide were forcibly displaced[148], presumably corresponding to >10 million people with CKD. However, very few reports focus on displaced patients on KRT and almost none focus on those with the earlier stages of CKD.

Displaced patients with kidney disease are faced with additional risks both when travelling and in their new environment. The main threats during their journey include: interruptions in medical treatment and/or dialysis with resulting complications; being separated from their care-givers and normal support systems; legal, cultural and linguistic barriers; and unethical behaviour by accompanying and local people in some areas worldwide. After reaching their destination, logistical and medical problems continue, as observed during Hurricane Katrina[81], and the Kosovo[149] and Syrian conflicts[150]. In Lebanon in 2014, more than 7% of the dialysis population consisted of Syrian refugees, which exhausted the resources of the host country, making treatment interruptions inevitable[151].

Well-planned evacuation of patients with kidney disease is an option to decrease displacement-related problems, although many patients may be reluctant to move. Appropriate nutrition, hygienic and healthy travelling conditions, keeping families together and opportunities to dialyse en route and at the destination should be ensured. Coordinators in host countries who meet patients with kidney disease at the border should perform triage to identify those in need of urgent interventions. Permanent settlement is associated with many difficulties (including provision of health care, ensuring safety, and economic, psychological, social, legal, ethical, cultural and linguistic difficulties), and finding solutions is challenging and necessitates engagement with multiple stakeholders. Return of displaced patients should be discouraged until safety and treatment possibilities have improved in the native region or country[26].

The logistics of health-care provision

The procurement, maintenance, distribution and replacement of personnel and material is indispensable to provide continued health care during mass disasters. Use of external workforce support may be very efficient because these individuals may be less physically or psychologically affected than local personnel, may decrease the workload of the local personnel and may provide moral support. However, unorganized support by unprepared personnel may be inefficient and may only add to the chaos[114]. Likewise, solicited and/or suitable medical supplies may be helpful to replace out-of-order devices and unavailable therapeutics; however, if material is provided that has not been solicited, the need to unpack, sort and destroy useless material may impose unnecessary burden[114].

To organize efficient support campaigns, accurate information is needed from the affected region. The WHO published guidelines on selection, presentation, packaging, labelling and management of donated material, and guidance to donors and recipients[152]. In reality, most donations fail to comply with these guidelines and provide too much or inappropriate material[153]. For example, after the Haiti earthquake in 2010, several thousand litres of unsolicited peritoneal dialysis fluid were destroyed, resulting in loss of manpower, ecological waste and extra costs[116].

Another logistical and ethical concern is how far support should extend. Donations of previously unavailable material or implementation of previously unavailable services may create unsustainable local expectations. Such interventions should ideally be discussed with local officials and providers before implementation. The NCD emergency health kit developed by the WHO may help to provide a structured set of medications, equipment and renewables following disruption of normal medical services, that complies with the essential needs for most common NCDs[154]. Finally, existing medical supplies in disaster areas should be used carefully until effective external support is received.

Ethical considerations

Although fundamental ethical principles such as patient autonomy, non-maleficence (avoiding harm), beneficence (doing good) and justice are non-negotiable, their relative weights may change during disasters

Glossary

Chronic kidney disease
Abnormalities of kidney structure or function that are present for longer than 3 months, with implications for health.

Crush syndrome
Crush injury and muscle damage-induced systemic manifestations, which may include, but are not limited to, hypovolaemic shock, acute kidney injury, electrolyte disturbances, sepsis, acute respiratory distress syndrome and disseminated intravascular coagulation.

Destructive disasters
Sudden calamitous events that result in huge amounts of damage, loss or destruction.

Kidney failure
Glomerular filtration rate <15 ml/min/1.73 m^2. Kidney failure is characterized by signs and symptoms of uraemia or a requirement to initiate kidney replacement therapy (dialysis or transplantation).

Primary survey
A basic survey to identify and simultaneously treat life-threatening conditions. For pragmatic reasons, the injuries are surveyed in an orderly fashion based on the simple mnemonic, ABCDE (airway, breathing, circulation, disability, exposure).

Somatic symptoms
Subjective distress related to physical symptoms, which may include pain, gastroenterological, cardiovascular, genitourinary, neurological and other symptoms.

Third spacing
Fluid shifts into the interstitial spaces or into a body cavity that normally contain little fluid, such as the muscle compartments.

depending on the severity of the event, collective needs, degree of preparedness, availability of resources and cultural and social factors[155].

In view of the disparity between supply and demand for health care, the main ethical concern is fair distribution of limited resources and manpower. The principle of utilitarianism recommends that the highest number of victims should receive the greatest benefit[155–157], which often necessitates triage. Triage criteria are, however, not uniform worldwide. During the COVID-19 pandemic, different countries chose different prioritization strategies[158], which were generally accepted by their populations. Since only a functioning workforce can help victims, priority of care is often given to health-care personnel[139,156], as advised during the COVID-19 pandemic[157]. If resources permit, treatment of the sickest patients who are able to survive should be prioritized. If patients are deprioritized for active care, palliative care must be arranged and ensured. When patients who are in need of the same treatment have similar medical and logistical risks and prognoses, younger age may be a criterion for prioritizing life-saving therapies, including dialysis, as was the case during the COVID-19 pandemic[157,159,160]. However, this option has been criticized because clinical frailty, survival probability or life expectancy do not necessarily correlate with age[159]. Other triage criteria may be the first-come-first-served principle, random selection or even a lottery[26,161], which were also discussed extensively during the COVID-19 pandemic[157,158]. A summit on legal and ethical issues on resource allocation recommended transparency in communication with the public about triage strategies for reducing conflicts at the bedside[162]. Preparation of local guidelines on decision making is needed for future disasters and should involve patients and their care-givers[160].

Conclusions

The incidence of disasters and their adverse consequences for patients with or at risk of kidney diseases is increasing worldwide. AKI is associated with a high risk of poor outcomes regardless of its cause, and the morbidity and mortality of patients with CKD during disasters far exceeds that of the general population. Policymakers must therefore adopt integrated health-care strategies that prioritize prevention, early detection and management of patients with AKI, CKD and their complications[30], and include these strategies in emergency preparedness plans. All stakeholders (health-care providers, authorities, patients and care-givers) should be trained on how to cope with disaster-related medical and logistical problems. Professional societies should consider preparing guidelines for the management of patients with kidney diseases in disasters, as well as providing education on disaster medicine, which differs considerably from routine medical practice. As disasters occur intermittently, and unapplied medical knowledge is easily forgotten, training courses should be repeated frequently to maintain a state of preparedness for these events.

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