Chronic Diseases and Natural Hazards: Impact of Disasters on Diabetic, Renal, and Cardiac Patients

Andrew C. Miller, MD;[1,2,4] Bonnie Arquilla, DO[1,3,4]

1. Department of Emergency Medicine, The State University of New York Downstate Medical Center, Brooklyn, New York USA
2. Department of Internal Medicine, The State University of New York Downstate Medical Center, Brooklyn, New York USA
3. Director of Disaster Preparedness and the Disaster Medicine Fellowship, The State University of New York Downstate Medical Center, Brooklyn, New York USA
4. The New York Institute of Hazard Preparedness, Brooklyn, New York USA

Correspondence:
Andrew C. Miller, MD
Department of Emergency Medicine
450 Clarkson Avenue, Box 1228
Brooklyn, New York 11203 USA
E-mail: andrewcmiller@optonline.net

Keywords: cardiac; chronic diseases; diabetes; disasters; emergency response; Renal Disaster Relief Task Force

Abbreviations:
AMI = acute myocardial infarction
BP = blood pressure
CDE = chronic disease exacerbations
CDC = Centers for Disease Control and Prevention
DM = diabetes mellitus
HD = hemodialysis
PD = peritoneal dialysis
RDRTF = Renal Disaster Relief Task Force

Received: 01 June 2007
Accepted: 07 July 2007
Revised: 05 September 2007

Web publication: 18 April 2008

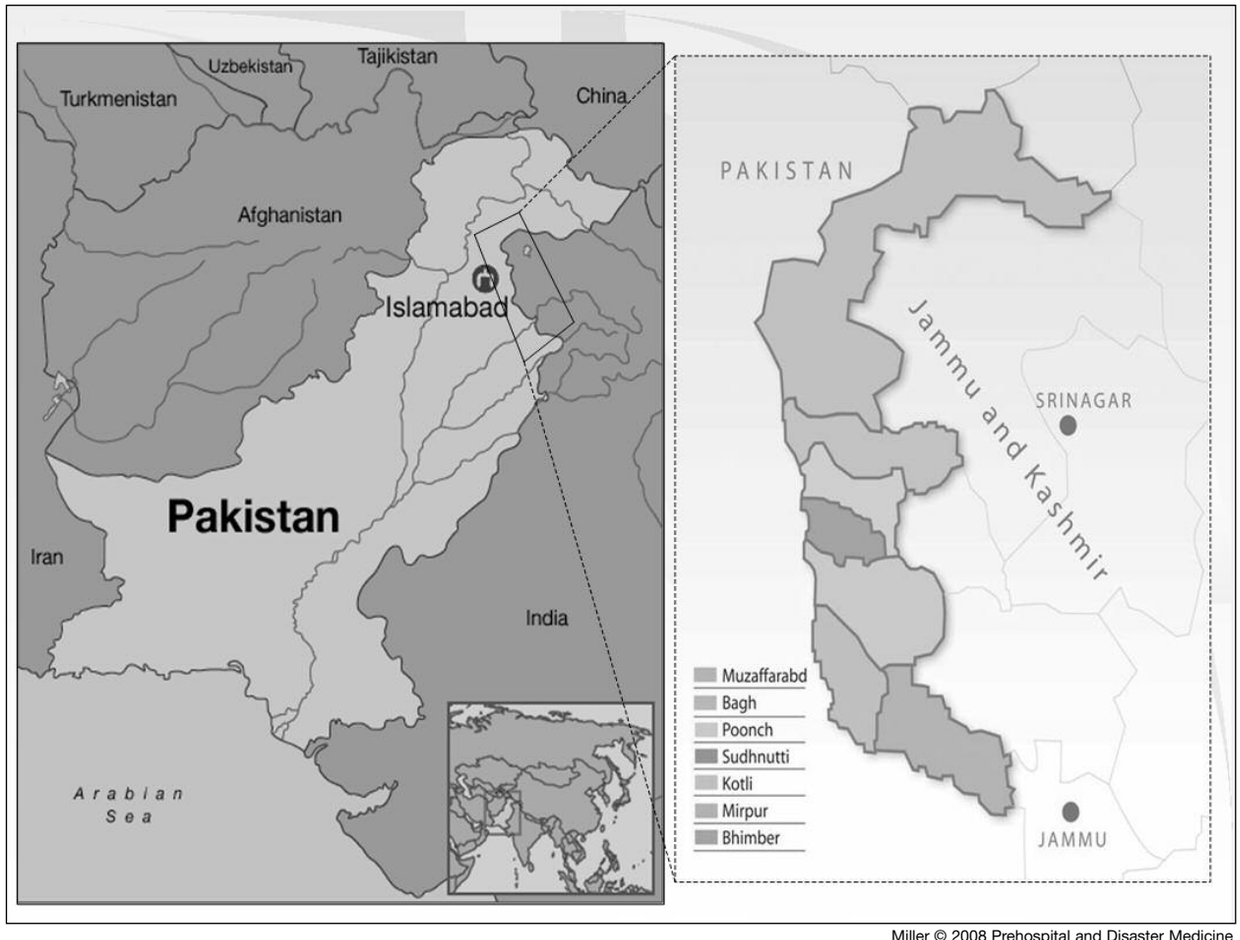
Abstract

Background: Inadequately controlled chronic diseases may present a threat to life and well-being during the emergency response phase of disasters. Chronic disease exacerbations (CDE) account for one of the largest patient populations during disasters, and patients are at increased risk for adverse outcomes.
Objective: The objective of this study was to assess the burden of chronic renal failure, diabetes, and cardiovascular disease during disasters due to natural hazards, identify impediments to care, and propose solutions to improve the disaster preparation and management of CDE.
Methods: A thorough search of the PubMed, Ovid, and Medline databases was performed. Dr. Miller's personal international experiences treating CDE after disasters due to natural hazards, such as the 2005 Kashmir earthquake, are included.
Discussion: Chronic disease exacerbations comprise a sizable disease burden during disasters related to natural hazards. Surveys estimate that 25–40% of those living in the regions affected by hurricanes Katrina and Rita lived with at least one chronic disease. Chronic illness accounted for 33% of visits, peaking 10 days after hurricane landfall. The international nephrology community has responded to dialysis needs by forming a well-organized and effective organization called the Renal Disaster Relief Task Force (RDRTF). The response to the needs of diabetic and cardiac patients has been less vigorous. Patients must be familiar with emergency diet and renal fluid restriction plans, possible modification of dialysis schedules and methods, and rescue treatments such as the administration of kayexalate. Facilities may consider investing in water-independent extracorporeal dialysis techniques as a rescue treatment. In addition to patient databases and medical alert identification, diabetics should maintain an emergency medical kit. Diabetic patients must be taught and practice the carbohydrate counting technique. In addition to improved planning, responding agencies and organizations must bring adequate supplies and medications to care for diabetic, cardiac, and renal patients during relief efforts.
Conclusions: By recognizing and addressing impediments to the care of chronic disease exacerbations after natural disasters, the quality, delivery, and effectiveness of the care provided to diabetic patients during relief efforts can be improved.

Miller C, Arquilla B: Chronic diseases and natural hazards: Impact of disasters on diabetic, renal, and cardiac patients. *Prehospital Disast Med* 2008;23(2):185–194.

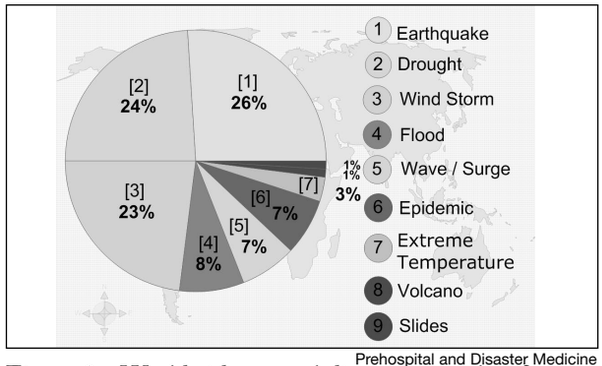
Introduction

Inadequately controlled chronic diseases may present a threat to life and well-being during the emergency response (relief) phase of disasters due to natural hazards. The toll that chronic disease exacerbations exact on populations during large-scale disasters was noted while working with the Islamic Medical Association of North America (IMANA) and the Turkish Red Crescent Society in Muzaffarabad, Pakistan following the 2005 Kashmir earthquake (Figure 1). These patients account for one of the largest patient populations and are at increased risk for adverse outcomes during disasters. A



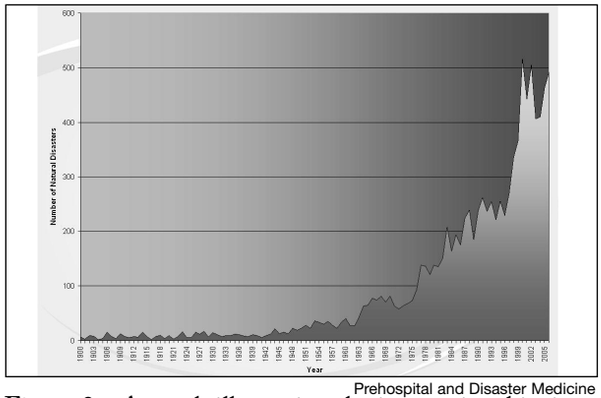
Miller © 2008 Prehospital and Disaster Medicine

Figure 1—Schematic map indicating the location of the 08 October 2005 earthquake centered in Azad Jammu and Kashmir, Pakistan



Prehospital and Disaster Medicine

Figure 2—Worldwide natural disaster mortality from 1970-2006 listed by event type. Total number (n) of fatalities was 2,785,424. Data from EM-DAT: The OFDA/CRED International Emergency Disasters Data Base, Université Catholique de Louvain, Brussels, Belgium



Prehospital and Disaster Medicine

Figure 3—A graph illustrating the international incidence of natural disasters from 1900–2006. Data from EM-DAT: The OFDA/CRED International Emergency Disasters Data Base. Université Catholique de Louvain, Brussels, Belgium.

thorough discussion of all chronic diseases is outside the scope of this manuscript, and therefore, after providing a brief introduction to the epidemiology of chronic disease exacerbations (CDEs) during disasters caused by natural hazards, this paper focuses on issues pertaining to chronic renal insufficiency, diabetes mellitus, and ischemic cardiovascular disease. The progress made by the international nephrology community is compared to the current status of treating diabetic and cardiac patients in similar situations.

Background

Since 1975, the number of persons affected by disasters has steadily risen, as have the number of injured persons and overall mortality (Figures 2 and 3).[1–2] The growing num-

Figure 4—The Muzaffarabad Military Hospital following the 2005 Kashmir earthquake. Photograph courtesy of Dr. Rehana Kausar, President of the Islamic Medical Association of North America (IMANA)

ber and magnitude of natural hazards, in conjunction with the increasing size and number of large urban areas, indicate that the healthcare community must be prepared and equipped to handle large numbers of patients with chronic disease complications in disaster scenarios.

In 2004, the population in Florida endured five hurricanes in 51 days. During this period, 9 million people were evacuated, 8 million residents lost electrical power, and 368,438 people were housed in general and special needs shelters.[3] During the 2005 hurricane season, the healthcare and public health infrastructures of southern Louisiana and Mississippi were decimated.[4] Similarly, the 2005 earthquake in northern Pakistan affected roughly 3.5 million people in three countries, resulted in >86,000 deaths, and left hundreds of thousands of people homeless or displaced.[5,6] The healthcare infrastructure of Muzaffarabad (population 742,000) was destroyed—only one hospital remained functional, though it sustained heavy structural damage (Figure 4).

The response to seismic events such as the earthquakes in Pakistan, Iran, Japan, Turkey, and Indonesia, the south Asian tsunami, and atmospheric-driven events such as the hurricanes that affected the United States Gulf Coast and Caribbean, indicate that during the early phases, much attention is focused on the care and prevention of primary illnesses, such as traumatic injuries. However, secondary illnesses such as CDEs comprise a sizable disease burden, and the care for such patients tends to be delayed until their status becomes serious.[7,8] These health effects may be sustained for several months, as seen following the 1988 Spitak earthquake in Armenia, where the increased morbidity from CDE became a heavy burden.[9,10] During the 1995 Great Hanshin-Awaji Earthquake in Japan, five of the eight most common major illnesses resulting in hospital admission were acute CDEs, including asthma, heart failure, ischemic heart disease, cerebral vascular disease, and malignancy.[11] Surveys of Hurricane Katrina evacuees indicate that up to 41% had ≥1 chronic health condition, and that when subtracting institutionalized adults (≥18 years of age), more than one-fourth of the remaining population, or an estimated 233,876 adults living in the New Orleans-Metairie-Kenner, Louisiana metropolitan statistical area, reported having at least one of the following chronic diseases: hypertension (29%); asthma (12%); diabetes (9%); angina or coronary heart disease (4.6%); history of myocardial infarction (3%); or stroke (2%).[12–15] A limited needs assessment performed in the field following Hurricane Katrina reported to the [US] Centers for Disease Control and Prevention (CDC) that five of the top six conditions treated were CDEs. Chronic illnesses accounted for 33% of the visits, peaking 10 days after hurricane landfall.[16] Excluding injuries, the majority of medical visits were for endocrine, cardiovascular, or psychiatric disorders.[14]

Chronic Renal Failure

Impediments to Dialysis

Dialysis is one of the most widespread, life-saving therapies for chronic illnesses in use worldwide.[17] Treatment of renal dialysis patients is problematic during disasters for logistical and medical reasons. After the Marmara earthquake, almost half (5 of 12) of the hemodialysis (HD) centers were non-functional. Even machines in seemingly undamaged buildings may not work effectively due to infrastructure damage.[18] During the 1999 Chi-Chi earthquake in Taiwan, the five leading causes for HD center failure were: (1) failure of the reverse osmosis system; (2) interruption of the water supply; (3) structural damage to HD facilities; (4) failure of the electrical power supply; and (5) telecommunications failure.[19] Highlighting the importance of the local infrastructure is the fact that dialysis requires a large quantity of controlled, microbiologically pure water (up to 120 L for a standard four-hour treatment, or 360 L per week). If the local water supply is compromised, pure water must be brought into the affected area from outside locations.[17]

Staffing difficulties may further compromise disaster care.[19] After the Marmara earthquake, only 58.4% of doctors, 44.2% of nurses, and 31% of clerical employees were present on the first day following the earthquake, and only 76.8% of the hemodialysis personnel were present one month following the earthquake.[18] This indicates that dialysis units and staff should be prepared to accommodate increased patient volumes with decreased numbers of personnel. For those patients who require dialysis, logistical problems may be encountered with regard to laboratory follow-up. This is largely due to damage of laboratory equipment and supplies, lack of attendance of laboratory technicians, and problems in obtaining laboratory chemicals for analysis.[18]

Primary Solution

The Renal Disaster Relief Task Force (RDRTF)

The Renal Disaster Relief Task Force (RDRTF) was created in the early 1990s by the International Society of Nephrology (ISN) in response to those barriers identified during the 1989 Spitak earthquake in Armenia. In Spitak, little dialysis was initiated before Day 8 following the earthquake.[20-21] The experience in Armenia illustrated how poorly organized relief

Date Completed:		
Personal Information Name:		
Address:		
City:	State:	Zip:
Phone: ( )		
Local Utilities:		
Emergency Contact Name:		
Address:		
City:	State:	Zip:
Phone: ( )		
Insurance Information Medicare:	Medicaid:	Other:
Policy Number:		
Your Dialysis Center Name:		
Address:		
City:	State:	Zip:
Phone: ( )		
Head Nurse:		
Nephrologist:		
Emergency Dialysis Center Name:		
Address:		
City:	State:	Zip:
Phone: ( )		
Head Nurse:		
Nephrologist:		
Medical Information Primary ESRD Diagnosis:		
Other Medical History:		
Medications:		
Allergies:		
Dialysis Access:		
Other Surgeries:		
Type of Treatment:	Center Hemodialysis:	CAPD:
	Home Hemodialysis:	CCPD:
	Intermittent Peritoneal Dialysis:	
Dialysis Prescription Dialyzer:	Dialysate:	Hours/Run:
Times/Week	Dry Weight:	Average Weight Gain:
Heparinization:		
Access Site:	Needle Site:	Blood Flow Rate:
Re-Use: Yes ( ) No ( )	Lidocaine: Yes ( ) No ( )	
Blood Type:	Transfusion Reaction (specify):	
Special Needs/Problems:		

Figure 5—Dialysis Patient Database—This form should be completed by the patient in conjunction with their dialysis provider as a means to effectively prepare for and convey their health information in the event of an environmental disaster

efforts may result in a chaotic influx of people and material, which overload available distribution systems and interfere with the transport of necessary supplies.[22] In response, the RDRTF was established to organize renal care during large-scale disasters, an approach that has proven to be useful and effective. The RDRTF is organized into rescue structures dividing the world into three geographical areas.[5,20] The organization offers personnel, material, advice, and psychological support to healthcare providers during any disaster that involves patients with chronic renal disease.[5] Recent interventions include: the 1999 Marmara earthquake in Turkey; the 2003 Bam earthquake in Iran; Hurricane Katrina in the US (2005); the 2005 Kashmir earthquake in Pakistan; the 2006 collapse of an exhibition hall in Poland; the 2006 Yogyakarta earthquake in Indonesia; and the 2006 Israeli-Lebanese War.

Additional Treatment Solutions

Chronic dialysis patients living in disaster-prone regions must be informed of and educated to comply with disaster plans including diet, fluid restriction, and dialysis modification.[19] In the event of a disaster, they should follow fluid restrictions strictly and avoid ingestion of food rich in potassium. Instructions dedicated to patient education in disaster conditions also should inform patients about omitting one or even two dialysis sessions per week, which might be tolerated without problems if strict fluid restriction, rescue therapy, and emergency diet policies are followed.[19,23] As part of disaster planning, patients should be provided with information on how and where to seek alternative, pre-determined, in-city or outside dialysis care for at least a limited period of time.[18–19] Medical alert jewelry (bracelet or necklace) identifying the individual as a dialysis patient is recommended. A dialysis patient database (Figure 5) has been devised to assist in information transmittal and improve patient care under emergent and non-emergent scenarios. Patients are recommended to keep it on their person at all times. If patients must go to a shelter, they immediately should inform personnel of their special health needs.[23] Additionally, it is recommended that individuals maintain personal stores of potassium exchange resins for use to prevent hyperkalemia in case dialysis treatment cannot be reached in the first days following the onset of a disaster.[24–25] For example, after the Marmara earthquake, physicians successfully utilized kayexalate and sorbitol, both to treat hyperkalemia and as a means to extend inter-dialysis intervals.[20]

Governments and relief agencies also may consider alternative dialysis techniques when applicable. During the 2000 Turin flood in northern Italy, the local water supply was compromised. The University of Turin was able to overcome the emergency and support other dialysis centers in Turin through its policy of maintaining the water-independent hemofiltration (HF) technique as a "rescue treatment".[17] Thus, while stockpiling supplies and training staff members, organizations also may consider utilizing a water-independent, extracorporeal dialysis technique. Despite maintaining such a back-up plan, when suitable water is available, intermittent HD should be the preferable treatment modality due to the ability to treat more patients per day per dialysis position.[26]

Hemodialysis centers also must be equipped with emergency generators and emergency plans for obtaining water should the water supply be interrupted. The lack of water following the Chi-Chi earthquake was overcome in part by pumping underground water and by water tank truck supply from public or private sources.[19] Such water trucks also were utilized following the Hanshin-Awaji earthquake and are advocated by the US Centers for Disease Control and Prevention (CDC) when necessary.[25,27,28] Guidelines for bringing a hemodialysis facilities' water system back online following suspected contamination after an environmental disaster are available from the CDC.[27,28]

Lastly, it is recommended that treatment facilities maintain an alternative communication system such as satellite telephones for use in disaster scenarios as landlines and cellular telephone networks may not be functioning or overloaded during disasters.

When discussing issues of dialysis in disaster scenarios, inevitably the issue of the cost-effectiveness and efficiency of providing dialysis in such an environment arises. There is no clear-cut answer. Whenever possible, it is suggested that dialysis patients stable for transport be moved to an outside location where they may receive dialysis for a temporary period. The reasoning for this is three-fold. First, as outlined above, there may be a paucity of dialysis stations, staff, and supplies in the afflicted area, and relieving as much of the patient load as possible helps to ensure that those in need of emergent HD have a greater likelihood of having their needs met. Also, apart from chronic HD patients, there may be a substantial need for emergent HD for victims of crush injury. Lastly, particularly with regard to earthquakes, a suitable HD facility may become unsuitable. Thus, the fewer patients in the affected area requiring HD, the more likely it is that the local facilities and relief operations will be able to meet the demand.

Considerations for Peritoneal Dialysis Patients

Patients receiving peritoneal dialysis (PD) typically are more independent and capable of providing necessary dialysis information than are those receiving hemodialysis.[4] However, they are dependent on certain supplies, and if using automated systems, electricity. Due to disruption of the electrical power supply, patients using automated systems may be required to switch their dialysis to manual exchanges.[19,24] Similarly, establishing pre-designated locations for PD shelters may be helpful, particularly for those patients who prefer to stay with their families in the disaster area, yet are unable to return to their homes. It is important that PD patients know the location of at least one alternative PD facility in the vicinity, and that they store a sufficient (at least 1 week) supply of medicines, dialysate, and other supplies. Patients also must be informed to register with their local water and power companies for priority service, and should be educated to understand and utilize the flexibility of PD, including the flexibility of the exchange schedule, frequency, and method.[24,29]

The extensive planning of the PD community in the US Gulf Coast region illustrates how effective planning can mitigate morbidity and mortality during disasters. For two years prior to Hurricane Katrina, PD providers engaged in

Diabetes Emergency Medical Kit

1. Oral Medication (7-day supply) if appropriate
2. Insulin (7-day supply)
3. Insulin Delivery Supplies
4. Lancets
5. Glucometer
6. Batteries (for meter and/or pump)
7. Flashlight
8. Rapid-onset glucose source
9. Glucagon emergency kit
10. Diabetes Patient Database
11. Medical Alert Identification

Table 1—List of supplies that all diabetic patients should have stored in a safe and easily accessible location

quarterly disaster plan discussions with patients that evolved into monthly discussions during the hurricane season. Patients were provided with information for emergency preparedness, contact information for PD nurses, dialysis supply company information, New Orleans Dialysis Clinic (DCI) emergency and corporate numbers, and PD program numbers in their evacuated city. Approximately 60 hours prior to landfall, the PD nurse contacted patients to remind them of the disaster plans, fluid restriction, and need for emergency supplies. Arrangements were made for patients to pick up limited additional supplies, and prescription refills were called into designated pharmacies. Of 22 PD patients in the DCI program, 17 evacuated before the storm, one was not in the strike zone and thus, not required to evacuate, two lived in areas not affected by the storm and were evacuated after the storm, and two were rescued from flooded homes and evacuated. Twenty-four hours later, the PD nurse re-contacted each patient (mostly by text messaging). Thanks to pre-developed standing orders for the treatment of common complications of PD including exit site infection, early peritonitis, volume overload, the management of hypertension, and insulin adjustment with and without sliding-scale insulin coverage, PD nurses were able to successfully address such issues when nephrologists were not available.[4]

Diabetes Mellitus

Effects of Disasters on Diabetic Patients

Diabetics often experience poor glycemic control after a lengthy duration in an unfavorable environment.[30–31] Glycemic control suffers, and patients are at increased risk for morbidity and mortality due to diabetic complications. Among the most recent and dramatic events highlighting the care of diabetics in disaster scenarios, occurred following Hurricane Katrina in the US Gulf Coast region, where hundreds of thousands of evacuees flooded shelters and neighboring communities. In the first few days after the hurricane, obtaining the necessary diabetic supplies was a major problem. Approximately 9 to 11% of the population previously living in the Orleans and Jefferson parishes of New Orleans had diabetes.[15,32] Therefore, the Civic Center in Baton Rouge that housed >6,000 individuals would have had to care for >600 individuals with diabetes in this shelter. Given that roughly 1 million individuals evacuated, about 100,000 individuals with diabetes now had to cope with the stresses of finding medications, testing supplies, food, and shelter. They also were at greater risk for concurrent illnesses such as soft tissue infections. Obtaining the required anti-diabetic medications was a particular problem for those in shelters. With no medical records to review, treatments were based on patient memory and knowledge. Replacement medication, at least initially, did not match their normal regimen, and was related simply to availability of pharmacologic agents. For example, an individual whose regimen pre-Katrina consisted of basal insulin (glargine) combined with shorter-acting analogs (asparte) would have to settle for what the shelter was able to obtain, generally NPH or regular insulin. Those on glitazones or newer secretagogues may have had to settle for a generic sulfonylurea and/or metformin during this time. Local, chain, and charity pharmacies filled prescriptions on an emergency basis, often a 7- to 14-day supply of medications, but typically did not provide glucose testing supplies.[32]

The lack of diabetes medications and supplies for during disasters was not unique to the post-Katrina environment. Following the 1992 Category 5 Hurricane Andrew in Florida, a special operations response team found that insulin supplies were exhausted within 24 hours.[33] Similarly, insulin-loaded syringes were found to be among the most needed supplies among the elderly following the September 1995 Category 3 Hurricane Marilyn in the US Virgin Islands.[34] In Kashmir (2005), diabetic supplies were rapidly depleted and not replenished. While blood glucose measurements were available in Kashmir, treatment was restricted to hydration, a scant supply of Insulin Lantus (long-acting), and there was a paucity of oral medication.[7]

Numerous studies have shown that HbA_{1C} (%) levels and insulin requirements during disasters, such as earthquakes and hurricanes, rise significantly as do observed diabetic complications.[30,31,35–39] After the Hanshin-Awaji earthquake, even patients who reported no interruption in their medication regimens experienced a significant increase in their HbA_{1C} levels.[35] The clinical implications of the elevation of post-disaster HbA_{1C} levels warrants further study; however reported post-earthquake diabetic complications include diabetic ketoacidosis (DKA), hyperosmolar, non-ketotic comas (HONC), hypoglycemic comas, gangrene and other soft tissue infections, pneumonia, and brain hemorrhage.[35–36] Long-term complications include worsening diabetic nephropathy necessitating new hemodialysis, stroke, deterioration of retinopathy, deterioration of cataracts, and tuberculosis infection.[35] Additionally, after the 1992 Hurricane Iniki in Kauai, diabetes-related deaths increased 161% (relative risk = 2.61, 95% CI 1.44– 4.74).[37]

As an important aside, one must recognize that it is not only long-standing diabetics who experience diabetes-related complications following seismic events. Indeed, following the greater Los Angeles earthquake of 17 January 1994, Kaufman *et al* noted a dramatic surge in the number of admissions for newly diagnosed, insulin-dependent diabetes mellitus admitted to Children's Hospital of Los Angeles.[40]

Date Completed:			
Personal Information Name			
Address:			
City:	State:	Zip:	
Phone: ( )			
Emergency Contact Name:			
Address:			
City:	State:	Zip:	
Phone: ( )			
Insurance Information			
Medicare:	Medicaid:	Other:	
Policy Number:			
Your Primary Medical Center Name:			
Address:			
City:	State:	Zip:	
Phone: ( )			
Physician:			
Alternative Medical Center Name:			
Address:			
City:	State:	Zip:	
Phone: ( )			
Physician:			
Medical Information Pertinent Medical History			
Diabetes	Type (Insulin Dependent vs. Non-Insulin Dependent)		
	Oral Medications		
	Insulin Regimen		
Asthma	Hospitalized	ICU Admission	Intubated
	Average Peak Flow	Steriod Use	
CAD	Catheterization	CABG	EF
COPD	Home O_2	BIPAP	
ESRD/CRI	Baseline Creatine	On Dialysis	Type
	*See Dialysis Patient Database		
Other Medications			
Allergies			
Surgeries:			
Blood Type:	Transfusion Reaction (specify):		
Special Needs/Problems:			

Figure 6—Diabetic Patient Database—This form should be completed by the patient in conjunction with their dialysis provider as a means to effectively prepare for and convey their health information in the event of an environmental disaster.

Impediments to Care

The causes of impaired glucose control and elevated HbA_{1C} levels are multi-factorial, but have been noted to include overeating due to hunger, fear, interruption of medications and exercise regimens, and disruption of the water and gas supplies, which limited cooking capabilities.[40] Baba *et al* reported that after the Hanshin-Awaji Earthquake, supplies of insulin and other drugs for diabetics were depleted, and there was rapidly increased anxiety among diabetics due in part to inability to reach their doctors and their altered medication regimens.[41] Additionally, most of the rationed foods following the Hanshin-Awaji and Marmara (1999) earthquakes were heavily carbohydrate-loaded.[30,31,35–36] Of those patients examined by physicians at shelters, significant impairments to care were misplaced medical charts and lack of patient knowledge of their treatment regimens.[35]

Solution

To prevent the negative influence of disasters on metabolic control and quality of life, countries must develop emergency aid and action plans for diabetics.[30,31] All diabetic patients should maintain a diabetes emergency medical kit (Table 1). First, diabetics should wear some form of medical alert identification, because in a medical crisis, the patient may be unconscious, obtunded, or unable to communicate effectively with relief workers.[42–43] Additionally, patients should carry copies of their Diabetic Patient Database (Figure 6) on their person at all times.[43] Diabetics should be encouraged to learn the carbohydrate counting approach, and to be aware of the importance of the carbohydrate/insulin ratio, as it may be useful under certain circumstances, such as when diabetics do not have insulin or adequate food supplies.[30,31] Diabetes educators should add this item to their diabetes education and disaster planning programs. By incorporating diabetes specialists into disaster planning and relief efforts, organizations can enhance the quality, delivery, and effectiveness of the care provided to diabetic patients during relief efforts.

Cardiovascular Diseases

Effects of Disasters on Cardiovascular Patients

It is known that acute psychological and physical stress raises blood pressure (BP) in humans and experimental animals. Following the Hanshin-Awaji Earthquake, the BP of hypertensive patients residing within 50 km of the epicenter on the day of the earthquake was higher than that just before the earthquake (+11/+6 mmHg; p <0.01 for systolic BP and p <0.05 for diastolic BP).[44] A study by Kario *et al* revealed a median (25^{th} to 75^{th} percentiles) increase in systolic BP from 152 to 170 mmHg (p <0.0001), and a median increase in diastolic BP from 83 to 91 mmHg (p <0.0001) after the Hanshin-Awaji earthquake.[45] These values returned to baseline by 3 to 5 weeks, but the earthquake-induced BP increase was prolonged in patients with microalbuminuria—lasted at least two months post-event, and was less pronounced in patients who had been treated with an alpha-blocker alone compared to those treated with calcium channel antagonists.[46] This suggests that activation of the sympathetic nervous system may be the mediating mechanism.

Cardiovascular-associated morbidity and mortality is known to increase dramatically during disasters.[10,47–50] The number of deaths due to ischemic heart disease was significantly elevated following the Rhode Island blizzard of 1978 and the Maine Ice Storm of 1998.[50,51] A three-fold increase in cardiac deaths was observed following the 1978 earthquake in Thessalonika, Greece (R2 = 3.0, 95% CI = 1.5–5.9),[47] and the 1994 Northridge earthquake in Southern California.[52] Brown *et al* found a 110% increase in admission rate for acute myocardial infarction in Los Angeles County on the day of the earthquake, compared with the average of the seven days before the earthquake (z = 4.349, p = 0.001), and a >80% increase of admission for acute myocardial infarction (AMI) compared with the same date in 1995 (RR 1.828, 95% CI 1.289-2.592).[52] Leor *et al* found a more modest yet still significant increase (35%) in the number of admissions for AMI after the Northridge earthquake (from 149 to 201). Although the number of myocardial infarctions was higher in both groups, hospitals located ≤15 miles from the earthquakes epicenter had a markedly higher increase than did those located ≥15 miles from the epicenter (p = 0.01).[53] Suzuki *et al* reported a 3.5 fold increase in the number of patients with AMI following the Hanshin-Awaji Earthquake.[48–49] The percentage of patients without prodromal angina pectoris had risen to 53% from a baseline of 15%, and the increased cardiovascular mortality persisted for up to eight weeks.[9,48,49]

The elevated cardiovascular-associated morbidity and mortality during disasters due to natural hazards is thought to be the product of multiple variables. It has been postulated that the neurohormonal, hemodynamic, and coagulation changes associated with physical or emotional stress may cause rupture of a vulnerable atherosclerotic plaque, platelet activation, and coronary artery vasoconstriction.[49,54,55] Emotional stress has been correlated with coronary artery vasoconstriction in individuals with coronary artery disease, and also has been shown to activate platelet aggregation.[49,56] Numerous blood viscosity determinants were shown to be elevated following the Hanshin-Awaji earthquake including hematocrit (p <0.001), fibrinogen (p <0.05), as was the Von Willebrand factor (p <0.01), D-dimer (p <0.0001), and plasma inhibitor complex (p <0.05). With the exception of the Von Willebrand factor, these abnormalities were transient and decreased to pre-earthquake levels by 4 to 6 months after the earthquake.[45] The transient increase in post-earthquake BP is thought to be due to activation of the sympathetic nervous system.[46] Diabetic patients with microalbuminuria have reduced nitric oxide synthesis compared with those who have normal albumin excretion.[57] This altered nitric oxide activity might influence catecholamine-induced vascular reactivity.[46] Vascular reactivity to noradrenaline also is exaggerated in microalbuminuric patients.[58] Thus, it is reasonable to believe that endothelial damage and altered vascular reactivity of the microvascular resistance vessels associated with microalbuminuria could mediate the prolonged earthquake-induced increases in blood pressure.[46] This increase in blood pressure, in conjunction with the neu-

rohormonal, hemodynamic, and coagulation changes associated with physical or emotional stress may work in concert to mediate the increased cardiovascular-associated morbidity and mortality during disasters.[49,54,55]

Solution

In disaster scenarios, people often arrive at shelters without vital medications, healthcare information, or records. Likewise, under conditions of profound stress, patients may not be able to recall vital healthcare information. Just as with dialysis and diabetic patients, it is recommended that a medical information card or form be kept with the patients prescriptions or preferably on their person at all times. Such a form can be laminated or kept in a resealable plastic bag for protection. Patients with cardiovascular disease often have multiple other co-morbidities, thus, the presence of an easily accessible form of medical record will both improve patient care and patient knowledge.

A heart-healthy, low-sodium, low-fat food selection should be standard fare in shelters. This may be accomplished best by using prepared meals similar to the military's ready-to-eat meals.[3]

Administrative Impedance to Disaster Preparedness and the Need for Changes in Policy

Despite the forward thinking and preparation by some residents of New Orleans, many patients seeking shelter at the Superdome suffered significant setbacks. Patients seeking shelter at the Louisiana Superdome were registered before entry was permitted. This registration process included a search of personal belongings. During the search, if patients had medications in containers other then the original dispensed container (such as pill boxes sorting multiple medications by day of the week and time of day), these were confiscated and destroyed.[4] Many patients with medications prepackaged in pill containers left home with enough medication for the presumed 3- to 4-day evacuation period, only to have their medications taken from them prior to the storm. Furthermore, despite recommendations for patients to keep an adequate supply of medications available for emergencies, prescription refill policies of commercial insurance, Medicare part-D providers, and Medicaid do not allow refills except once per 30-day period at local retail pharmacies. Shipment of 90-day prescriptions through mail-order pharmacies generally must wait until at least 10–14 days prior to the end of the refill period.[4,23] Such policies make it difficult if not impossible for patients to comply with the recommendations for medication management in their disaster plans. A rapid solution to these impediments is not readily available. With the help of national medical organizations and healthcare policymakers, current policies must be changed and amended to both allow for adequate disaster preparation, and to decrease the impact and need to seek medical attention for CDEs during disasters due to natural hazards.

Conclusions

Inadequately controlled chronic diseases may present a threat to life and well-being during the emergency response phase of disasters. Since 1975, the number of disasters due to natural hazards and persons affected has risen steadily, and the number of mortalities and wounded are on the rise as well.[1–2] In recent years, numerous such disasters have focused the world's attention on medical relief efforts in the wake of such events. The international nephrology community has responded to dialysis needs by forming a well-organized and effective organization called the RDRTF. The response to the needs of diabetic and cardiac patients has been less vigorous. When discussing such issues, the question of whether each subspecialty organization should form its own task force frequently arises. This probably is not the most efficient and effective answer. The special needs of dialysis patients lend themselves well to such a solution. Diabetic and cardiac patients probably are better served by improving the preparation and response of established relief agencies. Patients must be educated on disaster preparation, which may range from the large scale to local practice and drills. It is urged that patients wear some form of medical alert identification, and that they carry essential medical information on their person such as the patient databases provided. Patients must be familiar with emergency diet and renal fluid restriction plans, possible modification of dialysis schedules and methods, and rescue treatments such as kayexalate. Also, facilities may consider investing in water-independent extracorporeal dialysis techniques as a rescue treatment. In addition to the patient database and medical alert identification, diabetics should maintain an emergency medical kit, and be taught and practice the carbohydrate counting technique. By recognizing and addressing effects of natural hazards on people living with chronic diseases, the quality of care provided to these patients during relief efforts can be improved.

References

1. Braine T: Was 2005 the year of natural disasters? *Bull World Health Organ* 2006;84(1):4–6.
2. EM-DAT: The OFDA/CRED International Emergency Disasters Data Base. Université Catholique de Louvain, Brussels, Belgium. Available at http://www.em-dat.net/.
3. Baggett J: Florida disasters and chronic disease conditions. *Prev Chronic Dis* 2006;3(2):A66.
4. Kleinpeter MA, Norman LD, Krane NK: Dialysis services in the hurricane-affected areas in 2005: Lessons learned. *Am J Med Sci* 2006;332(5):259–263.
5. Vanholder R, van der Tol A, De Smet M, Hoste E, Koc M, Hussain A, Khan S, Sever MS: Earthquakes and crush syndrome casualties: Lessons learned from the Kashmir disaster. *Kidney Int* 2007;71(1):17–23.
6. The National Geophysical Data Center of the National Oceanic and Atmospheric Administration. Available at http://www.ngdc.noaa.gov.
7. Miller AC, Arquilla B: Chronic renal insufficiency and diabetes mellitus following disasters: A model for reform. *Prehospital Disast Med* 2007;22(2):s127.
8. Ohl CA, Taspell S: Flooding and human health. *BMJ* 2000;321(7270):1167–1168.
9. Ogawa K, Tsuji I, Shiono K, Hisamichi S: Increased acute myocardial infarction mortality following the 1995 Great Hanshin-Awaji earthquake in Japan. *Int J Epidemiol* 2000;29(3):449–455.
10. Armenian HK, Melkonian AK, Hovanesian AP: Long term mortality and morbidity related to degree of damage following the 1998 earthquake in Armenia. *Am J Epidemiol* 1998;148(11):1077–1084.
11. Matsuoka T, Yoshioka T, Oda J, Tanaka H, Kuwagata Y, Sugimoto H, Sugimoto T: The impact of a catastrophic earthquake on morbidity rates for various illnesses. *Public Health* 2000;114(4):249–253.

12. The Henry J Kaiser Foundation: Survey of Hurricane Katrina evacuees. Washington, DC. 2005 Sept 16. Available at http://www.kff.org/newsmedia/upload/74001pdf.
13. Brodie M, Weltzien E, Altman D, Blendon RJ, Benson JM: Experiences of hurricane Katrina evacuees in Houston shelters: Implications for future planning. *Am J Public Health* 2006;96(8):1402–1408.
14. Mokdad AH, Mensah GA, Posner SF, Reed E, Simoes EJ, Engelgau MM, Chronic Diseases and Vulnerable Populations in Natural Disasters Working Group: When chronic conditions become acute: Prevention and control of chronic diseases and adverse health outcomes during natural disasters. *Prev Chronic Dis* 2005 Nov;2 Spec no:A04.
15. Ford ES, Mokdad AH, Link MW, Garvin WS, McGuire LC, Jiles RB, Balluz LS. Chronic disease in health emergencies: In the eye of the hurricane. *Prev Chronic Dis* 2006 Apr;3(2):A46.
16. Centers for Disease Control and Prevention (CDC): Morbidity surveillance after Hurricane Katrina—Arkansas, Louisiana, Mississippi, and Texas, September 2005. *MMWR* 2006;55(26):727–731.
17. Piccoli G, Pacitti A, Mangiarotti G, Jeantet A, Mezza E, Segoloni GP, Piccoli GB: Blade Runner, blackout and haemofiltration: Dialysis in times of catastrophe. *Nephrol Dial Transplant* 2005;20(3):663–664.
18. Sever MS, Erek E, Vanholder R, Kalkan A, Guney N, Usta N, Yilmaz C, Kutanis C, Turgut R, Lameire N. Features of chronic hemodialysis practice after the Marmara earthquake. *J Am Soc Nephrol* 2004;15(4):1071–1076.
19. Hwang SJ, Shu KH, Lain JD, Yang WC: Renal replacement therapy at the time of the Taiwan Chi-Chi earthquake. *Nephrol Dial Transplant* 2001;16 Suppl 5:78–82.
20. Vanholder R, Sever MS, De Smet M, Erek E, Lameire N: Intervention of the Renal Disaster Relief Task Force in the 1999 Marmara, Turkey earthquake. *Kidney Int* 2001;59(2):783–791.
21. Vanholder R. Intervention of the renal disaster relief task force (RDRTF) in the Kashmir earthquake. *Nephrol Dial Transplant* 2006;21(1):40.
22. Solez K, Bihari D, Collins AJ, Eknoyan G, Eliahou H, Fedorov VD, Kjellstrand C, Lameire N, Letteri J, Nissenson AR, *et al*: International dialysis aid in earthquakes and other disasters. *Kidney Int* 1993;44(3):479–483.
23. Preparing for Emergencies: A Guide for People on Dialysis. The Centers for Medicare and Medicaid Services. The US Department of Health and Human Services. Available at http://www.medicare.gov/Publications/Pubs/pdf/10150.pdf.
24. Sakai R. The Japanese experience during the Kobe Earthquake: Management of continuous ambulatory peritoneal dialysis patients in a disaster. *Ren Fail* 1997;19(5):693–699.
25. Naito H: The basic hospital and renal replacement therapy in the Great Hanshin Earthquake. *Ren Fail* 1997 Sep;19(5):701–710.
26. Sever MS, Erek E, Vanholder R, Yurugen B, Kantarci G, Yavuz M, Ergin H, Bozfakioglu S, Dalmak S, Tulbek MY, Kiper H, Lameire N. Renal replacement therapies in the aftermath of the catastrophic Marmara earthquake. *Kidney Int* 2002 Dec;62(6):2264–71.
27. CDC: Safe use of "tanker" water for dialysis. Available at http://www.bt.cdc.gov/disasters/pdf/watertanker.pdf.
28. CDC: Technical considerations when bringing hemodialysis facilities' water systems back on line after a hurricane. Available at http://www.bt.cdc.gov/disasters/hurricanes/katrina/pdf/watersystems.pdf.
29. Letteri JM, Adams MB, Duffy M, Fedje L, Jacobs C, Kaysen G, Krohn BA, Norwood K, O'Connor P, Schiereth M, Witten B. Disaster preparedness for renal facilities and patients. *Ren Fail* 1997;19(5):673–685.
30. Sengul A, Ozer E, Salman S, Salman F, Saglam Z, Sargin M, Hatun S, Satman I, Yilmaz T: Lessons learnt from influences of the Marmara earthquake on glycemic control and quality of life in people with type 1 diabetes. *Endocr J* 2004;51(4):407–414.
31. Salman S, Sengul AM, Salman F, Ozer E, Gursoy N, Hatun S, Karsidag K, Dinccag N, Satman I, Yilmaz MT: Influence of earthquake on the quality of life of patients with type 1 diabetes. *Psychiatry Clin Neurosci* 2001;55(2):165.
32. Cefalu WT, Smith SR, Blonde L, Fonseca V: The Hurricane Katrina aftermath and its impact on diabetes care: Observations from "ground zero": Lessons in disaster preparedness of people with diabetes. *Diabetes Care* 2006;29(1):158–160.
33. Alson R, Alexander D, Leonard RB, Stringer LW: Analysis of medical treatment at a field hospital following Hurricane Andrew, 1992. *Ann Emerg Med* 1993 Nov;22(11):1721–1728.
34. Leonard RB, Spangler HM, Stringer LW: Medical outreach after hurricane Marilyn. *Prehospital Disast Med* 1997;12(3):189–194.
35. Kirizuka K, Nishizaki H, Kohriyama K, Nukata O, Arioka Y, Motobuchi M, Yoshiki K, Tatezumi K, Kondo T, Tsuboi S: Influences of The Great Hanshin-Awaji Earthquake on glycemic control in diabetic patients. *Diabetes Res Clin Pract* 1997;36(3):193–196.
36. Sone H, Kawakami Y, Okuda Y, Yamashita K: Diabetes care in emergency settings. *Diabetes Care* 1995 Sep;18(9):1310–1311.
37. Hendrickson LA, Vogt RL: Mortality of Kauai residents in the 12-month period following Hurricane Iniki. *Am J Epidemiol* 1996;144(2):188–191.
38. Takakura R, Himeno S, Kanayama Y, Sonoda T, Kiriyama K, Furubayashi T, Yabu M, Yoshida S, Nagasawa Y, Inoue S, Iwao N: Follow-up after the Hanshin-Awaji earthquake: Diverse influences on pneumonia, bronchial asthma, peptic ulcer and diabetes mellitus. *Intern Med* 1997;36(2):87–91.
39. Kamoi K, Tanaka M, Ikarashi T, Miyakoshi M: Effect of the 2004 Mid Niigata Prefecture earthquake on glycemic control in type 1 diabetic patients. *Diabetes Res Clin Pract* 2006;74(2):141–147.
40. Kaufman FR, Devgan S: An increase in newly onset IDDM admissions following the Los Angeles earthquake. *Diabetes Care* 1995;18(3):422.
41. Baba S, Taniguchi H, Nambu S, Tsuboi S, Ishihara K, Osato S: The Great Hanshin earthquake. *Lancet* 1996;347(8997):307–309.
42. Stallwood LG: Assessing emergency preparedness of families caring for young children with diabetes and other chronic illnesses. *J Spec Pediatr Nurs* 2006;11(4):227–233.
43. Miller AC, Arquilla B: Disasters, women's health, and conservative society: Working in Pakistan with the Turkish Red Crescent following the south Asian earthquake. *Prehospital Disast Med* 2007;22(4):269–273.
44. Minami J, Kawano Y, Ishimitsu T, Yoshimi H, Takishita S: Effect of the Hanshin-Awaji earthquake on home blood pressure in patients with essential hypertension. *Am J Hypertens* 1997;10(2):222–225.
45. Kario K, Matsuo T, Kobayashi H, Yamamoto K, Shimada K: Earthquake-induced potentiation of acute risk factors in hypertensive elderly patients: Possible triggering of cardiovascular events after a major earthquake. *J Am Coll Cardiol* 1997;29(5):926–933.
46. Kario K, Matsuo T, Shimada K, Pickering TG: Factors associated with the occurrence and magnitude of earthquake-induced increases in blood pressure. *Am J Med* 2001;111(5):379–384.
47. Katsouyanni K, Kogevinas M, Trichopoulos D: Earthquake-related stress and cardiac mortality. *Int J Epidemiol* 1986;15(3):326–330.
48. Suzuki S, Sakamoto S, Miki T, Matsuo T: Hanshin-Awaji earthquake and acute myocardial infarction. *Lancet* 1995;345(8955):981.
49. Suzuki S, Sakamoto S, Koide M, Fujita H, Sakuramoto H, Kuroda T, Kintaka T, Matsuo T: Hanshin-Awaji earthquake as a trigger for acute myocardial infarction. *Am Heart J* 1997;134(5 Pt 1):974–977.
50. Faich G, Rose R: Blizzard morbidity and mortality: Rhode Island, 1978. *Am J Public Health* 1979;69(10):1050–1052.
51. CDC: Community needs assessment and morbidity surveillance following an ice storm—Maine, January 1998. *MMWR* 1998;47(17):351–354.
52. Brown DL: Disparate effects of the 1989 Loma Prieta and 1994 Northridge earthquakes on hospital admissions for acute myocardial infarction: importance of superimposition of triggers. *Am Heart J* 1999;137(5):830–836.
53. Leor J, Kloner RA: The Northridge earthquake as a trigger for acute myocardial infarction. *Am J Cardiol* 1996;77(14):1230–1232.
54. Muller JE, Tofler GH: Triggering and hourly variation of onset of arterial thrombosis. *Ann Epidemiol* 1992;2(4):393–405.
55. Muller JE, Abela GS, Nesto RW, Tofler GH: Triggers, acute risk factors and vulnerable plaques: the lexicon of a new frontier. *J Am Coll Cardiol*;23(3):809–813.
56. Boltwood MD, Taylor CB, Burke MB, Grogin H, Giacomini J: Anger report predicts coronary artery vasomotor response to mental stress in atherosclerotic segments. *Am J Cardiol* 1993;72(18):1361–1365.
57. Elliott TG, Cockcroft JR, Groop PH, Viberti GC, Ritter JM: Inhibition of nitric oxide synthesis in forearm vasculature of insulin-dependent diabetic patients: blunted vasoconstriction in patients with microalbuminuria. *Clin Sci (Lond)* 1993;85(6):687–693.
58. Bodmer CW, Patrick AW, How TV, Williams G: Exaggerated sensitivity to NE-induced vasoconstriction in IDDM patients with microalbuminuria. Possible etiology and diagnostic implications. *Diabetes* 1992;41(2):209–214.