Disaster neurology

A new practice opportunity and challenge for the neurologist

Mill Etienne, MD, MPH

Anthony G. Alessi, MD, MMM

Summary

Headlines are filled with stories of the physical disability and loss of life that results from both natural and man-made disasters. The role of a neurologist as part of the response to these tragedies has moved from a supportive role to the front line. Recent earthquakes in Haiti and Japan as well as military conflicts in Iraq and Afghanistan have demonstrated an increased need for nonsurgical neurologic care. Disaster neurology has become attractive to neurologists at many stages of their careers. Employed, academic, and private practice neurologists all have the potential to embrace this opportunity to apply their clinical skills to help others in need of care. Neurologists interested in engaging in disaster relief efforts should have the ability to respond to a situation quickly with the flexibility of devoting several weeks to the response effort.

Traditional responders to disasters have included government/military physicians, trauma surgeons, intensivists, and emergency room physicians. Recent disasters such as the tsunami in Indonesia,¹ earthquake in Haiti,² and the triple disaster in Japan in 2011³ have demonstrated that the response to global disasters has become increasingly complex and commands the skills of a wide range of specialists including both adult and pediatric neurologists. With increasing numbers of neurologists performing on the front line of both local and international disasters, it is important that neurologists know what to expect as they increase their participation in this practice setting.

Dr. Etienne (left) and Dr. Alessi (right) on board USNS Comfort in Haiti, January 2010.

New York Medical College (ME), Bon Secours Charity Health System, Suffern; and the Departments of Neurology and Kinesiology (AGA), The William W. Backus Hospital, University of Connecticut, Norwich.

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Correspondence to: mill_etienne@bshsi.org

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Among the challenges faced while working in a disaster setting are the lack of medication, inability to obtain advanced laboratory and neurodiagnostic support, physical challenges of climate, food shortage, and uncertain living conditions. There is also a need to be mindful of personal safety in any disaster as there may be temporary disruption of law enforcement infrastructure. Personal safety also includes making sure that all immunizations are up to date and taking the appropriate prophylactic medications for the region.

Neurologists traveling abroad to a disaster zone should bring with them a penlight/flashlight, pocket ophthalmoscope, reflex hammer, tuning fork, and stethoscope. Neurologists responding to any disaster should make a note of what neurologic assets are available in the facility and in the surrounding facilities. Neurology assets include neurologists, nursing staff, neurodiagnostic technicians/technologists, imaging modalities, laboratory tests, and intensive care unit beds (table 1). The neurologist will not be working in isolation during the disaster. The neurologist has to function as part of the team and have some understanding of the surge capacity of the institution as well as how the resources are being allocated. Mobile phones and electronic mail capability have facilitated communication between providers, thereby making it easier to coordinate the response effort.

Life cycle of a disaster

A disaster is a tragic event that occurs when a natural or manmade hazard has a considerable negative effect on an area or region and often will overwhelm the local response system. The effect of a disaster is largely dependent on the vulnerability to the hazard. In order for a hazard to be classified as a disaster, it must go from being a theoretical threat to have an actual negative effect on health, life, property, or the environment. Vulnerability can be measured by vaccination rates, type of dwelling, quality of construction, overcrowding/population density, barriers to evacuation,⁴ and the overall health of the population prior to the disaster. Resource-poor regions tend to be disproportionately vulnerable⁵ and therefore have greater morbidity and mortality from disasters. Although the earthquake in Haiti was rated at 7.0 movement magnitude (Mw), with over 316,000 deaths, it remains the deadliest earthquake in the history of the Western hemisphere and the deadliest earthquake in the world in the past 2 decades.^{6,7}

There are 2 types of disasters: natural and man-influenced. Natural disasters include tsunamis, tornados, earthquakes, and volcanic eruption, while man-influenced disasters include nuclear disaster, terrorist attack, war, and other forms of armed conflict. Both natural and man-influenced disasters tend to occur unexpectedly, so the casualties from a disaster may present for medical care before the medical community has been fully informed of the nature and scope of the disaster. The medical response will largely depend on the type of injuries expected from the disaster. Disasters tend to have a rapid scale-up of services followed by return to predisaster levels of service. The disaster life cycle (figure) includes preparedness, response, recovery, and mitigation.⁸⁻¹⁰

The preparedness phase begins before the disaster. The level of preparedness can have a considerable effect on limiting the level of destruction caused by the disaster. Preparedness involves identifying hazards in the region and minimizing the vulnerability of the region to the hazard, which limits the hazardous effect. The preparation phase also includes identification of human and material resources that will be used to respond to a disaster. Neurologists interested in

Table 1 Neurologic disorders after a disaster

Neurologic disorders that may be exacerbated in disaster setting
Epilepsy
Myasthenia gravis and other neuromuscular junction disorders
Ventilator-dependent neuromuscular diseases (e.g., amyotrophic lateral sclerosis)
Migraine/headaches
Neuropathic pain
Stroke
Dementia/delirium
Multiple sclerosis
Neurologic manifestations of HIV
Infections endemic to region (e.g., malaria)
Sickle cell disease (e.g., sickle cell crisis with stroke or pain)
Conversion disorder
Other psychogenic disorders
Neurologic disorders that may be caused by disaster
Traumatic brain/spine injury
Traumatic plexus/peripheral nerve injuries
Rhabdomyolysis
Meningitis/encephalitis
Status epilepticus
Vaccine-preventable diseases: e.g., tetanus, polio
Neurologic manifestations of HIV
Conversion disorder
Other psychogenic disorders

disaster relief should consider registering with organizations that are known for responding to disasters, like the International Federation of Red Cross and Red Crescent Societies (www.ifrc.org), which has affiliates in many countries around the world (e.g., American Red Cross). Most major cities and states in the United States have some form of disaster readiness program and so neurologists can register with those programs as well. Likewise, practitioners in other countries can contact their local government to identify ways to volunteer for humanitarian assistance and disaster relief missions.

The response phase includes allocation of human and material resources, evacuation planning, and the provision of care to patients. The provision of care will often involve recruiting interpreters to overcome potential language and cultural barriers. The recovery phase of a disaster response includes the plan for the long-term recovery of the community. There is an increasing role for neurologists here. As communities rebuild, there are often limited medical resources, and so neurologists who may not have been able to participate in the initial disaster response can make a difference in the disaster-torn region. By this time, there are typically more established programs that neurologists can participate in. Neurologists can also provide services remotely by assisting with interpretation of neuroimaging and EEGs via telemedicine. This phase also includes the disengagement process, which is critical in order to provide an appropriate transition from disaster relief to pure humanitarian assistance. The disengagement process also helps to prevent providers from developing compassion fatigue,^{11,12} which is a risk for all responders to disasters, especially in prolonged humanitarian response. The final stage in

Figure Disaster life cycle

the disaster life cycle is mitigation. Mitigation involves going over lessons learned to decrease the chance of disaster recurring. This often will involve taking measures to decrease the vulnerability of the region to the most recent disaster and any future disaster.

Nonsurgical neurologic cases after a disaster

There are 3 types of cases one can expect after a disaster. There will be cases that are a direct result of the disaster, cases that are indirectly related to the disaster (table 2), and cases that reflect the background disease in the community, which may or may not have been exacerbated by the disaster. Often the latter 2 types of cases may overwhelm the emergency response system, thereby making it difficult to care for the patients who have injuries that are a direct result of the disaster. For example, after the earthquake in Japan, there was an increased number of patients presenting with seizures when compared to other neurologic diseases.¹³ Patients with epilepsy may lose access to their anticonvulsant medications, leading to seizure recurrence. This can then lead to problems related to uncontrolled seizures including drownings, vehicular injuries, fractures, burns, and sudden unexpected death in epilepsy. Likewise, patients who have neurodegenerative diseases like amyotrophic lateral sclerosis who are ventilator-dependent may lose electrical power necessary to power their ventilators, which can lead to immediate respiratory failure and death. Limited access to anticoagulants, antiplatelet agents, and medications used to treat hypertension, diabetes mellitus, and hypercholesterolemia may lead to an increased number of strokes in the acute phase of the disaster.

If the disaster has potential for causing trauma, there may be cases involving head trauma, spine trauma, and brachial plexus injury, as well as nerve and muscle injury. Patients who are trapped by objects for prolonged periods of time may develop rhabdomyolysis and be at risk for developing acute renal failure. People becoming displaced and living in close quarters, as was seen with Hurricane Katrina and the Haiti earthquake, increases the risk of communicable diseases,¹⁴ including infections of the CNS. Lumbar puncture kits may not be readily available, so treatment for presumptive meningitis may be necessary. If the disaster is in a country or region known to have decreased access to immunizations, there is a high likelihood of seeing vaccine-preventable diseases and infections like tetanus.^{2,15} There tends to be limited access to human tetanus immunoglobulin and tetanus toxoid in these settings. There may also be limited access to the antibiotics used for the treatment of tetanus, surgeons for wound debridement, and ventilators for patients who develop respiratory compromise. Such complex patients should ideally be referred to centers with the resources to treat these conditions.

In addition to the baseline chronic diseases of the local population, the disaster itself may introduce a new set of chronic diseases or health conditions to the region. The long-term effects of traumatic brain injury, like post-traumatic epilepsy, postconcussion syndrome, and post-traumatic vertigo, and chronic ventilator dependence can be seen after the immediate disaster

Table 2 Neurologic assets in disaster

Adult and pediatric neurologists
Neurosurgeons
Physical therapists
CT scan
Roentgenogram
EEG
Ultrasound
Anticonvulsants
Antibiotics
Hypertonic solutions (e.g., Mannitol, hypertonic saline)
Dexamethasone and other steroids
Human tetanus immunoglobulin, tetanus toxoid
Hemodialysis machines
Laboratory
Intensive care unit beds/ventilators

response. Additionally, permanent paraparesis or tetraparesis from spinal cord injury, as well as painful neuropathy from brachial plexus and peripheral nerve injuries, may be seen. Patients who develop major disabilities may face considerable problems after the initial disaster response given that disability services are typically not available for the long term in underdeveloped countries.

Prolonged periods of food scarcity increase the likelihood of having neurologic complications of nutritional deficiencies like thiamine, iron, folic acid, and vitamin B₁₂. Presentations can include peripheral neuropathy, myelopathy, and encephalopathy. Patients who have HIV may develop AIDS-defining neurologic diseases like cerebral toxoplasmosis, cytomegalovirus retinitis, HIV encephalopathy (dementia), primary CNS lymphoma, and progressive multifocal leukoencephalopathy. There is also a risk for increased activation of tuberculosis. The USNS Comfort, in their response to the earthquake in Haiti, obtained screening chest X-rays to rule out tuberculosis on all Haitian nationals who boarded the hospital ship.²

In a manmade disaster like a bioterrorism attack, it is important to obtain guidance from the government regarding any ongoing threat and treatment support being provided by the government. For example, if a particular chemical or biological agent was used as a weapon, this knowledge will be important for the treating physicians to know so they can be better prepared to treat these conditions.

Physicians, including neurologists, have increasingly been providing assistance in countries engaged in war, like in Afghanistan. Neurologists should have cultural humility and have respect for the communities, cultures, and traditions when volunteering in any foreign country.^{6,16} There are many laws and traditions that certain countries may have that if violated will render the neurologist no longer welcome in that community. When in an area with ongoing armed conflict, additional attention should be given to personal safety. Communicating with the US embassy or relevant embassy of the neurologist's home country prior to such travel is important as they may provide the neurologist with additional situation awareness and other safety concerns.

Neurologists volunteering in war zones and other regions with armed conflicts should be mindful that they may be exposed to gross acts of violence, starvation, displacement, and despair, and may hear tales of slaughter, rape, and killing. This can be psychologically traumatizing for the health care provider and there is typically limited to no access to mental health

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Neurodiagnostics and neurologic treatment after a disaster

In underdeveloped countries, there is limited and often no access to many of the medications available in the United States. After a disaster, there may be limited or no access to many medications that are normally in abundance, even in the United States. For example, decreased access to antibiotics increases the likelihood of developing rheumatic heart disease, which to the neurologist may present as Sydenham chorea. As stated earlier, decreased access to anticonvulsant medications may increase the overall number of seizures following the disaster. Neurologists will need to become familiar with what neurologic therapeutics are available in the region in which they will be practicing. The lack of neuroimaging and other neurodiagnostics can be frustrating to neurologists who are not accustomed to practicing in resource-poor settings. In the disaster setting, there will be limited or no access to MRI, CT scan, EEG, EMG, and other neurodiagnostic tools. For example, it can be difficult to differentiate ischemic and hemorrhagic strokes without the use of CT imaging. There have been numerous scales developed to help predict ischemic vs hemorrhagic stroke without neuroimaging¹⁸; however, these scales have been criticized for not adding enough value to differentiating intracerebral hemorrhage from ischemic stroke in the acute care setting.^{19,20}

Ethical considerations in international aid

There are numerous ethical considerations that must be taken into account during a disaster response abroad. Should neurologic care be provided only to “disaster-related” injuries/conditions or to all comers? How should the patients be prioritized? For example, should a patient with longstanding hydrocephalus receive a ventriculoperitoneal shunt? If so, who will be responsible for following up with the patient if there are complications from the shunt? Other considerations include whether or not to provide aid that cannot be maintained by the local community after the disaster response has ended. Offering treatments that could not be sustained can be seen as doing more harm than good.¹⁶ When offering humanitarian assistance to resource-poor countries, it is important to offer all services that are deemed appropriate, but the people delivering the care must understand that the local people and government still have autonomy and they reserve the right to refuse that care.

DISCUSSION

Disaster neurology provides an opportunity for neurologists to enhance their careers by volunteering their time in nontraditional modes of practice. Disaster neurology is filled with many challenges that have been embraced by the neurologists drawn to this area. This also provides a new opportunity to better train neurologists for the global environment of the 21st century. Neurologists who have volunteered in these settings soon become comfortable practicing neurology without many neurodiagnostics and they get accustomed to diagnosing and managing tetanus, malaria, rheumatic heart disease, and other conditions not typically seen in the United

States. Disaster neurology is a young field that welcomes all adult and pediatric neurologists, including the various neurology subspecialties.

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