Mitigating Matthew: 5 Lessons to Help Improve Hospital Preparedness in a Hurricane

Lancer A. Scott, MD, and Florence E. Hutchison, MD

Hurricane Matthew (Fig. 1) made landfall in the United States on October 8, 2016 near McClellanville, South Carolina, located just north of Charleston. The storm caused nearly $10 to $15 billion in damages along the southeast coastline, representing the 22nd most damaging storm in US history.[1] The uncertainty regarding the storm's path and strength caused great concern for hospital emergency management officials. Many hospitals in Charleston, such as the subject of this Perspective, are situated at the tip of a peninsula in a flood-prone historic district (Fig. 2). Although weather-related emergencies are common in Charleston, the prospect of a significant storm surge was alarming.

Charleston hospitals have made several modifications to improve hurricane preparedness. Following Hurricane Hugo in 1989, for example, hospitals revamped generator and electrical switch operations to ensure power and water delivery capability in the face of severe flooding. Interhospital communications were improved to enhance collaboration and ensure sharing of evacuation resources during a disaster. Finally, community-based training initiatives were established to help train providers to handle flood emergencies. Yet no amount of planning can fully prepare a hospital for a hurricane. This Perspective presents the experience of one Charleston hospital that was directly in the path of Hurricane Matthew, the Ralph Johnson Veterans Affairs (VA) Medical Center. The hospital is a 149-bed facility located in downtown Charleston, serving >69,000 military veterans. Matthew taught us several lessons.

Lesson 1: Make the Call Early

US coastline prediction models for Hurricane Matthew were largely inaccurate. With only 3 days left before the storm made landfall, many models predicted a Florida landfall for the storm, whereas others predicted Georgia, South Carolina, and North Carolina.[2,3] On Tuesday, October 4, 4 days before the storm made US landfall, the Charleston VA called for the evacuation of all patients. This was bold. Evacuation is expensive, fraught with opportunity for error, stressful on patients, and time consuming. Planning for the evacuation of patients with special needs (eg, ventilator or tracheostomy management) can take days and cost thousands of dollars per transport. More important, evacuation actually can harm patients; therefore, the decision to move is not without consequences. Healthcare facilities without existing transportation resources would be wise to establish contracts with transportation agencies/companies every year, before the beginning of hurricane season (June 1).

At the time, Hurricane Matthew was a category 4 storm (ie, sustained winds 130–156 mph) pummeling the Caribbean. Staring at the prospects of a 10- to 20-ft storm surge in Charleston, the VA made the call early to evacuate. Patients well enough to be discharged were discharged. Hospital leaders then coordinated with VA medical centers in Columbia, South Carolina, Augusta, Georgia, and Dublin, Georgia, to locate hospital beds for approximately 60 inpatients. Using VA's dual-use vehicles, patient transfers began at midday on October 5 and were completed safely on October 6, well ahead of storm landfall.

Lesson 2: Think Patients, All Patients

The integration of the VA allows for coordination of care and seamless evacuations during emergency situations. It also places a greater responsibility on the hospital to contact patients at home or in remote care facilities during a disaster. One group of outpatients, military veterans with spinal cord injuries and disorders (SCI/D), are among the most vulnerable during severe weather events. Many use respiratory equipment, motorized wheelchairs, specialized inflatable mattresses, and a host of other items requiring electrical or battery power that are essential for their care. It is ironic that these patients are the least likely to evacuate during a hurricane because of lack of transportation and fear that they will not have access to medical equipment.

Every year, before the beginning of hurricane season, the hospital develops a list of the patients with SCI/D in the community. As Matthew developed into a hurricane, all 300 SCI/D patients were called, starting with those most likely to be in danger if they experienced a loss of power. Fourteen patients were identified for transfer. The patients were placed safely in sister VA medical facilities well before the storm.

Lesson 3: Evacuated but Never Closed

A hospital can decide to evacuate, but that is not the same thing as being closed. Evacuations rarely accommodate all patients. Some patients may be too ill to travel, others may not have a place to go. In addition, patients in the community cannot be expected to stop coming to the hospital. Patients lacking power and heat will come to the hospital for help. Some will have chest pain, others will have dangerously high blood sugar concentrations. Preparation is essential.

Soon after the decision was made to evacuate, the hospital started planning to support a full range of emergency medical

From the Medical University of South Carolina and Ralph Johnson VA Memorial Hospital, Charleston.

Correspondence to Dr Lancer A. Scott, Department of Emergency Medicine, Medical University of South Carolina, MSC 300, 115 MUH, Main Hospital, 169 Ashley Ave, Charleston, SC 29425. E-mail: scottlan@musc.edu.

The authors have no financial disclosures to declare and no conflicts of interest to report.

Accepted February 15, 2017.

0038-4348/0–2000/110-528

DOI: 10.14423/SMJ.0000000000000682

Fig. 1. **Hurricane Matthew approaching the eastern South Carolina coast in October 2016. At the time the photograph was taken, Matthew was a category 3 hurricane. Courtesy of the Goddard MODIS Rapid Response Team, National Aeronautics and Space Administration.**

and critical care services, including services to support cardiac, stroke, and surgical emergencies. This meant a fully operational catheterization laboratory, operating rooms, radiology suite, anesthesia services, and laboratory services. It also meant food services to support staff and patients, social work services, and engineering support.

In Charleston, a total of 114 staff, including 20 family members, remained onsite during the storm to support critical staff and hospital operations. Hospital rooms were assigned to employees to ensure that they could rest when not working. It was determined that pets also must be accommodated. Employees were allowed to bring pets if they could provide proof of vaccination and proper crating.

Lesson 4: Disaster Staffing 101

The "best" thing about a hurricane is that hospitals can see it coming, but foresight can cause significant stress for hospital staff members. It is important to note that there will be great consternation expressed by staff regarding the planned evacuation of their families. A great deal of latitude should be given to staff, especially those who volunteer to stay through the storm, to ensure that their families are safe.

Staff members who are designated "essential personnel" (ie, those who should not evacuate with their families) should expect to experience significant confusion regarding who the primary clinical team will be during the storm. Because of the inability to predict the timing of a storm's landfall, staff will want to know if they will be the primary team (ie, the A team) or the relief team (ie, the B team).

All sections were staffed as per the normal schedule to allow staff to rest for reasonable periods. There would be no skeleton crew. Staff scheduled to work during the days leading up to the storm would be prepared to be the A team (packing clothes and toiletries to last 72 hours). The team working when the storm hit was designated the A team. As soon as the bridges opened and the facility was accessible following flooding, the next shift (the B team) would relieve the A team. Following the B team, the normal staff calendar would resume. Allowances were made for staff members who could not stay to support the ED by volunteering and switching shifts later in the month.

Lesson 5: In-House Preparedness

Just before the storm's landfall in South Carolina, weather experts predicted high tide at approximately 2 AM. The pace of the storm slowed, however, resulting in less-intense winds and landfall at lower tide. The storm surge was approximately 4 to 7 ft, and the corresponding rains resulted in a half-inch of water leaking into the first floor of the hospital.

It is difficult to contemplate the devastation presented by a category 4 hurricane at high tide with a 15- to 20-ft storm surge. During Hurricane Hugo in 1989, the city water supply and external power was lost, crippling hospital operations. All incoming roads were impassable because of high water, downed power lines, and debris for >3 days.

It is important for hospital administrators and staff to remember that they will be on their own during a large-scale disaster, likely for several days. The decisions made by staff—the staff

Fig. 2. **Flooding outside Ralph H. Johnson VA Medical Center during Hurricane Matthew.**

who are there when the disaster happens, not the staff who show up after the disaster—will largely dictate the health and safety of patients and the likelihood of the return of normal hospital operations.

This underscores the importance of facilities-based healthcare disaster competency training to support patient and staff safety. In Charleston, community-based training initiatives such as the Center for Health Training and Emergency Response have established training protocols for staff (protocols and further information are available at www.musc.edu/chpter).[4] These initiatives have helped train hundreds of providers to handle floods and other emergencies and will help support hospitals' most important resources during a disaster—people.

Lesson 6: Recover Early

Classic teaching in disaster medicine instructs us that we should "recognize, respond, and recover" in a clinical disaster. This axiom is still true and important, but the processes are intertwined and concurrent, not serial. Establishing a process for the early recovery of hospital operations is critical to the health and safety of patients and staff and should be started as early as possible. This is particularly true for a hospital that decides to evacuate in advance of a hurricane. In Charleston, discussions about transferring patients to the VA began on the same day we arranged their evacuation. Similarly, closing clinics requires rescheduling patients for the days following the storm. This process is time consuming but essential to reconnecting patients with their physicians when they need them most.

Conclusions

Hurricane Matthew could have been a lot worse, and in retrospect, the massive mobilization of resources may have been safely modulated downward, without risk. The potential for damage was real, however, and the early call to evacuate was the right call. We experienced a committed, compassionate, and coordinated response in Charleston. With minor modifications, coastal hospitals that adhere to these simple lessons should be ready.

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