The 12 January 2010 earthquake in Haiti, one of the worst natural disasters in the past 2 centuries, left 230 000 dead and 1.5 million homeless. Given the University of Miami’s proximity to Haiti and a 15-year relationship with Haitian physicians through Project Medishare, a not-for-profit health care organization set up by Miller School of Medicine faculty, the university was able to offer emergency relief within 20 hours after the earthquake. We have previously described our experience during the week after the earthquake (1). Here we describe the University of Miami Hospital in Haiti, a field hospital that began functioning at the Port-au-Prince airport 8 days after the earthquake (Figure 1).

**Organization of Systems, Teams, and the Field Hospital**

Given the magnitude of the relief effort, it immediately became apparent that logistic organization would be as challenging as delivering care. Critical needs were obvious: coordination of flights from Miami into a damaged airport; provision of guidance regarding medical precautions for hundreds of volunteers; and transportation of massive amounts of medical supplies, food, and water. We quickly established an organization table to keep track of multiple aspects of the operation (Figure 2) and put together a coordinating center housed at our Miami campus.

Our initial hospital was a small facility within the United Nations compound that we rapidly outgrew (1). The second hospital was constructed in 4 days after flying in 2 electric generators, construction equipment, and 4 air-conditioned tents from Miami: one tent each for a pediatric ward and an adult ward (with 4 operating rooms and a simple intensive care unit), supply storage, and staff quarters. Other supplies were airlifted from Miami several times daily. Approximately 140 patients from our first facility were transported to the new hospital on 21 January 2010.

Staffing of the hospital was accomplished almost exclusively through volunteers who signed up for 5- to 7-day deployments. A travel clinic was set up in Miami to provide counseling for deploying volunteers, and a Web-based survey for returning volunteers was used to assess their adherence to malaria prophylaxis and to determine whether referrals for medical or psychological issues were needed.

To coordinate efforts, we created under the supervision of a chief medical officer an organizational structure that mirrored our hospital structure in Miami but also addressed Haiti-specific issues. Because of the massive damage to the communications infrastructure, we set up satellite links for telephone and Internet connections. The command groups in Haiti and Miami had joint conference calls every morning, during which the day’s goals and plans were determined.

**Clinical Care and Coordination**

Because of limited resources and the large number of patients in need, medical and surgical triage was of paramount importance. On arrival, patients were triaged by an internist or a pediatrician, and then an appropriate surgeon (trauma, orthopedic, or neurosurgery) developed a plan of care. Many of our nursing and medical staff were of Haitian origin and spoke Creole. Family members helped in caring and feeding patients.

Limbs with gross infection and impending sepsis or compromised vascular flow had emergent guillotine amputation and staged debridement after 3 treating surgeons concurred and patients gave written consent through a Creole interpreter. No amputation was closed before the third debridement. Open fractures were scheduled for repeated debridement every 2 to 3 days. There was a low
threshold for repeated operative debridement. Intraoperative fluoroscopy permitted application of external fixators when appropriate. Because of the challenging field conditions, we chose not to undertake internal fixation. Patients requiring this were transferred to the USNS *COMFORT* or the United States. More than 203 surgical procedures were performed between postearthquake days 4 and 12.

We treated 48 chronic compartment syndromes by postearthquake day 12. On postearthquake day 10, we acquired a digital radiography machine and casted nearly all closed ankle, tibia, wrist, and forearm fractures (more than 98 in 3 days). Best attempts were made at closed reduction by orthopedic surgeons. The need for a wound care team became apparent—approximately 80% of patients had open wounds. Our wound care program consisted of both adult and pediatric bedside teams for dressing changes that were equipped to handle major debridement and vacuum-assisted closure application with conscious sedation.

Patients requiring surgical intervention in the immediate aftermath of an earthquake frequently have extremity injuries that are challenging in anesthetic management, because many individuals develop hypovolemia, sepsis, electrolyte, and coagulation disturbances (2, 3) that can complicate general and neuraxial anesthesia. Peripheral nerve blocks have a favorable safety profile and provide adequate anesthesia independent of oxygen supplies and electricity and, if necessary, with only limited monitoring. Therefore, most surgeries were performed under local peripheral nerve blocks, and only some complex surgical cases were performed under general anesthesia.

*Figure 1. Aerial view of University of Miami Hospital, Port-au-Prince, Haiti.*

Arrow A is the location of the operating room in the posterior part of the first tent. Arrow B is where the wound center was located. Arrow C is the triage area. Arrow D is the second triage tent, where the pediatric patients were admitted. Arrow E is the tent where staff and health care workers were housed. The supplies tent is to the left but is not included in the photograph.

Internists, pediatricians, and hospitalists focused on the medical management of surgical patients (for example, fluid and pain management and thromboembolism prophylaxis) and were responsible for the logistic aspects of organizing and running the hospital. Infectious diseases specialists helped select antibiotic regimens from a simple yet robust antimicrobial formulary. Combined medical-

*Figure 2. Organization of the team at the command center in Miami.*

Teams were created with a lead person responsible for each team, including finance, fundraising, IT, security, personnel and flight logistics, material donations, airport operations, supply chain, public relations and communications, and volunteers. IT = information technology.
Surgical rounds were held at least once daily, with the objective of establishing a joint plan of care and identifying cases that needed surgical or radiological procedures or were ready for discharge. The organization of the pediatric ward mirrored that of the adult ward.

Besides operative capability, the inability to perform radiography and fluoroscopy when the focus was on managing crush injuries and fractures presented a major challenge. Portable digital radiography and fluoroscopy units were not available for about 10 days. Figure 3 highlights the initial clinical impression of a pelvic fracture that was confirmed when radiography became available. Radiography technicians were always in short supply, and physicians were trained to use the machines by the technicians and the manufacturer’s representatives, who flew to Haití to provide training. Patients who could not be appropriately cared for at our hospital were transported to the Israel Defense Forces Medical Corps Field Hospital or the USNS COMFORT; some were flown to the United States in a military plane.

Many of our health care workers had clinically significant emotional stress. Our psychiatry department dispatched personnel with experience in supporting health care workers involved in disaster relief, and we encouraged volunteers to pair up and monitor each other’s stress.

Lessons Learned and Application to Future Responses to Disasters

Our university had never been involved in disaster relief of this magnitude. Aspects of our response that did not go as well as we would have hoped included our lack of adequate interaction early with the United States Southern Command based in Doral, Florida (which is responsible for U.S. military operations in South and Central America). Early interaction would have allowed us set up early communications between Haiti and Miami and to better procure and allocate personnel and supplies. Inclusion of immediate first responders who were fluent in Creole would have been most helpful.

It also took several days to create an organizational structure for the disaster response de novo. On the basis of our experience, we believe the highest priority should be placed on putting an organizational structure in place at the local institution that is preparing to respond to a natural disaster. This structure should reflect aspects of the operation that are necessary on the ground in the foreign country and at home.

We had a difficult time securing voluntary radiography technicians. Soliciting help early from national professional organizations, such as the American Society of Radiologic Technologists, might have prevented this limitation. Immediate creation of a Web-based document that specified medical needs for travel to the area (for example, immunizations and travel documents) and reflected what volunteers should expect to encounter would have been helpful. Preparedness counseling and planned postexposure counseling to deal with posttraumatic stress disorder should have been put in place immediately.

Figure 3. Initial presentation and radiographic diagnosis of a pelvic fracture.

Top. Initial presentation documents the initial impression for an earthquake victim admitted on 13 January 2010. Bottom. Radiographic diagnosis confirms the initial impression of pelvic fracture 9 days later on plain radiographs.
Despite the limitations and gaps we have outlined, we feel our intervention was successful and that university-based medical health care systems can play an important role in disaster relief. Our prior relationship with Project Medishare highlights the benefit of academic health centers having established relationships with foreign countries on which disaster response can be built. The critical and core elements of our response included prompt organization of teams and systems both in Miami and in Haiti, communication between personnel in Miami and Port-au-Prince on a scheduled and ongoing basis, deployment of short-stay medical volunteer teams, prompt transportation of essential supplies and equipment, and construction of a simple yet robust field hospital. The early phase of medical care delivery was focused on managing trauma. Very simple radiology equipment proved indispensable for the management of orthopedic trauma. Laboratory support was absent initially; however, many patients were successfully managed initially with clinical examination alone. Our experience and the lessons learned can be applied by medical centers and organizations interested in delivering emergent trauma care during future natural disasters.

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