Anesthesia in an Austere Setting
Lessons Learned from the Haiti Relief Operation

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KEYWORDS
- Earthquake
- Triage
- Regional anesthesia
- Ethics
- Disaster
- Anesthesia

KEY POINTS
- The earthquake will leave a disorganized medical system.
- Concurrently, masses of patients will need extremity surgery for fractures, crush, and burns. These surgeries are amenable to monitored anesthesia care and regional anesthesia.
- Language barriers may become a significant challenge.
- Some patients will have nonsurvivable injuries for the local environment, but still must be cared for ethically and humanely.
- The hospital and operating room team will need leaders.
- Adjust your own mental and physical expectations for yourself and anesthetic care to that required in a disaster zone with limited resources.

OVERVIEW OF ANESTHETIC CARE IN A DISASTER ZONE

Natural disasters of many types will continue to occur and will injure people living in both the developed and the developing world. The type, scope, and location of a disaster will dictate the kind of medical support needed to care for these patients. For example, the physical injuries (eg, many limb fractures)^1,2^ following an earthquake in Haiti required very different medical services than an illness sustained after a nuclear disaster in Japan.^3^ In 2010, the authors journeyed to Haiti after a severe earthquake that caused widespread damage to the national infrastructure and injury to many Haitians. This article recounts some of the authors’ insights that might be helpful to practitioners serving in other disaster zones.

Disclosure: Dr Morey and Dr Rice have no conflicts of interest related to disaster care.
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Anesthesiology Clin 31 (2013) 107–115
http://dx.doi.org/10.1016/j.anclin.2012.10.003
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Overall, one must mentally prepare for this challenge and possibly alter one’s expectations of current anesthetic practice. That is, one should be ready for massive need, which is difficult to meet with even a well-resourced health care system, for the possibility of severely limited health care resources to match this need, for alterations in anesthetic practices forced by onsite equipment and supplies, for questions about medical triage and care, and for unmitigated gratitude from injured patients and their families. As in your own practice though, all efforts should remain focused on outstanding patient care to the highest degree possible given the limitations of an environment markedly altered by the natural disaster.

**ORGANIZATION AMID CHAOS AFTER AN EARTHQUAKE**

Natural disaster leads to disorganization of every type: social, economic, financial, food and water supply, and others. Likewise, health care also becomes disorganized and woefully inadequate. With respect to providing anesthesia, this lack of orderliness means that scheduling governance, patients’ location, and supplies require extra attention to allow surgery in a timely manner.

**Governance**

The type of natural disaster will modify the number of patients seeking medical care. In the event of an earthquake, many patients will likely arrive for care because of an injury from falling debris, fires, and other hazards. Because disaster services are not immediately available, malnutrition and dehydration are almost certainly present at the time of surgical intervention. In the face of this wave, governance of the surgical services is especially important to allow optimal functioning and efficiency. Societies and cultures vary on how best to achieve this task. The authors recommend a senior member of the operating room team with previous governance experience take charge of overall organization of scheduling. As in traditional hospitals, the individual is required to understand the multistep process of providing care from posting to the recovery room and must have excellent communication skills and a high degree of organized forethought. Consultation with surgeons about case postings and nursing staff is necessary to ensure that patients receive appropriate surgical triage. Successful execution of the schedule (eg, “board running”) remains this individual’s task in addition to providing care. Multiple changes of posting and scheduling due to new patients or patient status can be anticipated. At many current hospitals with electronic scheduling and computerized tracking, one can readily appreciate a return to former decades with an operating room schedule arranged around paper notes and a cork board (Fig. 1).

**Patients**

Because the injured may be located outside of the immediate facility (the authors used a nearby elementary school for additional patient rooms), physically locating patients can become a major challenge that may delay surgery and waste surgical resources. These patients may be found in remote, obscure hospital rooms that volunteer staff did not even know existed or distantly out of the hospital in a field, lean-to, or hut. Likewise, identification of patients in the absence of wrist bands and the presence of differing languages can become challenging. For these reasons, a native group of transporters emerges as an extremely valuable component of the team to find and transport patients to the preoperative holding area (Fig. 2). To allow efficient operating room service, it may be advisable to queue all patients for the operating room the night before surgery. Likewise, knowledge of and fasting of several other “back-up” patients
requiring surgery may be advisable given the limited nature of operating room resources to allow maximal use of surgical resources.

**Supplies**

If fortunate, medical supplies will stream into the natural disaster site, although a wise clinician will attempt to bring his own provisions. Supplies may arrive in containers of every shape and material and identified in many languages. The onslaught of materials may lead to great disorganization of the anesthesia workroom, if one is even fortunate enough to have such a protected environment for supplies (Fig. 3). In the absence of supply organization, the services provided by anesthesia technicians, pharmacists, and pharmacy technicians in the home countries become much more appreciated during these times. For this reason, anesthetists can reliably plan on needing extra time to actually find drugs and supplies for any particular case. Likewise, nonclinical time (ie, late nights) can be valuably spent organizing supplies for yourself and colleagues, even if only in the most rudimentary manner. Alternatively, one should

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**Fig. 1.** Dr Mark J. Rice organizes the operating suite scheduling board. Shown are case postings on paper slips with patient name, surgeon name, and procedure. Those notes taped to the bottom of the corkboard frame indicate patients posted for surgery that could never be found.

**Fig. 2.** Invaluable native citizens who provided translation services, located patients, and transported patients for surgery to the preoperative holding area.
consider bringing an anesthesia technician to assist with these duties. In addition, many of the supplies donated from distant locations may be unfamiliar to even experienced clinicians. That is, supplies delivered from around the globe may have different names for the same pharmaceutical (eg, lidocaine, lignocaine) or perhaps different concentrations (eg, 1 mg/mL or 10 mg/mL midazolam). Proper care to understand what medicine is actually being used requires additional effort, especially when anesthetists are fatigued, distracted, hungry, or working in poor lighting. In addition to supplies, previously donated anesthesia equipment may not be completely functional. Simple assessments and fixes can be attempted and achieved to enable fully functional equipment. For example, the authors reactivated an anesthesia machine simply by replacing an electrical fuse scavenged from an automobile. Simple tools (eg, multifunctional utility hand tool, fuses, electrical multimeter) can be uncommonly useful.

TRIAGE ETHICS IN A DISASTER

Natural disasters will mean a triage of patients and forced decisions about the use of medical resources. For example, which patients will receive care in an operating room when there are masses of patients needing limb amputation or incisional debridement? Likewise, with limited oxygen cylinders and a single working ventilator on only one of the anesthesia machines, is it wise to chronically ventilate a patient with such pressing needs before other injured patients in the community? In the presence of diabetic coma, which patients will receive extremely limited supplies of insulin, a drug that needs refrigeration, when the electrical supply (and local batteries) may be disrupted? Whatever your own personal choices, medical ethics at any particular disaster site will reflect the morals and religions of the local society. These local ethics may be quite different from physicians visiting from other locations, but are just as valid and locally in force. During one’s visit to care for natural disaster patients, the local and guest values may well conflict. Successful resolution of this conflict relies on clear communication and mutual respect between local leaders (eg, native physicians, hospital director, priest, mayor) and those of the guest health care providers. Some starting points for resolution may include the formation of a local ethics committee that is charged with understanding the position of all parties, such as the hospital administration, guest anesthetists, local religious leaders and physicians, and the patient’s family. Indeed, one of the authors (MJR) served on such an emergency committee to assist in

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**Fig. 3.** Combined surgery and anesthesia supply area from supplies donated to the hospital for medical and surgical services.
developing appropriate choices for the discontinuance of ventilation in a patient with nonsurvivable injuries. In additional, this committee can obtain information from outside sources. For example, a Catholic hospital and community may well be attuned to church doctrine for the faithful that can be learned by communicating with global centers such as the National Catholic Bioethics Center (NCBC, Philadelphia, PA, USA). This organization is “…committed to applying the moral teachings of the Catholic Church to ethical issues arising in health care and the life sciences. The NCBC provides consultations to individuals and institutions seeking its opinion on the appropriate application of Catholic moral teaching to these ethical issues.”5 Given the authors’ deployment to a Catholic hospital, the services rendered by the NCBC were extremely valuable to address when the aforementioned situations were encountered (Fig. 4). In any event, no visiting anesthetist should be compelled to commit acts that violate his own personal medical ethics.

PERSONAL HEALTH OF VOLUNTEERS IN A DISASTER ZONE
Finding a Way There

The authors worked at the Hôpital Sacré Coeur, which is about 16 km south of the Cap Haitien International Airport. This airport is the second largest in Haiti and serves the city of Cap Haitien, with a population of 180,000. Like the surrounding city, the airport is destitute without runway lighting (ie, no night flights) or fuel depot. Because pilots must bring their own fuel, they pay scrupulous attention to weight limits, with all passengers and supplies carefully weighed. When necessary, medical supplies and equipment are abandoned to achieve a safe weight before takeoff. Indeed, the large trailer of medical supplies donated by the authors’ hospital was decimated to only what could physically be carried in a single knapsack at the expense of valuable supplies and personal items. At the Haitian airport, people and various animals were observed, including goats and dogs, on the runway both when the authors arrived and when the authors departed. The authors also took a letter of authorization from their sponsor, the CRUDEM (Center for the Rural Development of Milot) Foundation, which the authors were told would be required to pass through customs, although the officials never asked for this letter. It is not possible to know how the earthquake affected immigration and customs services. Several airlines serve Cap Haitien Airport, with flights to Fort Lauderdale, Florida and several Caribbean destinations, such as the Bahamas and

Fig. 4. A patient receives the Sacrament of Anointing of the Sick from a priest in an operating room.
Turks. Following the earthquake, the majority of medical personnel flying in and out of Haiti arrived via private aircraft. Hundreds of nongovernmental organizations and private individuals donated their airplanes, pilots, fuel, and maintenance to fly medical staff and supplies to Haiti. Given the private nature of flights, however, schedules can be chaotic and unpredictable. Prudent travelers will plan appropriately. The hospital provided ground transportation down a 9-mile, mostly dirt road littered with large potholes, people, goats, cows, and pigs. There was no organized traffic pattern of any kind.

**Living in a Natural Disaster**

In Milot, local citizens obtain water from a small river flowing through the town, which they also use to bathe and wash clothes. Fortunately, engineers constructing the CRUDEM Compound drilled a large well and installed a purification system to provide potable water in small quantities for cooking and washing clothes. Bottled water was used for drinking and brushing teeth. Meals were prepared from food bought locally, with all preparation and cooking performed by locals employed by the CRUDEM Foundation. Meals consisted of eggs, bread, lettuce, rice, beans, squash, and carrots with meat, such as chicken, goat, and ox tail, served every other day. The food was served in small quantities by American standards, but was delicious and wholesome.

A large gas generator and 24-lead-acid batteries provided electricity for the residential compound. Electricity at the hospital was supplied by 2 smaller gas generators; routine transfer of power from one to the other required a “blackout” twice daily for 30 to 60 seconds. Initially, Digicel, one of the largest mobile carriers in Haiti, was nonfunctional for several days following the earthquake; there are no landlines and no power grids in this area. At the compound and hospital, intramedical staff communications was limited to 20 two-way radios with just 1 band, which created issues with personnel “stepping” on one another and at night for staff “on call” who had to listen to the constant chatter. Cell phones worked intermittently and were highly position dependent as was the compound’s only satellite phone, reminiscent of an archaic military handset. Internet using a satellite high-speed system was set up by a local compound engineer. The access was 5 Ethernet stations hooked up to a variety of computers. The signal was intermittent and with so many trying to communicate back to their homes, access was quite limited. The Internet became a very important source of information, with searches ranging from treating an unfamiliar disease, such as tetanus, to the volume of oxygen in an H cylinder that allowed the authors to calculate their available oxygen supply.

Bedding was of a variable nature. Most of the workers were relegated to either an outdoor tent, sleeping on a mattress on the floor, a small couch, military cots in a hallway, or, if fortunate, a bed with mosquito netting treated with insecticides such as permethrin or deltamethrin. Because the netting was not available for all, high doses of DEET-containing insect spray was applied before sleeping. In addition, sleep deprivation was a major problem for some and resulted from the emotionally charged environment, uncomfortable accommodations, overcrowding, and lack of uninterrupted sleep from buzzing mosquitoes, boisterous crowing and clucking of several roosters, and multiple visits from the occasional large insect. Most laundry was done by Sisters from the local convent, using an industrial washer and dryer, providing the workers with clean scrubs and usually 1 small towel each day.

**Staying Healthy**

Tropical diseases are a fact of life in Haiti, the poorest country in the Western hemisphere, but receiving the appropriate immunizations and arranging for prophylaxis...
before traveling was straightforward. Assuming that hepatitis B and tetanus immunizations are current, additional prophylaxis was required for hepatitis A and typhoid. Because malaria is common in Haiti, the authors’ group members took doxycycline, starting 2 days before departure and continuing for 1 month after leaving the island. Tuberculosis is also endemic in Haiti. Although there is no prophylaxis, the authors were advised to take N95 masks. Finally, because approximately 2.0% to 3.5% of the Haitian population is HIV positive, universal precautions are necessary to avoid contact with body fluids, just as in any other nation.6,7 In addition to physical health, the mental health of volunteers is important to sustain daily care to patients. For the authors, 2 elements contributed to their own mental health. First, the authors went with a well-known, long-standing partner (one another) that allowed each to discuss the day’s events, provide mutual support, and consultation. Second, the director of the health care relief effort arranged nightly debriefing sessions of approximately 30 minutes, where problems of the day were openly discussed and solutions suggested. The authors think that it is important to stay healthy not only for one’s own sake, but to avoid burdening the already overtaxed health care system.

Security

During the authors’ stay at Hôpital Sacré Coeur, they felt perfectly safe. Even the women in the authors’ group felt safe enough to walk the short distance from the CRUDEM residential compound where they lived to the hospital, even at night. However, in the course of the week the authors provided service, there was a noticeable increase in the people living in the streets, most of whom had moved the 90 miles from the earthquake zone. Patients were not happy to be discharged from the hospital, which was their only known safe environment, along with their only source of daily meals. The security environment was unknown and dependent on the United Nations troops, Haitian military and police, and nongovernmental organizations. In a different situation of mounting desperation for food and shelter, it is unknown how secure these health care facilities might have been. Compound security was provided by the occasionally seen United Nations peacekeepers from Chile and Nepal, using armored vehicles and the sparse local police force. During the authors’ stay, they had only 1 intrusion by a group of local citizens looking for supplies.

ANESTHETIC PRACTICE IN AN EARTHQUAKE ZONE

Organizing this article, the authors left the nature of anesthetic practice as a last topic of discussion because one’s previous experience, nature of the natural disaster, and equipment or supplies currently available will focus on the anesthetic. Almost all surgeries consisted of limb amputation, incision and debridement, or burn care. Many of the more severely injured patients, mostly with chest or abdominal injuries, likely were immediately killed or died in the aftermath of the earthquake. In addition to physical traumatic injury, many may also have suffered from mental disease because of the stress of the event. From the patient’s point of view, an injured patient may have been trapped under rubble in Port-au-Prince, had one or more limbs amputated several days after the earthquake by search and rescue teams who have less than 60 seconds to spend on each patient, been evacuated to Milot by helicopter, been admitted to a new hospital without family members whose fate was unknown, without funds, without clothes, and without identity papers. For these reasons, the health care team tried to provide the most gentle and humane care possible.

In the authors’ own practice in the aftermath of the Haitian earthquake, their limitations revolved around minimal preoperative or postoperative care. For that reason,
the authors took steps to alter their patient’s native physiology as little as possible. Preoperatively and with the help of a translator, an anesthetic assessment consisted of fasting status, allergies, and past medical history (almost none of the authors’ patients had ever had any health care). Medical records during this tumultuous time were disorganized and often had to be co-located with the patient (eg, written on dressing or casts, Fig. 5). Without routine care, almost all past medical history dated to January 12, 2010, when the earthquake occurred. Intraoperatively, the authors’ focus was to cause as little physiologic perturbation as possible while rendering sufficient anesthesia. For that reason, the authors’ primary anesthetic technique relied on intravenous midazolam and ketamine with appropriate local anesthetic use by the surgeon, while minimizing the need for oxygen (Fig. 6). This technique was useful to fully use all 3 operating rooms (with a single fully functional anesthesia machine) and to convert 3 examination rooms into operating rooms to allow a 6-room surgical suite. Moreover, the continuation of spontaneous ventilation allowed only a brief stay in the 5-bed

Fig. 5. Medical records for a patient with a previous open fracture of the tibia sustained in Port-au-Prince. Follow-up directions on his medical record were written on his cast, “27/1/10. I&D Open Tibia. Return for Ex Fix 29/1/10.”

Fig. 6. A week’s supply of oxygen for the entire hospital composed of three H cylinders. A full H cylinder contains about 7000 L of oxygen. A patient on 2 L/min nasal cannula oxygen for 3 days would consume 8640 L of oxygen, over a third of the weekly oxygen allocation for all patients.
recovery room that was severely strained because of understaffing and co-location of critically ill patients with medical conditions, such as unremitting diabetic coma in the absence of insulin and fulminant tetanus. If monitored anesthesia care was insufficient, then a regional anesthetic was the next preferred technique with common techniques being brachial plexus from multiple approaches, femoral nerve and popliteal nerve block, or intrathecal anesthesia for the lower extremities. Given the lack of any oral analgesics in the hospital and surrounding community, regional anesthesia also provided some benefit for immediate postoperative analgesia. The authors discussed the creation of an acute regional pain treatment team using regional anesthesia, but the scope of the disaster, lack of supplies, and sheer provider exhaustion precluded this event. Authors participating in the Haitian earthquake relief independently reached similar conclusions.\textsuperscript{1,4,8,9} For example, a French team in Port-au-Prince conducted 92\% of their anesthetics with conscious sedation or regional anesthesia in patients who suffered most of the time (79\%) with limb injuries.\textsuperscript{8}

General anesthesia was possible, although supplies of oxygen and volatile agents were limited. In the authors’ cases, they recall only a single general anesthetic for a woman hit in the face by a falling roof truss who sustained a Lefort type III injury. In the absence of maxillofacial surgeons, the team was limited to the placement of a gastrostomy tube to facilitate nutrition until a definitive resolution could be arranged. In any event, anesthetic care that allows rapid throughput in the operating and recovery rooms is essential to care for large populations.

REFERENCES