

Disaster Medicine: A Multi-Modality Curriculum Designed and Implemented for Emergency Medicine Residents

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ABSTRACT

Objective: Few established curricula are available for teaching disaster medicine. We describe a comprehensive, multi-modality approach focused on simulation to teach disaster medicine to emergency medicine residents in a 3-year curriculum.

Methods: Residents underwent a 3-year disaster medicine curriculum incorporating a variety of venues, personnel, and roles. The curriculum included classroom lectures, tabletop exercises, virtual reality simulation, high-fidelity simulation, hospital disaster drills, and journal club discussion. All aspects were supervised by specialty emergency medicine faculty and followed a structured debriefing. Residents rated the high-fidelity simulations by using a 10-point Likert scale.

Results: Three classes of emergency medicine residents participated in the 3-year training program. Residents found the exercise to be realistic, educational, and relevant to their practice. After participating in the program, residents felt better prepared for future disasters.

Conclusions: Given the large scope of impact that disasters potentiate, it is understandably difficult to teach these skills effectively. Training programs can utilize this simulation-based curriculum to better prepare the nation's emergency medicine physicians for future disasters. (*Disaster Med Public Health Preparedness*. 2016;10:611-614)

Key Words: disaster medicine, emergency medicine, residency training, simulation, virtual reality, curriculum

Disasters, by definition, are unexpected events that have the potential to stress a health care system. Today's world is riddled with devastating natural disasters, terrorist attacks, and threats of the next pandemic influenza. Emergency physicians are on the forefront of caring for disaster victims and managing the diverse clinical presentations and departmental influx of patients following disasters on both small and large scales.

Several concepts are specific to mass casualty and disaster situations, including rapid triage and resource allocation. Several specialties have incorporated training in these topics into their core curriculum. Family Medicine and Pediatrics have specifically addressed these topics in published disaster curricula.¹⁻³ However, surveys still show that residents do not feel that they receive adequate training in disaster medicine.³⁻⁵ Research on how to implement these concepts has suggested that a formal curriculum contributes to long-term retention of knowledge.³

In addition, disaster training and bioterrorism training are gaining popularity in medical school curricula.^{6,7}

Several universities have created modules to address clinical presentations, flow, and management issues.⁸

Despite the expectation for emergency physicians to be well versed in dealing with disasters, only a few established curricula are available for teaching this to emergency medicine residents.⁹ To address this paucity of a curriculum, we have created a disaster preparedness module incorporating didactics, virtual reality, simulation, and tabletop exercises.

METHODS

We developed a comprehensive, multi-modality approach focused around simulations to teach disaster medicine to emergency medicine residents. To give the learner the best understanding of disasters and their management, we provided experiences that engaged the learner in the disaster from different vantage points. We incorporated a variety of venues (various scenes, transportation units, emergency departments, and hospitals), personnel (prehospital medical personnel, police, fire, hospital personnel), and roles (triage, treatment, transportation, definitive care).

We implemented this approach in a 3-year curriculum with 13 residents per class to prepare them for disaster response. Each subsequent class received a portion of the curriculum during 3 years of data collection. Attendance was mandatory, but because of some absences (vacation, off-site rotations), an average of 10 interns per session and 9 second- and third-year residents per session attended. There were 3 sets of interns ($n = 30$), 2 sets of second-year residents ($n = 18$), and 1 year of third-year residents ($n = 9$) for a total of 57 subjects.

Lectures

The interns were exposed to a full-day prehospital and disaster medicine day during their orientation in their first year of training. In an introductory lecture, terminology such as *disaster*, *mass casualty*, *multiple-casualty incident*, *triage*, and *command systems* was defined. Students were exposed to the concepts of the prehospital Incident Command System (ICS), the Hospital Incident Command System (HICS), and the National Incident Management System (NIMS). These lectures included prehospital operations; field triage and treatment; transportation and patient distribution decisions; hospital-based triage and treatment decisions; medical surge planning; distribution of resources; communications issues among the scene providers, between the scene and the hospitals, and within the hospital; social challenges; and media relations.

The lecture curriculum during the second and third years of training reinforced many of the concepts learned during the first year. In addition, lectures focused on more advanced concepts of medical management of disaster victims, including mass trauma emergent life-saving procedures and management, as well as management of specific injuries, such as crush injuries, smoke inhalation, burns, blast injuries, chemical and radiation exposure, and infectious disease events.

Tabletop Exercises

Interns participated in 2 distinct tabletop drills during their orientation month. Postgraduate year two and year three residents completed this portion of the curriculum as interns and therefore did not participate in the tabletop exercises. The first was a multiple casualty drill involving a freeway collision between a tanker truck carrying an unknown toxic substance and several other vehicles, including cars, minivans, and buses. There were a total of 37 patients with injury ranging from “walking wounded” to “expectant,” each of which was designated by one 3-by-5-inch index card. In the first part of this drill, the trainees had to learn to assess scene safety, including identification of the toxic substance leaking from the truck; hazardous materials management; designation of hot, warm, and cold zones; and decontamination. They learned to set up staging areas and took the roles of the various members of the ICS team. They then made decisions on distribution of patients to the local hospitals given the capabilities, both technical and volume-based, of these facilities.

The second part of this drill took place in one of the hospitals. The trainees took the roles of the medical staff using HICS. Patients were re-triaged at the hospital and decisions were made about patient distribution and definitive care.

The second tabletop drill involved an active shooter. In this scenario, the management of multiple trauma patients (each designated on a 3-by-5-inch index card), mostly with penetrating trauma, was complicated by the need to consider the safety of the medical team in its home environment. Scene safety in the hospital is often assumed, but it is not always the case. Integrating medical care with an active police action becomes a far more complicated matter, requiring participants to consider various options for risk mitigation.

Virtual Reality Simulations

Web-based computer simulations of disasters were developed to enhance the learning of physicians in training.¹⁰ Participants included 10 volunteer physicians, which included 7 residents, and 12 nurses. In this model, learners participated via computer and were represented in the scenario by avatars, which they controlled. One or more instructors viewed the scene from a different computer. Victims were represented by “robots” that responded to the learners’ actions by following preprogrammed algorithms. Using voice-over-Internet and other technologies used in the computer gaming industry, learners and instructors could be in disparate locations as long as they had an Internet connection. Instructors debriefed learners in a structured discussion, emphasizing key learning points.

Two distinct drills were developed. The first drill was a scene response involving the explosion of an organophosphate gas at a farm. The objectives included learning about management decisions of the hazardous materials (HazMat) team and integration of this activity into the ICS structure. Physicians took the roles of members of the ICS team, performing HazMat team functions of setting perimeters and decontamination, as well as field triage, assigning severity levels, and moving patients to temporary treatment areas. Finally, transportation decisions were made and the patient was placed in an ambulance and sent to the hospital.

The second drill was a hospital-based scenario involving caring for victims of a “dirty bomb” explosion. In this case the objectives included evaluation of the radioactivity risks, decontamination, and management of multiple blast and penetrating trauma injuries. Learners took the roles of HICS members and performed a secondary triage, staged patients in treatment areas, and moved patients through the scenario to definitive care.

High-Fidelity, Hybrid Simulations

Residents participated in simulation sessions that combined moulaged high-fidelity mannequin simulators with live actors in a high-fidelity environment with digital video-recording

and wireless communication to render realistic disaster conditions. The disaster scenarios were designed to be plausibly realistic and complex to engage participants to make critical decisions in managing patient care. Critical actions in managing direct patient care as well as managing the overall disaster were established. Each scenario included 10 to 12 victims to treat within an hour.

Each residency class underwent a different scenario, tiered for their level of training. Residents were expected to set up an ICS, assign triage teams, set up staging and treatment areas, and communicate with HICS. They needed to treat victims and determine dispositions as if it were a true event. Progressive deterioration of victims was coordinated with a scenario clock that actors and simulation staff carried out.

We ran 3 separate disaster simulations focusing on different injury patterns reflecting the proposed disaster. First-year emergency medicine residents, consisting of 10 interns, participated in scenario one, a massive earthquake. Injury patterns focused on blunt thoracic and abdominal trauma, burn injuries, crush syndrome, compartment syndrome, hemorrhagic shock, long bone fractures and amputations, and medical emergencies such as acute myocardial infarction and psychosomatic patients.

Scenario two was an explosion at a farm that uses organophosphate insecticides and was designed for second-year emergency medicine residents. Nine residents attended this scenario, which was intended to add the complexities of a hazardous materials response to that of multiple sick and injured patients. Injuries included exposure to organophosphate toxicity and required residents to implement HazMat protocols, decontamination, and antidotes as well as manage eye injuries and airway compromise.

Scenario three was a “dirty bomb” for third-year emergency medicine residents and had 9 participants. Knowledge of radiation detection as well as radiation exposure protocols made this scenario more difficult. Critical actions included implementing radiation exposure protocols and decontamination, caring for primary and secondary blast injuries, acute radiation syndrome and radiation monitoring, surgical care with radiation, thoracic and abdominal penetrating trauma, and airway compromise.

Following each scenario, the learners participated in a structured debriefing. The goals of the debriefing included a review of the case and a discussion of critical actions and their clinical implications. The general focus was on teamwork and interpersonal communications and coordination of care. Feedback was given during debriefing sessions, but observer assessment was not included in a measurable fashion. Individuals and the group as a whole were encouraged to critique their own performances and to find areas for improvement. Residents completed a post-exercise evaluation after each simulation.

Journal Club

Residents attended a monthly journal club as part of their training. Once a year we dedicate one journal club session to disaster and emergency medical services. Residents discussed current articles on disaster topics, which have included START versus SALT triage, virtual reality training methods, and post-traumatic stress disorder.

Hospital-Wide Disaster Simulation

The Joint Commission requires the hospital to run at least 2 hospital-wide emergency response exercises yearly, which traditionally are disaster exercises. The residents are encouraged to participate in these drills every year. In the last 3 years, our drills have included a novel drive-through clinic for influenza pandemic,¹¹ an active shooter exercise, an earthquake exercise, a bomb explosion at the football stadium, and an evacuation exercise.

Residents also have the opportunity to participate in monthly, multidisciplinary, emergency department-based simulations held at one of their training sites. These simulations integrate physicians, nurses, administrators, and other staff in responding to a variety of situations, including “routine” multiple casualty scenarios, such as earthquakes, hazmat exposures, and an airline crash at the local airport, as well as some more “exotic” scenarios, including an explosion at a local high tech company, a terrorist attack at a local shopping mall, and a zombie attack.

Quarterly skills sessions were integrated into the curriculum to allow residents to work on specific disaster management topics, such as SALT triage, radio communications, decontamination, and running alternate care areas.

RESULTS

Emergency medicine residents from a 3-year training program were asked to fill out a post-exercise evaluation after each simulation. A total of 57 surveys were distributed over the 3-year curriculum. The survey consisted of 9 questions with responses provided on a 10-point Likert scale, with a score of 1 being least favorable and 10 being most favorable. Twenty-five surveys were collected for a 44% response rate. Residents found the scenarios to be realistic (mean score, 7.96; SD, 2.03), educational (mean score, 9.20; SD, 1.35), and relevant to their practice (mean score, 8.40; SD, 2.29) and believed that they gained valuable knowledge to prepare for future disasters (mean score, 8.52; SD, 1.39).

Feedback from our learners was positive. Even the greatest critics in the arena of medical education, our senior residents, who have been official learners individually for a quarter of a century, noted that these were “very interesting cases, scary scenario that taught me a great deal about management of radiation exposure and blast injury” and had a “very realistic feel.”

DISCUSSION

Disasters, by their nature, are complex and cause a level of confusion for those involved. Developing a curriculum to effectively teach physicians how to manage patients in this environment is inherently challenging. Thus, it is significant that a curriculum with this level of complexity has been successfully implemented. Accomplishing the goals and objectives in a simulated environment requires a high level of detail and organization. This curriculum, despite its complexity, was created for implementation at other simulation centers and is portable. As the number of medical simulation centers continues to grow,¹² many individuals can benefit from this disaster curriculum.

A future direction is born with this feedback. It would be beneficial indeed to further develop this curriculum to be team training for disaster management. Many institutions accomplish team training through large-scale, countywide disaster drills. There may be value in developing a curriculum for team training for disasters in simulation centers. It may be less expensive and easier to organize than large-scale, countywide disaster drills.

It was fortuitous timing that we completed this disaster curriculum for our residents 2 months before the SFO plane crash on July 6, 2013. Stanford University Medical Center received 55 patients of whom 18 were admitted. According to internal reports,¹³ the Code Triage Major went smoothly. A total of 36 patients arrived in the first 4 hours. Six emergency medicine residents were on duty at the time of the crash and an additional 6 residents came in from home to help. Residents were able to put their skills from the simulation directly into practice in this real-life scenario.

Limitations

Many opportunities remain to improve disaster training for residents. Some suggestions made by the residents to make the scenarios more realistic were to include more realistic lag time to have orders completed and to combine different resident classes during the disaster simulations to work on how to organize a team of residents of different levels. The disaster simulations required a large number of props and a great deal of preparation and manpower to run, which can limit the number of drills a program can conduct. It would be helpful to formally evaluate this program to determine which modality taught the residents more, how long they retained their knowledge, and how the program contributes to their disaster preparedness.

CONCLUSIONS

Given the large scope of impact that disasters potentiate, it is understandably difficult to teach these skills in an effective manner. Yet, the world has become a place where a disaster can occur anywhere and at any time. Our medical personnel need to be proficient in caring for a large bolus of patients who are potentially infectious or contaminated. Physicians must be vigilant and ready at all times for the arrival of chemicals, biological agents, or radioactive material carried on patients' bodies. It is

inherently a part of the specialty of Emergency Medicine. Training programs can utilize this curriculum to better prepare the nation's faculty and residents for future disasters.

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