Effectiveness of Hospital Staff Mass-Casualty Incident Training Methods: A Systematic Literature Review

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Abbreviations:
JCAHO = Joint Commission on Accreditation of Healthcare Organizations
JHU-EPC = Johns Hopkins University Evidence-based Practice Center
MCI = mass-casualty incident

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Abstract

Introduction: Recently, mass-casualty incident (MCI) preparedness and training has received increasing attention at the hospital level.

Objectives: To review the existing evidence on the effectiveness of disaster drills, technology-based interventions and tabletop exercises in training hospital staff to respond to an MCI.

Methods: A systematic, evidence-based process was conducted incorporating expert panel input and a literature review with the key terms: "mass casualty", "disaster", "disaster planning", and "drill". Paired investigators reviewed citation abstracts to identify articles that included evaluation of disaster training for hospital staff. Data were abstracted from the studies (e.g., MCI type, training intervention, staff targeted, objectives, evaluation methods, and results). Study quality was reviewed using standardized criteria.

Results: Of 243 potentially relevant citations, 21 met the defined criteria. Studies varied in terms of targeted staff, learning objectives, outcomes, and evaluation methods. Most were characterized by significant limitations in design and evaluation methods. Seventeen addressed the effectiveness of disaster drills in training hospital staff in responding to an MCI, four addressed technology-based interventions, and none addressed tabletop exercises. The existing evidence suggests that hospital disaster drills are effective in allowing hospital employees to become familiar with disaster procedures, identify problems in different components of response (e.g., incident command, communications, triage, patient flow, materials and resources, and security) and provide the opportunity to apply lessons learned to disaster response. The strength of evidence on other training methods is insufficient to draw valid recommendations.

Conclusions: Current evidence on the effectiveness of MCI training for hospital staff is limited. A number of studies suggest that disaster drills can be effective in training hospital staff. However, more attention should be directed to evaluating the effectiveness of disaster training activities in a scientifically rigorous manner.

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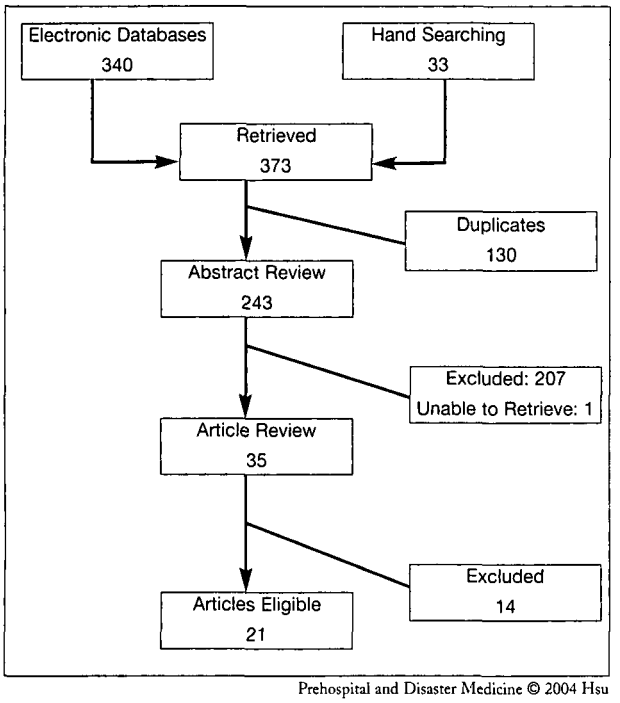

Figure 1—Results of searching the literature for studies evaluating the effectiveness of hospital disaster drills

Introduction

A disaster may be defined as "a disruptive event whose destructive impact overwhelms a community's ability to meet healthcare demands."[1] Disasters involving a significant human toll are termed mass-casualty incidents (MCIs). The emergence of state-sponsored terrorism, the proliferation of scientific weapons expertise, and the increase in less discriminate attacks all point toward a significant and growing threat of unconventional MCIs.[2] In recent years, the Tokyo subway sarin release, bombing of the Murrah Federal building in Oklahoma City, Oklahoma and the 11 September 2001 attacks in New York City in the US have underscored this concern and highlighted the current limits of emergency response capabilities.

Given the complexities of these issues, hospitals must invest substantial efforts in developing disaster preparedness plans and training while coordinating with public health systems and appropriate government agencies. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO), in the United States, has issued standards that require hospitals to develop cooperative disaster planning "among health care organizations that, together, provide services to a contiguous geographic area."[3] These standards also require hospitals to test their emergency management plan twice a year including at least one community-wide practice drill to assess communications, coordination, and the effectiveness of command structures.[4]

However, disaster preparedness training is time-consuming, expensive and may divert resources away from other important needs. Moreover, the degree to which training is effective is not known. Therefore, a systematic review was performed of the published literature on the effectiveness of hospital disaster drills, technology-based educational interventions, and tabletop exercises in training hospital staff to respond to an MCI.

Methods

Target population

The target population addressed in this systematic review consisted of all clinical, non-clinical, and administrative hospital staff who participated in an educational intervention related to MCI response.

Questions addressed

This review presents the main findings of an evidence report in which the Johns Hopkins University Evidence-based Practice Center (JHU-EPC) identified and reviewed the published evidence on the training of hospital staff to respond to an MCI.[5] This article focuses on the following key questions: (1) What is the effectiveness of disaster drills in training hospital staff to respond to an MCI?; (2) What is the effectiveness of technology-based interventions in training hospital staff to respond to an MCI?; and (3) What is the effectiveness of tabletop exercises in training hospital staff to respond to an MCI?

Literature search

The JHU-EPC searched seven electronic databases in December 2002, with an updated search of PubMed in February 2003. The search strategy was developed by an expert on the EPC team and reviewed by the team prior to implementation. The resulting citations were entered into a ProCite® database (ProCite, ISI Research Soft, Berkeley, CA). To ensure completeness, JHU-EPC team members also hand searched pertinent journals and the reference lists of eligible articles through January 2003.

Eligibility criteria

Articles underwent title, abstract, and full review if eligible. Articles were excluded from further consideration at each step based on the following criteria: not in English, no human data, no original data, only a meeting abstract, no data on healthcare professionals, no training or education, no evaluation data, or not relevant to research questions. Two members of the study team determined eligibility of each article by consensus.

Data abstraction

The reviewers abstracted information from each eligible study onto an 18-item form including: (1) a description of the participants; (2) geographic location; (3) type of MCI; (4) training method; (5) educational objectives; and (6) conclusions of the study. Training objectives were classified as addressing knowledge, attitudes, skills, behaviors, or clinical outcomes, and were grouped by the component of disaster response targeted in the exercise (e.g., incident command center, internal/external communications, patient flow and tracking, materials and resources, decontamination, and security).

						Objectives			
Ref	Year	Loc	Training	n	Staff Type	N	Knowledge	Skills	Clinical Outcome
9	1990	US	Drill fire + explosion	1	P, N	NS	Assess resources available if: (1) usual trial team unavailable due to injury; (2) usual treatment area unavailable	Assess triage ability of ICU nurses	
6	1989	US	Drill chemical	1	CEO, FR, TO, S, N, A, Adm, M	NS	Test preparedness of necessary resources (hospital employees, hospital fire brigade, ED staff, local FD) for ethylene oxide spill		
12	2000	US	Drill radiation	1	P, N, RS	NS	Assess function of intercom and security		
13	1990	US	Drill TA	1	Not specified	NS	Understand implementation of disaster plan and department interaction	Move victims through hospital appropriately and efficiently	Minimize time in each area waiting for disposition
14	1985	US	Drill TA	1*	FR, P, TT	NS	Gain knowledge of time needed to initiate care of patients from an airplane disaster at the local airport	Initiate care to patients with varying degrees of injury severity in a timely manner	Evaluate triage of victims and severity of injuries by arrival time at trauma center
20	1974	US	Drill TA	18	N, P, FR	NS	Evaluate effectiveness of exercise	Assess transportation of 300 victims to 18 hospitals	
17	1997	Middle East	Drill	8	FR, N, P	NS			Assess feasibility of integrating physicians among simulated casualties
8	2002	Europe	Drill hospital fire	1	A, FR, N, P	500	Educate coordinating physician in communication procedures	Evaluate immobile patients to collection points	Compare evacuation time using *Carry Sheet* versus single person using *Rescue Drag Sheet*
10	1993	US	Drill hospital fire in OR	1	N, P	48	List 3 elements of fire; initiate procedure for notification	Use fire extinguishers and evacuate patients safely	
25	2001	US	Other biological	3	Not specified	NS	Test readiness of top government and other officials to respond to attacks at multiple locations		
15	1997	Asia	Drill TA	1	A, N, P, S, T	60	Familiarize staff with plan and their roles	Handle patient flow and triage appropriately	Test efficiency of plan and coordination among hospital departments
21	1987	US	Drill TA	1	P, FR	NS	Assess value of victim-tracking cards		Appropriately triage and transport casualties to correct treatment areas
19	1968	US	Drill incendiary device Boiler explosion	4	P, FR	NS	Assess handling and transportation of victims; first aid at scene of event; assess medical care at hospital		

continued

Table 1—Characteristics of studies evaluating training programs for hospital staff to respond to a mass-casualty incident (A = administrators, Adm = admitting, CEO = chief executive officer, ED = emergency department, FD = fire department, FR = first responders, HazMat = hazardous materials, ICU = intensive care unit, Loc = location, M = maintenance, n = number, N = nurses, NA = nursing administration, NS = not stated, OR = operating room, P = physicians, RS = radiation safety staff, S = security, T = transport team, TO = telephone operator, TA = transportation accident, TT = triage team, US = United States of America)

Results

Literature search

The literature search process yielded 243 unique potentially relevant citations, 208 of which (86%) were found to be ineligible during the abstract review process. Of the 35 studies identified for full article review, 21 were eligible for data abstraction (Figure 1).

Focus of the reviewed studies

The 21 studies that met the inclusion criteria covered a variety of training interventions (Table 1). Most of the reported training occurred in the United States, although the Middle East, Europe, and Asia were represented. All included studies were published between 1968 and 2002. Seventeen of these studies used disaster drills to train hospital staff to respond to an MCI,[6–22] one of which was a complex exercise targeted at testing the readiness of top government and other officials.[22] Four studies used a technology-based learning technique such as computer simulation, video demonstration, or teleconferencing.[23–26]

The training scenario also varied, with most using a conventional MCI as the educational setting. Six studies

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						Objective			
Ref	Year	Loc	Training Type	n	Staff Type	N	Knowledge	Skills	Clinical Outcome
16	1985	US	Drill TA	NS	Not specified	NS	Analyze care to victims in airport drill		
18	1986	US	Drill chemical	1	P, FR	NS	Demonstrate coordinated response to HazMat incidents by dispatching local and state response teams; exercise chemical emergency plans within political guidelines; meet information needs of government agencies by establishing on-site communications; demonstrate ability to notify and assemble on-site Emergency Operating Center; demonstrate ability to manage HazMat accidents; demonstrate capabilities of a major hospital ED		
7	1999	Middle East	Drill chemical	21	Not specified	NS	Evaluate quality of patient care		Evaluate ability to provide continuity of care
11	1988	Europe	Drill fire in OR	1	A, N, P	NS	Assess time to evacuation		
26	1984	NS	Audio visual fire	1	N, EMT	NS	Evaluate nursing care	Assess 5 performance objectives, each requiring 4 to 5 activities (not specified)	
24	1996	Middle East (Saudi Arabia)	Video simulation TA	1	N, Other	500+	Evaluate recall in hospital; employees who viewed video demonstrating plan vs. group who had read plan		
22	1998	Middle East	Computer simulation	1	A	NS		Evaluate disaster plan w/o activating whole system (to carry out limited drill); train decision-makers	Assist managing real situations by identifying bottlenecks and evaluating solutions
23	2000	Eastern Europe	Audio-graphic teleconfer-ence Radiation accident	NS	ED	NS	Recognize accidental exposure	Perform assessment of exposed victims; estimate exposure; report to national authorities; establish communication between counties	Achieve coordination and consultation regarding victims

Table 1 (continued)—Characteristics of studies evaluating training programs for hospital staff to respond to a mass-casualty incident (A = administrators, Adm = admitting, CEO = chief executive officer, ED = emergency department, FD = fire department, FR = first responders, HazMat = hazardous materials, ICU = intensive care unit, Loc = location, M = maintenance, n = number, N = nurses, NA = nursing administration, NS = not stated, OR = operating room, P = physicians, RS = radiation safety staff, S = security, T = transport team, TO = telephone operator, TA = transportation accident, TT = triage team, US = United States of America)

were focused on a fire or explosion.[8–11,18,26] Seven studies described a transportation accident (e.g., a plane crash at a local airport).[13–16,20,21,25] Three studies were focused on a chemical event,[6,7,18] two studies described a radiation event,[12,24] and one study focused on a biological event.[22] The event type was not stated in two studies.[17,23] Although most took place in a single hospital,[6,8–15,18,21,23,25,26] five studies provided evidence from multiple hospital settings, ranging from 3–21.[7,17,19,20,22] Two studies did not specify the number of hospitals involved.[16,24]

Target audience of the training

In all but one study, the educational intervention targeted multiple types of hospital staff (Table 1). Thirteen studies included physicians in the target audience,[6,8–12,14,15,17–21] and 11 studies included nurses.[6,8–12,15–17,20,25,26] Hospital administrators were involved in five studies;[6,8,11,15,23] in addition to hospital personnel, first responders were included in nine studies;[6,8,14,17–21,25] security and transportation personnel were involved in two studies.[6,15] Four of the studies did not specify a targeted audience.[7,13,16,22]

Principal findings of key questions

The 21 studies reviewed evaluated the impact of the drill by observing targeted components, e.g., incident command, communications, clinical care, patient care, flow and tracking, security, materials and resources, and decontamination (Table 2). The methods used for evaluation were markedly heterogeneous and often not well-described or not specified. The training evaluation methods most commonly used were

Ref	Year	Incident Command System	Communication Internal/External	Clinical Care	Other
9	1990	Confusion resulted without designated commander	**Internal**: Delay because ED immobilized	**Triage**: Usual triage area not available. Relief staff inexperienced. **Victim care**: Treatment began in triage areas. **Victim flow**: Lack of triage area confused victim flow.	**Security**: Security informed FD of situation. **Resources**: Disaster charts not available.
6	1989		**Internal**: Contacted operator via hotline. Fire brigade alerted by code. **External**: Requested assistance from local FD. Hospital's CEO called a disaster code.	**Victim flow**: Victims evacuated to ED. **Victim tracking**: Admitting personnel in ED constructed charts and identification bracelets.	**Resources**: FD arrived in full gear: material safety data sheet and breathing apparatus used.
12	2000		**Internal**: Intercom inadequate. Fire alarms worked. Radiation call staff contacted. **External**: Contact radiation safety immediate; message incomplete (significant deficiency).	**Triage**: Physical barriers to identify hot, warm, and cold zones for victims not placed correctly. **Victim care**: Use of building exits as choke points for screening worked well. **Victim flow**: 30 victims transported to ED.	**Security**: Security of building and perimeter exceeded standards. **Decon**: County HazMat Team required 1 hour to set-up for portable decon. Insufficient staff released to prepare decon facility. Potentially contaminated deceased victims screened. **Other**: Response personnel lacked special identification. Bioassays needed exposure.
13	1990	Resulted in less confusion	**Internal**: Overheard announcement not heard. Vital personnel had not received new plan.	**Victim flow**: Congestion in triage and ED reduced; personnel reported directly to assigned areas.	**Other**: At least one person per department now has in-depth understanding of plan. Staff stress levels more manageable with game approach.
14	1985			**Triage**: Half of group requiring immediate care arrived >1.5 house post-disaster. 85% of victims triaged to trauma center required admission.	
20	1974		**Internal**: Emergency call-up system inadequate (names and phone numbers wrong). **External**: Radio communications developed technical and operational problems.	**Triage**: Teams of doctors and nurses not experienced in triage: course needed. Triage tags not easily identifiable (color coding recommended). **Victim flow**: ambulance crews became exhausted.	
17	1997			**Triage**: 9% of victims over-triaged; 4% of victims under-triaged. **Victim care**: Simulated casualties not fully examined. PTSD victims not examined full. Some victims referred directly to psychology (not triaged). **Victim flow**: Treatment delays due to lack of leadership and shortage of personnel. Victims transferred without appropriate medical escort or proper ventilation. **Victim tracking**: Medical documentation inadequate.	**Resources**: Shortage of ventilators and other equipment resulted from failure to report from storage to ED.

continued

Table 2—Results of studies on hospital disaster drills evaluating training of hospital staff to respond to an mass-casualty incident (CEO = chief executive officer; Decon = decontamination; ED = emergency department; EOC = Emergency Operating Centers; FD = fire department; HazMat = hazardous materials; OR = operating room; PPE = personal protective equipment; PTSD = post-traumatic stress disorder)

group interviews/debriefings (12 of 21)[8,10–13,15,17,20–23,25] and "smart" observers (6 of 21).[7,8,10,13,16,20]

What is the effectiveness of disaster drills in training hospital staff to respond to an MCI?

The majority of studies (17 out of 21) trained hospital staff to respond to an MCI through disaster drills.[6–22] Learning objectives of these exercises addressed: (1) knowledge (e.g., proper implementation of evacuation procedures);[8] (2) skills (e.g., ability to use fire extinguishers);[10] (3) behaviors (e.g., leadership[22] and safety[12]); and (4) clinical outcomes (e.g., improvement of evacuation times[8]). The authors concluded that hospital disaster drills were effective in illustrating better staff understanding of

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Ref	Year	Incident Command System	Communication Internal/External	Clinical Care	Other
8	2002	Coordinating physician and other hospital executives worked with incident commander effectively.	**External**: Went smoothly and provided true interface between authorities and hospital administration.	**Victim flow**: Flow and staff allocation greatly aided by *Rescue Drag Sheet*.	**Resources**: *Rescue Drag Sheet* improved evacuation times compared to carrying teams. **Other**: Victim collection points inadequate for actual number of victims.
10	1993		**Internal**: Staff could not hear overhead announcement in OR. Printed protocols needed. OR representatives to be added to disaster committee.	**Victim care**: OR beds too heavy to maneuver for evacuation. **Victim flow**: Corridors, exits, and evacuation routes blocked with equipment.	**Reources**: Gas levers difficult to find. Fire door in back corridor did not close. Second water hose needed. **Other**: Secondary program taught OR staff how to use fire extinguishers.
25	2001	Difficulties coordinating operation centers set up by state and federal emergency management. Unfamiliar with disaster control terms. Leadership roles and authorities unclear.	**Internal**: Substantial exchanging phone, beeper, and fax numbers. **External**: Conference-call decision-making inefficient, resulting in indecision and delays. Radios effective when phone lines unanswered or non-functional.	**Triage**: Accuracy of triage for potentially exposed and early infections questioned. **Victim care**: Hospitals over surge capacity within <24 hours. **Victim flow**: Inadequate plans for disposition of victims triaged, and for deceased.	**Security**: Concerns about ability to create effective security lock-downs. **Resources**: Antibiotic supplies exhausted early and distribution logistically difficult. Other resources scarce. **Other**: Serious disagreements about antibiotic distribution. Unclear which healthcare workers should be wearing PPE, and approriate level of protection.
15	1997	*Plan activated successfully.*	**Internal**: Radio training needed. **External**: Telephone operator relapsed to native language under stressful conditions.	**Triage**: 19 victims triaged and discharged. Updates inadequately documented. **Victim care**: Charting detracted from victim care. Staff from other units not adequately familiar with ED. **Victim flow**: 45 minutes from first victim to last victim. Porters did not know role. **Victim tracking**: Victims given identification bracelets and record sheet; all were accounted for.	**Resources**: Nurse wasted time summoning staff. Not enough *wheelchairs, extra chairs in waiting* room, poles, and ropes to maintain order.
21	1987			**Triage**: Victims not assigned triage level. **Victim care**: 13 of 14 victims treated appropriately. **Victim flow**: 3-minute median time to triage; 10 minutes to trieatment area. **Victim tracking**: 4 victims bypassed hospital triage without being tagged.	
19	1968	No recognized overall leader to coordinate services and agencies. No medical authority present.		**Triage**: No selection of victims for removal from scene. No established area for victim safety and treatment. Ineffective triage and no follow-up. **Victim care**: First-aid training of police and FD was deficient. Victims received inadequate first aid at disaster site. **Victim flow**: Haphazard triage of victims from scene. Ambulance services provided proper handling and transportation.	**Resources**: First-aid equipment and supplies in quantity must be taken to site as soon as type of event ascertained. **Other**: Out-of-town ambulance drivers did not know hospital locations (state highway signs inadequate).

continued

Table 2—Results of studies on hospital disaster drills evaluating training of hospital staff to respond to a mass-casualty incident (CEO = chief executive officer; Decon = decontamination; ED = emergency department; EOC = Emergency Operating Centers; FD = fire department; HazMat = hazardous materials; OR = operating room; PPE = personal protective equipment; PTSD = post-traumatic stress disorder)

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Ref	Year	Incident Command System	Communication Internal/External	Clinical Care	Other
16	1985			**Triage**: 44% of victims assigned to correct triage category. 5% of victims not assigned to a triage category. **Victim care**: 3% of victims with correctable injuries died and 6% of victims had deterioration attributed to late interventions. **Victim tracking**: All victim-tracking cards collected.	
18	1986		**External**: Notification for activation and communication among EOC ineffective. Chemicals incorrectly reported.		
7	1999		**External**: Effective communications between different sites and control center essential.	**Victim care**: Continuous care for victims essential during transfer and treatment. Training should occur in full PPE and include intubation mannequins, ventilation, and decon procedures. Medical personnel must be ready to handle casualties with unexpected injuries. **Victim tracking**: Clear labeling, identification, and record keeping vital for efficient victim processing.	**Decon**: Full PPE must be worn in contaminated area. Decon must be directed by personnel with loudspeakers. **Other**: Adequate pre-drill instructions and training vital for success.
11	1988	Absence of senior hospital nursing officer led to command confusion. Incident flow charts needed.	**Internal**: Poor communication due to few alarm bells and inaudible buzzers.	**Victim care**: Victim casualty occurred during OR evacuation. **Victim flow**: Victims incorrectly moved outside the building. **Victim tracking**: All victims and staff accounted for following evacuation.	

continued

Table 2—Results of studies on hospital disaster drills evaluating training of hospital staff to respond to an mass-casualty incident (CEO = chief executive officer; Decon = decontamination; ED = emergency department; EOC = Emergency Operating Centers; FD = fire department; HazMat = hazardous materials; OR = operating room; PPE = personal protective equipment; PTSD = post-traumatic stress disorder)

disaster plans and equipment[10,13] and improved patient tracking and flow;[7,8,12,13,15,16] however, they also demonstrated a number of deficiencies in decision-making[9,19,22] and information systems,[22] in clinical operations resulting from inexperienced staff,[7,9,19,20] errors in treatment, triage, or documentation,[11,15–17,19,21] and inadequate training.[7,9,19,22] The disaster drills also effectively identified resource shortages.[8,10,15,17,19,22]

In addition, drills effectively underscored critical issues in communication, such as the importance of clear lines of authority in incident command.[8,9,11,13,15,22] Communication breakdowns occurred with inadequate intercom systems or alarms,[10,12,13] radio problems,[15,20] and incorrect emergency call-up lists and numbers.[20,22] Identification of these issues allowed changes to be made in response, improving preparedness for the future.

What is the effectiveness of technology-based interventions in training hospital staff to respond to an MCI?

As shown in Table 1, four studies used a technology-based educational tool. In one study, a computer simulation was used to train senior hospital administrators to respond to an MCI and to identify bottlenecks in patient care.[23] Another study used Internet-based audiographic teleconferencing to test real time communications and to triage, diagnose, report, and treat radiation victims through video conferencing across time zones.[24] A third study used a video to demonstrate the hospital disaster plan.[25] The fourth study used audiovisual instruments to teach burn care.[26] Learning objectives of these interventions addressed knowledge, behaviors, and clinical outcomes.

The authors reported that these technology-based educational strategies were effective as evidenced by increased knowledge of injury treatment,[24,26] improved information retention,[25] and identification of bottlenecks, crowd control issues, and resource needs.[23]

What is the effectiveness of tabletop exercises in training hospital staff to respond to an MCI?

There were no articles that described and evaluated a tabletop exercise designed to train hospital employees in an MCI response.

Ref	Year	Incident Command System	Communication Internal/External	Clinical Care	Other
26	1984			**Victim care**: Burn care knowledge increased moderately from pre- to post-test. Leadership personnel from ED working with burn unit staff scored highest.	
24	1996				**Other**: Video reviewers retained information on disaster plan significantly better than did those who had read the plan (72% vs. 45%, p <0.01).
22	1998			**Victim flow**: Identified bottlenecks and predicted ability to care for casualties.	**Security**: Identified crowd control issues and other security problems. **Resources**: Identified specific medical equipment/medication needs and electro-mechanical failures.
23	2000		**External**: Extensive real-time communication among sites in 5 time zones. All sites participated in 7 live teleconferences within 74 hours. Proper authorities notified in each country.	**Triage**: Clinical symptoms in victims linked to common source of exposure. Names of exposed identified and sent to the departments of public health in participating countries.	

Table 2—Results of studies evaluating training of hospital staff to respond to a mass-casualty incident (ED = emergency department, Ref = reference)

Discussion

This heterogeneous group of studies revealed a substantial amount of work in the developing field of hospital disaster preparedness. The evidence is not yet strong enough to make definitive recommendations on the most effective way to improve clinicians' knowledge of hospital disaster procedures. However, some general statements can be made about the different techniques used in the studies reviewed.

Effectiveness of hospital disaster drills is difficult to determine as there is little objective data in the literature, such as pre- and post-test knowledge scores or statistics showing significant improvement of patient through put time. Instead, the authors of these 17 studies generally described the disaster drills as effective and successful based on the following accomplishments: (1) drills allowed hospital employees to become familiar with disaster procedures; (2) drills allowed identification of problems in the different components of response (e.g., incident command, communications, triage, patient flow, materials and resources, and security); and (3) drills provided the opportunity to apply lessons learned to disaster response.

As technology evolves, technology-based learning will be used more frequently in the future. Computer simulations may represent an effective way to educate key hospital decision makers about disaster procedures prior to a full scale drill and to identify bottlenecks through animation tools. Teleconferencing may be an effective way to educate hospital employees over a widespread geographic area. Video demonstrations may be an inexpensive, convenient way to rapidly educate a large number of staff about disaster procedures and equipment use. More analysis of these training strategies must be done before their effectiveness can be established.

Tabletop exercises have been used to train key decision-makers and to evaluate the logistics of disaster response. Although used frequently as a training method for first responders, and supported by experts as an important device in disaster preparedness,[27–30] there were no reports evaluating hospital tabletop exercises, making it difficult to determine its effectiveness as an educational tool in the hospital setting.

Limitations

This review has several limitations. First, the search was limited to published English language articles that described both the intervention and an evaluation. There may be classified or unpublished material on MCI training that is not included in this report.

Another limitation of this review is the small number of studies identified. Unfortunately, relatively few reports are publicly available on the use of disaster drills to train hospital staff in how to respond to MCIs, denying the disaster preparedness community the benefits of collective experience. To facilitate access to and use of data evaluating hospital disaster drill, a central reporting system for hospital

disaster exercises could be created, using templates for training reports (i.e., Utstein-Style Guidelines)[31] with universally recognized nomenclature.

The studies that were identified have important limitations, such as limited descriptions of the targeted learners and educational methods, lack of a comparison group, and subjective evaluations.[5] In the future, more attention needs to be given to evaluating the effectiveness of relevant training programs in a scientifically rigorous manner. Future studies should employ appropriate evaluation methods, such as pre- and post-testing and comparison groups. Well-defined objectives linked to measurable outcomes assure fair and unbiased determination of the efficacy of educational methods for training clinicians in disaster preparedness.

Evidence is lacking on the cost-effectiveness of any particular type of hospital disaster training. Although disaster drills may provide the most realistic training outside of an actual event, they can be expensive.[22] It is imperative that future studies report on the cost of the disaster preparedness training so that financial implications may be factored into training recommendations.

Given the increasing likelihood of an MCI resulting from terrorism, it is reassuring to note that six of the 21 studies[6,7,18,19,22,24] used a non-conventional disaster scenario, such as a chemical, biological, or radiation event. MCIs of this nature are more complex for many reasons, including the possible need for decontamination, isolation needs due to contagion, and/or the compounded psychological effects inherent to terrorism and the unknown. It is important to prepare hospitals for these unique challenges. Future training should continue to address biological, chemical, and radiation incidents.

Conclusion

This synthesis of existing evidence was directed at establishing baseline knowledge regarding the effectiveness of hospital staff MCI training. Due to marked differences in the design of these 21 educational interventions, and lack of scientifically rigorous evaluation, it is difficult to establish definitive recommendations. Given the limitations of current evidence, it will be important to develop well-designed studies and new evaluation tools to determine the effectiveness of different MCI training programs. By examining interventions with evidence-based methods and by reporting and publishing results, hospitals can catalyze development of improved standards for hospital disaster preparedness.

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