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Number 95

Training of Hospital Staff to Respond to a Mass Casualty Incident

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Preface

The Agency for Healthcare Research and Quality (AHRQ), through its Evidence-Based Practice Centers (EPCs), sponsors the development of evidence reports and technology assessments to assist public- and private-sector organizations in their efforts to improve the quality of health care in the United States. This report on *Training of Hospital Staff to Respond to a Mass Casualty Incident* was requested and funded by AHRQ's Center for Primary Care, Prevention, and Clinical Partnerships. The reports and assessments provide organizations with comprehensive, science-based information on common, costly medical conditions and new health care technologies. The EPCs systematically review the relevant scientific literature on topics assigned to them by AHRQ and conduct additional analyses when appropriate prior to developing their reports and assessments.

To bring the broadest range of experts into the development of evidence reports and health technology assessments, AHRQ encourages the EPCs to form partnerships and enter into collaborations with other medical and research organizations. The EPCs work with these partner organizations to ensure that the evidence reports and technology assessments they produce will become building blocks for health care quality improvement projects throughout the Nation. The reports undergo peer review prior to their release.

AHRQ expects that the EPC evidence reports and technology assessments will inform individual health plans, providers, and purchasers as well as the health care system as a whole by providing important information to help improve health care quality.

We welcome written comments on this evidence report. They may be sent to: Director, Center for Outcomes and Evidence, Agency for Healthcare Research and Quality, 540 Gaither Road, Rockville, MD 20850.

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Structured Abstract

Context: Because of recent terrorist attacks, hospitals are devoting increased attention to disaster preparedness by reexamining disaster plans and training hospital staff to respond to a mass casualty incident (MCI). An MCI is defined in this report as an incident that results in multiple casualties that overwhelm local resources and that may involve natural, biological, chemical, nuclear, or other agents.

Objectives: This evidence report identifies and synthesizes evidence on the effectiveness of hospital disaster drills, computer simulations, and tabletop or other exercises in training hospital staff to respond to an MCI, and it reviews the methods or tools that have been used to evaluate these types of training activities.

Data Sources: The Evidence-based Practice Center (EPC) searched for articles published through January 2003 using six electronic databases, including PubMed®, the Cochrane Central Register of Controlled Trials, the Excerpta Medica database (EMBASE), the Educational Research Information Clearinghouse, the specialized Register of Effective Practice and Organization of Care Cochrane Review Group, and the Research and Development Resource Base in Continuing Medical Education. Search terms included *mass casualty*, *disaster*, *disaster planning*, and *drill*. The EPC also conducted a hand search of references and selected journals.

Study Selection: Paired investigators reviewed the titles and abstracts of citations located by the search to identify articles that were written in English, included original human data, and reported on the evaluation of disaster training for hospital staff.

Data Extraction: Paired reviewers evaluated study quality in terms of the representativeness of the targeted hospital staff, potential bias and confounding, description of the intervention, assessment of outcomes, and analysis. The reviewers extracted information on the studies (e.g., geographic location, MCI type, training intervention, hospital staff targeted, other entities involved, objectives, evaluation methods, and results).

Data Synthesis: Sixteen studies addressed hospital disaster drills as a training method for hospital staff to respond to an MCI and indicated lessons learned. The studies had significant limitations in design and evaluation methods. One study addressed computer simulation for training hospital staff to respond to an MCI and identified bottlenecks in patient care, security problems, and other issues. Four studies, covering issues from burn care to a regional coordinated response to a biological attack, addressed the effectiveness of tabletop or other exercises in training hospital staff to respond to an MCI. The reviewed studies used a variety of methods to evaluate the effectiveness of hospital drills, computer simulations, and tabletop and other exercises in training hospital staff to respond to an MCI, and they targeted different groups of hospital staff. Internal and external communications were the key to disaster response (e.g., a well-defined incident command center reduced confusion, conference calls were inefficient, and accurate phone numbers were vital).

Conclusions: We concluded that enough studies were available to suggest that hospital disaster drills were effective in training hospital staff to respond to an MCI; however, weaknesses in study design limit the strength of these conclusions. Although computer simulations and tabletop and other exercises may have a role in identifying problems in disaster preparedness, the evidence is insufficient to judge their effectiveness in training.

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http://www.ahrq.gov/browse/bioterbr.htm#epcrep

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Training of Hospital Staff To Respond To A Mass Casualty Incident

Summary

Introduction

Disaster scenarios that once seemed merely theoretical have become a disturbing reality. The emergence of state-sponsored terrorism, proliferation of chemical and biological agents, availability of materials and scientific weapons expertise, and recent increases in less discriminate attacks all point toward a growing threat of a mass casualty incident (MCI). Governmental agencies, healthcare professionals, and public health advocates have sought to determine the best ways to mitigate the potential impact of an MCI that results in multiple casualties that overwhelm local resources and that may include natural, biological, chemical, nuclear, or other agents.

Hospital disaster preparedness has therefore taken on increased importance at local, state, and federal levels. Hospitals themselves are taking renewed interest in disaster preparedness, reexamining their disaster plans, and conducting disaster exercises. Preparing for MCIs is a daunting task, as unique issues must be considered with each type of event. For example, the systemic stress of a biothreat is entirely different from that of a chemical disaster or any other acute onset disaster. These differences hold challenging implications for preparedness training.

Hospitals must play a key role in developing disaster preparedness plans, and they need to coordinate efforts with public health systems and appropriate governmental agencies. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) actually requires hospitals to test their emergency plan twice a year, including at least one community-wide drill.[1] However, it is not known whether this type of training is effective. The current evidence report updates the evidence report *Training of Clinicians for Public Health Events Relevant to Bioterrorism Preparedness*[2] and focuses specifically on the effectiveness of hospital disaster drills, computer simulations, and tabletop or other exercises in training hospital staff to respond to an MCI. The following key questions were addressed: What is the effectiveness of hospital disaster drills in training hospital staff to respond to an MCI? What is the effectiveness of computer simulations in training hospital staff to respond to an MCI? What is the effectiveness of tabletop or other exercises in training hospital staff to respond to an MCI? What methods or tools have been used to evaluate the effectiveness of hospital disaster drills, computer simulations, and tabletop exercises or other exercises in training hospital staff to respond to an MCI?

Methods

Data sources

The Evidence-based Practice Center (EPC) searched for articles published through January 2003 using six electronic databases, including PubMed, the Cochrane CENTRAL Register of Controlled Trials, the Exerpta Medica database (EMBASE), the Educational Research Information Clearinghouse, the specialized register of the Effective Practice and Organization of Care Cochrane Review Group, and the Research and Development Resource Base in Continuing Medical Education. Search terms included mass casualty, disaster, disaster planning, and drill. The EPC also conducted a hand search of references and selected journals.

Study selection

Paired investigators reviewed the abstracts of citations located by the search to identify pertinent articles. Exclusion criteria were: not written in English; no human data; no original data; meeting abstract (no full article for review); did not include hospital staff; did not include response to an MCI or a disaster; did not include training or education; no evaluation of the training; or did not apply to any of the key questions.

Data extraction

Paired reviewers evaluated study quality in terms of the representativeness of the targeted hospital staff, potential bias and confounding, description of the intervention, assessment of outcomes, and analysis. The reviewers then extracted information on the studies (e.g., geographic location, MCI type, training intervention, hospital staff targeted, other entities involved, objectives, evaluation methods, and results).

Results

The literature search process identified 243 unique, potentially relevant citations, of which 208 were excluded at abstract review. Twenty-one of the remaining 35 articles were deemed eligible for data abstraction. Sixteen of these studies addressed the effectiveness of hospital disaster drills in training hospital staff to respond to an MCI (key question 1);[3-18] one study addressed the effectiveness of computer simulations in training hospital staff to respond to an MCI (key question 2);[19] and four studies addressed the effectiveness of tabletop or other exercises in training hospital staff to respond to an MCI (key question 3).[20-23]

The reviewed studies represented a heterogeneous body of literature. They ranged from descriptions of local drills, including transportation incidents, fires, and radiological exposures, to sophisticated telecommunication exercises, such as a large regional drill involving multiple agencies.[22] Studies also varied in terms of targeted staff, learning objectives, identified outcomes, and evaluation methods. Because of the wide range of foci for the studies, it was difficult to draw definitive conclusions about the most effective approaches for training hospital staff to respond to an MCI. However, some potentially valuable points could be identified in the literature: internal and external communications were the key to effective disaster response; a well-defined incident command center reduced confusion; conference calls were an inefficient way to manage disaster response; accurate phone numbers for key players were vital and regular updating was necessary; disaster drills appeared to be an effective way to improve clinicians' knowledge of hospital disaster procedures; computer simulation may be an economical method to educate key hospital decisionmakers and improve hospital disaster preparedness before implementation of a full-scale drill; a tabletop exercise can help to motivate hospital staff to learn more about disaster preparedness and can help to teach staff about aspects of disaster-related patient care in a way that simulates the practice setting; a regional exercise involving top government officials can help to increase awareness of the need for better disaster response planning; and video demonstrations may be an inexpensive, convenient way to educate a large number of staff about disaster procedures and equipment use in a short time.

Nineteen studies included specific evaluation methods (key question 4), and 13 of these used more than one type of evaluation method.[4,5,7,8,10,13,14,16-19,22,23] Group or individual debriefings were the most common,[5,7-10,12,14,17-20,22] followed by "smart" observers (medical personnel).[4,5,7,8,10,17] Other observers[4-6,8,19,23] and trained "smart" casualties[4,13,14] were also used in several studies. Four studies used a written exam.[14,16,21,23] Other methods of evaluating the educational intervention included individual interviews,[22] inspection and review by chemical spill specialists,[4] self-assessment,[23] a computer-generated detailed picture of the situation,[19] observer checklists,[10] mock disaster patient charts,[11] victim tracking cards,[13] and videotaping.[16] Due to the heterogeneity of the evaluation methods and the lack of data on their validity and reproducibility, the evidence was insufficient to support any firm conclusions about the usefulness of reported evaluation methods.

Discussion

Hospital disaster drills, computer simulations, and tabletop and other exercises are designed to test the hospital's disaster plan and to allow employees to become familiar with disaster procedures. Based on the review of the literature, discussion with experts, and analysis of disaster response plans,[24] the EPC team identified several important aspects of hospital disaster response that may be useful to evaluate. Most of the lessons learned relate to one or more of the following aspects of disaster response: the incident command system; communications (both internal and external); clinical care, including triage, patient care, patient flow, and patient tracking; security; materials and resources; and decontamination. Enough studies were available to suggest that hospital disaster drills can help to identify problems with incident command, communications, triage, patient flow, security, and other issues. Evidence also indicated that computer simulations and tabletop and other exercises may help to train key decisionmakers in disaster response. The studies demonstrated that different types of training exercises may have different roles to play in educating hospital staff in disaster response. However, the evidence was insufficient to support firm conclusions about the effectiveness of specific training methods because of the marked heterogeneity of studies, weaknesses in study design, and the limited number of exercises that have been reported in the literature. Future disaster preparedness efforts would benefit from increased reporting of hospitals' experiences in disaster response training.

Availability of the Full Report

The full Evidence Report from which this summary was taken was prepared for the Agency for Healthcare Research and Quality (AHRQ) by the Johns Hopkins University Evidence-based Practice Center, Baltimore, MD, under Contract No. 290-02-0018. Printed copies may be obtained free of charge from the AHRQ Publications Clearinghouse by calling 800-358-9295. Requesters should ask for Evidence Report/Technology Assessment No. 95, *Training of Hospital Staff to Respond to a Mass Casualty Incident*. Additionally, the report and this summary will be available online through AHRQ's Web site at www.ahrq.gov.

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Evidence Report

Chapter 1. Introduction

A disaster has been defined as "a natural or manmade force the destructive impact of which overwhelms a community's ability to meet healthcare demands."[1] Recent attacks against the United States have increased awareness of the limits of emergency response capabilities to meet the challenge of disasters.[1] Threats that once seemed merely theoretical have become a disturbing reality. The emergence of foreign state-sponsored terrorism, proliferation of chemical and biological agents, availability of materials and scientific weapons expertise, and recent increases in less discriminate attacks all point toward a growing threat of an unconventional mass casualty incident (MCI). Terrorist attacks, such as the September 11th attacks and the deliberate anthrax contamination of U.S. postal facilities, highlight the critical importance of strengthening hospital disaster preparedness.

Hospitals are taking renewed interest in disaster preparedness by reexamining their disaster plans and conducting disaster drills. Governmental agencies, healthcare professionals, and public health advocates have sought to determine the best ways to mitigate the potential impact of an MCI that may involve natural, biological, chemical, radiation, nuclear, or other agents. Preparing for MCIs is a daunting task, as unique issues must be considered with each type of event. For example, the systemic sustained stress of a biothreat is entirely different from that of a chemical disaster or any other acute-onset incident. Biological events may create large numbers of people requiring both emergency services and sustained medical care. Differences between scenarios hold challenging implications for preparedness training.

Accordingly, hospital disaster preparedness has taken on increased importance at local, state, and federal levels. The Frist-Kennedy "Public Threats and Emergencies Act of 2000" addresses bioterrorism prevention, preparedness, and response, and delineates the strategy for a national biodefense policy.[2] In addition, experts have outlined medical and public health management strategies for biological weapons such as smallpox, plague, and anthrax.[3-5] It is important to retain this focus in the face of competing national priorities related to both medical and non-medical issues.

As observed with the global Severe Acute Respiratory Syndrome (SARS) outbreak, the healthcare delivery system is the center of the response to an MCI. Unfortunately, the role of hospitals in this area has been neglected. Improving hospital capability therefore needs to be a top priority. Disaster preparedness has been impeded by out-of-date hospital practices and the lack of coordination between critical functional units and between the hospital and outside organizations and agencies. Hospitals need to play a key role in developing disaster preparedness plans, and they need to coordinate efforts with public health systems and with appropriate federal, state, and local agencies. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) issued new Environment of Care standards effective January 1, 2001. These standards require hospitals to develop "cooperative planning among health care organizations that, together, provide services to a contiguous geographic area."[6] The 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.[7] Either actual emergencies or planned drills are acceptable, and they are to be conducted at least four months and no more than eight months apart.

Despite the importance of disaster preparedness, hospitals must consider the investment required in the face of finite resources. For example, disaster preparedness training is time-consuming and may divert resources away from other activities. Furthermore, academic centers, community hospitals, urban hospitals, and rural facilities may have different training requirements. Some financially strapped hospitals may be reluctant to provide costly disaster preparedness training that does not benefit their financial position. This can be an issue with the JCAHO-required drills, as hospitals may be pressured to meet this requirement through standard training to avoid the costs of either disruption of services or planning and executing expensive drills.

The need to prepare hospitals to respond to MCIs has received increased attention recently. Disaster drills and other exercises have been performed or planned at an increasing number of hospitals. As a part of its new standards, the JCAHO now requires hospitals to conduct two disaster drills per year, although drill activity is not yet weighted heavily in accreditation due to a shortage of funds to support this activity. Since drills have many purposes, it is vital to be clear about the objectives that each drill is intended to address. Given the different objectives and operational elements involved, it may be valuable to use different types of drills. However, it is not known whether drill participation and training for hospital staff to prepare for MCIs is effective.

Purpose of This Evidence Report

In 2000, the Agency for Healthcare Research and Quality (AHRQ) awarded the Johns Hopkins University (JHU) Evidence-based Practice Center (EPC) a task order to develop the evidence report "Training of Clinicians for Public Health Events Relevant to Bioterrorism Preparedness" as part of the Agency's bioterrorism preparedness initiative. The report was requested by AHRQ's Center for Primary Care Research. The AHRQ published the evidence report, in print and on its website, in 2002.[8,9]

The current evidence report updates the previous report, focusing specifically on the effectiveness of hospital disaster drills, computer simulations, and tabletop or other exercises in training hospital staff to respond to an MCI. For the purpose of this report, hospital staff refers to all levels of individuals employed by the hospital, and an MCI is defined as an incident that results in multiple casualties that overwhelm local resources and that may involve natural, biological, chemical, nuclear, or other agents. This report also reviews evidence concerning the methods or tools that have been used to evaluate the effectiveness of these training activities.

By synthesizing the existing evidence on the training of hospital staff to respond to an MCI and by determining strategies most likely to work effectively, this report will provide direction for future training of staff in hospital disaster preparedness. The premise is that a review of published literature will help hospital leaders in their efforts to formulate best practices. Because some training programs for disaster preparedness, including those carried out by the military, may not be published, it would be a daunting task to identify such programs and obtain meaningful evaluations of them. Such an undertaking is beyond the scope of this review of evidence.

Chapter 2. Methods

Recruitment of Experts

The JHU EPC team identified 12 experts to provide input at key points during the project (see Appendix A). These included two representatives of relevant professional organizations, two experts representing government agencies, and eight experts from academic settings. The experts participated in the task of refining the key questions (see Identifying the Specific Questions, below), and they also reviewed the draft report (see Peer Review Process, below).

Target Population

The target population addressed in this evidence report consisted of hospital staff who participated in an educational intervention related to MCI response. For the purpose of this report, hospital staff included all clinical, non-clinical, and administrative staff.

Identifying the Specific Questions

The Health Resources and Services Administration (HRSA) developed the initial list of questions to be addressed. The EPC team refined the original questions through analysis of preliminary literature searches and input from the experts.

Key Questions

The EPC team sought evidence to address the following key questions:

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

2. What is the effectiveness of *computer simulations* in training hospital staff to respond to an MCI?

3. What is the effectiveness of *tabletop or other exercises* in training hospital staff to respond to an MCI?

4. What *methods or tools* have been used to evaluate the effectiveness of hospital disaster

Note: Appendixes cited in this report are provided electronically at http://www.ahrq.gov/clinic/epcindex.htm drills, computer simulations, tabletop exercises, or other exercises in training hospital staff to respond to an MCI?

For the purpose of this report, an MCI is defined as an incident that results in multiple casualties that overwhelm local resources and that may involve natural, biological, chemical, nuclear, or other agents.

Analytic Framework

The JHU EPC team developed an analytic framework (see Figure 1) to depict the central role the hospital will play in responding to an MCI. The framework illustrates the complex nature of such an event and the elements of hospital disaster response that have been identified as important. This complexity underscores the need for developing and testing hospital disaster plans. If an MCI occurs, the hospital will be at the center of all operations regarding victim care, yet it must be in contact with the local emergency services, other hospitals, and city, state, and federal agencies. Coordination of the entire incident will in many cases be through the public health system or the government, and so communications is a key area. Materials, equipment and supplies, and extra personnel will be drawn from outside the hospital, as well as from within. News media, family, and other area residents will impose an additional outside burden on hospital operations that must be managed. Inside the hospital, an incident command system will be needed for communication with all clinical care areas and hospital departments such as security and central supply.[10] The incident command system will address the need for and implementation of all disaster response activities. During the period of the MCI, the hospital will attempt to continue to deliver needed services as required (not depicted here).

Literature Search Methods

The literature search consisted of several steps, including identifying sources, formulating a search strategy for each source, and executing and documenting each search.

Sources

Several literature sources were used to identify all studies potentially relevant to the key questions. Both electronic database searching and hand searching were completed. Six electronic databases were searched. The databases included PubMed®, the Cochrane Central Register of Controlled Trials (CENTRAL), the Excerpta Medica database (EMBASE), the Educational Research Information Clearinghouse (ERIC), the specialized register of the Effective Practice and Organization of Care Cochrane Review Group (EPOC), and the Research and Development Resource Base in Continuing Medical Education (RDRB/CME). The electronic searches were conducted in December 2002, with an updated search of PubMed in February 2003, and no restrictions based on publication date were used.

EPC team members also hand searched the literature to ensure comprehensiveness. Team members reviewed the reference lists of relevant reviews, reference papers, and the eligible articles. Team members also hand searched the most recent issues of journals (through January 2003) frequently identified by the electronic search and/or identified as high priority by the team (see Appendix B).

Search Terms and Strategies

The search strategies were designed to maximize sensitivity and were developed in consultation with team members. Key articles were identified from the previous EPC project.[8] Using these key articles determined to be eligible for review, search strategies were developed and refined in an iterative process. A strategy was first developed for PubMed® and modified for use in the other electronic databases. The strategy used text words and controlled vocabulary words, such as *mass casualty*, *disaster*, *disaster planning*, and *drill*. All electronic database search strategies are included in Appendix C.

Organization and Tracking of Literature Search

The results of the searches were downloaded from electronic sources whenever possible or, if necessary, manually entered into a ProCite® database (ProCite, ISI ResearchSoft, Berkeley, CA). The ProCite® database was used to store citations and track search strategies and sources. The software was also used to track the abstract review process.

Abstract Review Process

Two members of the study team independently reviewed each abstract identified by the search. For each team of reviewers, one reviewer had training in emergency medicine and one had training in epidemiology and research methods. Team members applied the following criteria to exclude articles from further consideration:

1. not written in English;

2. did not include human data;

3. no original data;

4. meeting abstract (no full article for review);

5. did not include hospital staff;

6. did not include response to an MCI or a disaster;

7. did not include training or education;

8. no evaluation of the training or education; or

9. did not apply to any of the key questions

A copy of the abstract review form is included in Appendix D. Disagreements about the eligibility of an article were adjudicated by consensus.

Qualitative and Quantitative Data Abstraction

The EPC team developed and pilot tested two article review forms. The quality assessment form and the content abstraction form are included in Appendix D.

The quality assessment form asked questions designed to address study quality. The following areas were examined: representativeness of the targeted hospital staff, bias and confounding, description of the intervention, assessment of outcomes, and statistical quality and interpretation. The items in these categories were derived from study quality forms used in previous JHU EPC projects.[8,11] Items were modified to fit a focus on teaching strategies based on published criteria for evaluating an educational program.[12] The study team assigned each response level a score of zero (criteria not met), one (criteria partially met), or two (criteria fully met). The score for each category of study quality was the percentage of the total points available in each category and therefore could range from zero to 100 percent. The overall quality score was the average of the five categorical scores.

The content abstraction form was designed to collect such information as the description of the participants, the geographic location, the type of MCI, the training intervention, hospital staff targeted, and the hospital departments and other entities involved. The form also included items on the objectives of the training and the training evaluation methods. We classified objectives as knowledge, skills, behaviors, and clinical outcomes. On the form, we grouped outcomes and main conclusions of the drill by the target area involved in the exercise (e.g., incident command system, internal/external communications, patient flow and tracking, and security). We developed this grouping on the basis of discussions with experts and initial article review. This approach is consistent with the content of the job action sheets of the Hospital Emergency

Incident Command System (HEICS), developed to assist the operation of a medical facility in time of crisis.[10] Many hospitals have adopted the HEICS system as they develop disaster response systems.

Article Review Process

The EPC team conducted the article review in a serial fashion. The first reviewer completed the quality assessment form and the content abstraction form. The second reviewer then reviewed the article and checked each response on the forms. Any disagreements between the two reviewers were resolved by consensus. Reviewers were not masked to author or journal names because to do so is both costly and time-consuming, and previous work has shown that masking is unlikely to make a significant difference in the results of the review.[13]

Evidence Grading

For each question, the EPC team assigned evidence grades based on an established grading scheme with well-defined levels of evidence. The grading scheme, used in previous systematic reviews,[14,15] assigns grades as follows:

Grade A (strong): Appropriate data available for evaluating the outcomes of the training program, including at least one well-done randomized controlled trial; the population of learners is sufficiently large and well described, and adequate controls have been used; data are consistent; and the educational intervention is well described and one intervention is clearly superior, equivalent, or inferior to another for well-defined outcomes.

Grade B (Moderate): Appropriate data available for evaluating the outcomes of the training program; the population of learners is sufficiently large and well described, and adequate controls have been used; data are reasonably but not entirely consistent; and the educational intervention is well described and one intervention is superior or equivalent for well-defined outcomes, but there is insufficient evidence to make a definite conclusion of superiority of one approach over another.

Grade C (Weak): Some data for evaluating the educational intervention is available; the population is adequately large but poorly defined; there may be a trend for preference of one intervention over another for well-defined outcomes, but there is insufficient evidence to draw firm conclusions of superiority.

Grade I (Insufficient): Appropriate data not available, or there is an insufficient number of trainees to assess the intervention either alone or in comparison with alternatives.

Evidence Tables

Evidence tables were constructed to present the information addressing each key question. The evidence tables summarize the basic characteristics of each study, study quality, and results of the studies. Within each evidence table, studies are listed by type of training (i.e., hospital disaster drill, computer simulation, or tabletop and other exercises). The evidence tables are included in Appendix E.

Peer Review Process

The draft evidence report was sent to the 12 experts for peer review. Experts were asked to comment on the content of specific sections of the report according to their areas of expertise and interest. The EPC team addressed the reviewers' comments in the final report and submitted a detailed summary of the comments and responses to the AHRQ.

Chapter 3. Results

Literature Search and Abstract Review

The literature search process identified 243 unique, potentially relevant citations. Appendix F provides a summary of the results of the literature search and review process.

Two hundred eight articles (86 percent) were excluded from further consideration during the abstract review process. The following were grounds for exclusion: did not include hospital staff; no training or education; no original data; no evaluation; did not include a response to an MCI or a disaster; abstract only; or did not apply to any of the key questions.

Article Review

Of the 35 articles deemed eligible through abstract review, 21 (58 percent) were eligible for data abstraction. The remaining 14 articles were excluded for the following reasons: did not include hospital staff; no original data; no training or education; or did not apply to any of the key questions (see Appendix G). We were unable to locate one article (which was identified through hand searching) because of an incorrect or incomplete citation. All articles reviewed and referenced are listed in Appendix H.

Focus and Design of the Reviewed Studies

The 21 studies that met the inclusion criteria were a heterogeneous group. Most drills occurred in the United States,[16-27] although the Middle East,[28-31] Europe,[32-34] and Asia[35] were represented. In one study the location was not stated.[36] All included studies were published between 1968 and 2002, and were clustered between 1985 and 1990 and between 1995 and 2000 (see Appendix E, Evidence Table 1).

Sixteen of these studies addressed the effectiveness of hospital disaster drills in training hospital staff to respond to an MCI (key question 1);[16-26,28,29,32,33,35] one study addressed the effectiveness of computer simulations in training hospital staff to respond to an MCI (key question 2);[31] and four studies addressed the effectiveness of tabletop or other exercises in training hospital staff to respond to an MCI (key question 3).[27,30,34,36] Nineteen studies described methods or tools that have been used to evaluate the effectiveness of hospital disaster drills, computer simulations, and tabletop or other exercises in training hospital staff (key question 4).[18-36]

Note: Appendixes cited in this report are provided electronically at http://www.ahrq.gov/clinic/epcindex.htm

Type of MCI Addressed and Number of Hospitals Studied

The studies addressed a variety of MCIs. Six were focused on a fire or explosion,[18-20,32,33,36] one of which was a burn nursing practice simulation game[36] and the other five of which were simulated hospital disaster drills. Seven described transportation accidents (e.g., a plane crash at a local airport).[22-26,30,35] Three studies were focused on a chemical event,[16,17,28] two studies described a radiation event,[21,34] and one study focused on a biological event.[27] The event type was not stated in two studies.[29,31]

Although most studies took place in a single hospital,[16-19,21-23,25,30-33,35,36] five studies provided evidence from multiple hospital settings, ranging from three to 21.[20,24,27-29] Two studies did not specify the number of hospitals involved.[26,34]

Target of the Training

In all but one study, the educational intervention targeted multiple types of hospital staff (see Appendix E, Evidence Table 1). Thirteen studies included physicians in the target group,[16-21,23-25,29,32,33,35] and eleven studies included nurses.[16,18,19,21,24,29,30,32,33,35,36] Other groups targeted included administrators in five studies,[16,31-33,35] first responders in nine studies,[16,17,20,23-25,29,30,32] and security and transportation personnel in two studies.[16,35] Four of the studies did not specify a targeted hospital staff group.[22,26-28]

Quality Scores

Evidence Table 2 summarizes the study quality scores based on strict criteria for evaluating reports of the effectiveness of educational interventions (see Appendix E). There was substantial variation in overall study quality. Among the 16 studies that evaluated hospital disaster drills, the *total quality score* ranged from 21 to 75 percent on a scale from zero (none of criteria met) to one hundred percent (all criteria met). The *representativeness score* for these studies ranged from 0 to 100 percent, with a mean of 52 percent, median of 50 percent, and interquartile range of 25 to 75 percent. The *bias score* was not applicable, as no study had a control group. The *description of the study score* ranged from 25 to 75 percent, with a mean of 45 percent, median of 38 percent, and interquartile range of 25 to 63 percent. The *outcome score* ranged from 13 to 63 percent, with a mean score of 32 percent, median score of 38 percent, and interquartile range of 25 to 50 percent. Most studies did not assess their educational intervention with quantitative methods and of the two studies that did, one received a score of zero in the statistics category[32] whereas the other received a score of 100 percent.[25]

The one study on computer simulations had a low total quality score of 17 percent.[31] This study had a low score in all five study quality categories (see Appendix E, Evidence Table 2).

The single study that assessed a tabletop exercise[36] scored 56 percent on overall study quality. As shown in Evidence Table 2 (Appendix E), the Burns study also had a moderately high study quality score in all categories.

The three studies reporting on other types of drills scored between 61 percent[30] and 38 percent[27,34] overall (see Appendix E, Evidence Table 2). The Gray study had a score of 50 percent or greater in four of the five study quality categories, while the Levy and Inglesby studies had a score of at least 50 percent in only one study quality category.

Results of Key Questions

Each key question is individually addressed in this section. The evidence is reported for each question according to the type of event studied (see Appendix E, Evidence Table 3)

Question 1: What is the effectiveness of hospital disaster drills in training hospital staff to respond to an MCI?

The majority of studies we identified addressed the key question regarding hospital disaster drills.[16-26,28,29,32,33,35] The learning objectives of these exercises included various knowledge objectives (i.e., to test coordination of response and evacuation procedures),[32] skill objectives (e.g., to assess knowledge of use of fire extinguishers),[19] and behavioral objectives (e.g., timely contact of appropriate safety personnel)[19] (see Appendix E, Evidence Table 1). This group of studies also used a number of training evaluation methods, most typically group debriefings. "Smart" (i.e., medically trained) observers, other observers, and triage and/or victim tracking cards were often used to evaluate the outcomes. The outcomes of these studies provided many lessons having an impact on command and control, communications and patient flow, and other areas (see Tables 1 to 4). All studies reported important lessons learned.

The six hospital disaster studies that addressed transportation accidents took different approaches, resulting in a variety of conclusions.[22-26,35] Cook et al. took a "game" approach that allowed employees to study the disaster plan prior to the drill. The author believed this approach was useful in increasing understanding of the disaster plan, identifying plan flaws, and improving coordination.[22] Eisner, in a study focused on the emergency department and targeted to first responders and the triage teams, simulated an airplane crash at a nearby airfield. The study found that more than half of the notional victims experienced a serious delay in care that would result in excess deaths.[23] Paris also studied a simulated airport disaster and used "smart" casualties and triage cards to analyze the care provided to victims.[26] Lau, simulating an undescribed transportation accident designed to test knowledge, skills, and behaviors, found that although the disaster plan was successfully activated, there were difficulties in the areas of triage and charting.[35] However, Lau also found that practice drills provided clinicians with the opportunity to anticipate possible operational difficulties and find remedies to track them. Fishel and Maxwell reported difficulties in triage in their studies.[24,25] In addition, Maxwell reported problems with patient tracking, and Fishel reported problems in communications.

Five studies reported on a fire disaster or explosion, four of these placing the event within the hospital[18,19,32,33] and one setting the mock event at a college.[20] All studies targeted several groups, including physicians,[18-20,32,33] nurses,[18,19,32,33] administrators,[32,33] and first responders.[20,32] Training objectives varied from evacuation assessment[32,33] to assessing first aid at the scene of the fire[20] and knowing the location of and how to use fire extinguishers.[19] Similar to other hospital drills, these studies were evaluated by group interviews and de-briefings, and "smart" and other observers.

Chobin, Saxena, and Tur-Kaspa studied chemical spills.[16,17,28] Chobin et al. tested the Occupational Safety and Health Administration (OSHA) requirements in responding to a chemical spill.[16] This study used simulated patients and involved external and internal response and multiple departments. The authors found it very useful to test OSHA-required disaster plans before an emergency, and they concluded that the hospital may not be able to meet some OSHA regulations. Saxena evaluated the ability of a hospital to make a coordinated response to a hazardous materials incident and found that the list of chemicals involved was not correctly reported and that communication ranged from ineffective to nonexistent.[17] Tur-Kaspa evaluated a hospital drill with "smart" casualties—army physicians with experience in managing chemical casualties.[28] This study identified lessons learned that were incorporated into the hospital deployment plan. The authors felt their study had wide implications for disaster mitigation worldwide.

The EPC team concluded that enough studies were available to suggest that hospital disaster drills were effective in training hospital staff to respond to an MCI; however, the study designs were weak, and overall the evidence was insufficient to draw firm conclusions, leading to an evidence grade of C (weak) (see Chapter 2, Methods, Evidence Grades). The published literature lacked studies addressing either bioterrorism directly or other prolonged MCIs. These incidents have a different presentation, with sporadic presentation of cases and perhaps continuing over days or weeks with a high casualty toll and large numbers of concerned and potentially exposed as well.

Question 2: What is the effectiveness of computer simulations in training hospital staff to respond to an MCI?

One study used computer simulation in training hospital staff to respond to a basic disaster.[31] This study was targeted to senior administration and had both a behavioral objective of training decision makers and a clinical outcome objective of identifying bottlenecks and solutions. The computer simulation also identified electromechanical failures, crowd control issues and other security problems, and specific medical equipment and medication needs. The study was evaluated by observations of the staff while problem-solving and by post-exercise group discussion. Computer animation was used to describe the bottlenecks that arose in the emergency department, the diagnostic departments, and the operating rooms. Levi found that simulation techniques used in a limited scale preparatory drill improved preparedness of hospitals prior to implementation of a full-scale disaster drill.

Although this study provided valuable information, this question received an evidence grade of I (Insufficient) due to the limited amount of evidence.

Question 3: What is the effectiveness of tabletop or other exercises in training hospital staff to respond to an MCI?

One study addressed a tabletop exercise[36] and three studies addressed other types of exercises.[27,30,34] Burns studied a tabletop exercise designed specifically to educate nurses on the treatment of patients injured by an incendiary device.[36] The authors found the simulation exercise motivated participants and allowed them to use new concepts prior to an actual disaster. They also found it helpful to use the content material in a way that simulates the practice setting and provides an opportunity for immediate feedback.

The TOPOFF exercise, funded by the Department of Defense, was developed to test readiness of *top* government *off*icials and others to respond to multiple simultaneous terrorist attacks.[27] This exercise incorporated a regional response across hospitals and state and federal infrastructure. The authors concluded that public health resources now in place would not be sufficient to respond to the demand created by a bioterrorist attack. This study provided future directions for planning and preparedness at all levels of government.

Levy et al. took a novel approach and conducted an audio-graphic teleconferencing drill.[34] The authors concluded that this technology-based training activity was an effective means to familiarize emergency responders with policies and procedures regarding radiation accidents. Gray et al. developed a video simulating a disaster and designed to educate hospital staff on how the disaster plan worked.[30] The authors outlined the advantages of videos, which they found to be 1) allowing staff to see emergency equipment and demonstration of its use; 2) developing further staff insight into facing mass casualties; and 3) increasing the exposure of staff to the material, with over 500 hospital employees viewing the video within a two-week period.

Given the few studies available and their heterogeneity, the EPC team graded the evidence addressing this question as I (Insufficient).

Question 4: What methods or tools have been used to evaluate the effectiveness of hospital disaster drills, computer simulations, and tabletop or other exercises in training hospital staff to respond to an MCI?

Nineteen studies included specific evaluation methods (see Appendix E, Evidence Table 1). Thirteen of the studies used more than one type of evaluation method.[19,20,22,24-29,31-33,36] Group or individual debriefings were the most common,[19,21,22,24,25,27,29,31-35] followed by "smart" observers (medical personnel).[19,22,24,28,32,33] Other observers[18,28,31-33,36] and trained "smart" casualties[26,28,29] were also used in several studies. Four studies used a written exam.[20,29,30,36] Other methods of evaluating the educational intervention included individual interviews,[27] inspection of review by chemical spill specialists,[28] self-assessment,[36] a computer-generated detailed picture of the situation,[31] observer checklists,[22] mock disaster patient charts,[23] victim tracking cards,[26] and videotaping.[20]

As shown in Evidence Table 2 (Appendix E), the studies had scores ranging from 13 percent to 75 percent in the study quality category for assessing the outcomes of the educational intervention. Only three of the studies received full credit for describing the evaluation methods in sufficient detail to permit replication,[19,22,25] and only five of the studies received full credit for using objective methods to evaluate outcomes of the educational intervention.[22,23,25,30,32] One of these studies noted improvement in understanding of the hospital disaster plan, as measured by a multiple choice questionnaire.[30] Two studies focused on evaluating the timeliness of initiating patient care by assessing how the severity of injuries related to the arrival time at treatment.[23,25] The drill Gretenkort reported was focused on comparing two methods of evacuating patients, using point-to-point time measurements.[32] Cook used observer checklists to identify notification (start and stop of drill), available facilities and equipment (area opened and prepared for drill; wheelchairs and stretchers available), and personnel and procedures followed (whether security and transport personnel were present; whether a disaster log was started). Cook also reported that a de-briefing conference was held immediately post-exercise, followed by a written report.[22] However, none of the studies was specifically designed to demonstrate the validity and reproducibility of the evaluation methods.

Because of the heterogeneity of the evaluation methods and the lack of evidence on the validity and reproducibility of the methods, the EPC team concluded that the evidence on the utility of reported evaluation methods merited an evidence grade of I (Insufficient).

Outcomes of the Studies

Hospital disaster drills, computer simulations, and tabletop and other exercises are designed to test the hospital's disaster plan and to allow employees to become familiar with disaster procedures, leading to reduced chaos and improved institutional response at the onset of an actual disaster. These training exercises address many aspects of disaster response. On the basis of this review of the literature, discussion with experts, and analysis of the HEICS job action sheets,[10] the EPC team identified several important aspects of hospital disaster response that include outcomes that may be useful to evaluate.

Most of the lessons learned from the studies relate to one or more of the following categories: the incident command system; communications (both internal and external); clinical care, including triage, patient care, patient flow, and patient tracking; security; materials and resources; and decontamination (see Appendix E, Evidence Table 3).

Each of the three identified types of training exercises (hospital drills, computer simulations, and tabletops and others) addressed multiple aspects of a hospital's ability to respond to a disaster. A substantial overlap existed between the disaster drills and tabletop exercises in the outcomes addressed (see Figure 2). However, despite this overlap, two outcomes—*patient tracking* and *decontamination*—were unique to disaster drills in the current literature. Only three outcomes were addressed in the computer simulation study (patient flow, security, and materials/resources), and none of them were unique to this method of disaster response training.

Incident Command System

Seven studies reported findings related to the incident command system (see Table 1), all of which advocated the concept of strong leadership during a crisis. Gretenkort and Lau reported that the incident command system worked well,[32,35] and Cook reported that the incident command system decreased confusion in the drill.[22] Four studies reported that flaws in the incident command system led to a lack of communication and confusion.[18,20,27,33]

Communications

Thirteen studies dealt with the issue of communications (see Table 2). Nine of the studies reported findings related to internal communications,[16,18,19,21,22,24,27,33,35] and nine studies addressed external communications.[16,17,21,24,27,28,32,34,35]

Internal Communications. Among the studies addressing internal communications, only one, Chobin et al., found that communication occurred smoothly.[16] Eight studies illustrated breakdown of communications.[18,19,21,22,24,27,33,35] Studies cited the inadequacy of overhead intercom systems,[19,21,22,33] delay in communication because the emergency department was immobilized and unable to receive messages,[18] lack of training in the use of radios,[35] and significant time delays spent identifying correct contact numbers.[24,27]

External Communications. The results of the studies reporting on external communications were mixed. Chobin and Gretenkort reported smooth and successful interfaces with outside agencies.[16,32] In the Levy study, participants were able to successfully carry out notification of proper authorities and extensive live communication among sites in five time zones.[34] Tur-Kaspa emphasized that an effective communication system between different sites and the control center is essential.[28] Five studies noted shortcomings including incomplete messages,[21] ineffective activation of emergency operations centers,[17] language difficulties when the operator was under pressure,[35] technical and operational radio communication problems,[24] and a highly inefficient process of decision making by conference call leading to indecision and significant delays in taking action.[27]

Clinical Care

Nineteen studies cited results related to clinical care of patients (see Table 3). Eleven studies described outcomes on triage,[18,20,21,23-27,29,34,35] twelve studies described the impact of the drill on patient care,[18-21,25-29,33,35,36] fourteen studies described patient flow issues,[16,18-22,24,25,27,29,31-33,35] and six studies described patient tracking issues.[16,25,28,29,33,35]

Triage. Levy reported success in triage based on correlation of clinical signs with radiation exposure.[34] All other studies in this category reported triage problems, including confusion due to unavailability of the usual triage area;[18] incorrect use of physical zones for different categories of patients;[21] inadequate updating of patient demographics;[35] slow arrival at triage;[23] inexperienced staff in triage;[18,24] inadequate selection of victims for removal from the incident scene;[20] patients who were either never assigned to a triage category[25,26] or were assigned to an incorrect triage category.[29] Inglesby identified concern over the ability to distinguish between the concerned and potentially exposed and those with early signs of infection.[27] This point is significant because Inglesby was the only study that looked at a bioterrorism event.

Patient Care. Paris, Lau, and Maxwell found that patient care drills proceeded according to plan,[25,26,35] and Classic found that a plan to use building exits as a "choke point" for screening worked well.[21] Burns found a knowledge increase in nurses' capacity to treat victims of an incendiary device.[36] Other studies identified a range of deficiencies. Tur-Kaspa reported that clinicians must be able to access information on dosages and side effects of antidotes to be effective when responding to a chemical event.[28] Baughman reported that treatment began in triage area, before patients were sent to the treatment area.[18] Menczer reported a need for more thorough first aid after removal from the disaster site.[20] Paris reported that significant delays in patient care were noted for patients under the drill procedures, and Weston, Paris, and Halstead reported on events leading to adverse outcomes for patients, the latter due to inability to maneuver heavy operating room beds.[19,26,33] Gofrit reported that simulated casualties received incomplete medical evaluations,[29] and Lau found a conflict for busy clinicians between documentation and giving effective patient care.[35] The comprehensive exercise by Inglesby found that hospitals were beyond capacity for patients in less than twenty-four hours.[27]

Patient Flow. Several patient flow issues were identified by the studies. For example, Gretenkort studied the use of the *Jaerven Rescue Drag Sheet*, which greatly facilitated removal of patients from the area of the simulated hospital fire.[32] Cook found that personnel reporting to assigned areas lessened congestion in the emergency department.[22] Halstead and Inglesby identified needed improvements, the former finding that corridors and marked evacuation routes were blocked by equipment,[19] and the latter finding inadequate plans for patient disposition, including disposition of the deceased.[27] Gofrit, Menczer, and Weston identified issues in transporting patients,[20,29,33] and Fishel found that the ambulance crews became overwhelmed and exhausted in a planned drill.[24]

Patient Tracking. Weston reported that all patients were accounted for within the planned time limit of the drill.[33] Other investigators found that clear labeling, identification, and record keeping were vital for efficient reception and treatment of casualties.[28,35] Gofrit reported medical documentation was inadequate,[29] and Maxwell identified patients who had arrived in treatment areas without completing triage.[25] Chobin identified the importance of patient identification and charting.[16]

Security

Two studies described security issues in some detail. Security of the building and perimeter was described as exceptional in one study,[21] while another study raised concerns about the concept of a *security lockdown*, wherein all entrances would be locked and guarded as a measure to handle notional massive crowds.[27] Two other studies simply reported security as being present.[18,31]

Materials and Resources

Chobin reported on success with the prompt arrival of the fire department and proper use of breathing equipment.[16] Menczer found that first aid equipment and supples must be transported to the scene as soon as the disaster is identified.[20] Six of the studies identified deficiencies including difficulty accessing disaster charts;[18] a shortage of ventilators and other trauma care equipment;[29] inadequate numbers of wheelchairs, chairs, poles, and ropes to maintain order;[35] other equipment deficiencies and electro-mechanical failures;[31] gas levers that needed closing but were hard to find;[19] and inadequate antibiotic supplies with logistical difficulties in distribution.[27]

Decontamination

Two studies focused on decontamination. One study emphasized that full protective equipment must be worn in the contaminated area and that decontamination must be directed by personnel with loudspeakers.[28] Classic reported that after radiation exposure, the deceased must not be released to funeral homes until after the corpses are decontaminated.[21]

Chapter 4. Discussion

Principal Findings

The extensive literature search identified 21 articles that described and evaluated an educational intervention designed to train hospital staff to respond to an MCI. The majority of these studies addressed the use of hospital disaster drills as a training tool (key question 1).

The studies represent a heterogeneous body of literature, ranging from descriptions of local drills to sophisticated telecommunications exercises. Studies also varied in terms of targeted staff, learning objectives, identified outcomes, and evaluation methods. Because of the wide range of foci for the studies, it is difficult to make definitive recommendations on the most effective approaches for training clinicians to respond to an MCI. However, some potentially valuable points can be identified in the literature.

Question 1. What is the effectiveness of hospital disaster drills in training hospital staff to respond to an MCI?

- Sixteen studies were identified that evaluated disaster drills as a training tool for hospital disaster procedures. The studies focused on drills for responding to conventional disasters such as transportation incidents, fires, and chemical spills. None of these studies used disaster drills to provide training in how to respond to a biological MCI.

- Disaster drills appeared to be an effective way to improve clinicians' knowledge of hospital disaster procedures.

- Drawing lessons from planning and outcome evaluation in the published disaster drill literature may strengthen future disaster response planning, especially in the areas of incident management and communications.

- Lessons learned from one type of disaster response must be applied with some caution to other types of drills.

- Disaster drills have the potential to identify problems with incident command, communications, triage, patient flow, materials and resources, security, and decontamination.

- Disaster drills usually were not designed to evaluate the effectiveness of patient care.

- It is difficult to draw firm conclusions about the effectiveness of specific types of hospital disaster drills for different types of disasters because of marked heterogeneity of training methods and weaknesses in study design and evaluation.

Question 2. What is the effectiveness of computer simulations in training hospital staff to respond to an MCI?

- Only one study described and evaluated the use of computer simulation as a training tool for educating clinicians about their hospital's disaster plan.
- Computer simulation is an economical method to educate key hospital decision makers about disaster preparedness. This approach can be used to improve hospital disaster preparedness prior to implementation of a full scale drill.
- Computer simulation was able to identify bottlenecks in patient care, electromechanical failures, crowd control issues and other security problems, and resource deficiencies.
- The evidence was insufficient to make definitive conclusions regarding the effectiveness of computer simulation as a training tool.

Question 3. What is the effectiveness of tabletop or other exercises in training hospital staff to respond to an MCI?

- One study described and evaluated a tabletop exercise as a training tool.
- Tabletop exercises can be used to teach disaster-related patient care in a way that simulates the practice setting.
- A tabletop exercise can provide an evaluation that yields immediate feedback and reinforces learning.
- Evidence is insufficient to reach definitive conclusions regarding the effectiveness of tabletop exercises as training tools for educating clinicians about hospital disaster response.
- One report described a regional exercise testing the readiness of top government officials to response to terrorist attacks. This exercise increased the awareness of the need for better disaster response planning.
- One study used audio-graphic teleconferencing as a means to educate emergency department staff in six countries about radiation incidents. This may be an effective way to educate hospital employees over a geographically diverse area.
- One study evaluated the use of a video simulation to educate hospital employees about disaster response. Video demonstrations may be an inexpensive, convenient way to educate a large number of staff about disaster procedures and equipment use in a short time, especially when staff work in different locations.

- Evidence is insufficient to make definitive recommendations on the use of tabletop and other exercises as training tools for educating clinicians about hospital disaster response.

Question 4. What methods or tools have been used to evaluate the effectiveness of hospital disaster drills, computer simulations, tabletop or other exercises in training hospital staff to respond to an MCI?

- Nineteen studies described the methods that were used to evaluate the educational intervention used to train clinicians in disaster response procedures.
- Thirteen studies used more than one evaluation method.
- Twelve studies used group interviews or debriefings.
- Six studies included "smart" observers (those with medical training).
- Three studies included "smart" casualties.
- Four studies included a written exam or questionnaire.
- Other methods to evaluate the educational intervention included observer checklists, victim tracking cards, self-assessment forms, video tapes, and a computer-generated picture of the situation.

Lessons Learned Based on Outcome Categories

Incident Command System

- The presence of a well-defined incident command system reduces confusion during exercises.

Internal Communications

- Overhead intercom systems may be unreliable during an MCI.
- Important telephone numbers and staff contact information must be updated on a regular basis and readily available in the event of an MCI.
- Staff must be trained to use various modes of communication (e.g., radio communications, telephones).

External Communications

- Effective communication during an MCI is key to the disaster response.
- Drills and tabletop exercises may be an effective method of improving interfaces between hospitals and federal, state, and local response agencies.
- The process of decisionmaking by conference calls can be inefficient and may lead to delays in taking action.
- Radio communication is an effective backup to land lines but may experience technical difficulties.
- Phone numbers of Emergency Operations Centers must be updated regularly and checked for accuracy.

Patient Triage

- Effective patient triage requires emergency department staff experienced in triage procedures.
- Triage zones should be easily identifiable.

Patient Care

- Simulated casualties are not always examined thoroughly.
- Documentation requirements may detract from patient care.
- Patients must be continually reassessed.
- Adequate care for victims with serious injury must begin in the field.

Patient Flow

- Corridors, exits, and routes for transportation should be clear of extra equipment that could block patient transport and delay care.
- Bottlenecks to patient flow (e.g., radiology, operating rooms) should be identified and addressed.

Patient Tracking

- Patients should be clearly identified with a bracelet, tag or some other method.

Security

- Drills and exercises may identify security and crowd control issues.
- Adequate security must be provided.

Materials and Resources

- Drills and exercises can identify deficiencies in supplies, equipment, personnel, and pharmaceuticals.
- Central storage and the emergency department must communicate supply and demand.
- Emergency department staff must be familiar with location of critical supplies.

Decontamination

- A significant amount of time is required to set up decontamination equipment and don personal protective equipment.
- Appropriate personal protective equipment must be worn.
- Decontamination of deceased must be addressed.

Other

- Each drill provides learning opportunities. In any given drill, these will occur for specific groups of participants, but currently there is no standard by which to judge a drill as a whole as a complete success.
- Disaster response personnel must be clearly identified.
- Adequate pre-drill training is important for the drill's success.

Limitations

This evidence report has a number of limitations, of which the most obvious is the small number of studies that were directed to the training of hospital staff in how to respond to MCIs.

In addition, the search was limited to published English language articles. There may be classified, unpublished material or studies in press that were not included in this report. An example would be material from the U.S. Department of Defense, which undoubtedly has experience at testing different scenarios, but these materials are not available in the published literature. There may be aspects of military disaster drills that have potential applications for hospitals. Another example is unpublished results of drills and exercises associated with JCAHO requirements taking place at state and local levels. It is not known if this unpublished material includes evaluation data.

Another major limitation relates to the fact that different types of disasters raise different issues for training of hospital staff. For example, the issues differ for drills that simulate a transportation incident or fire and those that simulate a biological incident. The latter most likely would evolve over an extended time period while the former would introduce a sudden influx of cases to hospitals. Since nearly all of the published studies focused only on training in how to respond to conventional types of disasters, little direct evidence exists on the effectiveness of training hospital staff in how to respond to a biological MCI.

Although many experts believe that tabletop exercises have an important role to play in disaster preparedness,[37-40] the literature search identified only one study that evaluated use of a tabletop exercise for training of hospital staff in disaster preparedness.[36] One other study reported on the use of a tabletop exercise to provide disaster training to emergency medical technicians (EMTs).[40] However, this study did not meet our eligibility criteria because it did not involve hospital staff. In this study, Chi assessed the attitudes of EMTs toward tabletop exercises. Survey results showed that EMTs believed that tabletops performed better than field exercises in linking the results of disaster exercises to appropriate changes in terms of training, equipment, and supplies. Other tabletop exercises have been described in the literature,[38,39] but none of these reported any evaluation data. Without evaluation data, one cannot draw conclusions about the effectiveness of such exercises. Although numerous tabletop exercises have been conducted as a less expensive alternative to operationalizing drill training, most of the identified studies on tabletop exercises were not focused on hospital-based activity, and among those that were, no results, i.e., no data, were given.

The quality and methodological limitations of the studies make it difficult to judge external validity of results. Furthermore, marked differences in educational interventions, objectives, targeted audience, and evaluation methods present challenges in drawing generalized conclusions relevant to bioterrorism preparedness. Another specific limitation is that the search identified only one evaluation of a tabletop exercise, one of a computer simulation, one of video training, and one of teleconferencing. Although each of these educational techniques may have distinct advantages, the evidence is insufficient to draw definitive conclusions about their effectiveness.

In addition, the financial burden of the educational interventions generally was not reported. Full-scale disaster drills are expensive.[27] The large-scale three-day drill described by Inglesby et al. cost $3 million (U.S.). None of the other studies identified cost figures, thereby leaving a gap in this important aspect of hospital disaster preparedness. Finally, very few studies identified the organizing or sponsoring entity (e.g., federal, state, or local agency, or hospital) for the drill or exercise, thereby precluding any conclusions about who most effectively plans and conducts drills.

Future Research

Part of the challenge in reviewing the existing literature regarding training of hospital staff to respond to an MCI arose from the numerous formats of studies and differences in evaluation methods. Creating a template for future training reports (e.g., Utstein-style guidelines)[41] may facilitate the accessibility, synthesis, and interpretation of collected data. Authors of future reports should consider the merits of adopting a common nomenclature and explore establishing the incident command system among hospitals as a standard.

One major issue is the cost of conducting drills and the need for a steady stream of funding to support these activities. Although governmental funding has increased recently, many hospitals are short of flexible funding and are unable to assign high priority to disaster preparedness. Given the evidence on the potential value of drills, the recent international events that indicate an increasing likelihood of future MCIs, and the heightened focus of the government in providing funding, it has become a priority to explore the uses of drills. Evidence is needed. One approach might be to provide funding for hospital exercises that are designed to overcome the limitations identified here.

The purposes of drills are important and in general underexamined. Drills may have many different purposes and it is imperative to conduct different types of exercises to test the different operational elements involved. Valid purposes include testing communications, triage planning, evacuation or decontamination procedures, and focusing on improving familiarity with emergency protocols. Related issues in drilling include the necessity to be efficient and to incorporate continuous training to meet the needs related to turnover in the hospital workforce. To develop a drill, major preparedness issues should be identified and then tested in different types of drills; however, hospitals should remain open to learning from the unexpected that occurs during the course of a drill as well. Overall, it is important to follow the principle of learning from the experience without judging the drill as a *success* or a *failure*.

The current evidence is not definitive on the effectiveness of hospital disaster drills in training staff to respond to an MCI. Although hospital disaster drills arguably may provide the most realistic training, they also represent a resource-intensive training format for MCI preparation. To date, no evidence supports the cost effectiveness of any particular type of training intervention. Future studies addressing the costs of educational interventions will facilitate recommendations regarding training strategies. For example, the strength of a video is that it is a relatively inexpensive way to standardize training for a large group (hospital employees or others) who have different schedules and operate remotely from each other. A good tabletop exercise allows observers to see the action develop, to gain increased awareness, to build teamwork, and to test strategic scenarios. Tabletops are economical and more efficient for some purposes. Given these attributes of these different types of exercises, a logical progression to familiarize employees with a hospital disaster drill plan may be to use videos in a group setting, then demonstrate key points with a tabletop exercise, and later graduate to a fully operationalized partial or complete drill.

Another major issue that needs to be addressed is the lack of evaluation of completed drills, and an equally important issue is the dearth of published reports from individual hospital- or health department-supported drills. Very few reports of hospital disaster drills have been published or made available in electronic databases of relevant material. Therefore, hospitals and other agencies are denied the benefit of others' experience. In the future, agencies or institutions funding drills may chose to prioritize both evaluation and more rigorous written reports post-drill. Federal agencies might direct grantees to document their findings and submit them for publication. As drills of some nature are now mandated by JCAHO, hospitals should be able to generate an increased number of reports about what does and does not work well. JCAHO may also want to encourage hospitals to meet the drill requirements through other than standard (i.e., non-disaster-related) training exercises.

Translating the reports of drills into future activity may help to promote orderly development of capability in the field. Disaster drills might be designed to test specific elements of response as identified in this report, including incident command system, communications, triage, patient flow, tracking, security, materials and resources, and decontamination.

More attention should be given to evaluating the effectiveness of relevant training programs in a scientifically rigorous manner. The weak study designs led to insufficient strength of the evidence to draw firm conclusions. This is typical of the present literature in disaster medicine and points to a need for better-designed studies.

This synthesis of the existing evidence on the implementation and evaluation of hospital disaster drills, computer simulations, and tabletop or other exercises may help to establish criteria for assessing the effectiveness of future training exercises. Because the current evidence on tools or methods used to evaluate effectiveness of training hospital staff to respond to an MCI is insufficient, development of a modular evaluation tool to address the effectiveness of different educational interventions will be of significant importance. These modules could follow the elements of response identified above (e.g., incident command system, triage, treatment, communication, and security).

Finally, the published evidence includes very little information that directly pertains to the training of hospital staff in how to respond to a biological MCI. Although bioterrorism is a current federal priority, only one study described the response to a mock bioterrorist attack.[27] The majority of studies focused on more common disasters (e.g., a fire/explosion or transportation accident).[18-20,22,23,25,26,30,32,33,35,36] It seems reasonable to postulate that preparedness for a conventional MCI would enhance readiness for unconventional MCIs. For example, an effective response to a bioterrorist event will depend on the general training and preparedness necessary for other MCIs, including training on communications, triage, and treatment during an MCI. However, a biological event would differ from a conventional MCI in important ways, such as evolving presentation of cases over days or weeks with a potentially high casualty toll, coupled with a large number of concerned and potentially exposed victims. Future training should therefore also address biological as well as chemical, nuclear, or radiation events.

Disaster training activities at the local, state, and national level could improve our knowledge pertaining to drill training, but they have not yet been reported consistently in the peer-reviewed literature. This lack of information suggests a need for creating improved ways of sharing such training experiences. Future disaster preparedness would be facilitated by a systematic method for collecting this information and making it readily available for review and synthesis.

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Table 1: Summary of Results: Incident Command System

Author, year **Type of training**	**Incident Command System**
Baughman, 1990 Hospital fire and explosion in the emergency department	Confusion resulted because no single person was designated as incident commander.
Cook, 1990 Transportation accident	The drill led to less confusion in incident command.
Gretenkort, 2002 Hospital fire	The leadership concept of the Coordinating Physician of the hospital working together with other hospital executives and the incident commander proved effective.
Inglesby, 2001 Biological	It was unclear how to coordinate different operation centers set up by a variety of state and federal emergency management offices. Personnel were not familiar with language used in disaster control. Leadership roles and authorities in the crisis were uncertain; it was not clear who was in charge.
Lau, 1997 Transportation accident	The disaster plan activated successfully.
Menczer, 1968 Incendiary device and boiler explosion	No overall leader was recognized to coordinate services and agencies. No medical authority was at the scene.
Weston, 1988 Hospital fire in operating room	The absence of a senior hospital nursing officer led to command confusion. Incident flow charts were needed.

Table 2: Summary of Results: Communication

Author, year **Type of training**	**Internal Communication**	**External Communication**
Baughman, 1990 Hospital fire and explosion in the emergency department	Considerable time delay occurred because the emergency department was immobilized.	Not addressed.
Chobin, 1989 Chemical	Hospital operator was called using established hotline. Hospital fire brigade was alerted by code. Hospital operator notified nursing administration.	Assistance was requested from local fire department. The hospital's Chief Executive Officer was asked to call a disaster code.
Classic, 2000 Radiational	Intercom system was inadequate as messages could not be understood clearly. Fire alarms worked well. Radiation call staff were contacted successfully.	Contact of radiation safety was immediate, but message was incomplete (significant deficiency).
Cook, 1990 Transportation accident	Overhead announcement was not heard. Some vital personnel had not received new disaster plan.	Not addressed.
Fishel, 1974 Transportation accident	The emergency call-up system was inadequate because names and telephone numbers were not correct.	Radio communications developed several technical and operational problems.
Gretenkort, 2002 Hospital fire	Not addressed.	The drill went smoothly and provided true interface between authorities and hospital administration.
Halstead, 1993 Hospital fire in operating room	Staff could not hear overhead announcement of fire in operating room. Staff needed printed protocol for fighting fire. Operating room representatives need to be added to hospital committee.	Not addressed.
Inglesby, 2001 Biological	A significant amount of time was spent exchanging phone, beeper, and facsimile numbers (should have been done prior to exercise).	Process of decision making by conference call was highly inefficient and led to indecision and significant delays in taking action. 800 MHz radios had efficient communication where regular phone lines were not answered or otherwise dysfunctional.
Lau, 1997 Transportation accident	Better radio training was needed.	Telephone operator preferred native language under stressful conditions.
Levy, 2000 Radiational	Not addressed.	Extensive live communication occurred among sites in 5 time zones. All sites participated in 7 live conferences within 74 hours. Proper authorities were notified in each country.

Table 2: Summary of Results: Communication (continued)

Author, year Type of training	Internal Communication	External Communication
Saxena, 1986 Chemical	Not addressed.	Notification for the activation of Emergency Operating Centers among participating agencies was not effectively accomplished. The list of chemicals involved was not correctly reported to the state Emergency Operating Center. Exercise communications between the Emergency Operating Center were inefffective and in come cases nonexistent.
Tur-Kaspa, 1999 Chemical	Not addressed.	An effective communication system between different sites and the control center is essential.
Weston, 1988 Hospital fire in operating room	Communication was poor because of small number of alarm bells and low level of buzzers.	Not addressed.

Table 3: Summary of Results: Clinical Care

Author, year Type of training	**Triage**	**Patient Care**	**Patient Flow**	**Patient Tracking**
Baughman, 1990 Hospital fire and explosion in the emergency department	Usual triage area was not available, thus causing confusion. Relief staff was inexperienced in triage.	Treatment began in triage areas before patients were sent to treatment areas.	Lack of triage area confused patient flow.	Not addressed.
Burns, 1984 Incendiary device	Not addressed.	Participants' burn care knowledge increased 6 to 7 points out of 200 from pre-test to post-exercise. The median outcome of self-scoring was 87% with a range from 60%-96%. Leadership personnel from the emergency department working with members of the burn unit scored the highest. A team consisting of an emergency department technician and a staff nurse scored the lowest.	Not addressed.	Not addressed.
Chobin, 1989 Chemical	Not addressed.	Not addressed.	Victims were evacuated to emergency department.	Admitting personnel in the emergency department made charts and identification bracelets.
Classic, 2000 Radiational	Physical barriers to identify *hot*, *warm*, and *cold* zones for ambulatory victims were not used correctly.	Plan to use building exits as "choke points" for screening worked well.	30 victims were transported to emergency department.	Not addressed.
Cook, 1990 Transportation accident	Not addressed.	Not addressed.	Congestion in triage and emergency department was less since personnel reported directly to assigned areas rather than to the emergency department to ask for guidance.	Not addressed.

Table 3: Summary of Results: Clinical Care (continued)

Author, year **Type of training**	**Triage**	**Patient Care**	**Patient Flow**	**Patient Tracking**
Eisner, 1985 Transportation accident	53% of the group that needed immediate care arrived at care location greater than 1.5 hours post-disaster. 85% of patients triaged to the trauma center required admission, indicating excellent correlation between action and need.	Not addressed.	Not addressed.	Not addressed.
Fishel, 1974 Transportation accident	Teams of doctors and nurses were not experienced or knowledgeable in triage. A course to develop triage personnel is needed. The triage tags were not easily identifiable. Color coded tags may address this problem.	Not addressed.	Ambulance crews became exhausted moving the victims.	Not addressed.
Gofrit, 1997 Not specified	9% of patients were over-triaged. 4% of patients were under-triaged.	Simulated casualties were not examined head-to-toe. Patients with post-traumatic stress disorder were not examined fully and referred directly to psychology.	Delays were encountered in treatment due to lack of leadership and shortage of personnel. Patients were transferred from one area to another without appropriate medical escort and without properly controlled ventilation.	Medical documentation was inadequate.
Gretenkort, 2002 Hospital fire	Not addressed.	Not addressed.	Patient flow and staff allocation was greatly aided by *Jaerven Rescue Drag Sheet.*	Not addressed.
Halstead, 1993 Hospital fire in operating room	Not addressed.	Operating room beds were too heavy to maneuver for evacuation.	Corridors, exits, and evacuation routes were blocked with equipment. More storage space was needed for extra equipment.	Not addressed.

Table 3: Summary of Results: Clinical Care (continued)

Author, year Type of training	Triage	Patient Care	Patient Flow	Patient Tracking
Inglesby, 2001 Biological	There was concern over ability to distinguish between the concerned and potentially exposed and those harboring early signs of plague.	Hospitals were beyond capacity for patients in less than 24 hours.	Plans were inadequate for disposition of patients before and after triage, and for the deceased.	Not addressed.
Lau, 1997 Transportation accident	19 patients were triaged and discharged. Patients' particulars were inadequately up-dated on the Accident and Emergency clinical records sheets.	Charting and filling out forms detracted from patient care. Staff summoned from other units were not familiar with the emergency department.	It was 45 minutes from first patient in to last patient out. Porters did not know role in drill.	Patients were given bracelets and record sheet with identification. All patients were accounted for.
Levi, 1998 Not specified	Not addressed.	Not addressed.	The drill identified bottlenecks and predicted ability to care for more casualties.	Not addressed.
Levy, 2000 Radiational	Correlations were made between clinical symptoms in emergency department and common source of exposure. Names of those exposed were identified and sent to the Departments of Public Health in participating countries.	Not addressed.	Not addressed.	Not addressed.
Maxwell, 1987 Transportation accident	6 victims were not assigned any hospital triage category.	13 of the 14 victims were judged to have received appropriate treatment.	The median time to triage was 3 minutes with a range of 0 to 10. The median time to treatment area was 10 minutes with a range from 0 to 39.	4 victims slipped through hospital triage without being tagged.

Table 3: Summary of Results: Clinical Care (continued)

Author, year Type of training	Triage	Patient Care	Patient Flow	Patient Tracking
Menczer, 1968 Incendiary device and boiler explosion	There was no selection of victims for removal from the scene. Immediate establishment of an area for victim safety and treatment was an unfulfilled need. One observer found no evidence of effective triage and no follow-up.	Training of police and fire department personnel in first aid was deficient. Victims need more thorough and adequate first aid after being removed from the disaster site.	Transportation of victims from the disaster scene was done with little regard to the type or site of injury. A great deal of unnecessary handling of victims occurred. Several victims were laid on cold ground uncovered for as long as 20 to 30 minutes. Ambulance services generally provided proper handling and transportation.	Not addressed.
Paris, 1985 Transportation accident	5% of victims were never assigned to a triage category. 44% of victims were assigned to proper triage category.	All 133 patient-tracking cards were collected. 3% of victims with correctable injuries “died” as a result of necessary treatment not provided in timely manner. 6% of victims had deterioration attributed to lack of timely intervention.	Not addressed.	Not addressed.

Table 3: Summary of Results: Clinical Care (continued)

Author, year Type of training	Triage	Patient Care	Patient Flow	Patient Tracking
Tur-Kaspa, 1999 Chemical	Not addressed.	Continuous care and repeated reevaluation of patients are essential during transfer and treatment. Clinicians must know dosages and side-effects of antidotes. Training should occur in full protective equipment and include “intubation dolls”, ventilation, and decontamination procedures. At each treatment site, medical personnel must be ready to handle casualties with injuries other than those of the specific type and severity for which they have been prepared. Note: The above statements were presented as results of the study.	Not addressed.	Clear labeling, identification, and record keeping were vital for efficient reception and treatment of casualties.
Weston, 1988 Hospital fire in operating room	Not addressed.	Patient casualty occurred due to evacuation from the operating room.	Patients were incorrectly moved outside the building instead of to behind the first fire door.	In the 28-minute evacuation, all patients and staff were accounted for.

Table 4: Summary of Results: Security, Materials and Resources, Decontamination, and Other

Author, year Type of training	**Security**	**Materials/Resource**	**Decontamination**	**Other Findings**
Baughman, 1990 Hospital fire and explosion in the emergency department	Security informed fire department of situation.	Disaster charts were not available because stored in the emergency department.	Not addressed.	Not addressed.
Chobin, 1989 Chemical	Not addressed.	Fire department arrived on scene in full gear: material safety data sheet and breathing apparatus were used.	Not addressed.	Not addressed.
Classic, 2000 Radiational	Security of building and perimeter exceeded the standards.	Not addressed.	County Hazardous Materials Response Team required an hour to set up the portable decontamination facility. Only one nurse had been released to prepare the hospital decontamination facility, an activity that requires at least two people. Victims found dead on the scene were not released to local funeral homes until they had first gone to the autopsy laboratory, allowing control of the body in the event it is contaminated. County response team set up a portable decontamination facility outside the perimeter. Bodies should not be released until decontamination is done.	Disaster response personnel needed special identification. Bioassay specimen collection was needed for those with radiation exposure. Access to facilities may not occur within regulatory time frames.
Cook, 1990 Transportation accident	Not addressed.	Not addressed.	Not addressed.	At least one person in each department now has an in-depth understanding post-drill. Staff stress levels were more manageable with game approach.

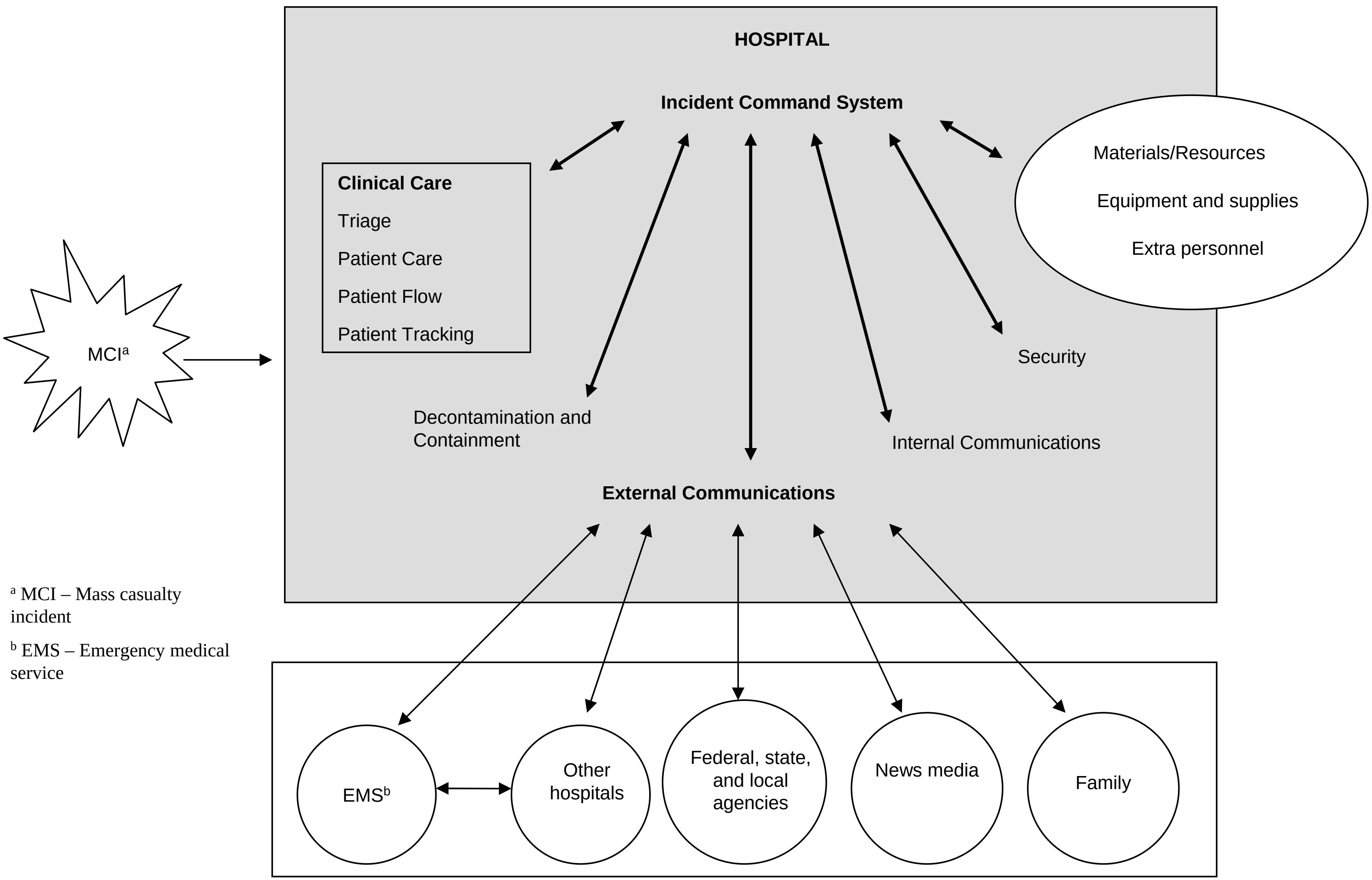
Table 4: Summary of Results: Security, Materials and Resources, Decontamination, and Other (continued)

Author, year Type of training	Security	Materials/Resource	Decontamination	Other Findings
Gofrit, 1997 Not specified	Not addressed.	There was a shortage of ventilators and other trauma care equipment resulting from failure to report from in-hospital storage to emergency department.	Not addressed.	Not addressed.
Gray, 1996 Transportation accident	Not addressed.	Not addressed.	Not addressed.	In a video describing the use of a control room, a staff reporting station, field equipment, and protective clothing in a transportation accident, video viewers retained information significantly better than those who had read the disaster plan (72% versus 45%, $p<0.01$).
Gretenkort, 2002 Hospital fire	Not addressed.	Not addressed.	Not addressed.	Preparation of patient collection points did not meet the needs for the actual number of patients.
Halstead, 1993 Hospital fire in operating room	Not addressed.	Gas levers were difficult to find. Fire door in back corridor did not close. A second water hose was needed.	Not addressed.	A secondary program taught the operating room staff how to use fire extinguishers.
Inglesby, 2001 Biological	There were concerns about ability of security to create an effective “security lock-down”.	Antibiotic supplies were exhausted early in the exercise and antibiotic distribution was logistically difficult. Other resources were scarce.	Not addressed.	Serious disagreements occurred about antibiotic distribution. It was not clear which healthcare workers should be wearing protective equipment or what level of protection was appropriate.

Table 4: Summary of Results: Security, Materials and Resources, Decontamination, and Other (continued)

Author, year Type of training	Security	Materials/Resource	Decontamination	Other Findings
Lau, 1997 Transportation accident	Not addressed.	Nurse wasted time to summon back staff. There were not enough wheelchairs, extra chairs in waiting room, or poles and ropes to maintain order.	Not addressed.	Not addressed.
Levi, 1998 Not specified	The exercise identified crowd control issues and other security problems.	The exercise identified specific medical equipment/medication needs and electro-mechanical failures.	Not addressed.	Not addressed.
Menczer, 1968 Incendiary device and boiler explosion	Not addressed.	First aid equipment and supplies in quantity must be taken to site as soon as the type of disaster is ascertained.	Not addressed.	Out-of-town ambulance drivers did not know hospital locations as the state highway signs were inadequate.
Tur-Kaspa, 1999 Chemical	Not addressed.	Not addressed.	Full protective equipment must be worn in the “contaminated area.” Decontamination must be directed by personnel with loudspeakers.	Adequate pre-drill instruction and training were vital for the drill’s success.

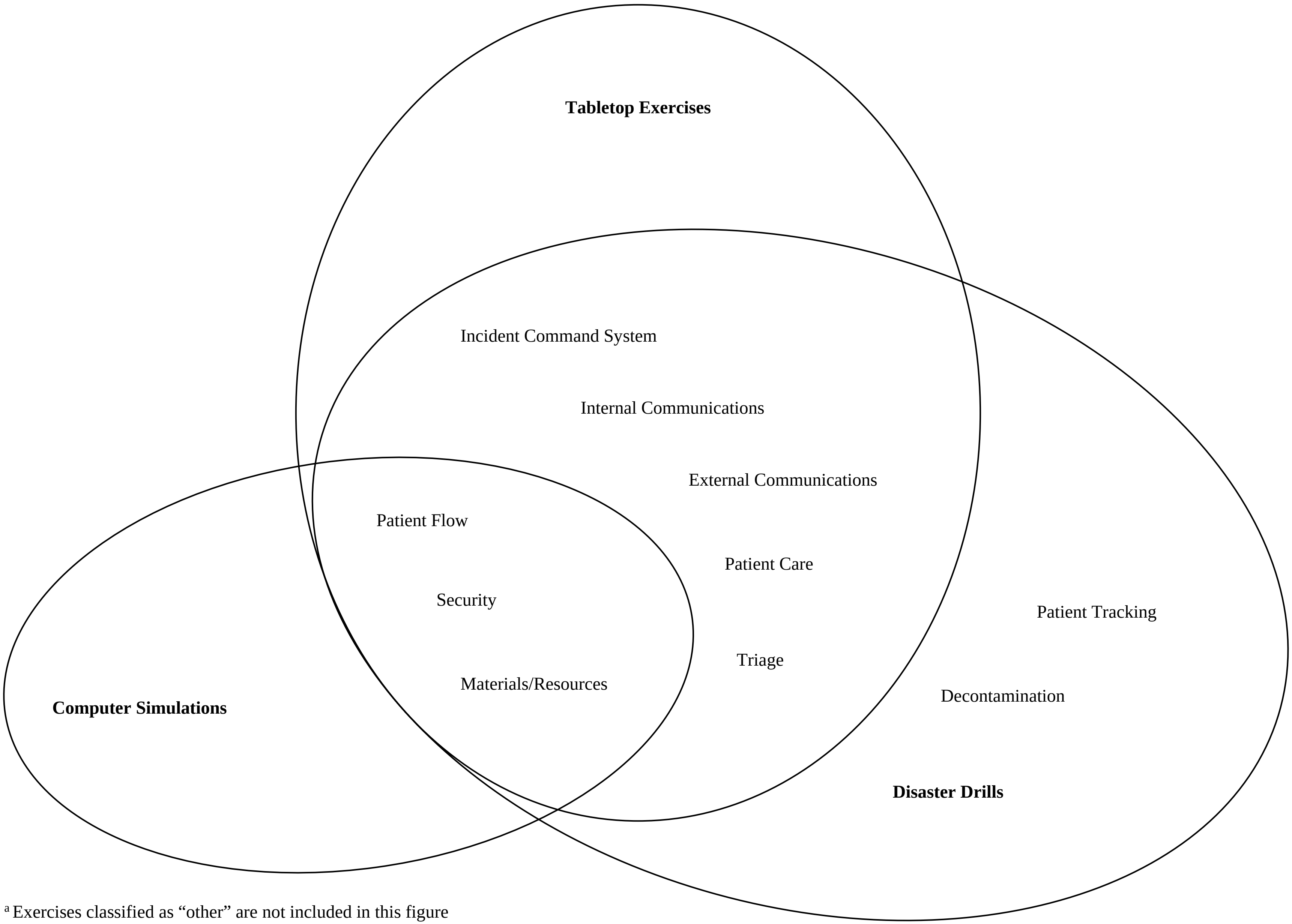
Figure 1. Analytic framework depicting the hospital's role in responding to an MCI



[a] MCI – Mass casualty incident

[b] EMS – Emergency medical service

Figure 2: Hospital Disaster Response Outcome Areas Addressed by Included Articles[a]



[a] Exercises classified as “other” are not included in this figure

Appendix A: Expert Reviewers

Organization	Last Name	First Name	Location and Position
Internal Reviewers - Johns Hopkins University			
Johns Hopkins University	VanRooyen	Michael	Johns Hopkins University Center for International Emergency, Disaster and Refugee Studies Baltimore, MD
Johns Hopkins University	O'Toole	Tara	JHU Center for Civilian Biodefense Strategies Baltimore, MD
Johns Hopkins University	Inglesby	Thomas	JHU Center for Civilian Biodefense Strategies Baltimore, MD
Government			
Health Resources and Services Administration (HRSA)	Bossler	Sumner	Commander, United States Public Health Service Health Resources and Services Administration's Bioterrorism Preparedness Program Rockville, MD
Agency for Health Care Research and Quality (AHRQ)	Phillips	Sally	Agency for Healthcare Research and Quality's Center for Primary Care Research Rockville, MD
University			
Vanderbilt School of Nursing	Conway-Welch	Colleen	Dean, Vanderbilt School of Nursing Nashville, TN
University of Alabama at Birmingham	Terndrup	Thomas	Professor and Chair, Department of Emergency Medicine Director, Center for Disaster Preparedness University of Alabama at Birmingham Birmingham, AL
Philadelphia Veterans Administration Medical Center	Henning	Kelly	Philadelphia Veterans Administration Medical Center Division of Infectious Diseases, University of Pennsylvania Philadelphia, PA
St. Louis University School of Public Health	Evans	Greg	Director, Center for Study of Bioterrorism and Emerging Infection, School of Public Health, St. Louis University St. Louis, MO

Appendix A: Expert Reviewers (continued)

Harbor-UCLA Medical Center	Kaji	Amy	Department of Emergency Medicine Harbor-UCLA Medical Center Torrance, CA
Professional Organizations			
Joint Commission for Accreditation of Health Organizations (JCAHO)	Smith	Marc	Chair, Joint Commission for Accreditation of Health Organizations roundtable on emergency preparedness Washington, DC
Society for Medical Decision Making (SMDM)	Bravata	Dena	Center for Primary Care and Outcomes Research Stanford University School of Medicine Stanford, CA

Appendix B: Priority Journals[a]

Academic Emergency Medicine
Annals of Emergency Medicine
Clinical Infectious Diseases
Disasters
ED Management
Emergency Medicine Clinics of North America
Emerging Infectious Diseases
Hospital Security and Emergency Management (formerly Hospital Security and Safety Management)
Journal of Emergency Nursing
Military Medicine
Morbidity and Mortality Weekly Report (MMWR)
Prehospital and Disaster Medicine
Prehospital Emergency Care

[a] All volumes of the journals listed were searched during the month of January 2003.

Appendix C: Methodological Approach to Searching Literature Sources

Search Strategy for PubMed®

(disaster planning[mh] OR disaster*[tiab] OR mass casualt*[tiab] OR mass-casualt*[tiab]) AND (drill*[tiab] OR simulation[tiab] OR exercise*[tiab]) AND eng[la] NOT (animal[mh] NOT human[mh]) NOT (review[pt] OR meta-analysis[pt])

Search Strategy for the Cochrane CENTRAL Register of Controlled Trials

(((DISASTER* or CATASTROPH*) or BIOTERRORISM) or CASUALT*)

((((EXERCISE* or TABLETOP) or SIMULAT*) or DRILL*) or TRAIN*)

(#1 and #2)

Search Strategy for the Excerpta Medica Database

#1Disaster Planning/
#2disaster$.tw
#3mass casualt$.tw
#4hospital$.tw
#5Emergency Health Service/
#6drill$.tw
#7simulation.tw
#8exercise$.tw
#91 or 2 or 3
#104 or 5
#116 or 7 or 8
#129 and 10 and 11

Search Strategy for the Specialized Register of Effective Practice and Organization of Care Cochrane Review Group

(disaster* OR catastroph* OR bioterrorism OR "biological weapon" OR casualt*) AND (exercise OR tabletop OR simulat* OR drill* OR train*)

Search Strategy for the Educational Research Information Clearinghouse

(poison,poisoning,"communicable disease","disease control",bioterrorism,"biological warfare",disaster,catastroph*) + ("health personnel","allied health personnel","health services") + ("program evaluation","course evaluation")

Search Strategy for the Research and Development Resource Base in Continuing Medical Education

‘disaster’ in indexed and non-indexed fields.

Appendix D: Coding Forms—Abstract Review Form

EPC Bioterrorism Update Project (BT2)Reviewer: _________
Abstract Review Form
Data Entry: ________

Delete article because (check one):

☐ not in English

☐ does not include human data

☐ no original data

☐ meeting abstract (no full article for review)

☐ does not include hospital staff

☐ does not include response to MCI or a disaster

☐ does not include training or education

☐ has no evaluation

☐ other: (specify)

____

☐ **Unclear: get article to decide**

Do not go on if any item above is checked.

Article addresses following questions (check all that apply):

Effective methods to train hospital staff to respond to MCI**:**

☐ the effectiveness of *hospital disaster drills* (#1a)

☐ the effectiveness of *computer simulation* (#1b)

☐ the effectiveness of *"tabletop" or other exercises* (#1c)

☐ *methods or tools* that have been used to evaluate the effectiveness of training (#2)

☐ This article does not apply to any of the questions

☐ Get article for reference regarding:____________________________

Appendix D: Coding Forms—Quality Review Form

Johns Hopkins University Evidence-based Practice Center
Hospital Disaster Drill Article *Quality* Review Form

Article ID: ______________ Reviewer 1:______________ Reviewer 2:.______________

Section I: Article Eligibility

Article is not eligible for review because (Check one):

- ○ Not in English
- ○ Does not include human data
- ○ No original data
- ○ Meeting abstract (No full article to review)
- ○ Does not include hospital staff
- ○ Does not include response to mass casualty incident (MCI) or a disaster
- ○ Does not include training or education
- ○ No evaluation
- ○ Article does not apply to any of the research questions
- ○ Other (Specify): ________________________________

IF ANY OF THE ABOVE ITEMS IS CHECKED, STOP: DO NOT COMPLETE FORM

Section II: **Focus of Article**

Article provides information to address the following questions (Check all that apply):

- ☐ What is the effectiveness of *hospital disaster* drills in training hospital staff to respond to an MCI?
- ☐ What is the effectiveness of *computer simulations* in training hospital staff to respond to an MCI?
- ☐ What is the effectiveness of *"tabletop" or other exercises* in training hospital staff to responded to an MCI?
- ☐ What *methods or tools* have been used to evaluate the effectiveness of hospital disaster drills, computer simulations, tabletop, or other exercises in training hospital staff to respond to an MCI?

Section III: Representativeness of Targeted Hospital Staff

For each question, circle one response.

1. Were detailed descriptions of subjects provided?

a.	Adequate	(Detailed description, e.g., number of doctors, number of nurses, etc.)	2
b.	Fair	(Some general description, e.g., professionals involved)	1
c.	Inadequate	(Minimal description or none at all, e.g., disaster team)	0

2. Were the setting and department(s) described?

a.	Adequate	(Setting and departments described in sufficient detail to replicate)	2
b.	Fair	(Setting OR departments NOT reported OR poor descriptions)	1
c.	Inadequate	(Neither specified)	0

Section IV: Bias and Confounding

For each question, circle one response.

3. Was there a comparison group?

a.	Adequate	(Concurrent and similar group)	2
b.	Fair	(Non-concurrent OR non-similar)	1
c.	Inadequate	(Non-concurrent and non-similar)	0
d.	None	⇨Skip to item 7	

4. Was assignment of study groups randomized?

a.	Yes	2
b.	No	0
c.	Unclear	0

5. Did the education intervention groups have any important differences on key factors at baseline?

   Key Factors:
   Profession (e.g., Nurses, Emergency Medical Technicians, Doctors)
   Specialty (e.g., Emergency Medicine, Internal Medicine, Pediatrics)

a.	Groups equivalent in all key factors	2
b.	Groups have minor difference in 1 factor	1.5
c.	Groups have major difference in 1 factor or minor differences in more than 1 factor	1
d.	No information about groups' characteristics or inadequate to compare	0

6. Was there any intervention other than the educational intervention of interest that differed between groups?

a.	Yes	0
b.	No	2
c.	Unclear	0

Section V: Description of Intervention

For each question, circle one response.

7. Are the objectives of the intervention clearly stated in specific measurable terms?

a.	Adequate	(Objectives clearly stated in measurable terms)	2
b.	Fair	(Objectives stated but not stated in specific measurable terms)	1
c.	Inadequate	(Objectives not stated)	0

8. Did the objectives of the intervention specifically take into consideration knowledge, beliefs/attitudes, skills, behaviors, or clinical outcomes?

a.	Adequate	(Considers any 3 of 5)	2
b.	Fair	(Considers 1 or 2 of 5)	1
c.	Inadequate	(Considers none of the above)	0

9. Was there a complete description of the educational methods, content, resources, and organization of the educational intervention?

a.	Adequate	(Intervention could be replicated given the completeness of description)	2
b.	Fair	(Some detail but insufficient to ensure replication)	1
c.	Inadequate	(No detail)	0

10. Were the key people measuring the educational outcomes appropriately masked to intervention?

a.	Yes	2
b.	No	0
c.	Unclear	0

Section VI: Outcomes of the Educational Intervention

For each question, circle one response.

11. Outcomes of the educational intervention were based upon:

a.	Pre- and post-intervention evaluation	2
b.	Post-intervention evaluation	1
c.	Neither pre- nor post-intervention evaluation	0

12. Are the evaluation methods described in sufficient detail to replicate?

a.	Adequate	(Evaluation methods could be replicated)	2
b.	Fair	(Evaluation methods described but could not be replicated)	1
c.	Inadequate	(Evaluation methods not described)	0

13. Were objective methods used to evaluate outcomes?

a.	Adequate	(Evaluation methods were objective)	2
b.	Fair	(Objectivity of evaluation is questionable)	1
c.	Inadequate	(Evaluation methods not objective)	0

14. Was there any evaluation of long-term retention of information related to training hospital staff in case of an MCI event?

a.	Yes	(At least one month after completion of the intervention)	2
b.	No		0

Section VII: Statistical Quality and Interpretation

For each question, circle one response.

15. Was there quantitative data analysis?

a.	Yes	⇨ Continue on with questions 16 - 18 below
b.	No	⇨ Thank you, your form is complete

16. For primary endpoints of the evaluation, does the study report the magnitude of difference between groups AND an index of variability (e.g., test statistic, p value, standard error, confidence interval)?

a.	Adequate	(Both reported with index of variability using standard error or confidence intervals)	2
b.	Fair	(Both reported with index of variability using only test statistic or p value)	1
c.	Inadequate	(One or both not reported)	0
d.	No comparison group		

17. Were the appropriate analyses and statistical tests performed?

a.	Adequate	(Yes for all analyses)	2
b.	Fair	(Yes for only some of the analyses)	1
c.	Inadequate	(Not for any of the analyses or can’t tell)	0

18. If groups were not comparable at study onset, was there adjustment of potential confounders with multi-variate or stratified analyses AND were confounders coded in a way to make such control adequate?

a.	Adequate	(Adjustment done AND confounders appropriately coded)	2
b.	Fair	(Adjustment done BUT confounders not coded appropriately OR coding unclear OR can't tell)	1
c.	Inadequate	(Adjustment not done OR comparability not previously reported)	0
d.	No comparison group		

THANK YOU! For completing this form. Please return it to Mollie.

Appendix D: Coding Forms—Content Review Form

Johns Hopkins University Evidence-based Practice Center
Hospital Disaster Drill Article *Content* Review Form

Article ID: _______________ Reviewer 1: ____________ Reviewer 2: ____________

1. Funding agency (Check all that apply):
   - ☐ Federal government agency (Specify): _____________ ☐ Other (Specify):__________
   - ☐ State/local government agency (Specify): __________ ☐ Not specified
   - ☐ Hospital

2. What group or organization requested this drill? (Check all that apply):
   - ☐ State/local government agency (Specify): _________________
   - ☐ Hospital
   - ☐ Other (Specify): _________________

3. Type of mass casualty event addressed (Check all that apply):
   - ☐ Biological
   - ☐ Nuclear
   - ☐ Radiational
   - ☐ Chemical
   - ☐ Incendiary device
   - ☐ Natural disaster (e.g. fire, earthquake)
   - ☐ Structural collapse
   - ☐ Transportation accident
   - ☐ Other (Specify): _________________
   - ☐ Not stated

4. Type of training intervention (Check all that apply):
   - ☐ Disaster drill
   - ☐ Computer simulation
   - ☐ Tabletop exercise
   - ☐ Other (Specify): ______________________

5. Type of hospital staff targeted (Check all that apply):
   - ☐ Administrator
   - ☐ Nurse
   - ☐ Physician
   - ☐ First responder (e.g., Emergency Medical Technician)
   - ☐ Other (specify): ______________________
   - ☐ Not specified

6. Total number of targeted hospital staff: | Total N: | | ☐ Not stated

7. Hospital departments or units involved:

☐ Emergency Medicine	☐ Pediatrics	☐ Social work
☐ Intensive Care Unit	☐ Pharmacy	☐ Central supply
☐ Radiology	☐ Nursing	☐ All hospital
☐ Surgery	☐ Public affairs	☐ Other (Specify): ______________
☐ Medicine	☐ Security	☐ Not specified

8. Number of hospitals participating in training intervention: _______

9. Other entities participating in training intervention:

☐ Emergency Medical System	☐ Federal agency
☐ Fire	☐ State agency
☐ Police	☐ None
☐ Local health department	☐ Not specified

10. In what part of the world was the intervention mainly performed? (Check all that apply)

☐ Africa	☐ Mexico, South or Central America
☐ Asia	☐ U.S.
☐ Australia	☐ Other (Specify): _______________________
☐ Canada	☐ Not specified
☐ Europe	

11. What was the length of the drill or exercise?

☐ < 1 day	☐ 8 - 30 days	☐ Not specified
☐ 1 - 7 days	☐ > 30 days	

12. How long after the close of the drill or exercise was the assessment completed? (i.e., post-testing)

☐ < 1 day	☐ 8 - 30 days	☐ > 365 days
☐ 1 - 7 days	☐ 31 - 365 days	☐ Not specified

13. Was retention of knowledge assessed (greater than one day post-intervention)?

☐ Yes ☐ No ☐ Can’t tell

14. Training evaluation methods (check all that apply):

- ☐ Group interviews/debriefings
- ☐ Individual interviews/debriefings
- ☐ Written exam or questionnaire
- ☐ Self-assessment forms
- ☐ Trained casualties
- ☐ Trained “smart” casualties[1]
- ☐ Trained observers
- ☐ Trained “smart” observers[1]
- ☐ Other observers
- ☐ Computer interactive tests
- ☐ Other (Specify): ___________________
- ☐ Not specified

15. Measurable Objectives? ☐ Yes ☐ No

Objectives ✔ **all that apply**	Record any stated objective(s) according to the type of objectives for targeted learners. (e.g., Knowledge objective: hospital staff will be able to describe their roles in the hospital command and control scheme)
Knowledge ☐	
Attitudes/beliefs ☐	
Skills ☐	
Behaviors ☐	
Clinical outcomes ☐	

[1] “Smart” casualties and observers are people with medical training.

Comments: ____

____

____

16. Results: record *qualitative* and *quantitative* measures of outcomes (e.g., External communications: completed within one hour timeline OR Security: noted to be present)

Incident control system (ICS)	
Triage	
Internal communications	
External communications	
Patient care	
Patient flow	
Security	
Materials/resources	
Decontamination	
Patient tracking	
Other (Specify):_______________ ______________________________	
Other (Specify):_______________ ______________________________	

Comments: ____

____

____

17. Main conclusion (Please limit to one sentence):

18. Any other comments?

THANK YOU! For completing this form. Please return it to Mollie.

Appendix E: Evidence Tables

Evidence Table 1. Characteristics of studies evaluating training programs for hospital staff to respond to an MCI[a]

Author, year location	Type(s) of training intervention, type(s) of event addressed	Hospitals involved (N)	Hospital department(s) involved	Type(s) of hospital staff targeted, total staff involved (N)	Training objective(s)[b]	Training evaluation method(s)
Hospital disaster drills						
Baughman, 1990 U.S.	Disaster drill; hospital fire and explosion in the emergency department	1	Emergency medicine; intensive care unit; nursing; security; other departments.	Nurses; physicians. (N=NS[a])	K: To assess what resources would be available if 1) the usual triage team was unable to perform because of injuries, 2) usual treatment area was not available because of a disaster in that location. S: To assess intensive care unit nurses' ability to triage victims.	Not specified.
Chobin, 1989 U.S.	Disaster drill; chemical	1	Administration; emergency medicine; nursing; security.	Administrator (CEO[a]); nurses; physicians; first responders; telephone operator; security office; nursing administration; admitting; maintenance. (N=NS[a])	K: To test the preparedness of the necessary resources (hospital employees, hospital fire brigade, emergency room staff, local fire department) in the event of an ethylene oxide spill.	Not specified.
Classic, 2000 U.S.	Disaster drill; radiational	1	Emergency medicine; security; hospital communications; facilities; operations; radiational safety.	Nurses; physicians; radiation safety staff. (N=NS[a])	S: To assess the function of intercom and security systems in radiation emergency. B: To assess the time to contact radiation safety staff and set up portable decontamination area; appropriateness of setup of triage area.	Group interviews/debriefings.

[a] Abbreviations: CEO = chief executive officer, MCI = mass casualty incident, NS = not stated
[b] Key: K = Knowledge, S = Skills, B = Behavior, C/O = Clinical outcome
[c] "Smart" casualties and observers have medical training

Appendix E: Evidence Tables (continued)

Evidence Table 1. Characteristics of studies evaluating training programs for hospital staff to respond to an MCI[a] (continued)

Author, year location	Type(s) of training intervention, type(s) of event addressed	Hospitals involved (N)	Hospital department(s) involved	Type(s) of hospital staff targeted, total staff involved (N)	Training objective(s)[b]	Training evaluation method(s)
Cook, 1990 U.S.	Disaster drill; transportation accident	1	All hospital.	Not specified. (N=NS[a])	K: To understand overall implementation of hospital disaster plan and how their departments interact. S: To move disaster victims through the hospital system as appropriately and efficiently as possible. C/O: To minimize patient time spent in each area waiting for disposition.	Group interviews/debriefings; "smart" observers[c]; observer checklists.
Eisner, 1985 U.S.	Disaster drill; transportation accident	>1 (but only data on 1)	Emergency medicine.	First responders; physicians; triage team. (N=NS[a])	K: To gain knowledge of time needed to initiate care of patients from an airplane disaster at the local airport. S: To initiate care to patients with varying degrees of injury severity in a timely manner. C/O: To evaluate triage of victims and severity of injuries by arrival time at trauma center.	Mock disaster patient charts.
Fishel, 1974 U.S.	Disaster drill; transportation accident	18	Central supply; emergency medicine; nursing; security;	Nurses; physicians, first responders. (N=NS[a])	K: To evaluate the effectiveness of the total exercise operation. S: To assess the transportation of 300 victims to 18 hospitals by ambulance and bus.	Group interviews/debriefings; "smart" observers[c].

[a] Abbreviations: CEO = chief executive officer, MCI = mass casualty incident, NS = not stated
[b] Key: K = Knowledge, S = Skills, B = Behavior, C/O = Clinical outcome
[c] "Smart" casualties and observers have medical training

Appendix E: Evidence Tables (continued)

Evidence Table 1. Characteristics of studies evaluating training programs for hospital staff to respond to an MCI[a] (continued)

Author, year location	Type(s) of training intervention, type(s) of event addressed	Hospitals involved (N)	Hospital department(s) involved	Type(s) of hospital staff targeted, total staff involved (N)	Training objective(s)[b]	Training evaluation method(s)
Gofrit, 1997 Middle East	Disaster drill; NS[a]	8	Emergency medicine; nursing; radiology; surgery.	First responders; nurses; physicians. (N=NS[a])	C/O: To assess the feasibility of integrating physicians among the simulated casualties of a hospital disaster drill.	Group interviews/debriefings; written exam or questionnaire; "smart" casualties[c].
Gretenkort, 2002 Europe	Disaster drill; hospital fire	1	Nursing; central supplies; inpatient units.	Administrators; first responders; nurses; physicians. (N=500)	K: To educate the coordinating physician of the hospital in communication procedures during an MCI[a]. S: To evacuate immobile patients quickly and effectively to designated collection points. C/O: Comparison of patient evacuation time with group using *carry sheet* versus single person using *Jaerven Rescue Drag Sheet.*	Group interviews/debriefings; "smart" observers[c]; other observers; patient impersonators.
Halstead, 1993 U.S.	Disaster drill; hospital fire in operating room	1	Nursing; security; surgery; operating room staff.	Nurses; physicians. (N=48)	K: To list the three elements of fire; know how to initiate the procedure for notifying hospital personnel of fire; know the location of the fire extinguishers. S: To know how to use fire extinguishers. S: To evacuate patients safely.	Group interviews/debriefings; "smart" observers[c].

[a] Abbreviations: CEO = chief executive officer, MCI = mass casualty incident, NS = not stated
[b] Key: K = Knowledge, S = Skills, B = Behavior, C/O = Clinical outcome
[c] "Smart" casualties and observers have medical training

Appendix E: Evidence Tables (continued)

Evidence Table 1. Characteristics of studies evaluating training programs for hospital staff to respond to an MCI[a] (continued)

Author, year location	Type(s) of training intervention, type(s) of event addressed	Hospitals involved (N)	Hospital department(s) involved	Type(s) of hospital staff targeted, total staff involved (N)	Training objective(s)[b]	Training evaluation method(s)
Lau, 1997 Asia	Disaster drill; transportation accident	1	Emergency medicine; nursing; radiology; security; central supplies; emergency mobile team.	Administrators; nurses; physicians; security; transport staff. (N=60)	K: To familiarize hospital staff with the disaster plan and with their roles in disaster management. S: To handle patient flow in an orderly and timely manner; to appropriately triage patients. B: To test the efficiency of the plan and coordinate among hospital departments during disaster management.	Group interviews/debriefings.
Maxwell, 1987 U.S.	Disaster drill; transportation accident	1	Not specified.	Physicians; first responders. (N=NS[a])	K: To assess the value of using victim- tracking cards in a hospital disaster drill. C/O: To appropriately triage and transport casualties to the correct treatment areas.	Group interviews/debriefings; trained casualties; victim-tracking cards.
Menczer, 1968 U.S.	Disaster drill; incendiary device and boiler explosion	4	Emergency medicine	Physicians, first responders. (N=NS[a])	S: To assess handling and transportation of victims; to assess first aid at the scene of a disaster; to assess medical care at the hospital after a disaster.	Written exam or questionnaire, trained casualties, videotape.
Paris, 1985 U.S.	Disaster drill; transportation accident	NS[a]	Not specified.	Not specified. (N=NS[a])	S: To analyze the care provided to victims in a community airport disaster drill.	"Smart" casualties[c]; triage cards.

[a] Abbreviations: CEO = chief executive officer, MCI = mass casualty incident, NS = not stated
[b] Key: K = Knowledge, S = Skills, B = Behavior, C/O = Clinical outcome
[c] "Smart" casualties and observers have medical training

Appendix E: Evidence Tables (continued)

Evidence Table 1. Characteristics of studies evaluating training programs for hospital staff to respond to an MCI[a] (continued)

Author, year location	Type(s) of training intervention, type(s) of event addressed	Hospitals involved (N)	Hospital department(s) involved	Type(s) of hospital staff targeted, total staff involved (N)	Training objective(s)[b]	Training evaluation method(s)
Saxena, 1986 U.S.	Disaster drill; chemical	1	Emergency medicine.	Physicians, first responders. (N=NS[a])	B: To demonstrate the capability to make a coordinated response to a hazardous materials incident by dispatching appropriate local and state response vehicles and teams; to exercise chemical disaster emergency plans within political guidelines; to meet the information needs of federal, state, and local government agencies by establishing on-site communications from an incident site; to demonstrate the ability to notify and assemble emergency response personnel at the scene of a chemical disaster and at Emergency Operating Center; to demonstrate the ability to cooperatively and effectively manage hazardous material accidents; to demonstrate the capabilities of a major hospital emergency room to handle the chemical disaster.	Not specified.

[a] Abbreviations: CEO = chief executive officer, MCI = mass casualty incident, NS = not stated
[b] Key: K = Knowledge, S = Skills, B = Behavior, C/O = Clinical outcome
[c] "Smart" casualties and observers have medical training

Appendix E: Evidence Tables (continued)

Evidence Table 1. Characteristics of studies evaluating training programs for hospital staff to respond to an MCI[a] (continued)

Author, year location	Type(s) of training intervention, type(s) of event addressed	Hospitals involved (N)	Hospital department(s) involved	Type(s) of hospital staff targeted, total staff involved (N)	Training objective(s)[b]	Training evaluation method(s)
Tur-Kaspa, 1999 Middle East	Disaster drill; chemical	21	All hospital.	Not specified. (N=NS[a])	S: To evaluate the quality of patient care in response to a chemical disaster. C/O: To evaluate the ability to provide continuity of patient care in response to a chemical disaster.	"Smart" casualties[c]; "smart" observers[c]; other observers (administrative personnel); Army physicians with experience in managing chemical casualties.
Weston, 1988 Europe	Disaster drill; hospital fire in operating room	1	Nursing; security; surgery.	Administrators; nurses; physicians. (N=NS[a])	S: To assess time to evacuation.	Group interviews/debriefings; "smart" observers[c]; other observers.
Computer simulations						
Levi, 1998 Middle East	Computer simulation; NS[a]	1	Senior management.	Administrators. (N=NS[a])	B: To evaluate hospital disaster plan without activating whole system (to carry out a limited scale drill); to train decision makers. C/O: To assist in managing real situations by identifying bottlenecks and evaluating solutions.	Group interviews/debriefings; other observers; constructing a detailed computerized scenario.

[a] Abbreviations: CEO = chief executive officer, MCI = mass casualty incident, NS = not stated
[b] Key: K = Knowledge, S = Skills, B = Behavior, C/O = Clinical outcome
[c] "Smart" casualties and observers have medical training

Evidence Table 1. Characteristics of studies evaluating training programs for hospital staff to respond to an MCI[a] (continued)

Author, year location	Type(s) of training intervention, type(s) of event addressed	Hospitals involved (N)	Hospital department(s) involved	Type(s) of hospital staff targeted, total staff involved (N)	Training objective(s)[b]	Training evaluation method(s)
Tabletop and other exercises						
Burns, 1984 Not specified	Tabletop exercise (competitive simulation); incendiary device	1	Emergency medicine; nursing.	Nurses; emergency management team. (N=NS[a])	K: To evaluate nursing care for persons with burn injuries. B: To assess 5 performance objectives, each requiring 4 to 5 activities (these were not specified further).	Written exam or questionnaire; self assessment forms; other observers.
Gray, 1996 Middle East (Saudi Arabia)	Other exercise (video simulation); transportation accident	1	All hospital.	First responders; nurses. (N=500+ viewed video within 2 weeks)	K: To evaluate information recall in a group of hospital employees who had seen the video versus a group who had read the disaster plan.	Written exam or questionnaire.
Inglesby, 2001 U.S.	Other exercise; biological	3	Emergency medicine; intensive care unit; medicine; pharmacy; security.	Not specified. (N=NS[a])	K: To test readiness of top government and other officials to respond to terrorist attacks directed at multiple geographic locations.	Group interviews/debriefings; individual interviews/debriefings.

[a] Abbreviations: CEO = chief executive officer, MCI = mass casualty incident, NS = not stated
[b] Key: K = Knowledge, S = Skills, B = Behavior, C/O = Clinical outcome
[c] "Smart" casualties and observers have medical training

Appendix E: Evidence Tables (continued)

Evidence Table 1. Characteristics of studies evaluating training programs for hospital staff to respond to an MCI[a] (continued)

Author, year location	Type(s) of training intervention, type(s) of event addressed	Hospitals involved (N)	Hospital department(s) involved	Type(s) of hospital staff targeted, total staff involved (N)	Training objective(s)[b]	Training evaluation method(s)
Levy, 2000 Eastern Europe (Russian Federation, Armenia, Estonia, Georgia, Moldova, Ukraine)	Other exercise (audio-graphic teleconferencing); radiational	NS[a]	Emergency medicine.	Emergency department staff. (N=NS[a])	K: To recognize accidental exposure to radiation. B: To perform medical assessment of exposed victims; to estimate radiation exposure; to report to national authorities; to establish communication between participating counties. C/O: To achieve coordination and consultation regarding victims.	Group interviews/debriefings.

[a] Abbreviations: CEO = chief executive officer, MCI = mass casualty incident, NS = not stated
[b] Key: K = Knowledge, S = Skills, B = Behavior, C/O = Clinical outcome
[c] “Smart” casualties and observers have medical training

Appendix E: Evidence Tables (continued)

Evidence Table 2. Quality of studies evaluating training programs for hospital staff to respond to an MCI[a]

Author, year	Representativeness[b]	Bias[c]	Description[d]	Outcomes[e]	Statistics[f]	Total score[g]
Hospital disaster drills						
Baughman, 1990	0	N/A	38	25	N/A	21
Chobin, 1989	75	N/A	63	13	N/A	50
Classic, 2000	75	N/A	25	25	N/A	42
Cook, 1990	25	N/A	63	63	N/A	50
Eisner, 1985	25	N/A	38	50	N/A	38
Fishel, 1974	75	N/A	38	13	N/A	42
Gofrit, 1997	50	N/A	25	38	N/A	38
Gretenkort, 2002	50	N/A	50	50	0	38
Halstead, 1993	100	N/A	75	50	N/A	75
Lau, 1997	75	N/A	38	38	N/A	50
Maxwell, 1987	50	N/A	63	63	100	69
Menczer, 1968	75	N/A	50	38	N/A	54
Paris, 1985	25	N/A	25	38	N/A	29
Saxena, 1986	50	N/A	63	13	N/A	42
Tur-Kaspa, 1999	50	N/A	38	25	N/A	38
Weston, 1988	25	N/A	25	25	N/A	25
Computer simulations						
Levi, 1998	0	N/A	38	13	N/A	17

Appendix E: Evidence Tables (continued)

Evidence Table 2. Quality of studies evaluating training programs for hospital staff to respond to an MCI[a] (continued)

Author, year	Representativeness[b]	Bias[c]	Description[d]	Outcomes[e]	Statistics[f]	Total score[g]
Tabletop and other exercises						
Burns, 1984	50	N/A	50	75	50	56
Gray, 1996	50	69	38	50	100	61
Inglesby, 2001	50	N/A	38	25	N/A	38
Levy, 2000	50	N/A	38	25	N/A	38

[a] Abbreviations: MCI = mass casualty incident, N/A = not applicable.
[b] Representativeness: The total maximum for this section was 4 points. This included detailed descriptions of subjects provided (maximum 2 points) and the setting and department(s) described (maximum 2 points).
[c] Bias (and confounding): The total maximum for this section was 8 points. This included presence of a comparison group (maximum 2 points), assignment of study groups (maximum of 2 points), whether the education intervention groups had important differences on key factors at baseline (maximum 2 points), and intervention other than the educational intervention of interest that differed between groups (maximum 2 points).
[d] Description (of intervention): The total maximum score for this section was 8 points. This included the objectives of the intervention clearly stated in specific measurable terms (maximum 2 points), whether the objectives of the intervention specifically took into consideration knowledge, beliefs/attitudes, skills, behaviors, or clinical outcomes (maximum 2 points), complete description of the educational methods, content, resources and organization of the educational intervention (maximum 2 points), and the key people measuring the educational outcomes appropriately masked to intervention (maximum 2 points).
[e] Outcomes (of the educational intervention): The total maximum for this section was 8 points. This included outcomes of the educational intervention based on pre- and post-intervention evaluation (maximum 2 points), the evaluation methods described in sufficient detail to replicate (maximum 2 points), objective methods used to evaluate outcomes (maximum 2 points), and evaluation of long-term retention of information relating to training hospital staff in case of a MCI (maximum 2 points).
[f] Statistics (quality and interpretation): The total maximum for this section was 6 points. This included the magnitude of difference between groups and an index of variability for primary endpoints (maximum 2 points), the appropriate analyses and statistical tests performed (maximum 2 points), and adjustment of potential confounders with multi-variate or stratified analyses and confounders coded (maximum 2 points).
[g] Total score: Mean of the percent scores from the previous four categories.

Appendix E: Evidence Tables (continued)

Evidence Table 3. Results of studies evaluating training programs for hospital staff to respond to an MCI[a]

Author, year	Type(s) of event addressed	Results	Summary/conclusion
Hospital disaster drills			
Baughman, 1990	Hospital fire and explosion in the emergency department	**Incident control:** Confusion resulted because no single person was designated as incident commander. **Triage:** Usual triage area was not available causing confusion. Secondary staff was inexperienced in triage. **Internal communications:** Considerable time delay because ED[a] was immobilized. **Patient care:** Treatment began in triage areas before patients were sent to treatment areas. **Patient flow:** No triage area. **Security:** Security informed fire department of situation. **Resources:** Disaster charts not available because stored in ED[a].	Disaster located in the ED[a] immobilized procedures, revealing deficiencies in the internal chain of command, distribution of disaster charts, and training of nurses in triage.
Chobin, 1989	Chemical	**Internal communications:** Hospital operator was called using established hotline. Hospital fire brigade alerted by code. Hospital operator notified nursing administration. **External communications:** Requested assistance from local fire department. Requested hospital Chief Executive Officer to call a disaster code. **Patient flow:** Victims evacuated to ED[a]. **Resources:** Fire department arrives on scene in full gear: material safety data sheet and breathing apparatus used. **Patient tracking:** Admitting personnel present in ED[a] making charts and identification bracelets.	Enactment of a disaster drill involving both external and internal response, and involving multiple departments with simulated patients, enables the departments, hospital and local agencies to test Occupational Safety and Health Agency-required disaster plans before an emergency arises.

[a] Abbreviations: decon = decontamination, ED = emergency department, MCI = mass casualty incident

Evidence Table 3. Results of studies evaluating training programs for hospital staff to respond to an MCI[a] (continued)

Author, year	Type(s) of event addressed	Results	Summary/conclusion
Classic, 2000	Radiational	**Triage:** Physical barriers to identify "hot", "warm", and "cold" zones for ambulatory victims not used correctly. **Internal communications:** Intercom system inadequate, as message could not be clearly understood. Fire alarms worked well. Radiation call staff contacted successfully. **External communications:** Contact of radiation safety immediate, but message incomplete (significant deficiency). **Patient care:** Plan to use building exits as "choke points" for screening works well. **Patient flow:** 30 victims transported to ED[a]. **Security:** Security of building and perimeter exceeded the standards. **Decon[a]:** County Hazardous Materials Response Team required an hour to set-up the portable decon[a] facility. Only one nurse had been released to prepare the hospital decon[a] facility, an activity that requires at least two people. Victims found dead on the scene are not released to local funeral homes until they have first gone to the autopsy laboratory, allowing hospital control of the body in the event it is contaminated. **Other:** Disaster response personnel needed special identification. Bioassay specimen collection needed for those with radiation exposure. Access to facilities may not be able to occur within regulatory time frames.	Drill provided education to spill team members and identified areas for improvement in response. Drill was not only educational but also built responder confidence in abilities.
Cook, 1990	Transportation accident	**Incident control:** Less confusion. **Internal communications:** Overhead announcement not heard. Some vital personnel had not received new disaster plan. **Patient flow:** Less congestion in triage and ED[a] since personnel reported directly to assigned areas rather than to the ED[a] to ask for guidance. **Other:** At least one person in each department now has an in-depth understanding post drill. Staff stress levels more manageable with game approach.	Use of a game approach in disaster planning produced benefits in increased understanding of disaster plans, identification of disaster plan flaws, and increased coordination regarding thoughtfully planned disaster care.
Eisner, 1985	Transportation accident	**Triage:** 53% of the group that needed immediate care arrived at care location greater than 1.5 hours post-disaster. 15% of patients triaged were discharged home compared to 85% of patients requiring hospital admission.	Simulation of an airplane crash at a local airport revealed a long delay in patient care for seriously or critically injured people.

[a] Abbreviations: decon = decontamination, ED = emergency department, MCI = mass casualty incident

Evidence Table 3. Results of studies evaluating training programs for hospital staff to respond to an MCI[a] (continued)

Author, year	Type(s) of event addressed	Results	Summary/conclusion
Fishel, 1974	Transportation accident	**Triage:** Teams of doctors and nurses were not experienced or knowledgeable in triage. A course to develop triage personnel is needed. The triage tags were not easily identifiable, color coded tags may address this problem. **Internal Communications:** The emergency call-up system was inadequate because names and telephone numbers were not correct. **External Communications:** Radio communications developed several technical and operational problems. **Patient Flow:** Ambulance crews became exhausted moving the victims.	An 18 hospital city-wide disaster drill was able to locate deficiencies in patient transport, internal and external communications, and triage even though only 175 of the expected 300 simulated casualties participated.
Gofrit, 1997	Not stated	**Triage:** 9% of patients were over-triaged. 4 % of patients were under-triaged. **Patient care:** Simulated casualties were not examined head-to-toe. Patients with post-traumatic stress disorder were not examined fully and referred directly to psychology. **Patient flow:** Delays were encountered in treatment due to lack of leadership and shortage of personnel. Patients transferred from one area to another without appropriate medical escort and without properly controlled ventilation. **Resources:** There was a shortage of ventilators and other trauma care equipment resulting from failure to report from in-hospital storage to ED[a]. **Patient tracking:** Medical documentation was inadequate.	Integrating physicians ("smart" casualties) among the simulated casualties in a hospital disaster drill may contribute to achieving the objectives of hospital disaster drills and add to disaster management education of the simulated casualty physicians. The "smart" casualty also can identify faults in the medical organization and in the medical care provided.
Gretenkort, 2002	Hospital fire	**Incident control:** The leadership concept of the Coordinating Physician of the Hospital working together with other hospital executives and the incident commander proved effective. **External communications:** Went smoothly and provided true interface between authorities and hospital administration. **Patient flow:** Patient flow and staff allocation greatly aided by *Jaerven Rescue Drag Sheet.* **Resources:** For 120 patients, *Jaerven Rescue Drag Sheet* took 601 minutes for complete evacuation, compared to 799 minutes for carrying teams. **Other:** Preparation of patient collection points did not meet the needs for the actual number of patients.	Reorganization of leadership for hospital disaster incidents, complemented by the use of predefined checklists and *Jaerven Rescue Drag Sheets*, greatly streamlined elevator-independent evacuation of immobile patients.

[a] Abbreviations: decon = decontamination, ED = emergency department, MCI = mass casualty incident

Appendix E: Evidence Tables (continued)

Evidence Table 3. Results of studies evaluating training programs for hospital staff to respond to an MCI[a] (continued)

Author, year	Type(s) of event addressed	Results	Summary/conclusion
Halstead, 1993	Hospital fire in operating room	**Internal communications:** Could not hear overhead announcement of fire in operating room. Needed printed protocol for fighting fire. Operating room representatives to be added to hospital committee. **Patient care:** Operating room beds too heavy to maneuver for evacuation. **Patient flow:** Corridors, exits, and evacuation routes were blocked with equipment. More storage space needed for extra equipment. **Resources:** Gas levers were difficult to find. Fire door in back corridor did not close. Need second water hose. **Other:** A secondary program taught the operating room staff how to use fire extinguishers.	Operating room specific drills and programs should be developed and tested to teach operating room staff about fire prevention and responding to fire disasters.
Lau, 1997	Transportation accident	**Incident control:** Disaster plan activated successfully. **Triage:** 19 patients triaged and discharged. Patients' particulars were inadequately up-dated on the Accident and Emergency clinical record sheets. **Internal communications:** Better radio training needed. **External communications:** Telephone operator preferred native language under stressful conditions. **Patient care:** Charting and filling out forms detracted from patient care. Staff summoned from other units were not familiar with ED[a]. **Patient flow:** 45 minutes from first patient in to last patient out. Porters did not know role in drill. **Resources:** Nurse wasted time to summon back staff. Not enough wheelchairs, extra chairs in waiting room, or poles and ropes to maintain order. **Patient tracking:** Patients given bracelets and record sheet with identification. All patients accounted for.	Organizing practice drills provided clinicians with the opportunity to anticipate possible operational difficulties and find remedies to track them, as well as develop effective coordination and cooperation around various departments of the hospital in disaster management.
Maxwell, 1987	Transportation accident	**Triage:** 6 victims were not assigned any hospital triage category. **Patientcare:** 13 of the 14 victims were judged to have received appropriate treatment. **Patient flow:** The median time to triage was 3 minutes with a range of 0 to 10. The median time to treatment area was 10 minutes with a range from 0 to 39. **Patient tracking:** 4 victims slipped through hospital triage without being tagged.	Victim tracking cards contribute to the process of post drill analysis.

[a] Abbreviations: decon = decontamination, ED = emergency department, MCI = mass casualty incident

Appendix E: Evidence Tables (continued)

Evidence Table 3. Results of studies evaluating training programs for hospital staff to respond to an MCI[a] (continued)

Author, year	Type(s) of event addressed	Results	Summary/conclusion
Menczer, 1968	Incendiary device and boiler explosion	**Incident control:** No overall recognized leader to coordinate services and agencies. No medical authority at the scene. **Triage:** No selection of victims for removal from the scene. Immediate establishment of an area for victim safety and treatment was an unfulfilled need. One observer found no evidence of effective triage and no follow-up. **Patient care:** Training of police and fire department personnel in first aid was deficient. Victims need more thorough and adequate first aid after being removed from the disaster site. **Patient flow:** Transportation of victims from the disaster scene was done with little regard to the type or site of injury. A great deal of unnecessary handling of victims occurred. Several victims were laid on cold ground uncovered for as long as 20 to 30 minutes. Ambulance services generally provided proper handling and transpiration. **Resources:** First aid equipment and supplies in quantity must be taken to site as soon as the type of disaster is ascertained. **Other:** Out-of-town ambulance drivers did not know hospital locations as the state highway signs were inadequate.	The disaster exercise identified a number of important deficiencies in disaster management.
Paris, 1985	Not stated	**Triage:** 5% of victims never assigned to a triage category. 44% of victims assigned to proper triage category. **Patient care:** All 133 patient-tracking cards collected. 3% of victims with correctable injuries "died" as a result of necessary treatment not provided in timely manner. 6% of victims had deterioration attributed to lack of timely intervention.	Victim-tracking cards useful in evaluating the patient management aspect of a disaster drill.
Saxena, 1986	Chemical	**External communications:** Notification for the activation of Emergency Operating Centers among participating agencies was not effectivity accomplished. The list of chemicals involved was not correctly reported to the state Emergency Operating Center. Exercise communications between the Emergency Operating Center were inefffective and in come cases nonexistent.	The chemical disaster drill will help the state to be in a state of readiness for hazardous material accidents.

[a] Abbreviations: decon = decontamination, ED = emergency department, MCI = mass casualty incident

Appendix E: Evidence Tables (continued)

Evidence Table 3. Results of studies evaluating training programs for hospital staff to respond to an MCI[a] (continued)

Author, year	Type(s) of event addressed	Results	Summary/conclusion
Tur-Kaspa, 1999	Chemical	**External communications:** An effective communication system between different sites and the control center is essential. **Patient care:** Continuous care and repeated re-evaluation of patients are essential during transfer and treatment. Clinicians must know dosages and side affects of antidotes. Training should occur in full protective equipment and include “intubation dolls”, ventilation, and decon[a] procedures. At each treatment site, medical personnel must be ready to handle casualties with injuries other than those of the specific type and severity for which they have been prepared. **Decon[a]:** Full protective equipment must be worn in the “contaminated area.” Decon[a] must be directed by personnel with loudspeakers. **Patient tracking:** Clear labeling, identification, and record keeping are vital for efficient reception and treatment of casualties. **Other:** Adequate pre-drill instruction and training are vital for the drill’s success. **Note:** The above statements were presented as the “results” of the drill.	Lessons learned from hospital disaster drills can be incorporated into the current hospital deployment plan. The described hospital deployment plan for management of chemical casualties and the preparation process that accompanies it can serve as a basis for hospital planning. This has implications for the handling of large-scale disasters, with maximum efficiency and minimum loss of life.
Weston, 1988	Hospital fire in operating room	**Incident control:** Absence of senior hospital nursing officer led to command confusion. Incident flow charts needed. **Internal communications:** Poor communication because of low number of alarm bells and low level of buzzers. **Patient care:** Patient casualty occurred due to surgical evacuation. **Patient flow:** Patients were incorrectly moved outside instead of to opposite side of first fire door. **Patient tracking:** All patients and staff were accounted for at the end of the 28 minute evacuation.	Simulation of a small fire in the surgical theaters revealed deficiencies in command, communication, and execution of evacuation during the disaster drill.

[a] Abbreviations: decon = decontamination, ED = emergency department, MCI = mass casualty incident

Appendix E: Evidence Tables (continued)

Evidence Table 3. Results of studies evaluating training programs for hospital staff to respond to an MCI[a] (continued)

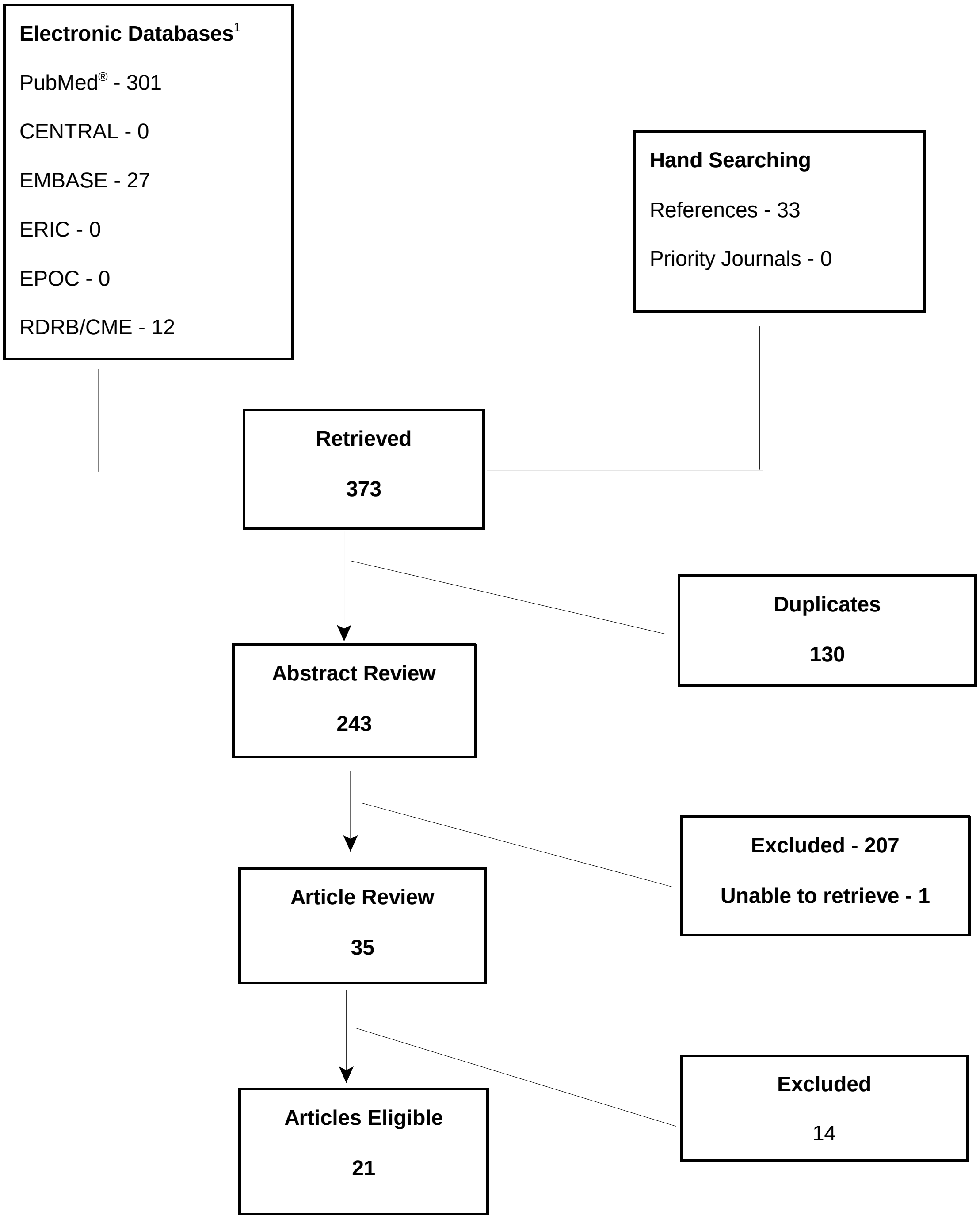
Author, year	Type(s) of event addressed	Results	Summary/conclusion
Computer simulation			
Levi, 1998	Not stated	**Patient flow:** Able to identify bottlenecks and predict ability to care for more casualties. **Security:** Able to identify crowd control issues and other security problems. **Resources:** Able to identify specific medical equipment/medication needs and electro-mechanical failures.	The described simulation techniques used in preparatory limited scale drill had advantages in evaluating and improving preparedness of hospitals for managing an MCI[a] before a full-scale drill is done.
Tabletop and other exercises			
Burns, 1984	Incendiary device (competitive simulation exercise)	**Patient care:** Participants' burn care knowledge increased 6 to 7 points from pre-test to post exercise (total score = 200). The median outcome of self-scoring was 87% with a range from 60-96%. Leadership personnel from the ED[a] working with members of the burn unit scored the highest. A team consisting of an ED[a] technician and a staff nurse scored the lowest.	The competitive simulation used to test and educate nurses on the treatment of burn victims was found to have advantages in motivation of the participants, utilization of new concepts prior to actual practice, realism, relevance, and the simplification of complex nursing problems.
Gray, 1996	Transportation accident (video simulation)	**Other:** In a video describing the use of a control room, a staff reporting station, field equipment, and protective clothing in a transportation accident, video viewers retained information significantly better than those who had read the disaster plan (72% versus 45%, p<0.01).	Use of video has three advantages: 1) video allows staff to see equipment and how to use it, 2) video gives staff insight into facing mass casualties, and 3) video viewing is easy to plan and supervise. Overall this was an efficient, convenient, and enjoyable way for hospital staff to learn about the disaster plan.

[a] Abbreviations: decon = decontamination, ED = emergency department, MCI = mass casualty incident

Author, year	Type(s) of event addressed	Results	Summary/conclusion
Inglesby, 2001	Biological	**Incident control:** Unclear how to coordinate different operation centers set up by a variety of state and federal emergency management offices. Not familiar with language used in disaster control. Leadership roles and authorities in the crisis were uncertain; not clear who was in charge. **Triage:** Concern over ability to distinguish between "worried well" and those harboring early signs of plague. **Internal communications:** A significant amount of time spent exchanging phone, beeper, and FAX numbers; exchange should have been done prior to exercise. **External communications:** Process of decision making by conference call was highly inefficient and led to indecision and significant delays in taking action. 800 MHz radios had efficient communication where regular phone lines were not answered or otherwise dysfunctional. **Patient care:** Hospitals were beyond capacity for patients in less than 24 hours. **Patient flow:** Inadequate plans for disposition of patients before and after triage, and for the deceased. **Security:** Concerns about security's ability to create an effective "security lock-down". **Resources:** Antibiotic supplies were exhausted early in the exercise and antibiotic distribution was logistically difficult. Other resources were scarce. **Other:** Serious disagreements about antibiotic distribution. Not clear which health care workers should be wearing protective equipment or what level of protection was appropriate.	Clear, scientifically and politically sound principles for containment of highly infectious disease in large, urban communities are needed. Public health resources now in place would not be sufficient to respond to the demand created by a bioterrorism epidemic.
Levy, 2000	Radiational (audio-graphic teleconferencing)	**Triage:** Correlations made between clinical symptoms in ED[a] and common source of exposure. Names of those exposed were identified and sent to the Departments of Public Health in participating countries. **External communications:** Extensive live communication among sites in 5 time zones. All sites participated in 7 live conferences within 74 hours. Proper authorities notified in each country.	Practice with the technological component of a training activity is an effective means to familiarize emergency responders with policies and procedures regarding radiation accidents.

[a] Abbreviations: decon = decontamination, ED = emergency department, MCI = mass casualty incident

Appendix F: Literature Search Summary



[1]CENTRAL - the Cochrane Central Register of Controlled Trials; EMBASE - the Excerpta Medica database; ERIC the Educational Research Information Clearinghouse; EPOC - the Specialized Register of Effective Practice and Organization of Care Cochrane Review Group; RDRB/CME - the Research and Development Resource Base in Continuing Medical Education.

Appendix G: Bibliography

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Appendix H: Excluded Articles

Citation	Reason for exclusion
Balch DC, West VL. Telemedicine used in a simulated disaster response. Stud Health Technol Inform. 2001; 81:41-5.	Does not include hospital staff
Bragdon RL, Gousse GC, Piwarzyk P, et al. Regional disaster planning for hospital pharmacies. Am J Hosp Pharm. 1982; 39(11): 1913-5.	Does not include training or education
Chi CH, Chao WH, Chuang CC, et al. Emergency medical technicians' disaster training by tabletop exercise. Am J Emerg Med. 2001; 19(5): 433-6.	Does not include hospital staff
DeMars ML, Buss RM, Cleland LC. Victim-tracking cards in a community disaster drill. Ann Emerg Med. 1980; 9(4): pp 207-209.	No information about hospital component of drill
ED managers react to threat against hospitals: here are security strategies. ED Management. 2003; 15(1): 1-5.	Does not include training or education
Fawcett W, Oliveira CS. Casualty treatment after earthquake disasters: development of a regional simulation model. Disasters. 2000; 24(3): 271-87.	No original data
Freeman KM, Thompson SF, Allely EB, et al. A virtual reality patient simulation system for teaching emergency response skills to U.S. Navy medical providers. Prehospital and Disaster Med. 2001 Jan-2001; 16(1): 3-8.	No original data
Klein JS, Weigelt JA. Disaster management. Lessons learned. Surg Clin North Am. 1991; 71(2): 257-66.	Article does not apply to any of the research questions
Lafreniere F. A mock evacuation is an exercise in saving lives. Dimens Health Serv 1988; 65(5): 35-7.	Results of evaluation not presented
Nigro CM. Economical citywide tabletop disaster preparedness drill. J Emerg Nurs. 1995; 21(2): 137-9.	No results of evaluation provided
Ochsner MG, Harviel JD, Stafford PW, et al. Development and organization for casualty management on a 1,000-bed hospital ship in the Persian Gulf. J Trauma. 1992; 32(4): 501-12; discussion 512-3.	No evaluation
Rutherford WH. The place of exercises in disaster management. Injury. 1990; 21(1): 58-60; discussion 63-4.	Does not include hospital staff
Vardi A, Levin I, Berkenstadt H, et al. Simulation-based training of medical teams to manage chemical warfare casualties. Isr Med Assoc J. 2002; 4(7): 540-4.	No original data
Whitney J. Disaster drill--'73. JFMA 1974; 61(3): 233-5.	Specific results of evaluation not reported