Establishing and Training Health Care Facility Decontamination Teams

John L. Hick, MD
Paul Penn, MS, CHEM
Dan Hanfling, MD
Mark A. Lappe, EMT-P
Dan O'Laughlin, MD
Jonathan L. Burstein, MD

From the Department of Emergency Medicine, University of Minnesota, and the Hennepin County Medical Center, Minneapolis, MN (Hick); EnMagine, Diamond Springs, CA (Penn); Emergency Management and Disaster Medicine, Inova Health System, Falls Church, VA, and the Department of Emergency Medicine, The George Washington University, Washington, DC (Hanfling); Safety and Emergency Preparedness, Hennepin County Medical Center, Minneapolis, MN (Lappe); the Department of Emergency Medicine, University of Minnesota, and Fairview Southdale Healthcare facility, Minneapolis, MN (O'Laughlin); and Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA (Burstein).

See related article, p. 370, and editorial, p. 391.

Recent terrorist events, changes in Joint Commission on Accreditation of Healthcare Organizations requirements, and availability of grant funding have focused health care facility attention on emergency preparedness. Health care facilities have historically been underprepared for contaminated patients presenting to their facilities. These incidents must be properly managed to reduce the health risks to the victims, providers, and facility. A properly equipped and well-trained health care facility team is a prerequisite for rapid and effective decontamination response. This article reviews Occupational Safety and Health Administration (OSHA) training requirements for personnel involved with decontamination responses, as well as issues of team selection and training. Sample OSHA operations-level training curricula tailored to the health care environment are outlined. Initial and ongoing didactic and practical training can be implemented by the health care facility to ensure effective response when contaminated patients arrive seeking emergency medical care.

[*Ann Emerg Med.* 2003;42:381-390.]

0196-0644/2003/$30.00 + 0
doi:10.1067/mem.2003.300

INTRODUCTION

Recent terrorist and industrial events have demonstrated that contaminated patients present to health care facilities seeking care.[1-6] The possibility of a terrorist attack with a chemical, biologic, or radiologic agent has focused attention on preparedness for managing contaminated casualties.[7]

Several incidents have been reported in which health care workers were sickened while caring for a chemically contaminated patient.[1,3-6,8,9] The most severe of these cases involved patients with ingested toxins rather than dermal contamination.[8,9] Although most secondary chemical exposures have resulted in mild and transient effects, organophosphate agents in particular can cause significant illness.[8,9] Health care facilities must be prepared to decontaminate patients to protect the facility, its patients, and staff and to provide appropriate treatment.

The majority of health care facilities are inadequately prepared to handle a significant number of contaminated casualties.[10-13] Institutions that have personal protective equipment for their employees might have inadequate training or personnel who are not comfortable with their equipment or duties, or the facility might be inadequately staffed to provide all-hours response. Several articles outline appropriate emergency department (ED) response to contaminated casualties, but limited attention is devoted to the education of the health care facility responders.[10,11,14-16]

This article will review some of the regulatory and training issues for health care facility providers dealing with contaminated patients, with an emphasis on decontamination team training. Sample curricula for decontamination team training are outlined.

HEALTH CARE FACILITY RESPONSE OPTIONS

The Joint Commission on the Accreditation of Health Care Organizations (JCAHO) sets standards for accreditation under Emergency Management Standard EC 1.4, which requires the health care facility to be prepared for contaminated patients and have regular drills and exercises "conducted to test emergency preparedness." Additionally, an incident management system is required, and a hazard vulnerability analysis must be conducted.[17]

Coordination with community emergency services to ensure incident command system consistency, to determine the particular threats to the community and health care facility, and to ensure agreement on the appropriate role for the facility in community response can help to define health care facility personal protective equipment and training needs. Industrial and terrorist events are particular threats in the urban environment, whereas transportation and agriculture-related incidents are more common near rural facilities.

Health care facilities have 3 basic options when a hazardous materials incident occurs. The first is to rely on public safety agencies for hazardous materials response and decontamination of victims. Unfortunately, this strategy poses a risk to providers, who might initiate treatment of contaminated casualties without waiting for public safety resources. Relying on outside agencies may be acceptable for highly selected facilities (especially small hospitals in rural areas) with specific advance planning, but when faced with on-scene responsibilities, most partner agencies are not able to dependably assist health care facilities.The second option is to provide decontamination services for self-referred contaminated patients and those transported from the scene but not to provide any hazardous materials release area (internal or external spill "hot zone") response capability. This is the option selected by the majority of health care facilities.

Finally, a few facilities train personnel for operations in hot zone release environments both at the health care facility and at the scene of release. These institutions work closely with public safety agencies and have committed significantly more training, equipment, and financial resources than can be expected of most facilities. Resource allocation must be carefully considered because few health care facilities will be able to provide simultaneous facility and release site response.

This article will concentrate on health care facilities that have elected to provide decontamination services only. The health care facility employees will be trained to provide services for contaminated patients who self-

refer or who are transported to the health care facility after exposure to a hazardous substance. This article assumes the following:

• Community emergency responders will provide out-of-hospital decontamination services for contaminated patients who are transported by emergency medical services (EMS).

• Patients whose contamination is recognized during transport to the health care facility will have their clothing controlled by the EMS crew to minimize ongoing exposure.

TRAINING REGULATIONS

Decontamination team operations must be integrated into the incident management framework of the health care facility. Use of an incident management system improves organization and lines of authority. The Hospital Emergency Incident Command System (HEICS) framework[18] or similar incident management templates can be used, placing responsibility for the team under the operations section. In addition to JCAHO requirements, the Occupational Safety and Health Administration (OSHA) requires an incident command system be used during hazardous materials responses.[19]

Regulations affecting decontamination team training are primarily those of OSHA's Hazardous Waste Operations and Emergency Response regulations.[20] Although the emergency response provisions were written for operations at the scene of the release, OSHA requires health care facility personnel providing decontamination services to be trained to the "operations" level.[21-25] Annual refresher training or demonstration of competency is also required.[26]

The following levels of OSHA training are most relevant to health care facilities:

• Hazard communication: required for all employees, orienting them to hazardous materials in their workplace and the institution's release-spill protocols.[27] There is no minimum hour requirement. Most institutions provide this at new employee orientation and refresh annually.

• First-responder awareness: intended for those employees likely to discover a hazardous materials situation. These workers are trained to initiate an emergency response (eg, triage nurse). The training provides an understanding of hazardous substances, their risks, and potential harm. It reviews the employer's emergency response plan, including site security, scene control, and recognition of the need for additional resources. There is no minimum hour requirement. These personnel are not involved in response or decontamination (except they might direct ambulatory patients in self-decontamination procedures from a safe distance).[28]

• First-responder operations: all members of the decontamination team must be operations trained. Other health care facility responders (eg, security, safety) who would respond to a release occurring at the health care facility in a defensive fashion (attempt to contain the release with basic actions to protect persons and the environment; for example, shutting off ventilation to the area) must also be trained to this level. Responders at the operations level must receive "at least eight hours of training or have sufficient experience to objectively demonstrate competency in the following areas:

a) Knowledge of basic hazard and risk assessment techniques

b) Selection and proper use of personal protective equipment (PPE)

c) An understanding of basic hazardous materials terminology

d) Basic control, containment and/or confinement procedures within the capabilities of the resources and personal protective equipment available to them

e) Employees must know how to implement basic decontamination procedures

f) Employees shall understand relevant standard operating procedures and termination procedures at their facility."[29]

• Skilled support personnel: personnel who are not part of the decontamination or response team but who have special skills that are emergently required in the contaminated area. Examples of these personnel might include respiratory therapists or physicians whose particular medical skills are immediately required to provide care for a contaminated patient. Skilled support

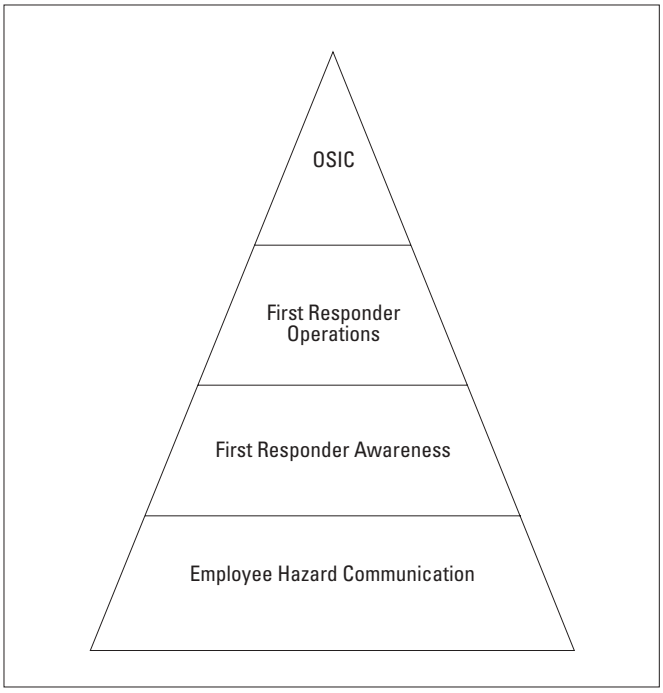
personnel do not require training in advance of an incident. They must be provided with a pre-entry briefing regarding their role, the chemical or other hazards involved, their expected duties, and any other relevant precautions to be taken. They must be provided with appropriate personal protective equipment, instructed in its use, and assisted with proper donning and doffing.[30] Staff do not qualify as skilled support if their role in the contaminated environment can be anticipated as regularly required. Health care facilities should include at least one medically trained person on every decontamination team to provide triage and limited predecontamination medical intervention; these personnel must receive operations training. If more specialized care or supplemental staff are required, these personnel might be considered skilled support and can receive just-in-time training to perform these services. Medical staff should clearly understand their potential roles in a response in advance of an incident and receive appropriate training.

• On-scene incident commander: this individual is responsible for oversight of decontamination operations (for health care facility purposes). Many health care facilities refer to this person as the "decontamination team leader" to differentiate him or her from the overall incident commander at the facility. This team leader is responsible for overseeing the hazardous materials response, including decontamination, and must appoint a safety officer. The on-scene incident commander makes overall operational decisions, including the selection of appropriate personal protective equipment for the incident. Standard operating procedures should be planned in advance and reassessed during an incident. Health care facility decontamination team leaders do not need to be trained to the same level as an incident commander at a release site but must safely oversee those responses that the health care facility is capable of undertaking. OSHA requires at least 24 hours of hazardous materials training (including operations-level training) for the on-scene incident commander.[31] Of note, decontamination procedures at the health care facility can be initiated while awaiting arrival of an on-scene incident commander.[21]

OSHA training information can be found in the nonregulatory guidance 29 CFR 1910.120 Appendix E (c).

The amount of training required for each of these levels is inversely proportional to the number of personnel who need to be trained to that level (Figure). How many personnel need to be trained at the facility depends on the staffing goals. Recently, the American Hospital Association proposed that 50 clinicians at metropolitan and 20 clinicians at nonmetropolitan health care facilities would require "front-line" personal protective equipment during a contamination incident over a 48-hour period.[32] Realistically, the vast majority of the decontamination effort will occur within a few hours of the event; patients presenting after this are unlikely to require significant decontamination. Most of this delayed decontamination could be performed at home or at an off-site facility and at most would require only supervised self-decontamination by health care facility staff.

Figure.
Health care facility training pyramid. ***OSIC,*** *On-scene incident commander.*



At small facilities, it might be reasonable to aim for a 2-person team to be available at all times. At larger facilities, the number of decontamination team members immediately available will depend on the potential hazards faced, the capacity of the facility, and the funding available for training and personal protective equipment. It might be a reasonable goal for a metropolitan hospital to be able to immediately field a 5-person team (1 triage-treatment, 2 nonambulatory corridor, and 2 ambulatory corridor decontamination personnel) at all times, with rapid augmentation available through staff call-in or response from other areas of the facility. Metropolitan mass exposure situations might require continued operations at maximum capacity for at least 2 to 4 hours, with appropriate staff rotations required.

The ultimate number of persons who must be trained to accomplish the facility goals will vary depending on the size and composition of the team and whether shift schedules are adjusted to ensure the availability of trained team members. As an example, a metropolitan Level I trauma center expecting 3 team members to be available 24 hours a day, seven days a week with standard staffing required the training of approximately 40 persons (JLH). This ratio will vary depending on the job class and staffing patterns used.

Training with the personal protective equipment available at the institution must be incorporated into decontamination team training. "The hospital staff's personal protective equipment must be sufficient for the type and exposure levels an employee can reasonably anticipate from … a patient whose skin or clothing has come in contact with hazardous liquids or (is) contaminated with hazardous particles."[33] The anticipated exposure levels must take into account the ventilation of the decontamination area, the number of casualties that might be in the area, the possible agents, how clothing is controlled, and historical data regarding the risk to health care facility personnel caring for contaminated casualties.[3] Specific community hazards to be accounted for include industrial, transportation, agricultural, terrorist, and criminal (eg, methamphetamine laboratories) sources of release. Additionally, the facility will need to consider the possibility that a terrorist or transportation incident could place it in the immediate release zone and determine whether staff protection for this type of event is justified or feasible. On the basis of possible threats to the facility, protective equipment should be selected that strikes an appropriate balance between level of protection, ease of use, ease of training, and cost.

Respiratory protective equipment must be integrated into an institutional medical surveillance program. The respirator program requirements can be found in OSHA's Respiratory Protection Standard 29 CFR 1910.134. Infection control or employee health might have an OSHA-compliant program for air-purifying respirators in place, which could be helpful if the health care facility is using this type of respirator as a personal protective equipment option.

Additional medical screening and surveillance requirements are detailed in 29 CFR 1920.120(f), which should be reviewed with employee health services at the facility to determine how best to implement an appropriate program. How strictly these requirements (eg, physical examinations for team members every 1 to 2 years) will be applied to health care facility decontamination teams is unclear because such teams do not meet the definition of a "HAZMAT team" per 29 CFR 1910.120(a).[3] OSHA does not regard health care facility decontamination personnel as "HAZMAT teams" in regard to training,[21,33] but no current interpretation addresses medical surveillance.

Finally, OSHA has standards for specific health care–related hazards. Training programs addressing formaldehyde, blood-borne pathogens, ethylene oxide, laboratory safety, and other issues might be in place at the facility and be of value to the organizer of the decontamination team.

CREATING AND EDUCATING YOUR DECONTAMINATION TEAM

Health care facilities will need to develop policies and hospital incident management system–compatible job action sheets for at least the following positions. These sheets will need to be tested in drill situations to ensure that each person's responsibilities are clear.

• Decontamination team leader: responsible for overall management of the decontamination operations (see on-scene incident commander responsibilities listed previously). This position might change hands as more experienced staff become available during an incident. The team might be directed by non–health care facility experts if appropriate arrangements are made to provide immediate service (eg, fire personnel) but most often can initially be directed by ED or environmental health and safety staff.

• Decontamination safety officer: monitors the decontamination area for developing hazards and ensures the overall safety of the team, including appropriate donning of personal protective equipment, preservation of warm and cold zones, adequacy of security, appropriate staff, and equipment time-exposure limits.

• Decontamination triage unit leader: provides medical assessment of patients to be decontaminated, provides basic life-saving interventions when possible, and prioritizes patients for decontamination.

• Decontamination team members: control clothing and perform or facilitate patient decontamination, drying, and dressing. Team members then aid in transferring the clean patient to the cold zone.

Decontamination team members can be drawn from a variety of labor pools. Some commonly used departments include engineering, environmental services, safety, housekeeping, security, physical therapy, and ED staff. The location, training, and availability of these staff pools must be considered (eg, physical therapy staff might easily abandon their regular duties during an event, and most therapists are in good physical condition, but usually these personnel are not available off hours, and their department is often located a considerable distance from the ED).

Consideration must also be given to the likelihood of job migration out of entry-level positions when deciding on team composition. In general, nonprofessional personnel have increased turnover, which might offset the lower training cost. Using medical professionals for the bulk of the decontamination team allows for better interpretation of clinical syndromes (and therefore assessment of provider risk) in the warm zone but might inappropriately concentrate medical personnel in an area where they can provide little effective care. A blend of health care providers and support personnel is possibly ideal, but little practical experience exists to provide guidance.

A variety of educational resources are available to health care facilities wishing to provide training. The Web site www.hazmatforhealthcare.org contains teaching resources that were developed for the California Specialized Training Institute with support from the US Public Health Service and are now available free of charge from EnMagine.

The Agency for Toxic Substances and Diseases Registry of the Centers for Disease Control and Prevention (CDC) has general information and a training video on health care facility hazardous materials response.[34] A substantial number of federal and other agencies offer training resources in the public domain (eg, Federal Emergency Management Agency, National Fire Protection Association, National Institute of Environmental Health Sciences), and many communities have OSHA operations-level courses available from technical colleges and other sites. Additionally, many commercial vendors offer operations-level courses. Although some of this material is applicable to the health care facility environment, these courses must be modified by de-emphasizing release site response issues and emphasizing patient care and decontamination issues.

Controversy exists as to how much training is required for health care facility decontamination team members. Competency with basic decontamination might be accomplished in less than 8 hours, but many institutions have settled on 8 hours as being both manageable and appropriate. Training programs at health care facilities of which we are aware vary between 4 and 24 hours in length.

There are practical and didactic components of the education. Some institutions have elected to provide the didactic portions as take-home materials or on CD-ROMs with self-launching audio-slide lectures. Because of the high turnover in some decontamination team job classes (eg, health care assistants, emergency medical technicians, housekeeping) and the time con-

straints in others (eg, physicians, nurses), this can reduce in-class scheduled time. However, careful attention must be paid to the need to appropriately reimburse employees for training time, regardless of where the training occurred.

Facilities must ensure that the employee's ability to ask questions and obtain answers from a resource person is clearly documented. Competency-based evaluation tools must be provided that document fulfillment of course objectives. State OSHA agencies might have specific requirements on how such education is provided. Instructors do not require specific certification but are required to "demonstrate competent instructional skills and a good command of the subject matter."[35]

Several health care facility systems (eg, Parkland Health and Hospital System, Dallas, TX, and Inova Health System, Falls Church, VA) have established decontamination education programs, and others are in development. Two programs are outlined in more detail below. Over the next few years, we expect additional standardization of operations-level curricula so that health care facilities will have access to standard didactic materials and be able to add institution-specific information.

Training program outlines vary depending on approach. EnMagine's "Hazmat For Healthcare" curricula closely follows the Hazardous Waste Operations and Emergency Response training requirements modified for a health setting (Table 1).

An alternative modular education system for operations-level training was designed by a task force associated with the Minneapolis/St. Paul Metropolitan Medical Response System in Minnesota, with assistance from out-of-state subject-matter experts (Table 2). The curriculum materials are designed to encourage facilities to use and modify the materials to develop internal training for their facility. Each core module is approximately 1 hour, except the postevent module, which is significantly shorter. The presentations and accompanying syllabus can be modified to reflect institutional policies and procedures.

Initial training must be followed by ongoing practical and didactic refresher training and drills to ensure

Table 1.
"Hazmat for healthcare" curriculum outline.

Section Title	Objectives
First-responder awareness	1. Recognize hazardous material incidents. 2. Describe the risks and problems. 3. Verbalize clues to recognize whether a hazardous material is present. 4. Describe methods for identifying characteristics of a substance. 5. Discuss the steps in responding safely and effectively. 6. Verbalize who needs to be notified and how to make the notification. 7. Demonstrate directed self-decontamination for a contaminated victim.
Operations foundation	1. Describe HEICS. 2. Apply basic hazard and risk assessment techniques to hazardous material incidents. 3. Demonstrate the use of the *Emergency Response Guidebook*. 4. Discuss event control, containment, and confinement within your capabilities. 5. Describe protective and rescue options available to first responders.
Personal protective equipment	1. Explain the need for, types, selection criteria, and limits of commonly used personal protective equipment. 2. Demonstrate how to select, don, and doff the proper personal protective equipment. 3. Understand the hazards and limitations of personal protective equipment.
Decontamination and spill response	1. Explain decontamination procedures for victims, personnel, and equipment. 2. Discuss application of relevant institutional standard operating procedures. 3. Describe proper disposal and documentation procedures. 4. Discuss methods for mass casualty decontamination.

HEICS, Hospital emergency incident command system.

Table 2.
Minneapolis/St. Paul Metropolitan Medical Response System hospital curriculum outline.

Educational Method	Module	Objectives
Didactic	Introduction to hazardous materials	1. Describe hazardous substances and their health risks. 2. Explain physical properties of hazardous materials. 3. Review common sources of hazardous materials information (eg, poison control center, Materials Safety Data Sheets, and the *Emergency Response Guidebook*). 4. Describe basic techniques used to contain a release (eg, physical barriers).
	Institutional hazardous materials protocols	1. Overview internal spill policies and the institution's response to contaminated patients. 2. Review the incident management system and how a hazardous material response or decontamination operation is integrated. 3. Discuss additional resources that are available to assist the health care facility if the facility is overwhelmed.
	Personal protective equipment	1. Learn different levels of personal protective equipment and discuss the situations in which the institution's equipment can be safely used and those in which it is inadequate. 2. Understand the importance of continuous reevaluation of the incident. 3. Adjust the level of personal protective equipment to the incident as needed. 4. Describe the health risks of personal protective equipment, including heat stress, dehydration, limitation of vision and physical abilities, and other potential adverse health consequences.
	Patient presentation and decontamination	1. Discuss common modes of arrival and initial management of contaminated patients (eg, EMS, walk-in patients recognized at triage, recognized once roomed). 2. Review materials that pose a significant threat to providers and that can be carried on patient's clothing. 3. Describe basic decontamination area set-up and decontamination procedures. 4. Understand the importance of control of clothing to prevent further spread of contamination. 5. Learn decontamination techniques. 6. Learn self-decontamination.
	Postevent procedures	Learn the notifications, belongings tracking, and clean-up procedures (or arrangement for contractual clean up) that will be used after an incident. This will include the tracking and disposition of contaminated belongings, as well as the handling of contaminated wash water.
	Decontamination team safety officer*	1. Review team member selection, assessment, and health maintenance in personal protective equipment. 2. Explain personal protective equipment selection, checking procedures, suit breakthrough times, and other duration-of-use conditions. 3. Discuss maintenance of the warm and cold zone environments. 4. Review overall safety concerns specific to decontamination operations.
	Security*	1. Discuss decontamination area access control and facility security (which might involve screening patients at other entrances to the health care facility for contamination, as well as maintaining orderly patient flow through the decontamination area). 2. Review security procedures in the event of unrest within or near the health care facility complex that occurs in a contaminated situation. 3. Demonstrate restraint techniques while in personal protective equipment and the use of chemical and other crowd-control techniques while wearing protective equipment.
	Hazardous materials toxicology*	1. Overview the basic hazardous materials toxidromes (eg, asphyxiants, irritant gases, cholinergic, hydrocarbons) and their initial treatment. 2. Discuss the relevance of physical properties of hazardous substances to toxicity.
	Radiologic hazards*	1. Review the health hazards associated with radiologic substances. 2. Discuss radiologic assessment (use of Geiger-Mueller counters). 3. Describe radiologic patient decontamination.
	Biologic hazards*	1. Review the situations when decontamination is required after a biologic exposure event. 2. Overview of selected CDC Class A biologic terrorist agents and their clinical course.
	Chemical terrorism*	1. Review common chemical terrorist agents, including their health effects (with a particular emphasis on organophosphates and nerve agents). 2. Discuss risks to providers and antidotal therapy including the use of Mark 1 kits.
Practical†	Set-up and safety (30 min)	1. Set up decontamination area for both ambulatory and nonambulatory situations. 2. Discuss wastewater control and warm-cold zone delineation. 3. Discuss team safety and what to do if overwhelmed by victims or other unsafe environment develops.
	Personal protective equipment (90 min)	1. Orientation to equipment, appropriate donning, use, safety issues, breakthrough times. 2. Doffing and donning with multiple practice attempts and practice communicating and performing basic and complex motor skills while in personal protective equipment.
	Drills and scenarios (120 min)	1. Decontamination area set-up for a variety of situations. 2. Selection and donning of appropriate personal protective equipment. 3. Practice decontamination. 4. Doff personal protective equipment. 5. Postevent procedures.

*Supplemental module for those personnel who require training on this topic.
†Additional practical training will be required for those with specialized responsibilities (eg, security, triage).

continued competency.[26] In the past, many institutions have chosen to use outside contractors to provide hazardous materials education for their employees. Often, there is no provision for ongoing education and no individuals at the health care facility to take responsibility for the team's competency. With the educational materials that are available, many health care facilities should be able to develop and maintain their own decontamination teams. Valuable partnerships with local and regional health care facilities can be established. The requirement for an on-scene incident commander means that each facility will need to identify a core group of individuals who can provide oversight for decontamination operations. These individuals are usually well suited to maintaining the educational curriculum. The involvement of local hazardous materials and public safety experts as resources in the education of health care facility employees should be encouraged.

At each health care facility, clear leadership for the program should be established. This leadership most often comes from either the safety department or the ED. A partnership between these departments is critical to the success of the program because the safety department has expertise in safety training, facility regulations, and facility operations and policy, whereas the ED brings patient management, disaster response, and clinical care expertise. Additional stakeholders, such as facility engineering, employee health, nursing, medical direction, and administration staff, must be identified and involved in the educational process.

Establishment of a health care facility decontamination team requires a significant amount of organization and institutional commitment. However, existing resources both within and external to the institution might help to reduce the effort. The ability to standardize portions of the curriculum should not substitute for appropriate institutional attention to the details of planning an effective decontamination response. Incident management system integration and appropriate initial and ongoing education will ensure not only the safety of the facility and its personnel but will also ensure that contaminated patients receive timely and appropriate care.

Received for publication January 13, 2003. Revision received March 3, 2003. Accepted for publication April 25, 2003.

The authors report this study did not receive any outside funding or support.

Reprints not available from the authors.

Address for correspondence: John L. Hick, MD, Emergency Medicine, MC 825, Hennepin County Medical Center, 701 Park Avenue South, Minneapolis, MN 55415; 612-347-3020, fax 612-904-4241; E-mail John.hick@co.hennepin.mn.us.

REFERENCES

1. Okumura T, Suzuki K, Fukada A, et al. The Tokyo subway sarin attack: disaster management, part 2: healthcare facility response. *Acad Emerg Med.* 1998;5:618-624.

2. Okumura T, Suzuki K, Atsuhiro F, et al. The Tokyo subway sarin attack: disaster management, part 1: community emergency response. *Acad Emerg Med.* 1998;5:613-617.

3. Horton DK, Berkowitz Z, Kaye WE. Secondary contamination of emergency department personnel from hazardous materials events, 1995-2001. *Am J Emerg Med.* 2003;21:199-204.

4. Nozaki H, Hori S, Shinozama Y, et al. Secondary exposure of medical staff to sarin vapor in the emergency room. *Intensive Care Med.* 1995;21:1032-1035.

5. Thanabalasingham T, Beckett MW, Murray V. Healthcare facility response to a chemical incident: report on casualties of an ethyldichlorosilane spill. *BMJ.* 1991;302:101-102.

6. Nocera A, Levitin HW, Hilton JMN. Dangerous bodies: a case of fatal aluminum phosphide poisoning. *Med J Aust.* 2000;173:133-135.

7. Macintyre AG, Christopher GW, Eitzen E, et al. Weapons of mass destruction events with contaminated casualties: effective planning for healthcare facilities. *JAMA.* 2000;4:261-269.

8. Centers for Disease Control and Prevention. Nosocomial poisoning associated with emergency department treatment of organophosphate toxicity–Georgia, 2000. *MMWR Morb Mortal Wkly Rep.* 2001;49:1156-1158.

9. Merrit N. Malathion overdose: when one patient creates a departmental hazard. *J Emerg Nurs.* 1989;15:463-465.

10. Cox RD. Decontamination and management of hazardous materials exposure victims in the emergency department. *Ann Emerg Med.* 1994;23:761-770.

11. Burgess JL, Blackmon G, Brodkin CA, et al. Healthcare facility preparedness for hazardous materials incidents and treatment of contaminated patients. *West J Med.* 1997;167:387-391.

12. Burgess JL. Healthcare facility evacuations due to hazardous materials incidents. *Am J Emerg Med.* 1999;17:50-52.

13. Wetter DC, Daniell WE, Treser CD. Healthcare facility preparedness for victims of chemical or biological terrorism. *Am J Public Health.* 2001;91:710-716.

14. Levitin HW, Siegelson HJ. Hazardous materials: disaster medical planning and response. *Emerg Med Clin North Am.* 1996;14:327-348.

15. Kirk MA, Cisek J, Rose SR. Emergency department response to hazardous materials incidents. *Emerg Med Clin North Am.* 1994;12:461-481.

16. Burgess JL, Kirk MA, Borron SW, et al. Emergency department hazardous materials protocol for contaminated patients. *Ann Emerg Med.* 1999;34:205-212.

17. Joint Commission on Accreditation of Healthcare Organizations. *The 2001 Joint Commission Accreditation Manual for Hospitals.* EC 1.4 and 1.6 (rev). Oakbrook Terrace, IL: Joint Commission on Accreditation of Healthcare Organizations; 2001.

18. San Mateo County Emergency Medical Services Agency. Healthcare facility emergency incident command system III—January, 1998. Available at: www.emsa.cahwnet.gov/dms2/heics3.htm. Accessed January 12, 2003.

19. Occupational Safety and Health Administration. *Hazardous Waste Operations Emergency Response.* Washington, DC: Occupational Safety and Health Administration. 29 CFR 1910.120(q)(3)(i,ii) and appendix C (6).

20. Occupational Safety and Health Administration. *Hazardous Waste Operations Emergency Response* regulations. Washington, DC: Occupational Safety and Health Administration; March 6, 1989. 54 CFR 9294.

21. OSHA interpretation letter, March 31, 1992, from Dorothy L. Strunk to Randy Ross. Washington, DC: US Department of Labor, Occupational Safety, and Health. Available at: http://www.osha.gov. Accessed June 24, 2003.

22. OSHA interpretation letter, April 25, 1997, from John B. Miles to Thomas Whittaker. Washington, DC: US Department of Labor, Occupational Safety, and Health. Available at: http://www.osha.gov. Accessed June 24, 2003.

23. OSHA interpretation letter, Oct. 21, 1992, from Colleen K. O'Toole to Larry Bloomfield. Washington, DC: US Department of Labor, Occupational Safety, and Health. Available at: http://www.osha.gov. Accessed June 24, 2003.

24. OSHA interpretation letter, Oct. 27, 1992, from Roger A. Clark to Howard W. Levitin. Washington, DC: US Department of Labor, Occupational Safety, and Health. Available at: http://www.osha.gov. Accessed June 24, 2003.

25. OSHA interpretation letter, March 10, 1999, from Richard E. Fairfax to Daniel Burke. Washington, DC: US Department of Labor, Occupational Safety, and Health. Available at: http://www.osha.gov. Accessed June 24, 2003.

26. Occupational Safety and Health Administration. *Hazardous Waste Operations Emergency Response.* Washington, DC: Occupational Safety and Health Administration. 29 CFR 1910.120(q)(8).

27. Occupational Safety and Health Administration. *Occupational Safety and Health Standards (Subpart Z)–Hazard Communication.* Washington, DC: Occupational Safety and Health Administration. 29 CFR 1910.1200.

28. Occupational Safety and Health Administration. *Hazardous Waste Operations Emergency Response.* Washington, DC: Occupational Safety and Health Administration. 29 CFR 1910.120(q)(6)(I).

29. Occupational Safety and Health Administration. *Hazardous Waste Operations Emergency Response.* Washington, DC: Occupational Safety and Health Administration. 29 CFR 1910.120(q)(6)(ii).

30. Occupational Health and Safety Administration. *Hazardous Waste Operations Emergency Response.* Washington, DC: Occupational Safety and Health Administration. 29 CFR 1910.120(q)(4).

31. Occupational Safety and Health Administration. *Hazardous Waste Operations Emergency Response.* Washington, DC: Occupational Safety and Health Administration. 29 CFR 1910.120(q)(6)(v).

32. American Hospital Association. Hospital resources for disaster readiness. November 1, 2001. Washington, DC: American Hospital Association. Available at: http://www.hospitalconnect.com/aha/key_issues/disaster_readiness/readiness/ReadyAssessmentB1101.html. Accessed February 22, 2003.

33. OSHA interpretation letter, Sept. 5, 2002, from Richard E. Fairfax to Francis J. Roth. Washington, DC: US Department of Labor, Occupational Safety, and Health. Available at: http://www.hazmatforhealthcare.org/download/pdf/misc_pdfs/OSHA_Interp.pdf. Accessed June 24, 2003.

34. Agency for Toxic Substances and Disease Registry. Managing hazardous materials incidents volume II–healthcare facility emergency departments: a planning guide for the management of contaminated patients. Version 2001. Atlanta, GA: Agency for Toxic Substances and Disease Registry. Available at: http://www.atsdr.cdc.gov/mhmi.html. Accessed January 11, 2003.

35. Occupational Safety and Health Administration. *Hazardous Waste Operations Emergency Response.* Washington, DC: Occupational Safety and Health Administration. 29 CFR 1910.120(q)(7).