Hospital Preparedness for Victims of Chemical or Biological Terrorism

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A B S T R A C T

Objectives. This study examined hospital preparedness for incidents involving chemical or biological weapons.

Methods. By using a questionnaire survey of 224 hospital emergency departments in 4 northwestern states, we examined administrative plans, training, physical resources, and representative medication inventories.

Results. Responses were received from 186 emergency departments (83%). Fewer than 20% of respondent hospitals had plans for biological or chemical weapons incidents. About half (45%) had an indoor or outdoor decontamination unit with isolated ventilation, shower, and water containment systems, but only 12% had 1 or more self-contained breathing apparatuses or supplied air-line respirators. Only 6% had the minimum recommended physical resources for a hypothetical sarin incident. Of the hospitals providing quantitative answers about medication inventories, 64% reported sufficient ciprofloxacin or doxycycline for 50 hypothetical anthrax victims, and only 29% reported sufficient atropine for 50 hypothetical sarin victims (none had enough pralidoxime).

Conclusions. Hospital emergency departments generally are not prepared in an organized fashion to treat victims of chemical or biological terrorism. The planned federal efforts to improve domestic preparedness will require substantial additional resources at the local level to be truly effective. (*Am J Public Health.* 2001;91:710–716)

There is growing concern about possible terrorist use of chemical or biological weapons against civilian populations. Although such incidents have occurred rarely to date, the need for concern is illustrated graphically by the sarin nerve gas attack in a Tokyo subway by the Aum Shinrikyo cult in 1995, causing 11 deaths and sending thousands of people to hospitals.[1,2] The United States is not immune from terrorist attacks within its borders, as evidenced by the bombings of the World Trade Center in New York and the Murrah Federal Building in Oklahoma and by a 1984 incident in Oregon, where members of a religious commune deliberately contaminated restaurant salad bars with *Salmonella typhimurium*, causing 751 cases of gastroenteritis.[3] One theoretical model predicted that a terrorist attack releasing *Bacillus anthracis* spores in prevailing winds toward the suburb of a major city could cause up to 50 000 cases of anthrax, with more than 32 000 deaths, in an exposed population of 100 000 people.[4]

The US government is taking seriously the need to prepare for terrorist attacks involving weapons of mass destruction. Presidential Decision Directive 39 in 1995 triggered actions among many national agencies.[5] Congress enacted the Defense Against Weapons of Mass Destruction Act of 1996, requiring development of a Domestic Preparedness Program, including efforts to improve the capabilities of local emergency response agencies.[5,6] The program developed training course materials for local responders, and it will train local responder-trainers in 120 cities by fiscal year 2001.[7]

True preparedness to reduce loss of life from an incident involving a biological or chemical weapon is critically dependent on the availability of resources at the local level.[8] Federal response teams and resources probably would not reach the scene of an unanticipated terrorist attack in time to substantially reduce mortality from a chemical weapon or until after a population exposed to a biological weapon had dispersed.[5] The Domestic Preparedness Program, however, has included no systematic efforts to integrate hospitals into response plans, and it has provided only limited funds to acquire resources for state and local responders and none for hospitals.[7,9]

A large proportion of hospitals probably are poorly prepared to handle victims of chemical or biological terrorism. Commonly, hospitals are not fully prepared to respond to massive casualty disasters of any kind, either in their capacity to care for large numbers of victims or in their ability to provide care in coordination with a regional or federal incident command structure.[10] Surveys of hospital emergency departments (EDs) have found broadly prevalent deficiencies in knowledge, plans, or resources for responding to hazardous materials or radiation incidents.[11–14] Even relatively small-scale hazardous materials incidents have overwhelmed the response capacities at some hospitals, producing symptoms in secondarily exposed ED staff or necessitating ED evacuations.[15–17] However, although the state of preparedness for hazardous materials incidents provides some indication of the level of preparedness for chemical weapons inci-

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dents, the hazardous materials model may have limited applicability to the potential types and scale of problems associated with a chemical weapons incident, and it probably has little or no relevance for biological weapons incidents.[18]

In this context, an increasing number of authors writing in major journals have advocated the need for health care providers and hospitals to make specific plans for response to incidents involving chemical or biological weapons, and they have put forth principles and guidelines for such plans.[18–24] Other reviewers, however, have expressed concern that the magnitude of government support for domestic terrorism initiatives may be disproportionate to the probability of such incidents occurring, particularly compared with government support for initiatives to address existent public health problems that affect large segments of the population.[25] A substantial need for additional expenditures at the local level to ensure true preparedness for managing victims of terrorist incidents, particularly without the commitment of additional federal funds, could reduce the availability of limited state and local funds for other health care and public health problems.

There is a clear need for information about current hospital preparedness for terrorist attacks, to provide a foundation for systematic planning and broader discussion about relative costs, probable effectiveness, and overall societal priorities. To address this need, the present study examined existing administrative, physical, and medication resources at hospitals in 4 northwestern states for managing the victims of incidents involving chemical or biological weapons.

Methods

This study was a cross-sectional questionnaire survey of all hospital EDs in US Public Health Service Region X (Alaska, Idaho, Oregon, and Washington). A subsample of respondent hospitals was visited to verify selected questionnaire responses. Study procedures were approved in advance by the University of Washington Human Subjects Review Committee.

Questionnaire Survey

We used the American Hospital Association directory[26] to identify all hospitals in Region X for potential inclusion in the study. Pediatric, urgent care, psychiatric, and rehabilitation facilities were excluded. A self-administered questionnaire, cover letter, and postage-paid return envelope were mailed to 224 eligible hospitals, addressed to the "manager" of the ED. Surveys were mailed up to 3 times (in June–July 1998) if there was no response to initial mailings, with the third mailing addressed to a specific person identified by a telephone call to the hospital.

The questionnaire requested information about (1) hospital and ED demographics; (2) respondents' awareness and opinions; (3) planning, training, and drills within the last 24 months; (4) patient isolation and decontamination resources; (5) personal protective equipment; and (6) inventory of selected antidotes. Questions about hazardous materials incidents assessed readiness for presentations similar to those that would arise after a chemical weapons incident. The questionnaire asked whether the ED had (1) an indoor decontamination area (a) with or without ventilation isolated from the rest of the hospital and (b) including or adjoining a shower, with or without a separate water containment system; (2) portable outdoor decontamination equipment; or (3) other relevant resources. Atropine and pralidoxime were selected to represent antidotes for nerve agents and ciprofloxacin and doxycycline for anthrax and other biological agents.

Data Analysis

Data were examined for possible associations between selected preparedness variables and 3 primary independent variables: hospital location (rural or urban),[27] ED annual census, and proximity to the US Army chemical weapons depot in Umatilla, Ore. The ED annual census was categorized post hoc according to sample-distribution tertiles (low, <5000 visits/year; medium, 5000–15 000; high, >15 000). The low and medium census categories were combined for some analyses, because there were only 2 low-census urban hospitals. On the basis of the probable transport distance for patients immediately after an accidental chemical release and computer-generated plume estimates, proximity to the Umatilla depot was defined as 35 miles or less.[28] Responses of "aware" and "somewhat aware" were combined into 1 category. Comparisons used χ^2 or Fisher exact tests to assess statistical significance. Relative risks and Taylor series 95% confidence intervals were calculated with Epi Info.[29] All other analyses used SPSS for Windows.[30]

Preparedness for Hypothetical Incident

The analysis examined the preparedness of individual hospitals to initiate treatment in 2 hypothetical incidents involving 50 individuals exposed to either a chemical weapon (sarin) or a biological weapon (anthrax).

For the hypothetical sarin incident, medication preparedness was defined by the reported inventory of atropine and pralidoxime. Using the Tokyo incident as a model, we projected treatment to require 160 mg of atropine (2 mg each for 40 patients and 8 mg each for 10 patients) and 96 g of pralidoxime (2 g each for 48 patients).[31,32] The present study defined "minimum recommended" physical resource preparedness by the following criteria: (1) a hazardous materials or chemical weapons plan; (2) either (a) an ED indoor area with isolated ventilation and a shower with water containment ("integral decontamination unit") or (b) an outdoor portable decontamination unit; (3) at least 1 self-contained breathing apparatus or supplied air-line respirator; and (4) at least 1 chemical-protective garment. Less stringent definitions for "questionably effective" levels of physical resource preparedness included (1) access to a conventional shower in lieu of criteria 2a and 2b, given that wastewater containment may be a low priority in a mass casualty situation,[24] or (2) a chemical cartridge air-purifying respirator in lieu of criterion 3. A chemical cartridge respirator, particularly in combination with a high-efficiency particulate air filter, could provide protection against some chemical agents.[24]

For the hypothetical anthrax incident, medication preparedness was defined by the reported availability of ciprofloxacin or doxycycline sufficient to provide prophylaxis for 2 days, with the assumption that replacement stocks would become available thereafter.[33–35] The risks of secondary aerosolization and person-to-person transmission of anthrax are negligible[36,37]; therefore, scenario preparedness was defined only by having a biological weapons plan and the necessary antibiotic supply, without any requirement for specific physical resources.

Results

Survey Participants

Responses were received from 186 of 224 contacted hospitals (83%; Table 1). Most respondents were registered nurses (n=162; 87%). The others were physicians (n=10; 5%), physician assistants or nurse practitioners (n=4; 2%), and other professionals (n=9; 5%). The response rate was highest in Idaho and Washington (90% and 86%), lowest in Alaska (67%), and intermediate in Oregon (80%). The response rate was similar for rural hospitals (n=114; 84%) and urban hospitals (n=72; 81%).

Most respondent hospitals (61%) were in rural locations. There were proportionally

TABLE 1—Hospital Emergency Departments Participating in Survey of Hospital Preparedness for Incidents Involving Chemical or Biological Weapons

	Alaska	Idaho	Oregon	Washington	Total
No. of hospitals contacted	24	42	64	94	224
No. of hospitals responded	16	38	51	81	186
Hospital location[a]					
Rural, n (%)[b]	14 (87.5)	34 (89.5)	27 (52.9)	39 (48.1)	114 (61.3)
Urban, n (%)[b]	2 (12.5)	4 (10.5)	24 (47.1)	42 (51.9)	72 (38.7)
No. located ≤35 miles from US Army chemical depot[c]	0	0	2 (3.9)	3 (3.7)	5 (2.7)

[a]Urban = within a standard metropolitan statistical area; rural = all other locations.
[b]Values in parentheses represent percentages of respondent emergency departments in each state (total n = 186).
[c]Army chemical weapons depot at Umatilla, Ore.

more rural hospitals in Alaska and Idaho than in Oregon and Washington (Table 1). Overall, median ED size was 8 beds (range = 1–58) and median hospital size was 64.5 beds (range = 7–697).[26] Median ED census for 1997 was 10 900 patient visits (range = 739–80 000). Most urban hospitals (65%) reported more than 15 000 ED patient visits per year, whereas most rural hospitals (75%) reported fewer annual visits. Conversely, 42% of rural hospitals reported fewer than 5000 visits per year, but only 2 urban hospitals fell into this low-census category. Responses were received from 5 of 7 eligible hospitals located within 35 miles of the US Army chemical weapons depot at Umatilla, Ore (Table 1).

Respondent Awareness and Opinions

Slightly more than half of the respondents were aware (or slightly aware) of local or state preparedness plans, and about one third were aware of plans or resources at the national level (Table 2). Only 14% reported any familiarity with applicable federal legislation. In general, respondents from urban hospitals reported levels of awareness equal to or higher than those reported by respondents from rural hospitals, and respondents from larger urban hospitals reported the greatest awareness.

Nearly half of the respondents (48%; n = 90) answered yes to a final question asking whether "biological and/or chemical weapons are a real enough threat to your community that your hospital should make specific plans in preparation to treat victims of such weapons." The other respondents answered no (41%; n = 76) or gave no answer (11%; n = 20) to this question. Twenty-one cited location in a rural area as the reason for no concern. Sixteen cited concern because of proximity to a military facility and 3 because of closeness to militia groups.

Administrative Plans and Training

About 80% of the hospitals reported having a plan for response to hazardous materials incidents, whereas fewer than 20% had response plans for incidents involving biological or chemical weapons (each, $P < .001$; Table 2). Urban hospitals were 3 times as likely as rural hospitals to have response plans for incidents involving chemical weapons (relative risk [RR] = 3.4; 95% confidence interval [CI] = 1.7, 6.8) or biological weapons (RR = 3.4; 95% CI = 1.5, 8.0), with no significant difference relative to urban ED census.

The number of hospitals that reported training for response to incidents involving hazardous materials was less than the number reporting the existence of plans for such a response (Table 2). However, the opposite was seen for weapons incidents, where training was reported more often than hospital plans. Ten hospitals reported conducting 1 practice drill within the preceding 24 months for a chemical weapons incident, and 5 reported 2 or more drills. A smaller number of hospitals reported practice drills for response to a biological weapons incident (n = 5).

Isolation and Decontamination Resources

Only 21% of hospitals reported having an ED indoor area with isolated ventilation, shower, and water containment systems (indoor "integral decontamination unit"; Table 3). About a third of these same hospitals (14 of 39) additionally had outdoor portable decontamination units, and 45 other hospitals (24%) had an outdoor decontamination unit but less than a fully integral indoor unit. Another 27% of EDs at least had access to a conventional shower, without separate water containment, and in most cases without isolated ventilation (46 of 51). There were no isolation or decontamination resources of any type, fixed or portable, at 25% of the hospitals. Urban hospitals were more likely to have integrated indoor or portable decontamination units (urban, 58%; rural, 37%; RR = 1.7; 95% CI = 1.2, 2.5). Among urban hospitals, however, there was no significant difference between those with relatively busy and those with less busy EDs (RR = 1.1; 95% CI = 0.8, 1.6).

Personal Protective Equipment

Most hospitals reported having no respiratory protective equipment that would be appropriate against chemical agents (Table 4). Only 23 (12%) reported at least 1 self-contained breathing apparatus (2–4 per hospital) or at least 1 air-line respirator (1–6 per hospital), or both. Nine of these hospitals also had at least 1 chemical cartridge mask. Another 20 hospitals (11%) had only chemical cartridge masks. Of all hospitals with chemical cartridge masks, most had only 1 or 2 masks (48%). Urban hospitals were more likely than rural hospitals to report having any such form of respiratory protective equipment (urban, 40%; rural, 14%; RR = 2.9; 95% CI = 1.9, 9.0). The availability of chemical-protective garments had a similar distribution. In addition to the limited available self-contained breathing apparatus and air-line respirators, most hospitals had respiratory-protective equipment that would provide at least partial protection against biological agents and particulate chemical agents, including high-efficiency particulate air masks and surgical masks.

Preparedness for Hypothetical Incident

Eighty percent of respondents provided quantitative information about hospital medication inventories ("central pharmacy and emergency department" supply). The remainder gave only qualitative or no information. Of respondents with quantitative answers, 29% (41 of 143) reported an atropine supply sufficient to treat 50 patients in the hypothetical sarin incident (see "Methods" section), although another 22% (n = 32) reported at least half the necessary amount. The median reported amount of atropine was 103 mg at urban hospitals and 60 mg at rural hospitals. Urban hospitals were almost twice as likely as rural

TABLE 2—Respondent Awareness of and Hospital Administrative Preparedness for Terrorist Incidents Involving Chemical or Biological Weapons

	Hospital Location,[a] No. (%)			Urban Hospitals,[b] No. (%)	
	Total No. (%) (n=186)	Rural (n=114)	Urban (n=72)	≤15000 Visits/Year (n=22)	>15000 Visits/Year (n=47)
Respondent aware or somewhat aware of:					
ATSDR resources	70 (37.6)	38 (33.3)	32 (44.4)	8 (36.4)	24 (51.1)
Nunn-Lugar-Domenici legislation	26 (14.0)	16 (14.0)	10 (13.9)	1 (4.5)	8 (17.0)
National domestic preparedness plans	62 (33.3)	28 (24.6)	34 (47.2)**	7 (31.8)	25 (53.2)
Local or state plans	107 (57.5)	54 (47.4)	53 (73.6)***	11 (50.0)	39 (83.0)**
Hospital has plan for incidents involving:					
Hazardous materials	149 (80.1)	85 (74.6)	64 (88.9)*	18 (81.8)	43 (91.5)
Chemical weapons	31 (16.7)	10 (8.8)	21 (29.2)**	5 (22.7)	15 (31.9)
Biological weapons	22 (11.8)	7 (6.1)	15 (20.8)*	4 (18.2)	11 (23.4)
Hospital offers training for incidents involving:					
Hazardous materials	116 (62.4)	64 (56.1)	52 (72.2)*	13 (59.1)	36 (76.6)
Chemical weapons	43 (23.1)	12 (10.5)	31 (43.1)***	4 (18.2)	24 (51.1)*
Biological weapons	36 (19.4)	9 (7.9)	27 (37.5)***	3 (13.6)	22 (46.8)*

Note. ATSDR = Agency for Toxic Substances and Disease Registry; Nunn-Lugar-Domenici legislation = Defense Against Weapons of Mass Destruction Act of 1996 (US Public Law 104-201, September 23, 1996).[6]

[a]Urban = within a metropolitan statistical area; rural = all other locations. Hospitals can have more than 1 resource; therefore, column totals can exceed 186.

[b]Emergency department census data were not available for 3 urban hospitals.

*P<.05; **P<.005; ***P<.001 for statistical significance (χ^2 test) of rural–urban comparisons and urban low–high visits per year.

TABLE 3—Hospital Emergency Department (ED) Resources for Patient Isolation and Decontamination Against Chemical or Biological Agents

	Hospital Location, No. (%)			Urban Hospitals, No. (%)	
Resource, n (%)	Total No. (%) (n=186)	Rural (n=114)	Urban (n=72)	≤15000 Visits/Year (n=22)	>15000 Visits/Year (n=47)
Integral decontamination unit[a]					
Indoor ED unit, plus outdoor portable unit	14 (7.5)	6 (5.3)	8 (11.1)	2 (9.1)	6 (12.8)
Indoor ED unit only	25 (13.4)	13 (11.4)	12 (16.7)	1 (4.5)	9 (19.1)
Outdoor portable unit, plus:					
ED area with isolated ventilation (but no shower)	6 (3.2)	5 (4.4)	1 (1.4)	1 (4.5)	0
ED with no isolated ventilation (plus conventional shower; n=6)[b]	39 (21.0)	18 (15.8)	21 (29.2)	7 (31.8)	13 (27.7)
No integral decontamination unit, but ED area has:					
Access to conventional shower, plus isolated ventilation system	5 (2.7)	1 (0.9)	4 (5.6)	0	4 (14.9)
Access to conventional shower (no isolated ventilation system)	46 (24.7)	30 (26.3)	16 (22.2)	7 (31.8)	9 (19.1)
Isolated ventilation system (no access to conventional shower)	5 (2.7)	2 (1.8)	3 (4.2)	0	3 (6.4)
None of the listed resources	46 (24.7)	39 (34.2)	7 (9.7)	4 (18.2)	3 (6.4)

Note. Urban = within a metropolitan statistical area; rural = all other locations. Hospitals can have more than 1 resource; therefore, column totals can exceed 186. ED census data were not available for 3 urban hospitals. Urban hospitals were more likely to have integrated indoor or portable decontamination units (relative risk [RR] = 1.7; 95% confidence interval [CI] = 1.2, 2.5). Among urban hospitals, there was no significant difference at busier EDs (RR = 1.1; 95% CI = 0.8, 1.6).

[a]Integral decontamination unit = specific indoor area that includes a shower with water containment and a ventilation system isolated from other portions of the hospital, or a portable outdoor decontamination unit.

[b]Some EDs had access to a "conventional" shower (i.e., without water containment or isolated ventilation).

hospitals to have sufficient atropine supplies for the hypothetical incident (RR = 1.8; 95% CI = 1.0, 5.2). Respondents at 87 hospitals (61% of 143) reported having no available pralidoxime, and the remainder reported having no more than one quarter of the hypothesized necessary amount of pralidoxime.

Only 12 hospitals (6.5% of 186) met the study definition for "minimum recommended" physical resource preparedness for an incident involving victims of sarin. An additional 4 to 17 hospitals had "questionably effective" levels of physical resource preparedness; they either lacked water containment and isolated ventilation for an available shower (n=4), had only chemical cartridge respirators (n=12), or both (n=1). Only 10 hospitals had the minimum recommended physical resources plus a reported atropine inventory sufficient for the 50 hypothetical sarin victims, while none had the necessary pralidoxime inventory.

TABLE 4—Resources for Protecting Hospital Staff Against Chemical or Biological Agents

	Hospital Location, No. (%)			Urban Hospitals, No. (%)	
	Total No. (%) (n=186)	Rural (n=114)	Urban (n=72)	≤15000 Visits/Year (n=22)	>15000 Visits/Year (n=47)
Self-contained breathing apparatus	17 (9.1)	5 (4.4)	12 (16.7)**	2 (9.1)	10 (21.3)
Supplied air-line respirator	8 (4.3)	3 (2.6)	5 (6.9)	0	5 (10.6)
Chemical cartridge respirator (any type)	29 (15.6)	11 (9.6)	18 (25.0)**	3 (13.6)	14 (29.8)
HEPA mask[a]	161 (86.6)	100 (87.7)	61 (854.7)	21 (95.5)	37 (78.7)
Surgical mask	171 (91.9)	105 (92.1)	66 (93.0)	20 (90.9)	43 (91.5)
Chemical protective garment	68 (36.6)	27 (23.7)	41 (56.9)*	9 (40.9)	29 (61.7)

Note. Urban = within a metropolitan statistical area; rural = all other locations. Hospitals can have more than 1 resource; therefore, column totals can exceed 186. Emergency department census data were not available for 3 urban hospitals.
*$P<.001$; **$P<.005$ for comparison of statistical significance of rural–urban and urban low–high visits per year (χ^2 test).
[a]High-efficiency particulate air mask.

Half of the respondents with quantitative answers about antibiotic inventories (96 of 149; 64%) described having enough ciprofloxacin and doxycycline to provide 2 days of prophylaxis for the 50 hypothetical anthrax-exposed individuals, and another 21% (n=31) described inventories representing at least half the necessary amount. Urban hospitals were slightly more likely than rural hospitals to report sufficient antibiotic supplies (RR=1.3; 95% CI=1.0, 5.2). Only 9% of hospitals (14 of 149) had a sufficient reported antibiotic inventory and a written plan for managing victims of biological weapons incidents.

Hospitals Near Chemical Weapons Depot

The 5 responding hospitals within 35 miles of the Umatilla chemical weapons depot were significantly more likely than distant hospitals to have a chemical weapons response plan (4 of 5; RR=5.4; 95% CI=3.1, 9.4) and to have arranged chemical weapons response training (4 of 5; RR=3.7; 95% CI=2.2, 6.2). Biological weapons plans and training, however, were no more prevalent (1 of 5 and 0 of 5, respectively). Hospitals near Umatilla were no more likely to have an indoor or outdoor decontamination unit (3 of 5), and none of the 5 reported having a self-contained breathing apparatus, air-line respirator, or chemical cartridge respirator. Reported medication inventories were similar to those of other hospitals, except that there was a slightly higher presence of sufficient atropine for the hypothetical sarin incident (3 of 5; $P=.14$).

Discussion

The findings of this survey, while not surprising, are nonetheless disturbing: they indicate that hospital EDs generally are not prepared in an organized fashion to treat victims of incidents involving chemical or biological weapons. Levels of preparedness were relatively low in all areas examined—awareness, plans and training, physical resources, and medication inventories. In general, urban hospitals were better prepared than rural hospitals, and urban hospitals with busier EDs tended to be better prepared than hospitals with EDs serving smaller populations. Very few hospitals, however, fully met the conservative criteria used in this study to assess preparedness for hypothetical incidents involving 50 individuals exposed to sarin or anthrax.

Few of the hospitals had developed plans and arranged training for response to a possible incident involving chemical or biological weapons. Most surveyed hospitals did have plans and training for response to a community or hospital hazardous materials incident, and it is conceivable that those plans could provide a foundation for the eventual development of plans for response to incidents involving chemical or biological weapons. However, this survey demonstrated less than complete administrative and physical preparedness for hazardous materials incidents, in spite of existing guidelines and regulations,[38,39] calling into question the utility of such preparedness as a foundation for more extensive planning or action. Respondents may have underreported preparedness, but the findings are comparable to those in other surveys of preparedness for hazardous materials incidents in Philadelphia and Washington State.[13,14]

The ability to expand local or regional planning will be constrained by the availability and capacity of existing hospital resources for isolating and decontaminating victims of a chemical weapons incident and for protecting hospital personnel and other patients. Half of the surveyed hospitals had an integral decontamination unit in the ED, a portable outdoor decontamination unit, or both. However, the other hospitals had only a conventional shower or no shower near the ED, and the survey could not assess the patient capacity of resources at the better-prepared hospitals. It is foreseeable that even the better-prepared hospitals could be overwhelmed by the potentially large number of victims in a chemical weapons incident. In the Tokyo sarin incident, one private 520-bed hospital received 640 victims in 1 day, most of whom bypassed prehospital responders and arrived without undergoing decontamination.[1,2,31] A substantial number of care providers experienced symptoms or signs of secondary exposure.[2,40]

Most surveyed hospitals did not have appropriate types and sufficient numbers of respiratory protective equipment for ED staff. These observations echo the findings of a 1989 study of 45 hospital emergency departments in California.[41] Two thirds reported having personal protective equipment; however, few knew where it was, and only 2 had equipment actually located in their department.

In addition to the 12 hospitals that met minimum recommended criteria for physical resource preparedness in the present study, another 12 hospitals "questionably" met these criteria in that they lacked self-contained breathing apparatuses or supplied-air respirators but did have chemical cartridge respirators. A well-fitting respirator with an organic vapor or high-efficiency particulate air cartridge could provide a meaningful level of protection against some chemical agents, and it might be better than using no respiratory protection in a crisis situation.[24] This study did not characterize the types of available cartridges.

The surveyed hospitals were universally unprepared to provide pralidoxime to a group of 50 victims in a hypothetical sarin incident,

and only 29% had sufficient atropine. These findings mirror those of another study of antidote supplies in Colorado, Montana, and Nevada: 62% of 137 hospital pharmacies did not have adequate pralidoxime to provide the necessary 2-g dose for even 1 70-kg individual poisoned by an organophosphate insecticide, which causes the same symptoms and pathophysiology as sarin or VX nerve agent.[42]

The surveyed hospitals generally were more prepared to initiate treatment for exposures to anthrax, which is not surprising given that the necessary antibiotics are commonly used in usual clinical practice. However, particularly in the absence of a prearranged plan, the antibiotic inventories might be exhausted more rapidly than indicated by the hypothetical scenario. Considering other possible antibiotic sources, it is unlikely that in-hospital inventories of appropriate intravenous antibiotics would substantially expand the capacity to initiate broad-scale treatment. It is also unlikely that antibiotics from possible nonhospital sources could be distributed to hospitals in a coordinated manner without a prearranged plan.

Not surprisingly, hospitals close to the Umatilla chemical weapons depot were more likely than other hospitals to have plans for responding to incidents involving chemical weapons. These survey responses may not have included military antidote kits or protective equipment stockpiled near the hospitals, and they may underrepresent the true level of preparedness. However, the availability of isolation areas, decontamination facilities, and identified personal protective resources was comparable to that of other hospitals. This is particularly noteworthy, because more than $33 million has been allocated to prepare for chemical emergencies in this region.[43]

These study findings are based entirely on a self-administered questionnaire survey, which carries inherent risks of reporting error or bias. The respondents were ED professionals, who should be sufficiently informed, or who should have ready access to the necessary information, to answer the survey questions. However, some questions, such as those about medication inventories, required effort to answer accurately. The quality of effort-dependent responses could have been adversely affected by the frequently expressed opinion of respondents that biological and chemical weapons do not present a real threat to their community. Some respondents may have portrayed their institution in an overly positive manner, especially given that many administrative actions and physical resources covered by the survey are required under existing regulations pertaining to chemical hazards.

Conclusions

The current state of hospital preparedness in these 4 northwestern states for managing victims of chemical and biological terrorism is generally not adequate to support the present strategy of the Domestic Preparedness Program. Although efforts to improve national preparedness—such as the Centers for Disease Control and Prevention National Pharmaceutical Stockpile Program, which establishes a medication and resource cache for terrorist incidents[44]—are under way, there is still a tremendous gap between federal efforts and the current state of preparedness at the level of individual hospitals. A broadly focused plan to establish effective local preparedness could require huge expenditures on a national scale, yet it could be undermined by the lack of clear consensus at the hospital level supporting the need for such preparedness. A more narrowly focused national plan for local preparedness might develop and maintain locally centralized caches of immediately deployable resources, and it might concentrate on preparedness at a small number of designated hospitals in each community or only in urban centers or communities judged to be at relatively higher risk. Such a focused plan, however, could still entail considerable cost while achieving only limited capacity to reduce morbidity and mortality from a chemical or biological terrorist attack.

A clear need exists for the planners of the Domestic Preparedness Program to confront the large deficiencies in local preparedness and the possible ineffectiveness of a program that is critically dependent on such preparedness. A need also exists for expanded public discussion of the feasible options for national and local preparedness—including projected costs and probability of effectiveness—and funding mechanisms that do not compromise financial support for other important health care and public health efforts. □

Contributors

D.C. Wetter planned the study and was responsible for data collection, data analysis, and manuscript preparation. W.E. Daniell supervised data analysis and manuscript preparation. C.D. Treser participated in data interpretation and manuscript preparation. All authors assisted with the study design, including questionnaire development.

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