

# Comfort Level of Emergency Medical Service Providers in Responding to Weapons of Mass Destruction Events: Impact of Training and Equipment

Michael J. Reilly, MPH, NREMT-P;<sup>1</sup> David Markenson MD, EMT-P;<sup>2</sup>  
Charles DiMaggio, PhD, PA-C<sup>3</sup>

1. Assistant Director, Center for Disaster Medicine, Assistant Professor of Public Health Practice, New York Medical College, School of Public Health, New York, New York USA
2. Principal Investigator, CDC TIIDE Grant National Association of EMTs, Director, Center for Disaster Medicine, Associate Professor of Public Health and Associate Professor of Pediatrics, New York Medical College and Chief, Pediatric Emergency Medicine, Maria Fareri Children's Hospital, New York, New York USA
3. Assistant Professor of Clinical Epidemiology, Columbia University, Mailman School of Public Health, New York, New York USA

## Correspondence:

Michael J. Reilly, MPH, NREMT-P  
New York Medical College  
SPH Bldg, 3rd Floor  
Valhalla, New York 10595 USA  
E-mail: michael\_reilly@nymc.edu

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**Keywords:** bioterrorism; emergency medical services; equipment; training; weapons of mass destruction

## Abbreviations:

CDC = (US) Centers for Disease Control and Prevention  
CME = continuing medical education  
DOJ = (US) Department of Justice  
EMS = emergency medical services  
EMT = emergency medical technician  
FEMA = (US) Federal Emergency Management Agency  
HRSA = Human Resources and Service Administration

## Abstract

**Background:** Numerous studies have suggested that emergency medical services (EMS) providers are ill-prepared in the areas of training and equipment for response to events due to weapons of mass destruction (WMD) and other public health emergencies (epidemics, etc.).

**Methods:** A nationally representative sample of basic and paramedic EMS providers in the United States was surveyed to assess whether they had received training in WMD and/or public health emergencies as part of their initial provider training and as continuing medical education within the past 24 months. Providers also were surveyed as to whether their primary EMS agency had the necessary specialty equipment to respond to these specific events.

**Results:** More than half of EMS providers had some training in WMD response. Hands-on training was associated with EMS provider comfort in responding to chemical, biological, and/or radiological events and public health emergencies (odds ratio (OR) = 3.2, 95% confidence interval (CI) 3.1, 3.3). Only 18.1% of providers surveyed indicated that their agencies had the necessary equipment to respond to a WMD event. Emergency medical service providers who only received WMD training reported higher comfort levels than those who had equipment, but no training.

**Conclusions:** Lack of training and education as well as the lack of necessary equipment to respond to WMD events is associated with decreased comfort among emergency medical services providers in responding to chemical, biological, and/or radiological incidents. Better training and access to appropriate equipment may increase provider comfort in responding to these types of incidents.

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## Introduction

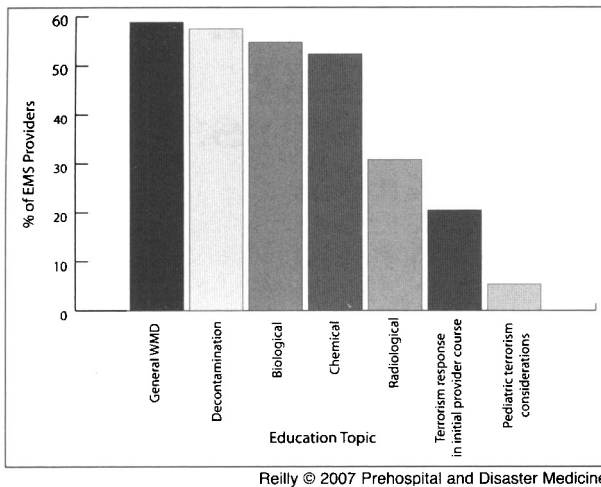
The emergency medical services (EMS) system repeatedly is identified in the literature as one of the strongest components of trauma systems.<sup>1-7</sup> In spite of this apparent strength, reports have shown major deficiencies in the preparedness of EMS agencies and systems to respond effectively to events involving weapons of mass destruction (WMD) and other public health emergencies.<sup>3,8-14</sup>

In their 2002 survey of trauma and EMS systems throughout the United States, the Health Resources Service Administration (HRSA) reported that there was a lack of adequate training programs at the state level.<sup>3,13</sup> The results of the HRSA survey helped to illustrate this lack of training and education among EMS personnel, as only six (12%) states required prehospital providers to have education on disaster-related topics, only one (2%) state required biological agent training, and three (6%) required education on chemical agents.<sup>3,13</sup>

PPE = personal protective equipment  
WMD = weapons of mass destruction

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**Figure 1**—Percent of emergency medical services providers who have attended terrorism-related educational programs

Additionally, results of the HRSA evaluation indicated that the availability of personal protective equipment (PPE) for all healthcare workers was lacking, as only one state (Ohio) had enough PPE resources immediately available for its EMS personnel, and only one state (New Jersey) had enough PPE resources immediately available for its hospital personnel should a chemical or biological agent release occur.<sup>3,13</sup>

The role of the EMS providers is evolving with the threat of WMD, bioterrorism, and emerging infectious diseases. Emergency medical services providers are expected to render care to patients who may be contaminated or infectious, and traditionally have not received appropriate education and training at the awareness or operations level to handle these complex situations.<sup>3,8–13</sup> Furthermore, funding opportunities have been focused at equipment and training for law enforcement through (US) Department of Justice (DOJ) grant assistance, the fire service through the (US) Federal Emergency Management Agency (FEMA) grants, and hospitals through HRSA and the (US) Centers for Disease Control and Prevention (CDC) funding.<sup>11</sup> With the exception of the metropolitan medical response system (MMRS) and some fire-based EMS agencies, prehospital medical first responders have been neglected by the (US) Department of Health and Human Services (DHHS), DOJ, and FEMA funding programs that have left EMS providers under-equipped and under-prepared to respond to WMD events and other public health emergencies.<sup>3,9,11,13</sup>

## Methods

In 2002, a nationally representative sample of 1,919 of the basic and paramedic EMS providers in the US was surveyed. Eight hundred twenty-three (42.9%) completed questionnaires were returned. The study employed a sampling methodology that was developed and validated by the National Registry of Emergency Medical Technicians (NREMT).

The current study was an extension of an earlier prospective survey of a random population of prehospital providers certified at the Emergency Medical Technician (EMT)-Basic or EMT-Paramedic level. This sample had been creat-

ed to be representative of the national population and for use in a longitudinal study and in periodic surveys related to specific areas of interest regarding prehospital providers and prehospital care. The details of this sample and its use for longitudinal and snapshot analyses have been described previously.<sup>15–17</sup> This study was approved by the Columbia University Medical Center Institutional Review Board.

Sampling was stratified by both EMT status (i.e., EMT-Basic versus EMT-Paramedic) and the duration of continuous registration at each level (<1 year [new] or >1 year [old]). The sample further stratified by race to allow over sampling of minorities. Sample size was intended to maximize the efficiency of the sample for comparing different levels of EMTs, as well as for estimating population parameters. Sampling probabilities (i.e., weights) within strata were adjusted to reflect non-response. A two-stage, systematic random selection sampling process was employed based on state use of national EMT registrations as either the sole basis for, or as part of, their initial licensure/re-licensure requirements and levels of EMT-Basics and EMT-Paramedics. The precision of the estimates for the sample was calculated to be +4.2%. Further details of this sampling methodology have been described previously.<sup>15–17</sup>

Individuals were asked to indicate whether they had received training in the areas of WMD, chemical, biological, radiological, decontamination, or pediatric terrorism considerations in their initial EMS provider course, or in any continuing medical education (CME) within the last 24 months. Additionally, providers were asked to indicate whether any training involved “hands-on” components or simulations as a part of the curriculum. Providers also were surveyed as to whether their agencies had equipment designed to respond to these specific emergencies.

Providers were asked to gauge their comfort level in responding to various types of disasters based upon four levels of comfort: (1) very comfortable; (2) comfortable; (3) uncomfortable; and (4) very uncomfortable. In order calculate odds ratios, these choices were dichotomized into two categories. Responses “very comfortable” and “comfortable” were considered comfortable, and responses “uncomfortable” and “very uncomfortable” were considered uncomfortable. Odds ratios are presented with 95% confidence intervals.

All statistical analyses were conducted using SPSS (SPSS, Inc., Chicago, IL) version 13.0. Basic illustrative tables and figures were created using Microsoft Excel 2002 (Microsoft, Inc., Redmond, WA).

## Results

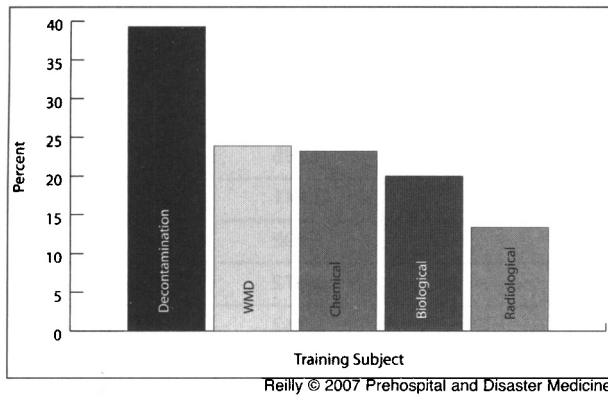
Of the EMS providers surveyed, 58.9% had received WMD training within the past 24 months, 57.5% had received training in decontamination, 54.8% had received training in biological agents, 52.4% had received training in chemical agents, 30.8% had received training in radiological materials, 20.5% had indicated that terrorism response was a topic covered in their initial provider course, and only 5.4% of EMS providers surveyed indicated that they had received education in pediatric terrorism considerations (Figure 1).

Attending a general WMD course was associated with comfort in responding to chemical, biological, and radio-

<b>Radiological Patients</b>		<b>95% CI</b>	
<i>Variable</i>	Odds Ratio	Lower	Upper
Attended radiological CME with "hands-on" component	4.669	4.545	4.797
Attended radiological CME with simulation component	3.885	3.779	3.995
Primary agency has necessary radiological equipment	3.241	3.162	3.321
Attended radiological CME	2.992	2.932	3.054
Attended general WMD CME with "hands-on" component	2.472	2.419	2.525
Primary agency has necessary WMD equipment	2.442	2.386	2.449
Attended general WMD CME with simulation component	2.423	2.37	2.476
Attended general WMD CME	1.949	1.91	1.99
<b>Biological Patients</b>		<b>(95% CI)</b>	
Attended biological CME with "hands-on" component	3.314	3.240	3.390
Attended general WMD CME with "hands-on" component	3.005	2.942	3.070
Attended general WMD CME with simulation component	3.003	2.939	3.068
Attended biological CME with simulation component	2.908	2.842	2.975
Primary agency has necessary WMD equipment	2.768	2.705	2.832
Attended biological CME	2.690	2.638	2.743
Attended general WMD CME	2.571	2.520	2.623
Primary agency has necessary biological equipment	2.475	2.422	2.530
<b>Chemical Patients</b>		<b>(95% CI)</b>	
Attended chemical CME with "hands-on" component	3.202	3.134	3.271
Attended general WMD CME with "hands-on" component	2.705	2.649	2.763
Attended chemical CME with simulation component	2.667	2.621	2.735
Primary agency has necessary WMD equipment	2.604	2.546	2.665
Attended chemical CME	2.555	2.507	2.604
Attended decontamination CME	2.534	2.485	2.583
Attended general WMD CME with simulation component	2.417	2.366	2.469
Attended decontamination CME with "hands-on" component	2.327	2.284	2.37
Primary agency has necessary chemical equipment	2.323	2.276	2.371
Attended general WMD CME	2.259	2.216	2.303
Primary agency has necessary decontamination equipment	2.004	1.967	2.041
Attended decontamination CME with simulation component	1.956	1.919	1.994

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**Table 1**—Comfort of emergency medical services providers in treating multiple victims of a weapons of mass destruction (WMD) attack based on the type of continuing medical education (CME) training delivered and access to necessary equipment (CI = confidence interval)



**Figure 2**—Percentage of continuing education courses within the past 24 months which included a “hands-on” component

logical events. The association was stronger for training that included a simulation component. However, general WMD training that incorporated a “hands-on” component was associated most strongly with comfort in responding to a terrorist event (OR = 3.0, 95% CI 2.9, 3.1) (Table 1).

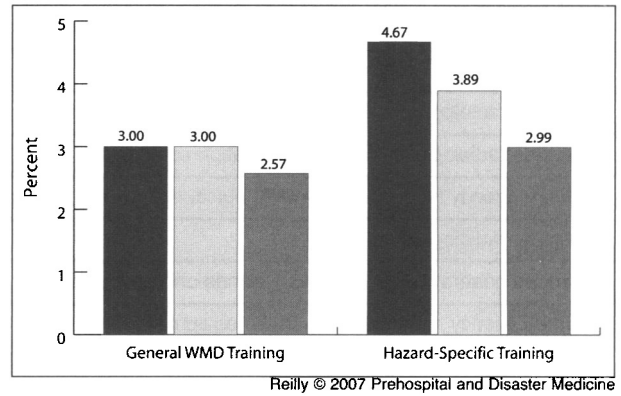
Only a small percentage of hazard-specific CME courses (chemical, biological, radiological) incorporated a hands-on component (13.4–39.3%). The percentage of respondents who attended CME programs with a hands-on component is plotted in Figure 2. Providers who indicated there was a hands-on component to their training were more comfortable with the notion of responding to chemical, radiological, and biological disasters, than those who had attended CME with a simulation component or CME alone (OR = 2.47–3.00) (Figure 3).

Hands-on training for radiological events was associated more strongly with comfort in responding to radiological emergencies, than hands-on training for any other hazard (OR = 4.7, 95% CI = 4.5, 4.8). When assessing a provider's comfort with performing clinical skills on victims of WMD attacks, hands-on training produced the highest measures of association among all training models, and generally, simulation-based training was more successful than standard CME. (Tables 1 and 2)

Only a small proportion (18.1%) of providers surveyed indicated that their agencies had the necessary equipment to respond to a WMD event. The types of equipment that were reported by respondents are illustrated in Figure 4. Generally, providers who had equipment were not as comfortable with chemical, biological, or radiological responses as were those who had attended some type of training program (Tables 1 and 3). Additionally, those responders who had received hands-on training were most likely to have the equipment necessary to respond to a terrorist event (OR = 3.1, CI = 3.0, 3.2). Providers whose primary EMS agency had the necessary equipment to respond to a WMD hazard or meet the need for decontamination showed a higher comfort level in providing care to victims (Table 3).

### Discussion

This analysis supports previous reports that assert that there is a serious lack of adequate training in disaster and terrorism-related emergency response operations for EMS



**Figure 3**—Associated range of comfort-level with type of training received

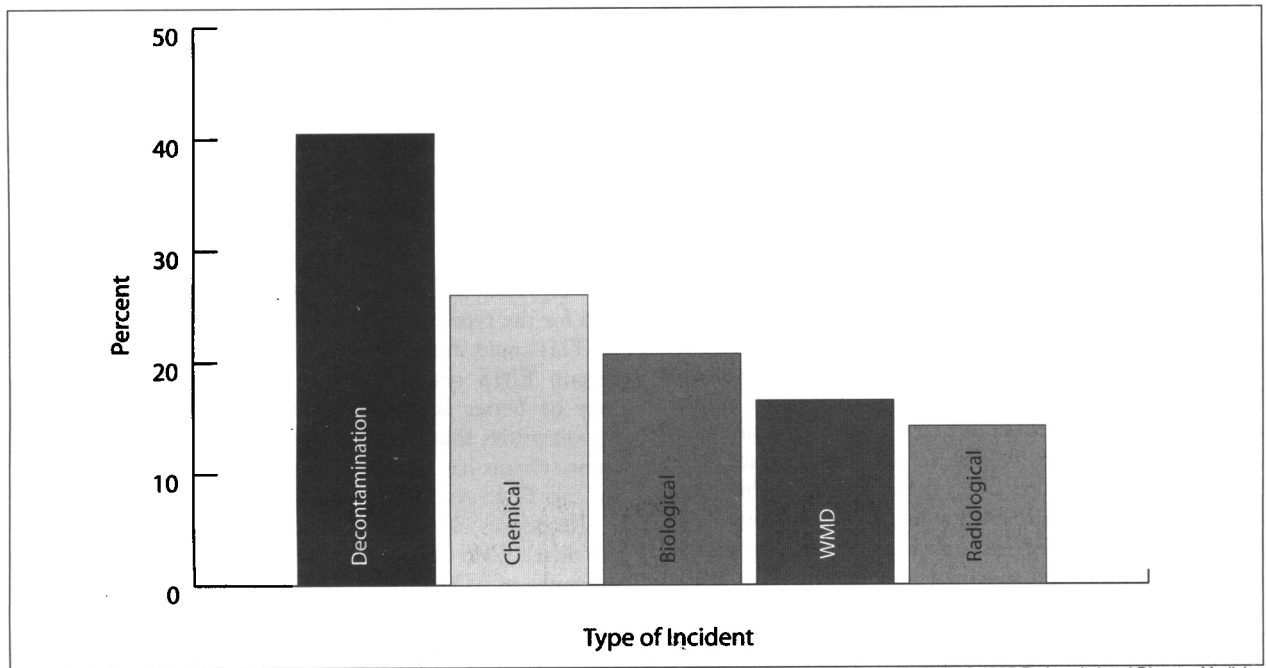
responders.<sup>3,8,13,18–21</sup> Responder training that does exist, even at the basic CME level, has been shown to improve the EMS workers' comfort in providing care when responding to disasters. Existing CME programs can be augmented with hands-on or simulation components to increase the retention of critical skills and increase the comfort level of providers when responding to these types of events and rendering care.

Although hands-on training was associated with an increased odds ratio for comfort in hazard-specific trainings, in programs described as general WMD training, providers reported that simulation training produced an almost identical level of comfort as hands-on training. When compared to the significant increase in provider comfort from simulation to hands-on training in a hazard-specific course, this difference may be explained by the “all-hazards” nature of general WMD courses. Providers may need to spend dedicated educational time and energy developing proficiency and comfort with one incident at a time, as opposed to learning about many agents and their necessary responses at once. Further evaluation of the differences in changes in comfort level for general versus incident-specific training is warranted.

An interesting finding was that EMS providers who reported having the necessary equipment to respond to a WMD incident did not always have training in WMD response. Providers who had the necessary equipment to respond to a chemical, biological, or radiological emergency had a lower level of reported comfort in responding to WMD events than their colleagues who had training but no equipment. Equipping prehospital providers to respond to WMD incidents without providing adequate training is akin to providing paramedics with a laryngoscope and not teaching them how to perform intubation. In order for providers to feel comfortable providing patient care and performing skills in the austere environment of a disaster or public health emergency, they must be provided with the necessary education and training.

An additional area of improvement that is needed in EMS disaster training and education is the need for specific training in the clinical and patient care considerations for special and vulnerable populations, including (but not limited to) pediatrics. There is a paucity of information for





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Figure 4—Percentage indicating that the primary emergency medical services agency had the necessary equipment to respond to the following incidents (WMD = weapons of mass destruction)

Variable	Hands-On			Simulation		
	Odds Ratio	Lower	Upper	Odds Ratio	Lower	Upper
Biological	3.005	3.240	3.390	3.003	2.942	3.068
Radiological	2.472	2.419	2.525	2.423	2.370	2.476
Chemical	2.705	2.649	2.763	2.417	2.366	2.469

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Table 2—Comparison of comfort-levels in responding to weapons of mass destruction (WMD) events after hands-on versus simulation assisted training in general WMD courses

	Odds Ratio	Lower	Upper
Primary agency has necessary radiological equipment	3.241	3.162	3.321
Primary agency has necessary biological equipment	2.475	2.422	2.530
Primary agency has necessary chemical equipment	2.323	2.276	2.371
Primary agency has necessary decontamination equipment	2.004	1.967	2.041

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Table 3—Comfort of emergency medical services providers in providing care to victims based upon their access to necessary equipment

educators and trainers in this area. In order to design and implement training and education programs, which will satisfy this deficiency in core provider knowledge, academic centers of excellence, researchers, and professional organizations must work to develop key performance standards and knowledge competencies that can be modeled and used when designing training programs.

With >80% of respondents stating that they did not have terrorism or public health emergency response education as a part of their initial provider training, this may be an area for future consideration in EMS educational program development. Initiatives already have been taken by academic and governmental bodies to develop competencies in emergency preparedness and response for health professionals.<sup>22,23</sup> Most of these initiatives have been suggested for the public health workforce and for graduate-level health professionals. The DOJ, Office of Justice Programs, and Office for Domestic Preparedness have developed a set of competencies for first responders at the awareness level, performance level, and planning and management levels. These emergency response guidelines contain specific roles and responsibilities for each first responder profession and each level of operational responsibility.<sup>24</sup> Emergency medical services-specific educational competencies can be created by combining these guidelines with the existing recommendations for the education of health profession students. Until standardized curricula can be modified, EMS educators can use these tools to ensure that prehospital providers are supplemented with the appropriate educational materials to be more effective at responding to these incidents and caring for the victims of these events.

A 2002 report released by HRSA on the national state of trauma system and EMS preparedness for disasters and mass-causality events showed that only one state reported that its EMS system would have access to PPE in the event of a bioterrorism event.<sup>3,13</sup> Similar research has underscored a general lack of protection for the public health workforce against any type of chemical, biological, or radiological contamination in the event of a disaster.<sup>2,3,8,9,12-14,19,20</sup>

In order for prehospital providers to support and perform decontamination, triage, and provide medical treatment for patients who may be contaminated or infectious, workers must be trained and equipped in the evaluation, selection, and use of PPE for chemical, biological, and radiological hazards.<sup>2,3,5,8,9,12-14,18-20,24</sup>

Additionally, providers must develop an affective and psychomotor mastery of the complexities of delivering patient care in the austere and sensory-limited confinement of PPE. This only will be possible through hands-on training programs and the availability of the necessary equipment. There is a need for targeted funding of EMS systems by national preparedness and equipment grant programs, so that it can be assured that EMS workers will be prepared to provide the necessary level of emergency response that is expected, and is necessary to reduce the morbidity and mortality of disasters.

### Limitations

There were a few potential limitations in this study. Although the sample size was robust at 1,919 persons, the response rate to this survey was only 42.9% (823/1,919) leading to the possibility of non-response bias. In light of this potential limitation, a non-responder survey indicated that there were no differences in socio-demographic factors among respondents. Nevertheless, in future study design, it may be beneficial to use more varied methods of survey response elicitation.

Responses in this survey were not controlled or stratified for the type of EMS system that the provider worked in. This could introduce bias, as one may postulate that in certain EMS systems (fire-based, hospital-based), there may be better access to specific equipment or training opportunities that make it more likely that the workers in these systems have certain equipment or training that those in other EMS systems (private, third-service) would not have.

Responses also were not stratified for the size of the provider's EMS systems. One could propose that due to the existence of MMRS systems, and certain DOD resources that were distributed among the very urban sections of the US, a disparity exists among EMS system preparedness. In fact, this may be a valid assumption. If urban providers were disproportionately represented in the data, this could be a potential source of response bias.

### Conclusions

Lack of training and education, as well as the lack of necessary equipment needed to respond to WMD events, is associated with decreased comfort among emergency medical services providers in responding to chemical, biological, or radiological incidents. Implementing competency-based curriculum enhancements to initial provider education and continuing medical education, along with providing the opportunity for psychomotor skills building, using "hands-on" training, may increase the confidence and overall comfort levels of prehospital providers to effectively deliver emergency medical care during a disaster or public health emergency. A well-trained and well-prepared EMS system is a critical component of the ability to effectively respond to disasters and public health emergencies.

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