

Mission Failure: Emergency Medical Services Response to Chemical, Biological, Radiological, Nuclear, and Explosive Events

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Abbreviations:

CWIRP = Chemical Weapons Improved Response Program
EMS = emergency medical services
MTCWA = mass-terrorism chemical weapons attack
PPE = personal protective equipment

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Abstract

Introduction: Only 4% of the United States Homeland Security funding for public safety terrorism preparedness is allotted to emergency medical services (EMS), despite the primary threat from a mass-terrorism chemical weapons attack (MTCWA) being personal injury. This study examines the preparedness of the EMS to respond to, treat, and transport victims of such attacks.

Hypothesis: It was hypothesized that US EMS agencies lack the necessary equipment to mitigate large-scale morbidity and mortality from a MTCWA.

Methods: Seventy after-action reports from full-scale, chemical weapons exercises conducted in large cities across the US were examined by the Office of Domestic Preparedness, Chemical Weapons Improved Response Program to ascertain if EMS responders had personal protective equipment sufficient to operate at the scene of a MTCWA.

Results: Of the 50 after action reports that mentioned EMS personal protective equipment, only six (12%) EMS agencies equipped their staff with personal protective equipment.

Conclusions: Results indicate that EMS responders are not prepared to safely respond to MTCWAs, which may result in a significant loss of life of victims and responders.

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Introduction

There are >192,000 emergency medical service (EMS) providers throughout the United States who provide both emergency medical care and inter-facility transportation for the sick and injured.¹ (Total numbers of certified emergency medical service providers at all levels, which would include first responders whose primary role is not emergency medical care, totaled over 840,669 certified EMS providers in a 2004 survey by the National Association of Emergency Medical Service Directors.) Emergency medical services in the US are provided by a vast network of organizations and individuals, including fire departments, private companies, volunteers, hospitals, and 3rd services. However, all states require a trained and certified EMS responder to provide emergency medical care in the event of a mass-terrorism chemical weapons attack (MTCWA), and if the state permits, the administration of antidotes.²

Traditional methods of hazardous materials response involve identifying the event, isolating the area, and then, demarcating the area into three zones: (1) a hot zone, or exclusion zone, where contamination exists; (2) a warm zone, or contamination reduction zone, where victims and responders disrobe, are decontaminated, and transition into the next zone; and (3) the cold zone, or support zone, where no contamination exists, and victims are transported to definitive medical care.³ Emergency medical services responders work in the cold and warm zones.⁴

According to the *Emergency Responder Guidelines* of the (US) Office of Domestic Preparedness, there are three training levels for EMS responders: (1) Awareness-Level responders are expected to identify the MTCWA and retreat; (2) Performance Level-A EMS responders provide medical care in

the warm and cold zones; (3) and Performance Level-B EMS responders who will provide medical care in the warm and cold zones, but have some special training in rescuing or assisting in caring for victims in the highly-contaminated hot zone.⁵

There are four different levels for personal protective equipment (PPE): (1) *Level A* provides the highest degree of respiratory and skin protection by means of a totally encapsulating, chemical-protective suit with a self-contained breathing apparatus that is worn in the hot zone when the risks are unknown; (2) *Level B* provides the same high degree of respiratory protection, but less skin protection, with the self-contained breathing apparatus being worn on the outside of the chemically-resistant suit, and used in hot zones when the chemical is known; (3) *Level C* is worn in the warm zone, and utilizes an air-purifying respirator and chemical-resistant suit—it is used in environments when the chemical is known, the concentration in the air is known, and there are sufficient levels of oxygen; and (4) *Level D* is a work uniform affording minimal protection and typically would be worn in the cold zone.⁶ Emergency medical services providers traditionally utilize Level C and D PPE depending on whether their agency permitted them to work in the warm or the cold zone.

The primary problem that occurs from the use of chemical weapons is the large number of casualties that may result. Chemical weapons can be classified into one of five basic classes: (1) nerve agents (e.g., sarin); (2) vesicants—blister agents (e.g., sulfur mustard); (3) blood agents (e.g., cyanide); (4) incapacitating agents (e.g., BZ 3-quinuclidinyl benzilate); or (5) choking agents (e.g., chlorine). When used as a weapon, the chemical effects, dispersal methods, timing, and placement are designed to create the maximum number of casualties. Within these five classes, the first treatment priority is clear: removal of the victim from the area and disrobing, which can be accomplished by any first responder wearing the necessary protective equipment.⁷ But for nerve and blood agents, the next (or even simultaneous) step is rapid antidote or antagonist therapy—atropine, pralidoxime hydrochloride (Mark I kit), and diazepam for nerve agents and amyl nitrate, sodium thiosulfate, and sodium nitrate for blood agents—pharmacological therapy, which clearly is the responsibility of EMS responders.⁸

Rapid treatment of patients who are severely intoxicated with a nerve agent is the key to their survival. According to the US Army Soldier Biological Chemical Command's *Guidelines for Mass Casualty Decontamination during a Terrorism Chemical Agent Incident*, if patients severely intoxicated by nerve agent "...have not received Mark I kit treatment or decontamination within five minutes of exposure...they will die regardless of what type of medical intervention is provided."⁷ For a patient exposed to blood agents, therapy is just as urgent. According to De Lorenzo, victims of a high-concentration exposure will be unconscious within 30 seconds and dead within eight minutes without treatment.⁹ As a result, time constraints force EMS responders to be equipped with Level A or B PPE to work in the hot zone if they are to have a significant impact on morbidity for severely intoxicated victims of chemical weapons.¹⁰

However, even if the provision of necessary pharmacological intervention was abandoned in the hot and warm zones, previous research has demonstrated that the cold zone is not so cold.¹¹ Victims will not stay put until decontaminated, and will swarm EMS responders upon arrival, and thus, contaminate every EMS responder at the scene. As a result, all EMS responders, even those involved in support roles, must be trained at least to the performance Level A and be equipped with at least Level C personal protective equipment.

This paper examines one simple factor: do urban EMS responders have personal protective equipment, Levels A, B, or C, sufficient to operate in at least the warm zone? Independent of training and antidotes, PPE for EMS responders is a prerequisite to being able to provide pharmacological treatment before the victims have been decontaminated, especially since decontamination can take up to 20 minutes to set up, and then up to five minutes to serially shower each of the incapacitated victims.^{12,13}

Methods

In this study, the authors examined 70 after-action reports from the Office of Domestic Preparedness, Chemical Weapons Improved Response Program that had been held in cities across the US as part of the US Domestic Preparedness Initiative required by the 1997 Nunn-Lugar-Domenici legislation.¹⁴ Each after-action report reviewed the results from a full-scale exercise that tested response of the city and region to a release of a chemical weapon and was written by an expert contracted by the Office of Domestic Preparedness. The exercises covered the first response, incident management, decontamination, secondary devices, and hospital care. The chemical released in the scenario varied, but most commonly was a nerve or blister agent (agents included hydrofluoric acid, nerve agents, blister agents, chlorine trifluoride, and hydrochloric acid). Reports were analyzed to ascertain the answer to whether EMS responders in each city were equipped with Level A, B, C, or D personal protective equipment. Because the reports were not conducted in a standardized format, data were not reported consistently.

Results

Of the 70 after-action reports, there were 20 evaluations (40%) in which no comments were made on the PPE used by the EMS providers. Of the 50 reports that did address EMS PPE, 44 out of 50 (88%) EMS systems only had their work uniform available, while six (12%) had at least some Level C PPE or higher. Across the exercise series, the evaluators consistently noted the need for EMS responders who were able to provide rapid antidote treatment in the warm zone. One typical report concluded:

There was no medical evaluation observed in the Hot Zone and no attempt to move casualties from the Hot Zone early (i.e., out of the area of highest agent concentration). After 1 hour and 45 minutes, there were still many non-ambulatory victims in the Hot Zone awaiting assistance. Ambulatory patients were extracted one and two at a time while other salvageable, non-ambulatory patients remained on the scene. Additionally, there

was neither Basic Life Support (BLS) equipment nor Advanced Life Support (ALS) personnel in the decontamination area to assist those in need. This made triage of casualties and rapid medical intervention difficult and would have greatly increased the mortality among casualties. One victim in great distress made it to the decontamination lines and then collapsed onto the pavement. He convulsed on the ground for an extended period and was eventually declared dead by decontamination Controllers. Responders made no visible effort to examine patients for wounds, to continue medical care, or to address the needs of injured as they were decontaminated. In addition, patients did not always receive thorough decontamination of open wounds.

There did not appear to be any technology-based scanning of patients to determine the effectiveness of decontamination before the patients entered the Cold Zone. Since EMS personnel in the rear of the decontamination area performing triage were not wearing proper PPE, they could have been contaminated if they had had contact with any patient who had not gone through proper decontamination.¹⁵

In this series of MTCWA exercises all across the US, it is obvious that victims from chemical weapons attacks died because of the lack of rapid treatment by EMS.

Discussion

Personal safety of EMS responders through provision of PPE is essential to any response to a MTCWA. Unless EMS responders can work safely, training and equipment to provide therapy to these patients is useless. Even in New York City, the American city most at risk of terrorism, most EMS responders only have been provided with protective equipment to escape a MTCWA, not to treat patients in a contaminated zone.¹⁶

The lack of PPE for EMS responders indicates the general lack of preparedness of EMS for terrorism of any sort. Since the Tokyo subway sarin attack of 1995, a MTCWA has been recognized as a significant, probable, even imminent threat, both by independent researchers and government-sponsored groups like the Gilmore Commission.^{17,18} While considerable funding has poured into police and fire departments since 1995, substantially less attention has been paid to the role of EMS responders. According to a New York University report, although EMS responders constitute one-third of all first responders, they have received <4% of the Department of Homeland Security's Homeland Security Grant Program for Equipment in 2002, 2003, and 2004. In fact, a number of states did not provide state homeland security grant funding to EMS, even though the primary immediate outcome of terrorist events is illness and injury.¹⁹

In many areas, including high risk environments like New Jersey, where the ring of chemical plants surrounding western edge of New York City have been called "the most dangerous two miles in America",²⁰ EMS responders either do not carry or are not permitted to administer chemical

antidotes to patients.²¹ However, the reasons for this are not what one would expect. This is not because the administration of such antidotes is too complicated: all 50 states permit EMTs to "assist" patients suffering severe allergic reactions with the use of the patient's own Epi-pen auto-injector (e.g., wrapping the patient's hand around the Epi-pen and then wrap his or her own hand over to administer it).²² The primary treatment for exposure to a nerve agent, a combination of atropine and pralidoxime chloride (2-pam), is supplied in the exact *same type* of pre-measured, spring-loaded syringe.²³ Nor is excessive risk a factor, as severely intoxicated nerve agent victims will die within five minutes of exposure if left untreated.²⁴ It should also be noted that there is no substantial risk to administering the Mark-1 kit to children—the Pediatric Expert Advisory Panel Addressing Terrorism, Disaster, and Public Health Emergency advised that if the Mark-1 kit was the only treatment on hand, it should be used to treat all children.²⁵ The reason EMS will be unable to prevent deaths is because of the lack of funding and interest in providing EMS providers with the tools they need to manage this real threat.

Due to underfunding, EMS responders lack the essential equipment and training. According to a report, >50% of EMS personnel received <1 hour of training in biological, chemical, and explosive hazards since 11 September 2001, while 20% of EMTs and paramedics did not receive training. Furthermore, since 11 September 2001, less than one-third of all EMS responders participated in a drill simulating a radiological, biological, or chemical attack.²⁵

Although police and fire are equipped to rescue victims of MCTWAs, most patients exposed to nerve or blood agents will be dead before decontamination is complete. Early, rapid treatment by EMS responders is a critical part of the rescue, and is the only way that the emergency services can make a positive difference in the morbidity and mortality related to such events.

What is needed now is an EMS affirmative-action program, with at least 50% of the Department of Homeland Security's Homeland Security Grant Program dedicated to EMS equipment and training for the 2007–2010 period. Only through a rapid infusion of capital can one hope to bridge the balance between the enhanced capabilities of fire and police departments and the poorly developed capabilities of EMS. If antidote therapy does not happen within the narrow window before irreversible damage occurs, a future MTCWA will result in the loss of hundreds, if not thousands of lives.

Conclusions

After a MTCWA, the primary mission in the immediate phase is the rapid removal, treatment, and decontamination of victims. Given that <12% of EMS responders in the multi-city Chemical Weapons Improved Response Program had any protective equipment, let alone training or antidote therapy, the US is faced with avoidable civilian and EMS responder illnesses and deaths. Only by dramatically increasing EMS funding for weapons of mass destruction training, equipment, and response at the national level can this trend be reversed.

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