

TECHNICAL ISSUES AND ORGANIZATIONAL DEMANDS FOR COMBATING WMD PROLIFERATION

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ABSTRACT

Weapons of mass destruction (WMDs) proliferation currently represents one of the greatest threats to international security. Just as the threat of “loose nukes” exemplifies a risk that cannot be countered via sole reliance on traditional safeguards, the threats exemplified by chemical and biological weapons proliferation require the formulation of strategies focused on prevention and preparedness. The emerging international security environment is characterized by overlapping objectives of persons involved in the formulation and implementation of strategies to counter these threats. Such overlapping objectives create redundancy and inefficiency unless persons involved in counterproliferation initiatives are afforded sufficient opportunities to discuss their concerns and exchange information. This paper discusses four interrelated strategies aimed at countering the WMD proliferation threat and addresses the need for coordination among persons involved in developing and implementing these strategies. These include: 1) denying or controlling access; 2) detection and interdiction; 3) crisis management; and 4) consequence management. These four strategies will be discussed in detail for nuclear, chemical and biological threats in order to assess the technical issues involved in effectively implementing such measures. The paper outlines the strengths and weaknesses of current technical capacity in countering the threat and offers guidelines for the further technical developments essential to the effective implementation of prevention and preparedness strategies. The paper further argues that in the formulation of coherent approaches for mitigating proliferation threats there is a need for a forum that brings first responders, scientists and policy makers together to exchange ideas, discuss technical issues and foster greater awareness of their common objectives and concerns.

I. INTRODUCTION

In response to the emerging threat of weapons of mass destruction (WMD) proliferation, policy decisions in recent years center on achieving capabilities to counter those threats, both on the battlefield and in civilian settings. International regimes represent the first-best solutions in attempting to control access to or production of the materials requisite to attainment of WMD capability. Whereas materials control and accounting largely succeeded in assuring restricted acquisition of nuclear materials for non-peaceful objectives and similar approaches are contained in the non-proliferation regimes for chemical and biological weapons, increasing awareness of the difficulty in controlling access in the latter two types of weaponry leads to heightened focus on counterproliferation efforts.

Countering WMD proliferation threats encompasses four interrelated strategies. These include: 1) denying or controlling access; 2) detection and interdiction; 3) crisis management; and 4) consequence management. Perhaps more than any other security concern, this threat necessitates coordination among persons involved in developing and implementing these strategies. While international organizations, such as the International Atomic Energy Agency and the Organization for the Prohibition of Chemical Weapons, fulfill the operational tasks of verifying treaty compliance, domestic agencies are responsible for ensuring the civil protection against the rogue state or terrorist organization with the capacity to use WMDs to inflict, if not “mass destruction,” at least sufficient panic or injury to achieve short-term success. This discussion will focus more on the technical issues of domestic measures of prevention and preparedness in response to the perceived emerging threats. These strategies will be evaluated in order to assess the technical issues of implementation. An evaluation of the current technical capabilities helps to delineate the needs for further technical developments in achieving effective response. Regardless of the technical prowess attained, the formulation of coherent approaches for mitigating WMD threats inherently involves in-depth coordination between first responders, scientists and policy makers to overcome technical barriers and organizational impediments.

II. DOMESTIC PREVENTION AND PREPAREDNESS

In 1996, the Defense Against Weapons of Mass Destruction Act of 1996 gave the Federal Bureau of Investigation (FBI), in conjunction with other agencies, the lead for those measures focused on detection and/or interdiction. The FBI is also responsible for crisis management, including resolving a hostile situation, investigating the incident, and preparing the case for prosecution. The Federal Emergency Management Agency (FEMA) is the lead federal agency charged with responsibilities of consequence management. FEMA coordinates federal activities in support of state and local governments to protect public health and safety, restore essential federal services, and offer emergency relief.

Under this legislation, the Department of Defense (DOD) was charged with the responsibility of establishing the Domestic Preparedness Program. This program's objective is to enhance the capability of the federal government to prevent or respond to terrorist incidents involving WMDs as well as to improve state and local emergency response capabilities for nuclear, biological and chemical (NBC) threats and potential consequences. The bulk of the course materials and equipment made available to domestic responders clearly targets crisis and consequence management capabilities. The DOD's role in prevention assumes that awareness training is a necessary and not inconsequential aspect in attaining prevention objectives. Under this training program, selected cities receive an equipment set that includes four categories of devices: protection, detection, and decontamination equipment as well as training kits. This program has focused on training the trainers in order to maximize its impact. Thus far, 9,000 individuals in 27 cities have received training. The program plans to have conducted training in 120 cities by the year 2001.

In even a cursory overview of current activities, the degree of focus on consequence and cleanup evidences the technical and organizational issues involved in countering a WMD attack. In short, the lack of remote detection and identification capabilities puts the emphasis on post-diffusion or post-detonation mitigation of damage. This is particularly true with respect to biological threats. This fact becomes clearer in the discussion of the complex nature of NBC agents and the current status of technologies for detection and identification of BW and CW agents.

III. TECHNOLOGIES FOR DETECTION AND RESPONSE

Prevention of an attack will most probably hinge on intelligence capabilities, whether its origins are domestic or international. The fact that the Aum Shirinkyo had yet to attract the attention of U.S. intelligence agencies prior to its chemical assault on the Tokyo subway indicates a substantial deficit in our earlier awareness and understanding of the potential threat of NBC terrorism. An intelligence failure necessitates effective crisis and consequence management. This, in turn, is heavily contingent on detecting an attack early on and achieving sufficient agility in the response so as to mitigate damage or injury. The technical issues of counterproliferation involve comprehending the nature of different agents and how delivery or dissemination is impacted by other circumstances for different NBC agents. The following overview attempts to briefly summarize these complexities and extrapolate from these to the technical issues involved in providing adequate capabilities to counter these threats. Biological and chemical threats will be examined more closely based on probability factors and emphasis on these threats in the Domestic Preparedness Program itself.

Nuclear

As human senses do not respond to ionizing radiation, special instrumentation must be used for radiation detection and measurement. The hazard from radiation depends on the type of radiation, its energy spectrum, and the quantity to which one is exposed. Thus, qualitative and quantitative measurement capabilities are required of radiation detectors used in the field. No single instrument at present incorporates all the necessary characteristics for comprehensive evaluation of different types of radiation hazards. The pocket Radiac and Radiac sets represent state-of-the-art, portable radiation detection equipment.² Although not ideal, achieving these detection capabilities would have required a suite of devices just a few years ago. Improvements are still necessary in measuring dose rate in units directly applicable to the tissue of concern; responding to only one kind of radiation at a time; eliminating extraneous effects from immediate environmental or weather conditions; and having a means of field checking operability.

It is important to note that meteorological conditions greatly effect fallout, particularly local fallout. Snow and rain can accelerate local fallout, while rain showers above a radioactive cloud can create areas of heavy contamination.

Biological

The utility of any biological agent as a weapon is a factor of its infectivity, virulence, toxicity, pathogenicity, incubation period, transmissibility, lethality and stability. Unlike their chemical counterpart, biological agents have the ability to multiply in the host and increase their impact over time. At the same time, most of these variables are highly sensitive to other conditions surrounding an agent’s dissemination. Biological weapons are most likely to be delivered by aerosol, though other routes are possible. Inhalation through respiratory exposure, ingestion through contamination of water, food or medicines, and dermal exposure are the most probable routes of entry. Another possibility includes live vector (mosquitoes, ticks, etc.) dissemination. Table 1 offers basic information on typical biological agents. This table serves to underscore the complexity of detection, problems of containment and other difficulties in countering a BW threat.

Table 1: Characteristics of Biological Agents

<i>Agent/Disease</i>	<i>Dissemination</i>	<i>Transmissibility (b/t persons)</i>	<i>Infectivity</i>	<i>Incubation Period</i>	<i>Duration of Illness</i>
Anthrax	Spores in Aerosols	No	Moderate	1-6 days	3-5 days
Plague (pneumonic)	1. Aerosols 2. Infected Vector	No	High	Days to months	1 or more weeks
Smallpox	Aerosol	High	High	1-5 days	Days to weeks
Ricin	Aerosol	No		Hours	Days

For better or worse, humans are the most sensitive biodetectors. Detection of a BW attack is difficult due to the prolonged incubation time and complexity of diagnosis in many cases. At present, a BW attack will most likely be completed before anyone is aware of its occurrence. First responders in this instance are likely to be medical personnel, and any single physician is unlikely to be able to distinguish between the symptoms arising from a biological event and naturally occurring phenomena. However, if sufficient coordination among medical professionals exists, a BW attack distinguishes itself from an epidemic in several ways. Among other indicators, an artificially-induced outbreak will usually be more compressed than a naturally occurring epidemic, and rather than peaks and troughs most common in natural disease outbreaks, a steady and increasing stream of patients is likely.³

In countering this threat, medical professionals must maintain routine disease surveillance and an atypical pattern should trigger immediate notification of authorities and other agencies. Although emerging technology may soon provide provisional diagnostic capabilities locally, specialized laboratory facilities will be required for a definitive diagnosis in most cases. While medical personnel are responsible for the collection and submission of diagnostic materials from patients (blood culture, acute serum, organ tissues), environmental sampling by other agencies is required for corroborating the occurrence of a BW attack. Success or failure in offering a timely and effective response will depend on the rapidity and accuracy of diagnostics in conjunction with timely information from organizations responsible for environmental sampling.

Detection and identification devices for BW defense are evolving and represent a high priority within the research and development community. Three primary detection systems have already been fielded, but these systems are largely applicable to battlefield operations rather than civilian defense operations.⁴ As in the case of a physician’s diagnosis, the principal technical difficulty in biological agent detection is differentiating between an artificially generated biological cloud and the background of organic matter normally present in the atmosphere.

At present, the best available technology for detection by first responders consists of “smart tickets,” as identification technologies are neither inexpensive nor particularly portable.⁵ Critical to biological defense is adequate training and coordination among health care professionals themselves as well as real-time communication with intelligence agencies and entities responsible for environmental sampling. Small, portable and sensitive detection and identification technologies with adequate range capabilities would enhance first responders capability to minimize the impact of a biological assault. Effective long range detection, in conjunction with virtual reality analysis capability, would significantly enhance response capabilities.

Chemical

Chemical agents in munitions are liquid, but with detonation of their container, the agent is dispersed as an aerosol. As chemical agents are volatile by nature, under certain conditions they evaporate, forming a vapor. An agent's tendency to evaporate is a factor of its chemical composition, temperature, air pressure as well as variables such as wind velocity and the contact surface. Volatility is related to persistence, and a more persistent agent is a more significant liquid hazard, while less persistent agents create a serious vapor hazard. Persistent agents (mustard, VX) are suitable for contaminating an area for an extended duration. Non-persistent agents (sarin and cyanide) are largely more suitable for tactical direct assault due to their quick evaporation.⁶ Wind, temperature, rain, and atmospheric stability play a significant role in augmenting or diminishing the impact of any given agent.

The concentration of the agent at the time of exposure governs the dose received. Chemical agents are similar to biological in that the routes of entry also include inhalation, ingestion or dermal. They differ from their biological counterparts in that most chemical agents will induce an immediate effect. Subsequently, there is substantially less difficulty in delineating between a chemical attack and a "natural occurrence."⁷ Nerve, blister, choking and vomiting agents all constitute different threats, depending on the conditions under which they are dispersed and the dosage.

While chemical "smart tickets" are widely available for detection or identification of chemical agents after dissemination, the M22 Automatic Chemical Agent Alarm provides a remote continuous air sampling device with a range limited to 400 meters between the alarm units and the detector cells.⁸ The system usually consists of the M43A1 detector, up to five alarm units and a variety of power supplies. Detector cells are connected to the alarm units via telephone cable. This unit is being fielded now. It offers greater sensitivity than its predecessor (M8A1) with significantly less interference. Its disadvantages are that its wiring requirements are ill-suited for detection in a civilian setting. Although chemical detection instrumentation is well-advanced, its cost, portability and reliability make its implementation for first responders largely impracticable. The JCAD, which is slated for fielding this summer and is a small portable device, achieves the same objectives as the M8A1 and could overcome some of these disadvantages.

Simulation and Modeling Capabilities

In all cases of NBC weapons, the duration, scope and intensity of the danger they may present are subject to the conditions under which they are disseminated. For this reason, a critical aspect of our defense capabilities is the ability to model chemical or biological clouds, levels of airborne activity and contamination conditions at the location during the time of detonation. For this reason, research and development efforts are focused on digitization, communications and virtual reality modeling capabilities.

Current technology is capable of detecting only a fixed number of agents with multiple point sensors at limited (1-5 km for chemical) distances. Digitized data is only available in some cases. Projected advances in five years will achieve increased detection of agents at greater distances with fewer point sensors, greater portability and offer early warning detection. Moreover, there will be a significant increase in the availability of digitized data. In ten years, research and development will achieve person-portable biodetection systems, chemical detection at a range of 20 km and real-time data and time-projection access for area of concern. Fifteen years from now technology could provide integrated person-portable chemical and biological detection and global access to virtual reality simulations.⁹

Significant advances in detection and identification capabilities must be coupled with miniaturization, digitization and lowered costs for these devices to meet the needs of the civilian response community. Agent detection must be coupled with capabilities for mapping of agent contamination and clouds in a given area to mitigate potential damage. Mapping and simulation capabilities that incorporate data collected in the field with atmospheric, meteorological and terrain information specific to the area at hand can greatly enhance consequence management capabilities.¹⁰ Digitization of the data gathered makes communications for further analysis of the data feasible and fast. Technical capabilities for simulation are particularly critical in light of the sensitivity of chemical and biological agents to these conditions. These comprise the fundamental assumptions dictating the direction of research and development efforts for NBC defense.

Sophisticated technology, however, is only one part of the solution. Although advanced detection and identification capabilities are a primary component of mitigating the potential consequences of an attack, effective response after

detection will rely on coordination and communication among responsible agencies and local first responders. Not solely, but at least partially, the gaps in our technical capability to prevent WMD attacks underscore the need for adequate coordination of intelligence capabilities and awareness at all levels of involvement in responding to these threats. In addition, the effective implementation of the available and next generation technologies requires more attention to the actual risks and greater coordination among the entities involved to attain adequate defense.

IV. THE TECHNICAL IS ORGANIZATIONAL

Soldiers confronting WMDs on the battlefield have an impressive array of detection, protection and decontamination technologies. Battlefield scenarios, however, offer specific advantages for technical solutions that are not present in the case of a civilian setting. Vaccines can be administered to soldiers that provide an effective layer of immediate defense; secondly, a battlefield precisely limits the area to be monitored. Nuclear, chemical or biological threats in civilian settings extend to all citizens and the battlefield, especially for the terrorist, unlimited. Technology only offers limited solutions in a defined set of circumstances. In many respects, these circumstances are not present for domestic counterproliferation efforts.

Intelligence Needs, Information Analysis and Risk Assessment

International regimes are the first line of prevention in controlling access to weapons materials. Increasingly, however, the threat of terrorist attacks using WMDs controls our perception of domestic security. Monitoring suspicious activities and detection/interdiction efforts are largely the responsibility of intelligence and law enforcement agencies - FBI, CIA, National Security Agency, local police, etc. Real-time communication and analytical tools to facilitate the work of these agencies are available. What is lacking is coordination.

Recent reports on counterproliferation efforts state that analytically sound threat and risk assessment is requisite to making sound policy decision about domestic preparedness investments.¹¹ Along these same lines, renewed thought is necessary to address the real utility and implementation potential of improved instrumentation. Equipment with battlefield applications may be wholly unsuited for first responders in a domestic setting. Portable, reliable, sensitive and less expensive detection devices can undoubtedly enhance crisis and consequence management capabilities, especially if these devices are integrated with modeling capabilities that afford accurate determination of factors related to dissemination and fallout.

More important, however, is to recognize that many of the technical issues are also organizational. The foremost example is that biological detection requires coordination between individual medical professionals and agencies responsible for environmental sampling in the field. Similarly, intelligence agencies should be constantly involved in risk and threat assessment in order to facilitate the work and minimize the element of surprise for response efforts by other agencies. Evaluation of the threat and risks would not only offer better orientation as to where, when and by what means a terrorist attack might occur, but it would also provide necessary information for deployment of detection assets.

In order to achieve focus in our counterproliferation efforts, policy makers, scientists and field operations personnel must be provided with a forum to discuss both technical and organizational issues. Such opportunities would greatly facilitate understanding of the technical issues confronted at the level of local first responders; simultaneously, policy and organizational concerns of federal, state and local representatives could be addressed. While the Chemical and Biological Defense Command has an excellent track record of incorporating state and local officials in awareness training and formulation of its training course for a specific municipality, only minimal opportunities exist for persons involved in international non-proliferation to coordinate with those involved in the Domestic Preparedness Program. Even more significantly, insufficient fora exist for coordination among agencies responsible for the separate strategies (controlling access, detection/interdiction, crisis and consequence management) for a layered defense against WMD threats.

V. CONCLUSION

Admittedly, the threat is amorphous. Technical achievements can and will continue to enhance the ability to quickly detect and identify agents, as well as offer proficient tools for modeling the potential damaging consequences to be countered. In conjunction with and in implementation of the technical capability, the response involves the

engagement and coordination of an inordinate number of private, local, state and federal agencies. Unfortunately, the effort spent on the development of equipment greatly outweighs those focused on achieving adequate cooperation and integration between responsible agencies and independent actors. Risk and threat assessment must rely on a broad base of input at all levels. The direction provided by these analyses can greatly facilitate effective deployment and provide direction for technical research and development. Lastly, it can aide in guiding cooperation among the actors involved. Only through a deliberate combination of reliable and readily employable equipment and streamlined coordination among those responsible for these strategies can the amorphous threat be more clearly defined and counterproliferation efforts attain the desired outcome.

¹ Official participation of this co-author is pending approval of his sponsor.

² The Radiac Set (AN/PDR-77) can detect and measure nuclear radiation from nuclear accidents and other sources, has stable calibration and high reliability. Unlike earlier radiation detection devices, it can also measure alpha, beta, gamma and low energy x-ray radiation, while also measuring environmental levels. The "Pocket" Radiac is a hand-held device capable of measuring prompt gamma/neutron dose from an event plus gamma dose and dose-rate from nuclear fallout. The Radiac Set AN/PRD-77 has already been fielded and is the first unit to measure an individual's total dose.

³ Other indicators would include: large casualties within 48-72 hours; illness type that is unusual for the specific geographic area; illness occurs in an unnatural epidemiological setting; casualty distribution is aligned with wind direction; and lower attack rates among those working indoors.

⁴ These include three specific systems: 1) The Biological Integrated Detection System is vehicle mounted and tests environmental air samples by concentrating on relevant aerosol particle sizes in the air samples and subjecting samples to both generic and antibody-based detection for selected agents. Planned upgrades and expansion of point detection on the BIDS should enhance its capability. 2) The Long Range Standoff Detection System provides a first time biological standoff detection capability for early warning. It utilizes infrared laser to detect aerosol clouds from a distance of up to 30 kilometers. Development is underway to extend the range to 100 km. This system will be available for fixed site applications or inserted into various transport platforms such as fixed-wing or rotary aircraft. 3) The Short Range Biological Standoff Detection System employs ultraviolet and laser induced fluorescence to detect biological aerosol clouds at distances up to 5 km.

⁵ Both biological and chemical "smart tickets" are supplied to first responders under the Domestic Preparedness Program. Either in the form of a tape or a swab kit, these instruments function similar to a home pregnancy test and can detect and/or identify specific agents. They are cheap, portable and relatively reliable.

⁶ Medical Management of Chemical Casualties, Medical Research Institute of Defense (September 1995), 9-11.

⁷ Here a "natural occurrence" versus an attack is related to intent. A chemical hazard from an accident at a facility is considered "natural," as opposed to a deliberate release of toxic agents with the objective of causing harm. The Technical Escort Unit at Aberdeen has been called in on occasion to verify that a hazard was caused by an accidental collision of chemicals inducing harmful physical effects on local populations rather than a CW attack by outside actors.

⁸ Detection papers can identify (M8) or merely detect (M9) the presence of chemical agents. Such papers, which are similar to litmus paper in their application, and Simulator Detector Kits are being made available to first responders through the Domestic Preparedness Program. The alarm draws samples into a chamber and ionizes airborne agent molecules. A detector cell analyzes the resulting ion clusters, comparing their masses and charges with electronically stored standards to detect any presence of nerve agent vapor.

⁹ *Defense Technology Area Plan*, Chapter II "Chemical/Biological Defense and Nuclear," 11 July 1998, p. 3, <<http://www.dtic.mil/dstp/97_docs/dtap/cb/ch0201.html>>

¹⁰ The Joint Warning and Reporting Network (JWARNS) combines field information from NBC detectors with command post units housing meteorological and terrain information. Through digitized communications between field detection units and command post analysis capabilities, direction, degree and type of contamination can be quickly evaluated and consequence management can be implemented.

¹¹ Richard Davis, *Combating Terrorism: Observations on Crosscutting Issues*, USGAO, 23 April 1998, p. 1.