

# First Responder Knowledge and Training Needs for Bioterrorism

by

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## TABLE OF CONTENTS

Abstract.....	vi
Introduction and Statement of Problem.....	1
Specific Aims.....	11
Research Design and Methods.....	12
Results.....	21
Discussion.....	39
Conclusions and Recommendations.....	44
References.....	45

## APPENDICES

Appendix A.....	Survey
Appendix B.....	International Association of Fire Chiefs, Model procedures for responding to a package with suspicion of a biological threat.
Appendix C.....	Location of First Responder Knowledge and Training Needs Documents and Websites
Appendix D.....	Department of Homeland Security Proposed Guidance for Protecting Responders' Health During the First Week Following a Wide-Area Anthrax Attack (Draft September 2009)

**LIST OF TABLES**

<b>Table 1.</b> Statistics and analyses used to understand and reach aims of study.....	16
<b>Table 2.</b> Model inputs for outdoor scenario.....	19
<b>Table 3.</b> Survey participants' organizational information.....	21
<b>Table 4.</b> Survey participants' training information. ....	24
<b>Table 5.</b> Responses regarding who is in charge of different pieces of the response and who should be in charge of each response effort.....	26
<b>Table 6.</b> Level of PPE used for indoor and outdoor <i>B. anthracis</i> response.....	29
<b>Table 7.</b> Responses to Likert scale questions, with mean and 95% confidence intervals....	30

## LIST OF ILLUSTRATIONS

<b>Figure 1.</b> Timeline of 2001 anthrax response in USPS building. Data to create timeline gathered from Sanderson et al., 2003.....	8
<b>Figure 2.</b> Influence diagram showing decisions involved in <i>B. anthracis</i> response.....	9
<b>Figure 3.</b> Mean responses and 95% confidence intervals for attitude and perception questions.....	31
<b>Figure 4.</b> Risk of infection vs. distance for different meteorological stability classes.....	36
<b>Figure 5.</b> Risk of infection vs. distance for different release amounts.....	36
<b>Figure 6.</b> Risk vs. distance for different dose-response coefficients (r-value).....	36
<b>Figure 7.</b> GIS map showing risk of scenario during unstable atmospheric conditions.....	37
<b>Figure 8.</b> GIS map showing risk of scenario during neutral atmospheric conditions.....	37
<b>Figure 9.</b> GIS map showing risk of scenario during stable atmospheric conditions.....	38

## ABSTRACT

### First Responders Knowledge and Training Needs

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**Objective:** The 2001 anthrax attacks highlighted the need to protect first responders from bioterrorism attacks. While there have been updates to response protocols, the focus of these protocols varies, and first responders may still be unprepared. This study seeks to address the problem of a lack of a specific, universal bioterrorism training program for first responders. The research 1) determines current training practices for bioterrorism incidents, 2) evaluates the effectiveness of current training procedures, 3) investigates differences in training programs based on geography and organization, and 4) assesses attitudes and perceptions of bioterrorism and training. It also identifies areas of weakness and suggests where future training efforts should be focused.

**Methods:** *First Responders Knowledge and Training Needs* is a descriptive study based on interviews and a survey. The study used a questionnaire containing a combination of qualitative and quantitative questions. Subjects included 70 first responders from the United States who were recruited at a national conference and through personal and professional networking. Subjects' intuitive assessments of dispersion were contrasted with results of simple dispersion models, the Gaussian puff equation for an outdoor release (Long et al. 2006) and a completely mixed compartment model for an indoor release (Hong et al. 2010).

**Results:** 17.4% of participants did not have any training regarding bioterrorism, while a plurality of participants (29%) had received awareness level training, which is designed for those who require the skills necessary to recognize and report an incident or are likely to witness or investigate an incident. Less than one quarter of participants (24%) had on-line training, and the majority (39%) was trained in-residence at their facility. Less than half of the participants had been trained on how to use on-site testing devices, how to handle an indoor release scenario, or how to handle an outdoor release scenario. Low confidence levels were found regarding the use of on-scene testing devices and responding to outdoor release scenarios. This low confidence responding to an outdoor release where weak evidence was found that participants underestimate downwind risks and overestimate anthrax transfers perpendicular to wind direction during an outdoor release. Regarding personal protective equipment, participants gave varied responses to the level they would choose and the location at which they would dress.

**Conclusions:** A rapid response to a bioterrorism attack is critical for ensuring the safety of American citizens and can save costs associated with medical attention, cleanup, and decontamination efforts (Keim and Kaufmann, 1999). Educating first responders on the proper level and use of personal protective equipment is necessary to ensure they are protected and do not infect their colleagues or family. Utilizing alternative training programs, such as a “train-the-trainer” approach or on-line programs could also increase the number of first responders who have the knowledge and ability to respond to a bioterrorism attack.





## INTRODUCTION AND STATEMENT OF THE PROBLEM

After the 2001 anthrax attacks, the need to protect first responders from a bioterrorism attack was highlighted. The lack of an effective bioterrorism preparedness protocol resulted in a number of civilian illnesses and deaths caused by anthrax exposure (Gursky, Inglesby, and O'Toole, 2003). Several first responders were exposed to *Bacillus anthracis* spores due to a lack of training and understanding of potentially contaminated areas. In addition to protecting first responders, addressing the need for enhanced training will help safeguard the public. Without treatment, the risk of mortality for inhalational anthrax is nearly 100% (DHS, 2009). Even with treatment, those who were ill from anthrax and treated during the 2001 anthrax attacks still faced a 45% risk of fatality (Holty, Bravata, Liu, Olshen, McDonald, and Owens, 2006). The need to protect families and co-workers of first responders is also a high priority concern, as was demonstrated by the off-site contamination by equipment and clothing from the Capitol police Hazardous Device Unit who had responded to the 2001 anthrax attacks (Meehan, Rosenstein, Gillen et al., 2004). In addition, efficient training programs may reduce the costs involved with unnecessary cleanup and decontamination efforts, antibiotic distribution, and medical attention (Keim and Kaufmann, 1999).

An assessment of the response to the 2001 anthrax attacks could help in the development of improved and standardized response protocols. However, there has still not been a comprehensive published analysis of the response (Gursky et al., 2003). As of May 2010, the National Institutes of Standards and Technology (NIST) has been working on new standards based on the 2001 attacks. Currently, these standards are not published, but they plan to be released this year. Additionally, the peer-reviewed literature lacks studies assessing training and knowledge gaps of first responders in regards to on-scene decision making. Some studies have,

however, investigated community level response strategies, focusing on medical professionals and corporations (Flowers et al., 2002; Wrigley et al., 2003; Ablah et al., 2006). One study, including German firefighters responding to a simulated bioterrorism incident, evaluated the effectiveness of a specific training module. Problems with the response tactics were found, but the study did not elicit the firefighters perceptions on the effectiveness of the training they had received (Lenz and Richter, 2009). Abatamarco et al. (2007) have published one study that identified knowledge and perceptions of emergency medical technicians (EMTs), but this research focused mainly on respirator use in the event of a chemical or biological attack. Abatamarco et al.'s study involved 17 volunteer EMTs participants from Hunterdon County, NJ. The participants were given a pre-training survey with 20 questions assessing their attitudes and perceptions toward bioterrorism, biological agents, and respirator use. Participants then took part in a training program which included background information on bioterrorism, biological agents, respiratory health and protection, and fit-testing. After the training session, a post-training survey was administered. Statistically significant changes in knowledge and perceptions were found after the training, suggesting a need for training to address these knowledge gaps. Additionally, the authors mention the lack of background and baseline data on first responder knowledge and training needs as a major data gap. In light of this missing information, this study aims to help fill that gap and provide information on necessary training procedures and protocols for on-scene decision making.

This study seeks to address the problem of a lack of a specific, universal bioterrorism training program for first responders. The research evaluates the effectiveness of current training procedures for first responders to a bioterrorism event. It also identifies areas of weakness and suggests where future training efforts should be focused.

## **BACKGROUND AND SIGNIFICANCE**

### *Anthrax as a Weapon*

*Bacillus anthracis* has a number of properties that make it ideal for weaponization: the spores are very stable, spores cause infections through the respiratory tract, and there is a high case-fatality rate for inhalation (Meehan et al., 2004). Currently over a dozen countries have a biological warfare program, and terrorist groups such as Al-Qaeda have shown interest in biological weapons (Davis and Bennett, 2004). The Iraqi bioweapons program has reported over 22,000 gallons of anthrax, with over 2,000 of these gallons being weaponized (Missouri Department of Health and Senior Services, 2004). The United States Army Medical Research Division for Infectious Disease ranks anthrax as the most likely agent to be utilized in a biological attack (Kortpeter and Parker, 1999). As such, planning and training for an anthrax attack is necessary to include in public health preparedness plans.

Inhalation exposure after an anthrax attack can occur through both primary and secondary aerosolization. Primary aerosolization occurs during the initial release from a disseminating device or handling a package. Secondary aerosolization/ occurs when settled anthrax particles are resuspended (Meehan et al., 2004). While inhalational anthrax cases have been reported in United States in the 20<sup>th</sup> century, the first cases of intentional anthrax release resulting in an outbreak were not documented until 2001 (Jernigan, Stephens, Ashford, et al., 2001; Sanderson, Stoddard, Ect et al., 2003). Earlier inhalational exposures were associated with occupational exposures from processing contaminated animal fibers (Sanderson et al, 2003).

### *Current State of Training Programs*

While there has been a great deal of recent activity regarding bioterrorism preparedness in federal, state, and local public health agencies since the 2001 anthrax attacks, many of the developments and programs are inconsistently shared and vary across government levels (Gursky et al., 2007; Fraser and Brown, 2000). Federal government agencies, including the Centers for Disease Control and Prevention (CDC), Department of Transportation (DOT), Environmental Protection Agency (EPA), American Society for Testing and Materials (ATSM), Department of Homeland Security (DHS), and National Institute for Occupational Health and Safety (NIOSH) have published guidelines and protocols for biological terrorism attacks, yet these protocols vary between agencies (CDC, 2010; DOT 2008; ATSM, 2006; DHS 2008; NIOSH, 2004). Even in the military sector, the Department of Defense has failed to prepare a procedural solution to a biological threat (Davis and Bennett, 2004). In 1999 and 2000, \$730 million was appropriated by Congress for bioterrorism preparedness programs in local and state health departments. In 2000 and 2001, bioterrorism exercises were conducted to assess the efficiency of response tactics (Jones, 2002). A lack of coordination among state and federal agencies was highlighted in these mock attacks, and Congressional hearings emphasized the need for first responder training programs (Jones, 2002). After the attacks in 2001, the Bioterrorism Preparedness Act, S.1765, and the Tauzin-Dingell bioterrorism measure, H.R.3448, were introduced (Jones, 2002). Since the 2001 terrorist attacks, there has been an increase in funding and efforts to create and improve first responder training, yet there are still many gaps that need to be filled. In 2009, DHS drafted guidance for first responder procedures during a wide-area outdoor attack (Appendix D). This guidance mainly addresses personal protective equipment, post-exposure prophylaxis and vaccination, and notes knowledge gaps regarding

methods of decontamination, isolation from contaminated areas, and understanding of dispersion (DHS, 2009). This study will assess the effectiveness of the newly created training programs and highlight areas that need strengthening.

Waeckerle et al. (2001) developed recommendations for training and planning initiatives for emergency physicians, emergency nurses, and emergency medical technicians in response to weapons of mass destruction (WMDs). Their analysis, however, does not cover first responders such as the fire department or police personnel. The authors point out that “one of the most critical elements of [training development] is to identify and analyze specific learner needs...in order to produce a list of performance-based learning objectives that is both comprehensive and relevant to particular job demands” (Waeckerle, Seamans, Whiteside, et al., 2001, p.598).

Additional needs assessments have been carried out assessing physicians’ preparedness, needs, and ability to treat patients who have suffered from a bioterrorism attack (Sterling et al., 2005; Henreig et al., 2002; Shadel, et al., 2005). This points directly the need for an analysis such as the one completed in this study.

### *2001 Anthrax Attack Response*

In the October 2001 anthrax attacks, *B. anthracis* spores were mailed to Washington D.C., New Jersey, New York, and Florida from Trenton, NJ. (Sanderson et al., 2003; Jernigan et al., 2001). Four of the eleven total cases of inhalational anthrax were diagnosed in workers of a U.S. Postal Service processing and distribution center in Washington, D.C. The timeline below (Figure 1) describes the path of the anthrax-containing envelopes and the response:

**Figure 1.** Timeline of 2001 anthrax response in USPS building. Data to create timeline gathered from Sanderson et al., 2003



As shown in Figure 1, the response to anthrax was slow. Ten days passed until the HVAC system in the USPS building was shut down and the building was evacuated. It took another two days until the Centers for Disease Control and Prevention (CDC) arrived to begin an investigation. Similar mistakes were made in the response to the anthrax that reached Senator Daschle's office on Capitol Hill where the possibilities of cross-contamination were high (Martin, 2003). During the Capitol Hill incident, over an hour passed until the anthrax threat was taken seriously and the police were notified. An additional hour passed until the police arrived (anonymous, personal communication, October 2011). Such delays highlight the need for standardized, efficient training protocols.

In addition to the delay in response time, many additional problems were identified in the 2001 response procedures. First, a diluted bleach solution (sodium hypochlorite) was used to inactivate the *B. anthracis* spores at Capitol Hill, USPS Centers in Washington D.C. and Trenton, New Jersey, the Department of State in Washington D.C. and Boca Raton, Florida. (EPA, 2007). Responders were first told to use a 5% bleach solution to decontaminate the buildings. However, the 5% bleach solution was not effective, and live spores were found after decontamination. Later, a 10% bleach solution was found to be effective, but did result in some response personnel getting rashes (anonymous, personal communication, October 2011). Additionally, many first responders put on their personal protective equipment approximately 100 feet from the release site, resulting in their exposure. The containment effort in the 2001 response was not aggressive due to the vast amounts of uncertainty regarding responsibilities for duties and proper response procedures. Treatment, however, was aggressive which saved many lives. First responders in the 2001 attacks also underestimated the extent of contamination due to dispersion, such as the potential for an aerosol release to spread even to parts of the building

served by different HVAC systems, and the transfer of spores by tracking (anonymous, personal communication, October 2011).

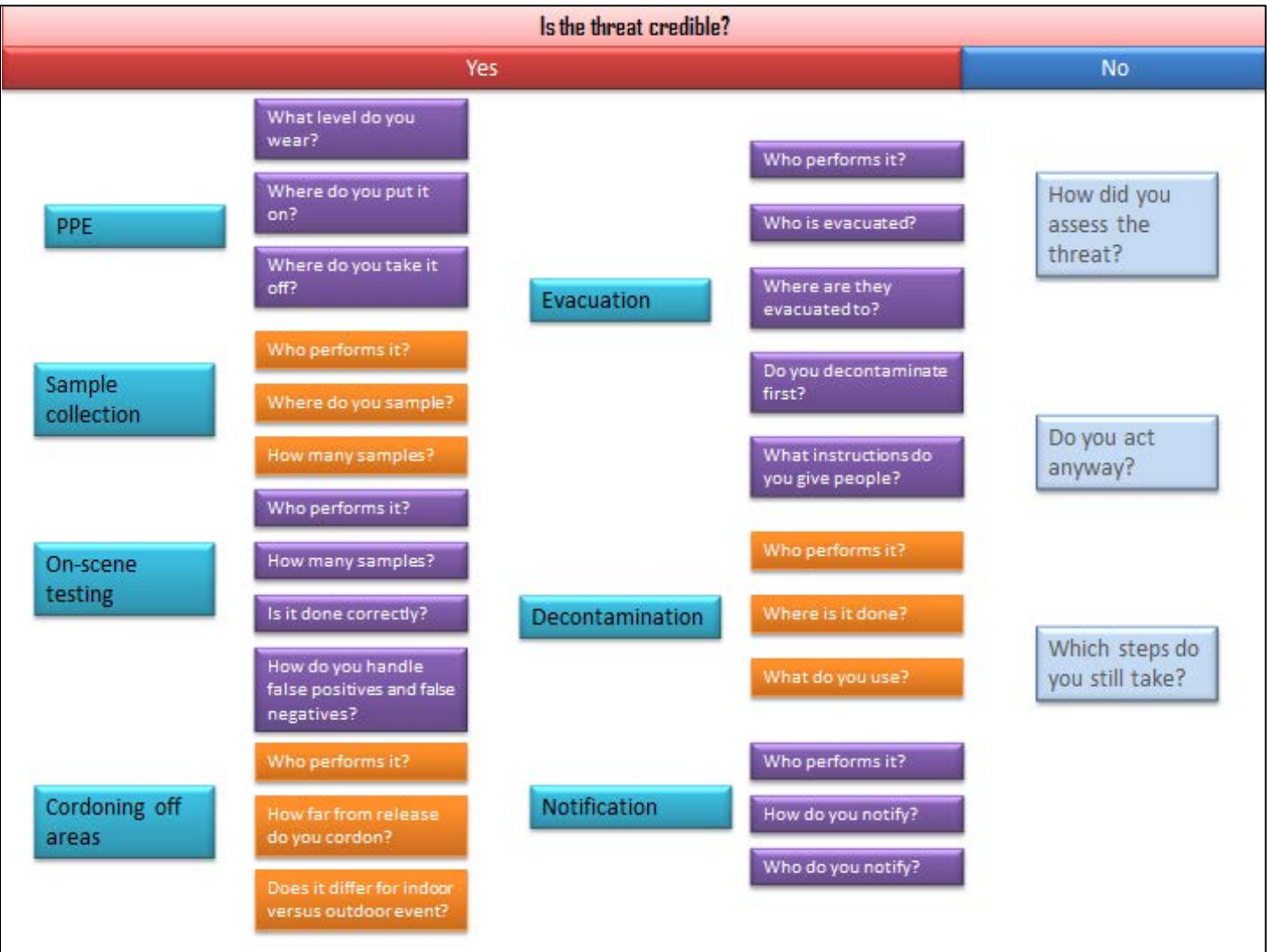
### *Theoretical Framework and Conceptual Models*

A majority of the survey is based on the conceptual model shown in Figure 2. This model visually represents the decisions first responders must make during a bioterrorism event. Previous training and confidence in reacting to a situation will influence these decisions. This conceptual model was built based on discussions with experts, including Fire Chiefs, first responders involved in the 2001 anthrax attacks, and state preparedness coordinators. The model was also influenced by the International Association of Fire Chiefs' First Responder Decision Matrix (Appendix B).

In addition to the conceptual model in Figure 2, the survey includes Likert scale questions and scenarios. The Likert scale is used to evaluate attitudinal questions of prioritization and confidence. The use of scenarios has been used in many disciplines, including military strategy, marketing, economy, and decision making (Leite, Hadad, Doorn, and Kaplan, 2000). Scenarios have been shown to be effective methods of evaluation due to their ability to stimulate thinking (Leite et al., 2000). The scenarios used will be based on possible real-life situations and will include both indoor releases of anthrax and outdoor releases. These scenarios will evaluate participants' confidence in reacting to the situation, and their decontamination and evacuation techniques. This can then be modeled to check if the respondents answers will assure safety and protection for all who may be exposed.



**Figure 2.** Influence diagram showing decisions involved in *B. anthracis* response.



In order to evaluate the scenario questions, past modeling studies and current modeling work will be evaluated. Modeling and simulation of chemical and biological agent releases has been used extensively in response applications (Jain and McLean, 2003). Additionally, emergency response personnel often use the results of such modeling to develop training and action plans for real-life scenarios (Jain and McLean, 2003). While current modeling systems are able to capture many aspects of a disaster (i.e. evacuation, deposition and transport, medical response, etc.), the modeling in this study mainly looks at a single dispersion event (one for an indoor release and one for an outdoor release).

#### *Contribution to First Responders and the Public*

This study increases the safety of first responders and the public in the event of a bioterrorism attack. Through the evaluation of our results, training programs for first responders can be improved. This will not only ensure that the first responders are protected from the threats posed by biological warfare, but will also safeguard the public that relies on first responders to properly manage incidents.

#### *Factors not Addressed in this Study*

This research focuses on inhalation risk of aerosolized *B. anthracis* only, and does not consider ingestion or cutaneous forms. The inhalation pathway was selected due to the high fatality risk, which historically ranged from 89 to 96% in untreated (Hong et al., 2010; Holty et al., 2006; Swanson and Fosnocht, 1999). During the modeling phase of this study, which will be used to assess the accuracy of first responders' evacuation and decontamination knowledge based on fictitious scenarios, uniform mixing will be assumed in indoor areas. This assumption may neglect high risk localized areas, such as areas where a letter was first opened, but will be

appropriate for areas removed in time and space from the release (i.e. a different room or building) (Hong et al., 2010). The modeling of an outdoor release will not include the influences of buildings, traffic, or other factors that would interfere with dispersion.

Additionally, this study will not compare the perceived capability of participants with their actual performance during a threat or mock event.

## **SPECIFIC AIMS**

*First Responders Knowledge and Training Needs for Bioterrorism* has 4 specific aims:

- 1) Determine the current training practices for bioterrorism incidents;
- 2) Investigate the differences in training programs on the basis of geography and organization;
- 3) Identify gaps in knowledge;
- 4) Develop recommendations for a protocol for a universal training program;

The determination of current training practices includes identification of who administers the training, where it takes place, how long it takes, and what the contents include. The investigation of differences in training programs assesses variations in training based on 1) geography: urban (with specific groups in high-threat areas of New York City and Washington, D.C.), suburban, and rural areas; 2) organizational level: local, state, or federal; and 3) organization type: Fire, Police, Health Department, and/or Hazardous Materials (Hazmat) Response Unit. Identification of knowledge gaps focuses on selection of personal protective equipment, cordoning off areas, evacuation, and decontamination. The development of recommendations for a training program protocol is based on both participants' beliefs in what should be included and an evaluation of knowledge gaps.

## RESEARCH DESIGN AND METHODS

### *Overview of Study Design*

*First Responders Knowledge and Training Needs* is a descriptive study utilizing interviews and surveys. The study design used in this project is a questionnaire containing a combination of qualitative and quantitative questions. Surveys are often used as a measurement of quality, and in this research are used to measure the perceived quality of training programs (Allen and Seaman, 2007).

### *Subjects*

The subjects in this study include first responders in the United States. In order to be included in the study, participants must currently be, or in the past have been, first responders. The Department of Homeland Security defines a first responder as

*individuals who in the early stages of an incident are responsible for the protection and preservation of life, property, evidence, and the environment, including emergency response providers as defined in section 2 of the Homeland Security Act of 2002 (6 U.S.C. 101), as well as emergency management, public health, clinical care, public works, and other skilled support personnel (such as equipment operators) that provide immediate support services during prevention, response, and recovery operation (DHS, 2009).*

This study includes members of police forces and fire departments, both volunteer and paid, the health department, and HAZMAT teams. Both males and females were included. An attempt was made to represent various geographical areas within the United States, including participants from urban and suburban areas.

### *Sample size and justification*

The study enrolled 70 participants. This number allows the study enough statistical power to make significant comparisons and conclusions. IRB approval was granted for 100 participants. While a larger sample size would further increase the power, it was unfeasible for the time and funding constraints on the project.

### *Recruitment and enrollment procedure*

Subjects were recruited by a number of means. Surveys were distributed at a national conference (Fire Rescue EAST in Daytona Beach, Florida January 20 and 21, 2011) and through personal, professional, and local networking. Publically available contact information on state and agency websites was also used to recruit participants. Potential subjects not present at the conference were contacted via e-mail, phone, or personal interaction. Incentives have been shown to have a significant positive effect on response rate, so this study offered compensation in the form of gift cards (Church, 1993). A \$20.00 Amazon.com or Starbucks gift cards were offered as compensation for completion of the survey.

### *Data Collection Methods and Procedures*

The survey was designed to take approximately 20 minutes. This provided an adequate amount of time to complete the survey and gather all the data needed for analysis and still accommodated the busy schedules of first responders. The survey was designed using language familiar to the first responder community, including terms used in the National Incident Management System emergency response protocols. Several first responders, regional preparedness experts, and personnel from government agencies, including the Federal Emergency Management Agency (FEMA) and the Department of Health and Human Services

(HHS) were involved in the development and pre-testing of the survey. The survey was given in-person and mailed to fire departments. Due to the complexity of the scenario questions, the majority of surveys (n=52) were administered orally. 18 surveys were returned via the U.S. Postal Service, with a mailed survey response rate of 30%.

Many of the questions in the survey instrument use a Likert scale, ranging from 1 to 5. Likert scales have been used widely to measure attitudes and opinions (Gob, McCollin, and Ramalhoto, 2007). Five response categories is the minimum recommended number of categories, and this survey utilizes five (Allen and Seaman, 2007). The attitude and perception response ratings included: 1= “strongly disagree,” 2= “disagree,” 3= “neutral/no opinion,” 4= “agree,” and 5= “strongly agree.” This scale is similar to the one used to assess perception of first responders in a related study (Abatemarco et al., 2007).

Scenarios have been shown to be effective methods of evaluation due to their ability to stimulate thinking (Leite et al., 2000). The first scenario developed for use in the survey are modeled after those used by Hong, Gurian and Ward (2010) to determine risk-informed concentration standards for *B. anthracis* and by the National Institutes of Technology (NIST). This scenario models a hypothetical office with a simple heating, ventilation, and air conditioning (HVAC) system. The second, an outdoor release of anthrax, uses parameters similar to those found in the Hazard Prediction and Assessment Capability (HPAC) model (Davis and Bennett, 2004).

The survey was pilot tested with individuals from the first responder community. This helped identify any questionnaire problems (ASA, 1997). Pilot testing also ensured that the

questions were understandable and addressed any problems with formatting that may have caused participants to skip questions or become confused (ASA, 1997).

**Data management and file development activities.** Data was entered manually into Microsoft Excel and SPSS Statistical Package, Version 19. Files were saved to a hard drive and back up externally once a week. Coding systems were used to define variables for data entry into SPSS. Checks were made after data entry to ensure the correct data has been entered into the system.

#### *Analysis Plan*

In order to analyze the data collected from the survey, a number of statistical calculations were performed. Data were entered into Microsoft Excel and SPSS Version 19. Means, frequencies, correlations, regression, and cross-tabs were calculated. The statistical operations used to achieve each project aim are outlined in Table 1.

**Table 1.** Statistics and analyses used to understand and reach aims of study

<b>Aim</b>	<b>Analysis</b>
Determine current training practices for bioterrorism incidents	Calculate means for questions asking about training in specific areas of response; use logistic regression to determine why there may be differences; ANOVA and contingency tables/chi-square tests to assess relationship between training and location, organization, and other categorical variables
Investigate differences in training programs on the basis of geography and organization	Use logistic regression and cross-tabs to determine what influences competencies
Identify gaps in knowledge	Calculate means for questions asking about confidence; evaluate number of correct responses for questions that are included as a "check"
Develop recommendations for a protocol for a universal training program	Combine results of previous analyses to determine where gaps in knowledge are, why they occur, and what first responders think should be a priority for training; Compare this to current training recommendations and procedures

There is no common standard for the analysis of Likert scale data (Gob et al., 2007); however mean and standard deviation are often invalid parameters when analyzing ordinal scales such as Likert scales (Allen and Seaman, 2007). Because of this, tabulations, frequencies, contingency tables, and chi-square statistics were calculated. Means were also calculated for other questions that were ordinal in scale. This process is similar to the groupings that were done in the study of first responders by Abatemarco et al., 2007.

### **Modeling scenarios.**

*Indoor Scenario Modeling.* Modeling studies have been performed to estimate the effects of anthrax releases indoors. Reshetin and Regens (2003) numerically modeled the intentional release and subsequent dispersion of anthrax spores in a typical 50-story, high-rise building.



Their model predicts the time required for spores to disperse throughout a building. Results of the analysis show that even with a small release, infectious concentrations of spores quickly disperse throughout the building. Webb and Blaser (2002) mathematically modeled transmission of inhalational anthrax via the postal system by cross-contaminated mail. The model used state vectors to consider the generation of cross-contaminated letters, the numbers of anthrax spores on the letters, and the numbers of infections that would result in recipients. It created a general framework to investigate potential impacts of future outbreaks. Ho and Duncan (2005) used simulated anthrax spores to describe the biological aerosols created by manipulating letters contaminated with spores, as well as the dispersion of those spores when the letter was processed by a mail sorter. The results were used to estimate aerosol dosages that result from spore contaminated letters. Hong et al. (2010) discuss the need to use environmental concentrations of *B. anthracis* to infer past or future aerosol exposures in an indoor environment given the rapid decline in air concentrations immediately after a release. Their model relates concentrations of spores on walls and floors, in ventilation system filters, and in human nasal passages to human health risk. Given the large numbers of assumptions that need to be made, they conclude that there are large uncertainties associated with the calculated risk.

*Outdoor Scenario Modeling.* The second scenario included in the survey was an outdoor release at Love Park in Philadelphia, Pennsylvania where anthrax was sprayed from someone posing as a landscaper. There have been a number of studies which have attempted to quantify the impact of a large-scale release of anthrax (WHO 1970; OTA 1993; Wein et al. 2003; Isukapalli et al., 2008), which can be used to compare participants' responses to the scenario questions. In addition to using these past studies, we performed a risk assessment analysis.

The risk assessment regarding the outdoor scenario was performed to determine the extent of contamination from an outdoor release in Love Park. The base case for this scenario was assumed to be a release of 1 gram of anthrax at Love Park on a day when the prevailing wind was from the west. It was assumed that the release occurred at a height of 2.4 m above the ground surface, and the concentration was measured at a height between 1.2 and 1.7 m above the ground surface. Wind speed was estimated to be 4 m/s, which represented a “neutral” meteorological condition. In determining dose, the average dose response parameter discussed in Hong et al. (2010) was used.

The release was assumed to be instantaneous, so a Gaussian puff equation was used to model transport and dispersion of the spores after release (Long et al. 2006). The model was used to calculate the concentration profile with time after release. The puff model is defined by the following equation:

$$C_r(x_r, y_r, z_r, t) = \frac{Q}{(2\pi)^{1.5} \sigma_x \sigma_y \sigma_z} \exp\left(\frac{-(x_r - Ut)^2}{2\sigma_x^2}\right) \exp\left(\frac{-y_r^2}{2\sigma_y^2}\right) \left[ \exp\left(\frac{-(z_r - H_e)^2}{2\sigma_z^2}\right) + \exp\left(\frac{-(z_r + H_e)^2}{2\sigma_z^2}\right) \right]$$

where

- $C_r$  = concentration at receptor, spores/m<sup>3</sup>  
 $x_r, y_r, z_r$  = Cartesian coordinates downwind of the puff, m  
 $Q$  = emission rate, spores  
 $t$  = time since release, s  
 $U$  = wind speed, m/s  
 $H_e$  = height of puff centerline, m  
 $\sigma_x, \sigma_y, \sigma_z$  = standard deviations of the concentration distribution x-, y-, z-directions, m

The following assumptions were made in utilizing the Gaussian puff model:

1. The dispersion coefficients in the x- and y-directions were assumed to be the same.
2. The wind was assumed to be a uniform speed parallel to the x-direction.

3. The spore concentration was calculated in a cube with dimensions of 1m x 1m x 0.5m at a height between 3.8 and 5.4 feet above the ground surface.
4. The anthrax was released at a height of 8 feet above the ground surface.

Details of the parameters used in the base case are shown in Table 2.

**Table 2.** Model inputs for outdoor scenario.

MODEL INPUTS		
<b>CONSTANTS</b>	Base (variations)	
Q (spores)	1.3E12 (1.3E11, 1.3E13)	
U (m/sec)	4 (2, 6.7)	
H <sub>e</sub> (m)	2.4384	
Solar Radiation	2.21	
Inhalation rate:	3.33E-4 m <sup>3</sup> /sec	
R value	7.43E-6 (9.10E-7, 7.10E-5)	
Stability Class	C (A, G)	
<b>Time Step (seconds)</b>		
	300	
<b>Exposure Time (seconds)</b>		
	1800	
<b>Source Height (m)</b>		
	2.4384	
<b>Inhalation Height Range (m)</b>		
	1.17 - 1.67	
<b>Dispersion Parameters for Instantaneous Releases</b>		
Dispersion Parameter	Stability	Equation (x in meters)
σ <sub>y</sub>	Unstable	0.14x <sup>0.92</sup>
	Neutral	0.06x <sup>0.92</sup>
	Very stable	0.02x <sup>0.89</sup>
σ <sub>z</sub>	Unstable	0.53x <sup>0.73</sup>
	Neutral	0.15x <sup>0.70</sup>
	Very stable	0.05x <sup>0.61</sup>

Source for dispersion parameters: Isplitzer and Slade 1968.

The resulting concentration profile was used to calculate the inhalation dose according to the following equation:

$$Dose = \text{inhalation rate} * \text{concentration} / \text{volume}$$

As shown in Table 3, a constant inhalation rate of  $3.33 \times 10^{-4} \text{ m}^3/\text{s}$  (Hong et al. 2010) was used for the base case. In applying this equation, it was assumed that the inhalation rate was

constant and that anthrax dose is from inhalation only. Other exposure pathways such as dermal and ingestion exposure were considered to be negligible compared to inhalation.

To determine risk, the exponential dose response equation was used:

$$Risk = 1 - e^{-r(dose)}$$

where  $r$  = dose response coefficient specific to *B. anthracis*. For the base case, a dose response coefficient of  $7.43 \times 10^{-6}$  was used (Hong et al. 2010). Uniform population characteristics, including age distribution and susceptibility to infection, were assumed in applying this equation. The following parameters were varied in the sensitivity analysis: amount of anthrax released; dose response parameter; wind direction; acceptable risk; meteorological stability class; and, time of release (day vs. night). The results of the sensitivity analysis are discussed in the results section.

## RESULTS

A total of 70 first responders participated in this research study. Table 3 shows the organizational breakdown of the participants. Of the 70 first responders involved in this study, 55 were from the fire department, 1 was from the police department, 2 represented the health department, 5 were Hazmat technicians and 7 fell in the “other category” which included combination of organizations and other first responder personnel such as emergency medical technicians (EMTs). 50 study participants represented local departments, 12 were state-level first responders, 3 were from federal agencies, and 5 were included as “other.” Regarding location, 29 of the participants were from urban areas, 18 were from suburban regions, and 22 were located in rural areas of the United States.

**Table 3.** Survey participants' organizational information.

<b>Organization</b>	
Fire	55
Police	1
Health Department	2
Hazmat	5
Other	7
<b>Total</b>	<b>70</b>
<b>Organizational Level</b>	
Local	50
State	23
Federal	3
Other	6
<b>Total</b>	<b>70</b>
<b>Location</b>	
Urban	29
Suburban	18
Rural	22
<b>Total</b>	<b>69</b>

Table 4 gives the summary of participants' training levels, locations, and providers. Additionally, it gives the breakdown of the percentage of participants who have been trained in specific areas. Of the 69 first responders who answered what level training they had regarding bioterrorism, 12 (17.4%) had not received any training. 29% of participants had received awareness level training, which FEMA defines as "designed for responders who require the skills necessary to recognize and report a potential catastrophic incident or who are likely to witness or investigate an event involving the use of hazardous and/or explosive devices" (NTED, 2011). 10% of participants had received performance level training, which is "designed for first responders who perform tasks during the initial response to a catastrophic event, such as safeguarding the at-risk public, rescuing victims, or decontaminating victims" (NTED, 2011), and 3% had received management and planning level training, which is "designed for managers

who build plans and coordinate the response to a mass consequence manmade or natural event (NTED, 2011). 22% had been trained in Hazmat response, and 19% had a combination of different training levels. Note that the definition of “Hazmat training” varies, and there are different levels of training, including awareness, materials operation, and technical training (IAFF).

The location of where the first responder participants had been trained and the training provider varied. 39% were trained in-residence at their facility, 27% were trained at a location other than their facility, such as a national or regional training center, 12% completed their training on-line, and 22% had been trained at more than one of the location choices. When “other” responses included a combination with “on-line,” this raised the total amount of participants who had been trained using *at least* on-line training to 24%. 45% of participants were trained by personnel from their facility, such as a chief. 22.6% of participants received their training from someone in the U.S. Department of Homeland Security, for example someone from the Federal Emergency Management Agency (FEMA). 6.5% of participants were trained by someone from the Occupational Health and Safety Administration (OSHA), and 1 participant was trained by someone from the National Institute for Occupational Health and Safety (NIOSH). 12.8% of participants had training from a combination of providers, and 11.3% received training from someone not mentioned on our list of choices.

The survey asked about training in specific areas, including 1) who to notify in the event of a white powder event, 2) what areas to cordon off in the event of a white powder event, 3) how to perform personal decontamination, 4) how to use hand-held, on-site testing devices, 5) how to handle an indoor release of anthrax such as the situation presented in the first scenario, and 6) how to handle an outdoor release of anthrax such as the situation presented in the second

scenario. Over half of the participants had been trained regarding notification (67.3%), cordoning off areas (61.8%), and personal decontamination (70.9%). Less than half were trained regarding hand-held, on-site testing devices (34.5%), and how to respond to the indoor (41.8%) and outdoor (32.7%) release scenarios.

**Table 4.** Survey participants' training information.

	Number	Percent
<b>What level training have you received?</b>		
Awareness Level	20	29.0%
Performance Level	7	10.1%
Management and Planning Level	2	2.9%
HAZMAT	15	21.7%
Combination	13	18.9%
No Training	12	17.4%
Total	69	100.0%
<b>Where did you receive training?</b>		
In-residence, at my facility	23	39.0%
A location other than my facility	16	27.1%
On-line	7	11.9%
Combination	13	22.0%
Total	59	100.0%
<b>Who provided the training?</b>		
Someone from my facility	28	45.2%
Someone from DHS	14	22.6%
Someone from OSHA	4	6.5%
Someone from NIOSH	1	1.6%
Combination	8	12.8%
Other	7	11.3%
Total	58	100.0%
<b>General training topics</b>		
	<b>Yes n(%)</b>	<b>No n(%)</b>
I have been trained about who to notify in the event of a white powder event.	37 (67.3%)	18 (32.7%)
I have been trained on what areas to cordon off in the event of a white powder event.	34 (61.8%)	21 (38.2%)
I have been trained on how to perform personal decontamination.	39 (70.9%)	16 (29.1%)
I have been trained on how to use hand-held, on-site testing devices.	19 (34.5%)	36 (65.5%)
I have been trained on how to handle an indoor release of anthrax*.	23 (41.8%)	32 (58.2%)
I have been trained on how to handle an outdoor release of anthrax*.	18 (32.7%)	37 (67.3%)

\*These questions referred to scenarios presented in the survey, not indoor and outdoor releases in general.



In order to evaluate the differences between who is in charge of certain efforts of a white powder response, participants responded to questions asking who is in charge of 1) sample collection, 2) on-scene testing, 3) cordoning off, 4) evacuation, and 5) decontamination. Participants then chose the department they believed *should be* in charge of each response effort (Table 5). There were slight variations (less than a 5 person change) between who is in charge and who should be in charge for all of the response efforts. Regarding sample collection, nearly half (48.5%) of participants responded that the fire department is in charge, and 43.1% believed they should be in charge. 10% responded that the police department currently handles sample collection, 15.7% chose the health department, and 4.3% said sample collection is handled by whoever is on the scene first. Responses followed a similar pattern for on-scene testing, cordoning off, and evacuation, with the majority of respondents selecting the fire department as who is currently in charge and who should be in charge. For on-scene testing, the next highest selection was the health department, with 21.7% stating they are currently in charge and 26.1% believing they should be in charge. The fire department was chosen by over half of participants (66.7%) as being responsible for personal decontamination, the only response element to have over 50% of responses in agreement.

**Table 5.** Responses regarding who is in charge of different pieces of the response and who should be in charge of each response effort.

	In Charge		Should be In Charge	
	#	%	#	%
<b>Sample Collection</b>				
Fire Department	32	48.5%	28	43.1%
Police Department	7	10%	6	9.2%
Health Department	11	15.7%	15	23.1%
Whoever is first on the scene	3	4.3%	1	1.5%
Other	11	15.7%	14	21.5%
Total	66	100.0%	65	100.0%
<b>On-scene Testing</b>				
Fire Department	28	40.6%	28	40.6%
Police Department	3	4.3%	3	4.3%
Health Department	15	21.7%	18	26.1%
Whoever is first on the scene	6	8.7%	3	4.3%
Other	15	21.4%	17	24.6%
Total	69	100.0%	69	100.0%
<b>Cordoning off</b>				
Fire Department	28	40.6%	28	40.6%
Police Department	15	21.7%	12	17.4%
Health Department	2	2.9%	5	7.2%
Whoever is first on the scene	15	21.7%	12	17.4%
Other	9	13.1%	12	17.4%
Total	69	100.0%	69	100.0%
<b>Evacuation</b>				
Fire Department	32	45.7%	31	44.9%
Police Department	22	31.4%	17	24.6%
Health Department	2	2.9%	7	10.1%
Whoever is first on the scene	5	7.1%	3	4.3%
Other	8	11.3%	11	15.8%
Total	69	100.0%	69	100.0%
<b>Decontamination</b>				
Fire Department	46	66.7%	43	62.3%
Police Department	1	1.4%	2	2.9%
Health Department	7	10.1%	11	15.9%
Whoever is first on the scene	4	5.8%	2	2.9%
Other	11	15.7%	11	15.7%
Total	69	100.0%	69	100.0%

In order to determine if the responses generated for questions regarding who is and who should be in charge of response elements were a function of bias, cross-tabulations were performed to examine differences between fire department and non-fire department responses.

The main differences included:

- In non-fire department responses, the health department received higher overall responses, especially for “who should be in charge of sample collection” (27% of fire department participants chose the health department while 44.5% of non-fire department participants chose health department)
- 47% of fire department participants think they should be in charge of on-scene testing, while 65% of non-fire department participants think the fire department should be in charge. 40% of fire department participants think health department should be in charge, while only 27% of non-fire department participants think health department should be in charge.
- 29% of fire department participants think the police should be in charge of cordoning off areas, while 0% of non-fire department participants think the police should be. 27.3% of non-fire department participants think health department should be in charge of cordoning off areas, while only 5% of fire department participants think health department should be in charge.

These differences could just be an effect of small sample size of non-fire department participants or different protocols for different areas and may not necessarily represent a disconnect between groups in a geographic location that would need to work together during a response.

The survey also asked first responders what level of PPE they would wear when responding to an indoor white powder incident and an outdoor white powder incident (Table 6). According to OSHA (1993), Level A is required when the “greatest level of skin, respiratory, and eye protection is required.” It consists of 1) a positive pressure, full face-piece self-contained breathing apparatus (SCBA) or positive pressure supplied air respirator with escape SCBA, 2) a total-encapsulating chemical-protective suit, 3) inner and outer chemical-resistant gloves, 4) chemical resistant boots, and 5) disposable protective suit, gloves, and boots. Level B provides the highest level of respiratory protection but a lesser level of skin protection, and it consists of 1) a positive pressure, full face-piece SCBA or positive pressure supplied air respirator with escape SCBA, 2) hooded chemical-resistant clothing, 3) inner and outer chemical-resistant gloves, and 4) chemical resistant boots (OSHA, 1993). Level C is recommended when responders know concentrations and types of airborne substances and require air purifying respirators. The equipment for Level C consists of 1) a full-face or half-mask, air purifying respirator, 2) hooded chemical-resistant clothing, and 3) inner and outer chemical resistant gloves (OSHA, 1993). Level D is a standard work uniform which is used for “nuisance contamination only” (OSHA, 1993). For an indoor incident, the majority (39.7%) would wear Level A, 25% would wear Level B, 8.8% would wear level C, 2.9% would wear Level D, and 23.5% would remain outside until a certified team is notified. The majority of participants (34.3%) responded that they would wear Level B to an outdoor white powder event, 29.4% would wear Level A, 8.6% would wear Level D, and 22.9% would remain outside the affected area until a certified team is notified.

**Table 6.** Level of Personal Protective Equipment used for Indoor and Outdoor *B. anthracis*

Response.

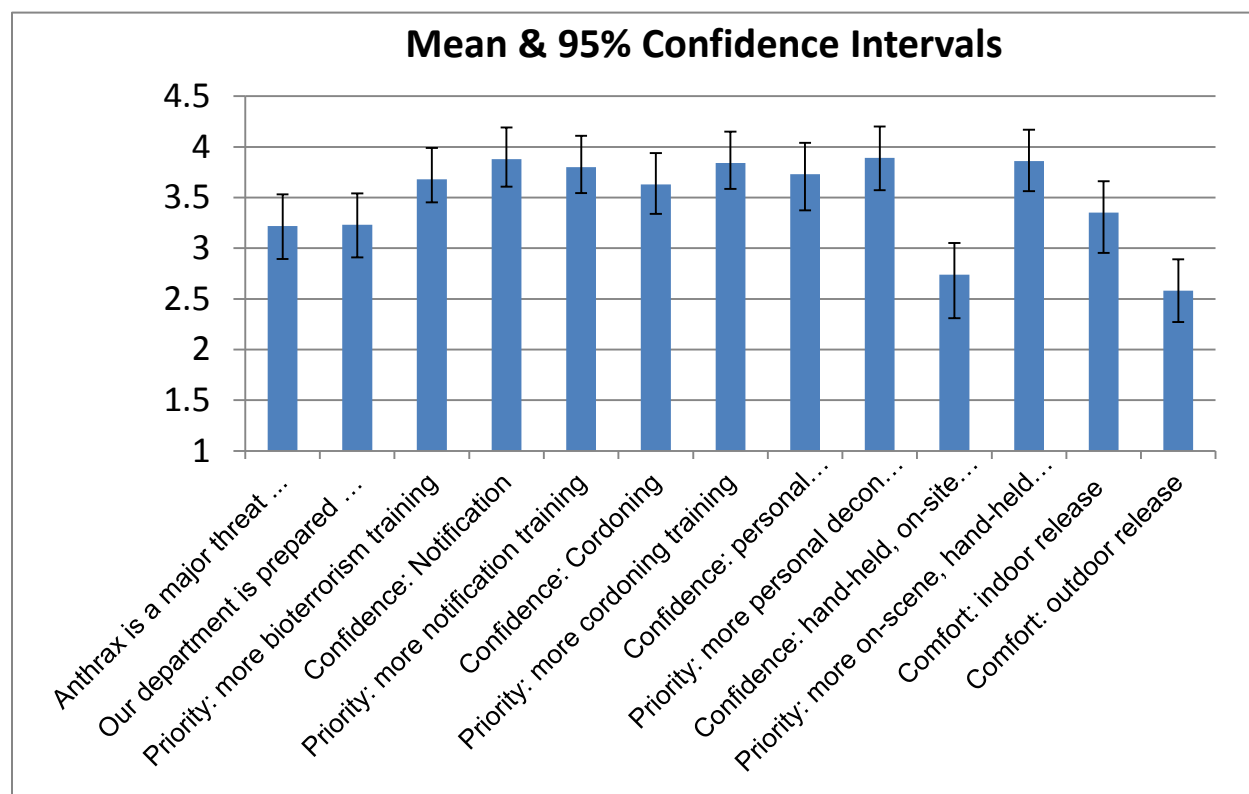
	#	%
<b>Indoor White Powder Incident</b>		
Level A	27	39.7%
Level B	17	25.0%
Level C	6	8.8%
Level D	2	2.9%
Remain outside until certified team is notified	16	23.5.0%
Total	68	100.0%
<b>Outdoor White Powder Incident</b>		
Level A	20	29.4%
Level B	24	34.3%
Level C	6	8.6%
Level D	2	2.9%
Remain outside until certified team is notified	16	22.9%
Total	68	100.0%

Thirteen questions on the survey were used to assess attitudes and perceptions regarding bioterrorism attacks, preparedness, training needs, and confidence. Means were calculated from Likert scale responses ranging from 1 to 5 (Table 7). The mean responses are also shown graphically in Figure 3. The lowest confidence was found for hand-held, on-site testing device use and responding to an outdoor release as described in the second scenario.

**Table 7.** Responses to Likert scale questions, with mean and 95% confidence intervals.

<b>Q #</b>	<b>Question</b>	<b>Mean (95% CI)</b>	<b>n</b>
15	I believe anthrax is a major threat to the population our department serves.	3.22 (2.90, 3.71)	70
16	Our department is prepared to handle a white powder threat or incident	3.23 (2.97, 3.88)	70
17	It is a priority that our department offer more training in regards to anthrax and bioterrorism threats/attacks.	3.68 (3.45, 4.00)	69
19	I am confident in my decisions on notifying the correct groups (i.e. FBI, public health department, etc.) in the event of a white powder event.	3.88(3.57, 4.24)	64
20	It is a priority that there be additional training regarding notification.	3.80 (3.30, 4.23)	66
22	I am confident in my decisions of which areas should be cordoned off.	3.63 (3.47, 4.17)	64
23	It is a priority that there be additional training regarding cordoning off areas.	3.84 (3.35, 4.12)	68
25	I am confident in my ability to perform personal decontamination.	3.73 (3.31, 4.43)	63
27	It is a priority that there be additional training regarding personal decontamination.	3.89 (3.59, 4.16)	65
29	I am confident in my ability to use hand-held, on-site testing devices.	2.74 (2.26, 3.70)	58
30	It is important to be able to perform on-scene testing, and it should be a priority to have more training related to using them.	3.86 (3.48, 4.17)	64
32	How comfortable are you with the training you've received regarding the type of scenario involving an indoor release of anthrax?	3.35 (2.94, 3.90)	52
33	How comfortable are you with the training you've received regarding the type of scenario involving an outdoor release of anthrax?	2.58 (2.07, 3.06)	52

**Figure 3.** Mean responses and 95% confidence intervals for attitude and perception questions.



Cross-tabulations were calculated to determine differences between confidence and attitude questions and categorical variables (organization type, organizational level, training location, training provider, geographical location, and highest training level completed). The small sample size for some of the groups may have made statistical significance difficult to achieve, but differences were observed between confidence and comfort questions. Hazmat personnel participants had the highest confidence in on-site testing (3.4), while police (2.0) and fire department (2.6) personnel had the lowest confidence. The health department participants had the lowest comfort level with responding to the indoor scenario (2.5), while Hazmat personnel participants had the highest comfort level (4.0). Federal agency participants rated “anthrax is a

major threat” the lowest (2.5), while participants with local organizations rated this highest (3.3). Participants from a state-level department had the lowest rating for how prepared their department is (2.8), while local departments rated this highest (3.3).

Despite the small sample size for some groups, some statistically significant results ( $p < 0.05$ ) were observed. Participants from Washington D.C. believed anthrax to be a major threat more than participants from other locations ( $p = .044$ ) and also believed their department was more prepared to handle responding to an anthrax attack ( $p = 0.049$ ). Those who had management/planning level training believed anthrax to be a major threat more than participants who had lower-levels of training ( $p = 0.019$ ). Participants with the most confidence in decontamination decisions had been trained to the performance level ( $p = 0.046$ ). Participants from local organizations also rated priorities for additional training in notification ( $p = 0.005$ ) and on-site testing ( $p = 0.028$ ) as the highest.

### *Personal Protective Equipment*

For both the indoor white power incident scenario and the outdoor release scenario, participants were asked where they would put on their PPE. For the indoor scenario ( $n = 59$ ), 40 stated that they would put on their equipment outside of the building, which many specified as the cold zone. 9 participants would put on their PPE before arriving at the scene, either while at the station or while on the vehicle en route to the incident. 4 participants said they would put on their PPE on inside the building where the release went off, which was specified as the cold zone lobby area ( $n = 3$ ) or the warm zone ( $n = 1$ ). The remaining 6 participants who answered this question did not give a response that was able to determine whether the equipment would be put on inside or outside of the building.



56 participants responded to the outdoor scenario PPE question: 19 participants responded that they would put on PPE “upwind” of the release; 11 stated that they would put on their equipment before arriving on-scene, either on the vehicle or at the station; 13 specified that they would put on their PPE in the “cold zone,” which included both “upwind” responses and areas that were downwind; 2 would put on their equipment in the parking lot or approximately a block away; and 3 stated they would put on their equipment in the warm zone . The remaining participants did not give specific enough answers to evaluate.

*Decontamination.* Participants were asked about decontamination in the first scenario (for occupants in the building where there was an indoor release of anthrax). When asked if occupants of the room where the envelope was opened needed decontamination, 97% said yes (n=66). 80% of participants (n=64) thought occupants of the floor where the envelope was opened needed decontamination. Less than half of the participants (42%, n=66) thought that occupants of the entire building needed decontamination. 10 participants identified setting up decontamination stations somewhere inside the decontaminated building, 27 would set up decontamination stations outside or in a nearby building, and 11 gave answers that could not be identifiable.

### *Qualitative Responses*

30 total participants responded when asked an open-ended question regarding a specific aspect they would like more training on. 12 responded that they did not want any training of specific aspects of bioterrorism, 11 wanted more general training about bioterrorism or more frequent refresher courses, 2 wanted training regarding how to identify anthrax, 2 wanted

training for on-site testing, 2 were interested in Incident Command System training, and 1 participant identified training in evacuation and decontamination as a need.

### *Modeling and Scenario Responses*

*Indoor Scenario.* Based on modeling indoor risk by Hong et al. (2010), we have approximated that people in the room where the anthrax was released is three times higher than in the next room. Additionally, we consider the results of Reshetin and Regens (2003), which demonstrates that the entire building will be contaminated with anthrax spores in a short time period. Participants coded the indoor release scenario diagram by establishing zones. According to the IAFF, these zones include:

**Hot Zone** - *The area in which the hazardous material is actually located. It is the area of maximum hazard and is restricted to essential personnel using appropriate protective clothing and equipment. Access to this area is tightly controlled at a single entry point, and no one is allowed to enter this zone for any reason without a “buddy.” Also, prior to entry, a backup team with the same number of members as the entry team must be standing by. Time within the hot zone must be minimized through careful planning and monitoring. The entry team must have communication devices and alternate plans for communication if radios do not function. There must be an emergency recall system in case it becomes necessary to rapidly evacuate the area.*

**Warm Zone** - *The warm zone (also called the transition zone or the contamination reduction zone) is a transition area between the hot zone and the cold zone (clean area). This area, located away from the hazard, helps prevent contaminants from spreading to unaffected areas. Decontamination takes place in the warm zone, and personnel must use protective equipment appropriate to the level of hazard. The line that separates the hot zone from*

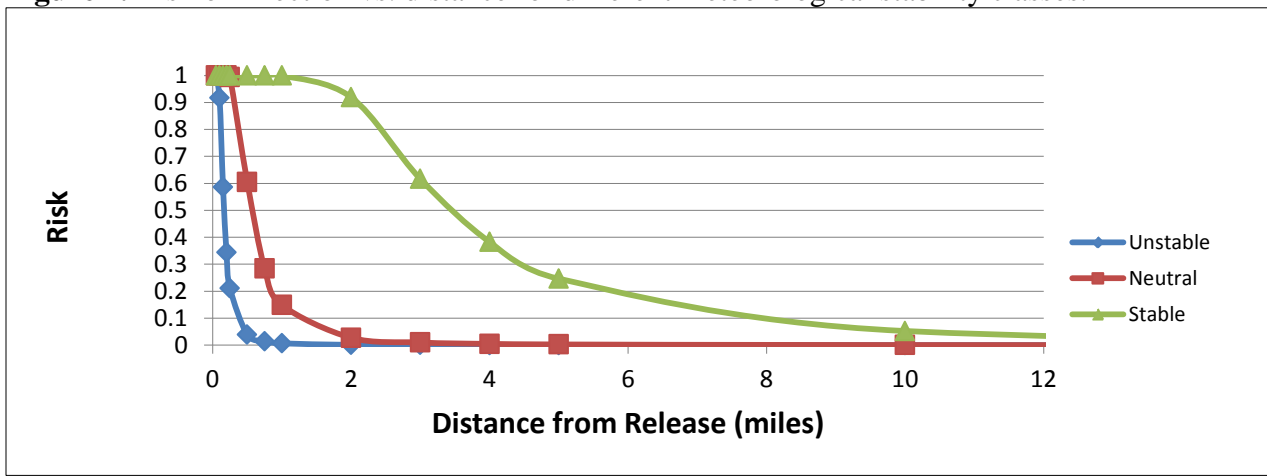
*the warm zone is the hot line, and this may be marked with barrier tape.*

**Cold Zone** - *The cold zone is the area beyond the range of potential contamination. The public is excluded from this area to allow the fire department and other emergency response agencies to function. The command post, treatment area for decontaminated patients, and rehabilitation area for emergency response personnel are established in the cold zone.*

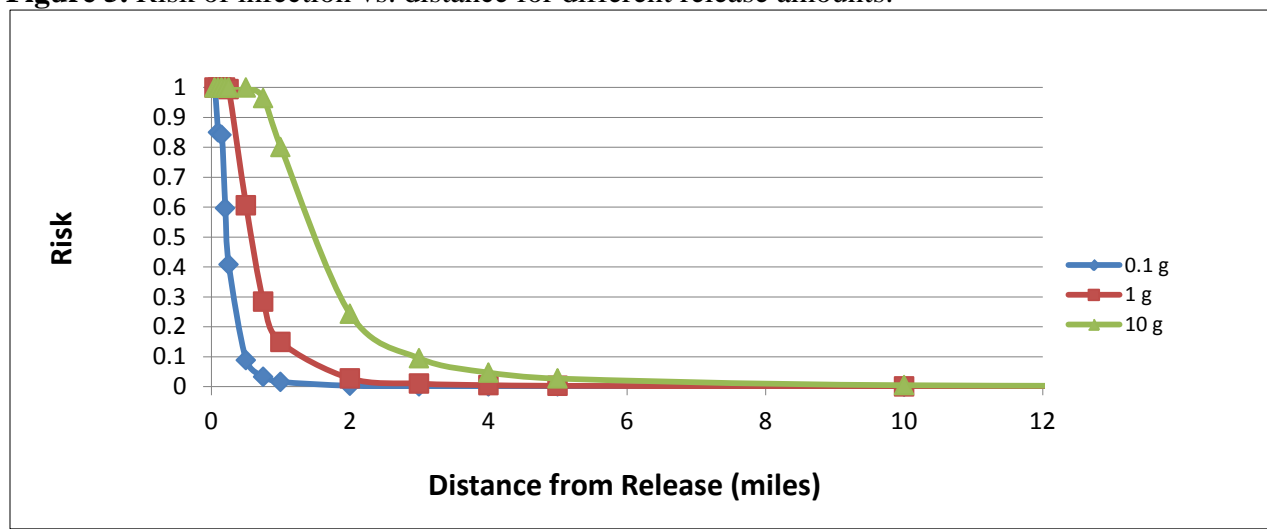
30% of participants who coded the diagram of the indoor release scenario (n=42) chose the entire building as the hot zone. 35% of these participants chose parts of the building, either the lobby area or floors above the release, as the cold zone.

*Outdoor Scenario.* Using the Gaussian puff model and risk equations (described in *Methods*), the risk of infection from anthrax was calculated for areas in Philadelphia. As shown in Figure 4, the meteorological conditions greatly impact how far the risks extend from the initial release point. In an unstable atmosphere, the risk drops to 0 in less than a mile from the release. The risks of infection remain above 0 until approximately 2 miles, and a stable atmosphere still results in a risk of 20% 5 miles from the release (Figures 7, 8, and 9 show these risks on a GIS-produced map.) Figure 5 shows how different amounts of anthrax released would affect the distance of infection risks. Figure 6 shows how risks vary with distance for different dose-response coefficients (r-value).

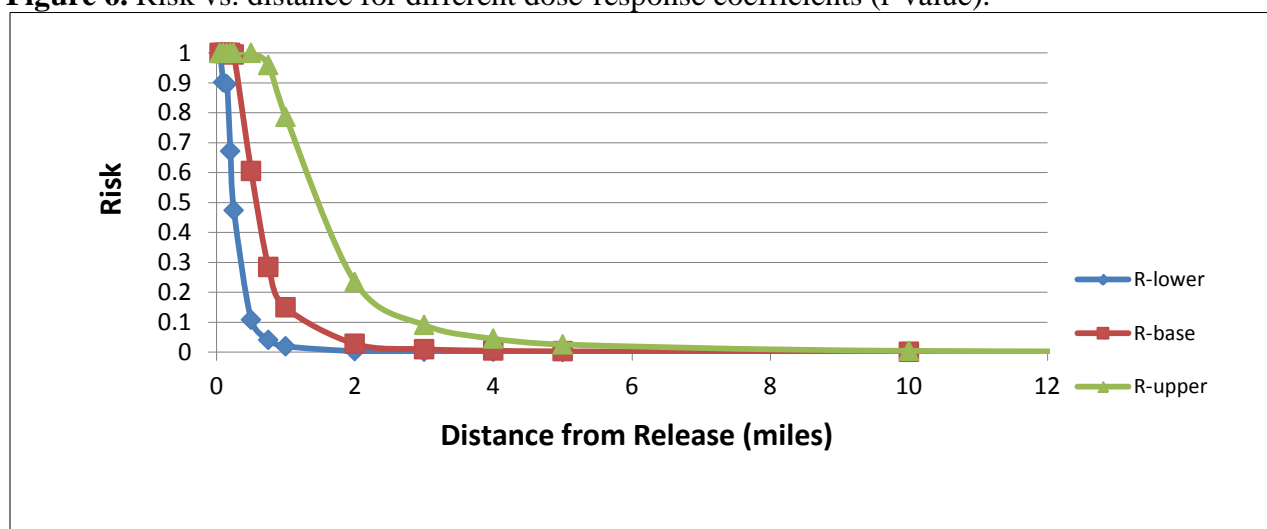
**Figure 4.** Risk of infection vs. distance for different meteorological stability classes.



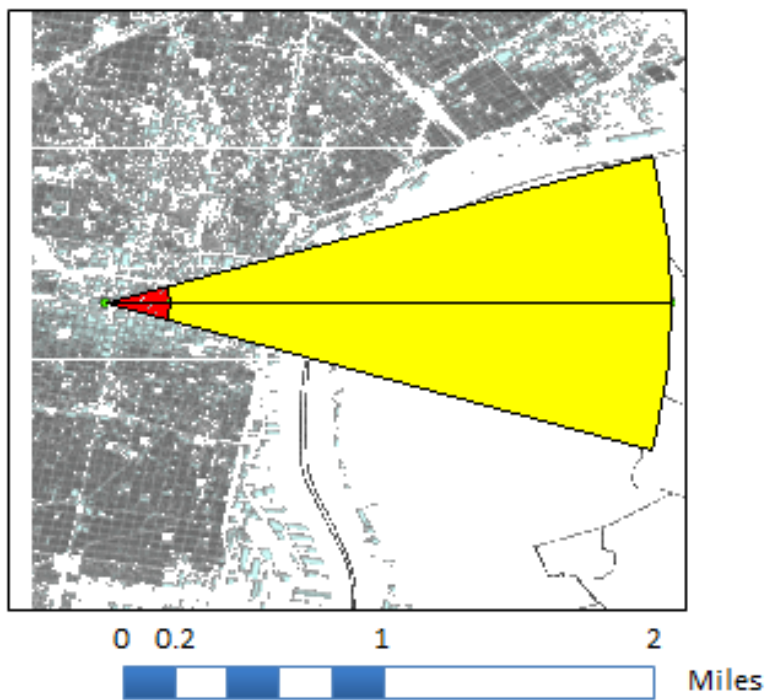
**Figure 5.** Risk of infection vs. distance for different release amounts.



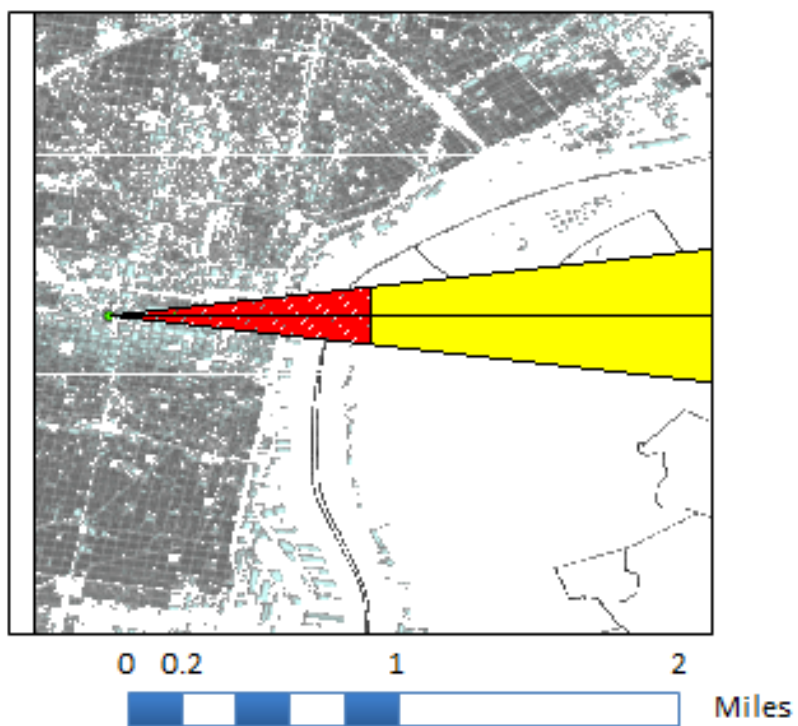
**Figure 6.** Risk vs. distance for different dose-response coefficients (r-value).



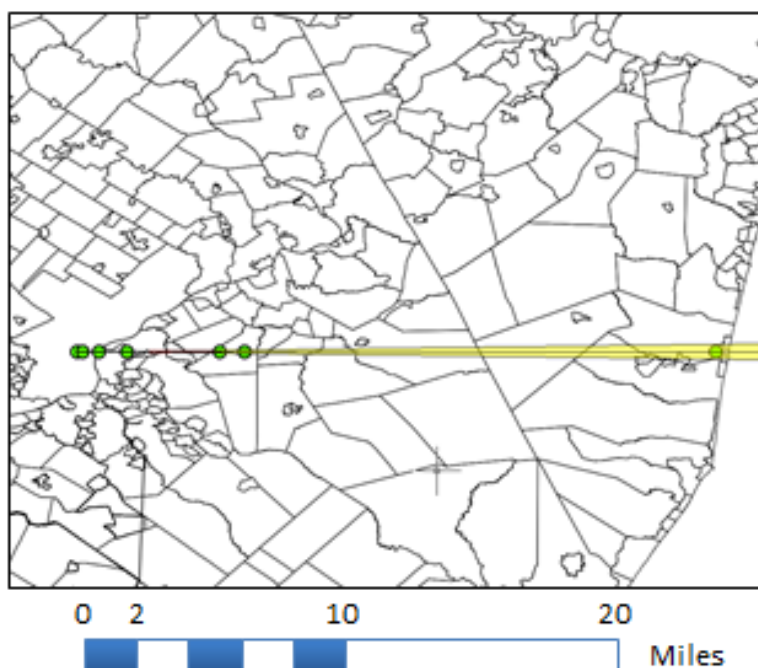
**Figure 7.** GIS map showing risk of scenario during unstable atmospheric conditions.



**Figure 8.** GIS map showing risk of scenario during neutral atmospheric conditions.



**Figure 9.** GIS map showing risk of scenario during stable atmospheric conditions.



Participants were asked to code the outdoor scenario map with zones, including the hot zone, warm zone, and cold zone. Only 30 of the 70 participants coded this map in a manner that could be analyzed. Of these, 67% indicated awareness of a plume, by drawing the zones downwind. As demonstrated by the modeling results (Figures 7 through 9), the downward plume of anthrax risks extends into New Jersey in all three meteorological conditions. The transfer of anthrax perpendicular to the wind is between 1 and 12 orders of magnitudes less than downwind transfer. Participants, however, did not note this major difference when coding the map. 33% coded a 1:1 ratio of the area where anthrax dispersed (i.e. a circle around the release area), 27% coded a 2:1 ratio (i.e. the anthrax traveled twice as far downwind as it did parallel to wind direction), 10% coded a 3:1 ratio, 10% coded a 4:1 ratio, 3% coded a 5:1 ratio, 7% coded a 6:1 ratio, and 10% coded a 10:1 ratio, which just hit the lower bound of the modeled range.

## DISCUSSION

Developing emergency response training is often challenging due to the diversity of first responders and number of organizations involved. As a NIST workshop report points out:

*Of the total of approximately one million firefighters in the nation, 75% are volunteers. Most of the volunteer firefighters are based in rural areas. In metropolitan areas, firefighters are mostly professionals. The responsibilities of the different organizations overlap and sometimes are not clearly defined. For example, local police, local fire department and emergency medical service (EMS) are responsible for initial response while the role of the FBI for this function is not clearly defined for this function (NIST, 2003).*

This paper, however, has reached some key conclusions which can be applied when developing or initiating a bioterrorism training protocol, some of which can be aimed toward specific sectors of the first responder community.

*Charge of Response Elements.* Generally, participants believed in the structure that was in place for their geographic area, region, and department. The largest disconnect was between who should be in charge of on-scene testing. If on-scene testing is implemented as a response protocol, guidelines need to be in place for who is responsible for the testing. The differences in opinion of charge that were present when calculating fire department versus non-fire department responses could just be an effect of small sample size of non-firemen or different protocols for different areas and may not necessarily represent a disconnect between groups in a geographic location that would need to work together during a response.

*Scenarios.* Much of the current modeling literature on anthrax releases indoors suggest that entire buildings will be contaminated in short amounts of time after an initial release. Reshetin and Regens (2003) numerically modeled the intentional release and subsequent

dispersion of anthrax spores in a typical 50-story, high-rise building. Their model predicts the time required for spores to disperse throughout a building. Results of the analysis show that even with a small release, infectious concentrations of spores quickly disperse throughout the building. Hong et al. (2010) discuss the need to use environmental concentrations of *B. anthracis* to infer past or future aerosol exposures in an indoor environment given the rapid decline in air concentrations immediately after a release. Their model relates concentrations of spores on walls and floors, in ventilation system filters, and in human nasal passages to human health risk. Given the large numbers of assumptions that need to be made, they conclude that there are large uncertainties associated with the calculated risk; however, anthrax spores easily spread throughout an entire building.

The 2001 anthrax attacks highlighted a need to address decontamination decisions. Hong et al. (2010) found that larger areas would be “subject to antibiotic treatment of exposed individuals than environmental decontamination” in the 2001 attacks. This study identified a similar need to address decontamination in a building. Overall, participants in this study stated that they were confident in their decisions regarding decontamination; however we found that many of their decisions regarding the indoor scenario would still place themselves or occupants at risk. Generally, first responders were not aware of the ability for anthrax to spread quickly throughout an entire building. Only 30% (n=42) of participants coded the entire building as a hot zone, and only 42% of participants thought that occupants of the entire building required decontamination. While this could be due to interpretation differences (i.e., some may have thought that occupants could decontaminate at home and therefore selected “no”), this still points to a major knowledge gap. 2 participants did not think that occupants of the room where the anthrax was released needed decontamination, and 20% of participants did not think that



occupants of the floor where the anthrax was released required decontamination. Additionally, 21% (n=48) of participants identified setting up decontamination stations somewhere inside the decontaminated building. A major knowledge gap appears to exist as to the risks in a building where anthrax is released, as many underestimate the ability for anthrax spores to spread throughout a building, even with separate HVAC systems.

For outdoor releases of anthrax, the modeling performed in this study find similar results as the literature (Isukapalli et al., 2008, Wein et al., 2003). Based on the survey results, weak evidence exists that participants underestimated the risk downwind and overestimated how far it transfers perpendicular to the wind. This finding, however, could be an effect of the map we provided in the survey. The map was approximately a 1:3 ratio, and did not extend into New Jersey. This bias would not affect the result that approximately one third of participants were not aware of downwind dispersion plumes.

*Hand-held, on-site testing.* Questions regarding the use of hand-held, on-site testing devices showed that first responders are generally not confident in their ability to use them. Additionally, over half (65.5%) of the first responders in this study have not been trained in the use of on-site testing devices. Early detection and a fast response to an anthrax attack is extremely important – without early detection, mortality could be as high as 30,000 to 3 million (Hogan et al., 2007). A speedy and well-planned response could help reduce the number of casualties during an attack. For example, if treatment is administered immediately, mortality could be limited to less than 1% of those exposed (Hogan et al., 2007). Preliminary test results from on-site testing can give first responders and staff at the laboratories an idea of the nature of the threat and help responders, medical officers, and laboratory personnel being immediate response actions. Additionally, rapid screening and identification of substances on-site can

prevent expenditures related to unnecessary medical treatment and closing of businesses and operations (Wills, Leikin, Rhee, Taming, Saeedi, 2008).

While on-site testing may be beneficial in expediting response procedures, samples must still be sent to the CDC's Laboratory Response Network (LRN) for confirmation (CDC, 2003). The CDC states that they do "not have enough scientific data to recommend the use of these assays" because "the analytical sensitivity of these assays is limited by the technology, and data provided by manufacturers indicate that a minimum of 10,000 spores is required to generate a positive signal" (CDC, 2003). These testing devices may still be very useful for heavy contamination, but may yield a negative signal with low-level contamination. For example, Hong et al., (2010) notes that "surface concentrations corresponding to acceptable risk levels are often very low, which questions whether a negative test result is enough to conclude that the risk is below the standard." In guidance issued by the Federal Bureau of Investigation (FBI), DHS, and HHS, they recommend against on-site testing: "Currently, there are no definitive field tests for identifying biological agents. Additional field testing can mislead response efforts by providing incorrect or incomplete results, and destroy limited materials critical for definitive laboratory testing required to facilitate any appropriate public health and law enforcement response" (2004). Currently, the CDC is undergoing a study to evaluate the sensitivity and specificity of these devices, after which recommendations for use may be more valid (CDC, 2003). With the release of these recommendations, specific training can be developed which addresses 1) accuracy, 2) how to address false negatives and/or false positives, 3) where to use them, 4) who uses them, and 5) how to use them properly.

*Personal Protective Equipment.* The answers regarding what level of PPE and where to put in on varied greatly, with every level of PPE (A through D) being chosen by at least one

participant. OSHA recommends Modified Level C PPE for responding to an indoor contaminated letter or package (OSHA, “Anthrax in the Workplace”), such as the first scenario presented in this survey. For the second scenario in this survey, OSHA recommends Level B protection (“where anthrax spores may have been dispersed with an aerosol-generating device but are no longer being released”). Level A is recommended by OSHA only when an unknown dispersal method has been used or if an aerosol-generating device is used and the release is still occurring (OSHA, “Anthrax in the Workplace”). Following these guidelines, approximately 3% of participants would be under-protected in the first scenario and 11.5% (if assuming the release had ended, if assuming the release was ongoing this number would be 46%) under-estimated the level of protection they would need. This under-protection could lead to first responders being exposed. On the other hand, 64% of participants would be over-protective in the indoor scenario and 29% (if assuming the release had ended) would be over-protective in the outdoor scenario. Drawbacks to over-protection include increasing public panic and limiting the number of responders available due to limited PPE equipment available.

### *Limitations*

This study serves as a useful starting point for improving training for first responders. There are several limitations of this study. First, the study does not compare the perceived capability of participants with their actual performance during a threat or mock event, with the exception of a few knowledge-check questions. Additionally, the study may over represent the fire department, which could lead to biased results. Most of the participants surveyed were present at a national conference in the southeastern part of the U.S., which could have introduced bias. The modeling of the scenarios also has assumptions such as uniform mixing and excludes factors such as buildings and traffic which would influence dispersion. This study also only

addresses the inhalation route of anthrax exposure and does not account for dermal or ingestion exposures. Additionally, anthrax was used to represent a bioterrorism attack, but responses may be different for other biological agents used in terrorist operations.

This research does not address other issues related to preparedness and training for first responders, such as how to assess the credibility of a threat (which was mentioned by many people as the major issue when deciding how to handle the response). This study also does not assess issues with staffing, including getting first responders to the incident in timely ways and ensuring there are enough responders present to handle the incident. Lastly, issues related to secondary response, such as the health department, EPA, FBI, etc. are not explored in this pilot study.

## **CONCLUSIONS AND RECOMMENDATIONS**

This pilot study was performed to help identify training needs for first responders to an anthrax attack. Major areas for first responder training identified include improving knowledge regarding personal protective equipment and understanding of anthrax dispersion, both indoors and outdoors. Online training may be an effective method to increase knowledge and preparedness for an anthrax attack.

## LIST OF REFERENCES

- Abatemarco, A.; Beckley, J.; Borjan, M.; Robson, M. (2007) Assessing and improving bioterrorism preparedness among first responders: A pilot study. *Journal of Environmental Health*, 69(6), 16-22.
- Ablah, E.; Wetta-Hall, R.; Molgaard, C.A.; Fredrickson, D.D.; Grube, C.D.; Skalacki, M.K.; Wolfe, D.J.; Cook, D.J. (2006) Evaluation of interdisciplinary terrorism preparedness programs: A pilot focus group study. *Journal of Allied Health*, 35(4), 189-197.
- Allen, I.E.; Seaman, C.A. (2007) Likert scales and data analysis. *Quality Progress*, 40(7), 64-66.
- American Statistical Association (ASA). "How to conduct pre-testing" Section on Survey Research Methods, Alexandria, VA. Retrieved from <http://www.webpages.uidaho.edu/~redgeman/Sampling%20PDF%20Files/pretesting.pdf>
- ASTM E2458 - 06 Standard Practices for Bulk Sample Collection and Swab Sample Collection of Visible Powders Suspected of Being Biological Agents from Nonporous Surfaces. 2006. DOI: 10.1520/E2458-06
- Centers for Disease Control and Prevention, "Anthrax Q & A: Laboratory Testing" Retrieved from <http://www.bt.cdc.gov/agent/anthrax/faq/labtesting.asp>. June 2, 2003.
- Centers for Disease Control and Prevention, "Emergency Preparedness and Response, Anthrax: Environment/Response" Retrieved from <http://www.bt.cdc.gov/agent/anthrax/environment/> November 20, 2010.
- Church, A.H. (1993) Estimating the effect of incentives on mail survey response rates: A meta-analysis. *Public Opinion Quarterly*, 57, 62-79.
- Davis, J.A.; Bennet, B.W. (2004) Needed now: The "85% quick fix" in bio-defense.

*Counterproliferation Paper No. 23.* USAF Counterproliferation Center, Maxwell Air Force Base, Alabama.

Department of Homeland Security, “National Response Framework” 2008. Retrieved from <http://www.fema.gov/emergency/nrf/index.htm>

Department of Homeland Security. “Proposed Guidance for Protecting Responders’ Health During the First Week Following a Wide-Area Anthrax Attack.” September 29, 2009. Draft. Version 4.

Department of Transportation, “Emergency Response Guidebook”. 2008. Retrieved from <http://www.phmsa.dot.gov/Hazmat/library/erg>

Environmental Protection Agency. (July 2007) Anthrax spore decontamination using bleach (sodium hypochlorite). Pesticides: Topical & Chemical Fact Sheets. Retrieved from <http://www.epa.gov/pesticides/factsheets/chemicals/bleachfactsheet.htm>

Flowers, L.K.; Mothershead, J.L.; Blackwell, T.H.; (2002) Bioterrorism preparedness II: The community and emergency medical services systems. *Emergency Medical Clinics of North America*, 20, 457–476.

Federal Bureau of Investigation, Department of Homeland Security, Health and Human Services. *Guidance on Initial Response to a Suspicious Letter/Container with a Potential Biological Threat.* November 2, 2004.

Fraser, M; Brown, D. (2000) Bioterrorism preparedness and local public health agencies: Building response capacity. *Journal of American Public Health*, 115(4), 326-330.

Gob, R.; McCollin, C.; Ramalhoto, M.F. (2007) Ordinal methodology in the analysis of Likert scales. *Quality & Quantity*, 41, 601-626.

- Gursky, E.; Inglesby, T.V.; O'Toole, T. (2003) Anthrax 2001: Observations on the medical and public health response. *Biosecurity and Bioterrorism*, 1(2), 97-110.
- Heller, M. B.; Bunning, M.L.; Martin, E.B. France, D. M.; Niemeyer, L.P; Naimi,T.; Talboy, P.M; Murray, P.H.; Pietz, H.W.; Kornblum, J.; Oleszko, W.; Beatrice., S (2002) Laboratory response to anthrax bioterrorism, New York City. *Emerging Infectious Diseases*, 8(10), 1096-1103.
- Henretig, F.M.; Cieslak, T.J.; Kortepeter, M.G.; Fleisher, G.R. (2002) Medical management of the suspected victim of bioterrorism: an algorithmic approach to the undifferentiated patient. *Emergency Medical Clinics of North America*, 20, 351–364.
- Hogan, W.R.; Cooper, G.F.; Wallstrom, G.L.; Wagner, M.M.; Depinay, J. (2007) The Bayesian aerosol release detector: An algorithm for detecting and characterizing outbreaks caused by an atmospheric release of *Bacillus anthracis*. *Statistics in Medicine*, 26,
- Holty, J.C.; Bravata, D.M.; Liu, H.; Olshen, R.A.; McDonld, K.M; Owens, D.K. (2006) Systematic review: A century of inhalation anthrax cases from 1900 to 2005. *Annals of Internal Medicine*, 4, 270-280.
- Hong, T.; Gurian, P.; Ward, N. (2010) Setting risk-informed environmental standards for *Bacillus anthracis* spores. *Risk Analysis*,30(10), 1602-1622.
- International Association of Fire Fighters (IAFF) *Course Description: Training for Hazardous Materials Response*. Retrieved from [http://www.iaff.org/et/hw/PDF/Course\\_Description\\_TECH.pdf](http://www.iaff.org/et/hw/PDF/Course_Description_TECH.pdf)
- Isukapalli, S.S.; Liroy, P.J.; Georgopoulos, P.G. (2008) Mechanistic modeling of emergency events: Assessing the impact of hypothetical releases of anthrax. *Risk Analysis*, 28(3), 723-740.

- Jain, S.; McClean, J. (2003). A framework for modeling and simulation for emergency response. *Proceedings of the 2003 Winter Simulation Conference, 1068-1076.*
- Jernigan, J.A.; Stephens, D.S.; Ashford, D.A.; Omenaca, C.; Topiel, M.S.; Galbraith, M.; Tapper, M. Fisk, T.L.; Zaki, S.; Popovic, T.; Meyer, R.F. et al. (2001) Bioterrorism-related inhalation anthrax: the first 10 cases reported in the United States. *Emerging Infectious Disease, 7(6), 933-944.*
- Jones, T.(2002) Bioterrorism preparedness – what progress has Congress made since September 2001? *Policy Politics Nursing Practice, 3, 217-219.*
- Keim, M.; Kaufmann, A.F. (1999) Principles for emergency response to bioterrorism. *Annals of Emergency Medicine, 34(2), 177-182.*
- Kortepeter, M.G.; Parker G.W. (1999) Potential biological weapons threats. *Emerging Infectious Diseases, 5(4), 523-528.*
- Leite, J.S.; Hadad, G.; Doorn, J.; Kaplan, G. (2000) A scenario construction process. *Requirements Engineering, 5, 38-61.*
- Lenz M.; Richter, T. (2009) Disaster response to the release of biohazardous agents: Instrument development and evaluation of a firefighter’s exercise. *Prehospital Disaster Medicine, 24(3), 197–203.*
- Long, K.J.; Haupt, S.E.; Young, G.S. et al. (2006). “Characterizing Contaminant Source and Meteorological Forcing using Data Assimilation with a Genetic Algorithm.” *Fifth Conference on Artificial Intelligence Applications to Environmental Science.*
- Martin, G. Anthrax: Lessons learned from the U.S. Capitol experience. *Military Medicine, 168(9), 9-14.*



- Meehan, P.J.; Rosenstein, N.E.; Gillen, M.; Meyer, R.F.; Kiefer, M.J., Deitchman, S.; Besser, R.E.; Ehrenberg, R.L.; Edwards, K.M.; Martinez, K.F. (2004) Responding to detection of aerosolized *Bacillus anthracis* by autonomous detection systems in the workplace. *MMWR*, 53, 1-11. Retrieved from <http://www.cdc.gov/mmwr/preview/mmwrhtml/rr53e430-2a1.htm>
- Missouri Department of Health and Senior Services. (2004) *Bioterrorism Epidemiology Module II: Introduction to Bioterrorism*. May 18, 2004. Retrieved from [www.bioterrorism.slu.edu/bt/products/bio\\_epi/scripts/mod2.pdf](http://www.bioterrorism.slu.edu/bt/products/bio_epi/scripts/mod2.pdf)
- National Institute of Standards and Technology (NIST, 2003) Modeling and Simulation for Emergency Response. *Report of Workshop*. March 4-6, 2003. Gaithersburg, MD.
- National Training and Education Division, Federal Emergency Management Agency. (2011) *Course Levels*. Retrieved from <https://www.firstrespondertraining.gov/TEI/levels.jsp;jsessionid=0592B9F4554EE05618261D467D27935D>
- National Institute for Occupational Safety and Health (NIOSH). “Protecting Emergency Responders: Safety Management in Disaster and Terrorism Response” Vol. 3. 2004. NIOSH Pub. No. 2004-144. Retrieved from <http://www.cdc.gov/niosh/docs/2004-144/default.html>
- Occupational Safety and Health Administration (OSHA, 1993). Standard 1926.65 Appendix B: General Description and Discussion of the Levels of Protection and Protective Gear.
- Occupational Safety and Health Administration (OSHA). Anthrax in the Workplace. Retrieved from <http://www.osha.gov/dep/anthrax/matrix/index.html>
- Office of Technology Assessment (OTA, 1993). Technologies Underlying Weapons of Mass Destruction, U.S. Congress.

- Reshetin, V.P.; Regens, J.L. (2003). Simulation modeling of anthrax spore dispersion in a bioterrorism incident. *Risk Analysis*, 23(6), 1135–1145.
- Sanderson, W.T.; Stoddard, R.R.; Echt, A.S.; Piacitelli, C.A.; Kim, D.; Horan, J.; Davies, M.M.; McCleery, R.E.; Muller, P.; Schnorr, T.M.; Ward, E.M.; Hales, T.R. (2003) Bacillus anthracis contamination and inhalation anthrax in a mail processing and distribution center. *Journal of Applied Microbiology*, 96, 1048-1056.
- Shadel, B.N.; Chen, J.J.; Newkirk, R.Y.; Lawrence, S.J.; Clements, B.; Evans, R.G. (2004) Bioterrorism risk perceptions and educational needs of public health professionals before and after September 11, 2001: A national needs assessment survey. *Journal of Public Health Management Practice*, 10(4), 282–289.
- Sterling, D.A.; Clements, B.; Rebmann, T.; Shadel, B.N.; Stewart, L.M.; Thomas, R.; Evans, R.G. (2005) Occupational physician perceptions of bioterrorism. *International Journal of Hygiene and Environmental Health*, 208, 127–134.
- Swanson, E.R.; Foschnoet, D.E. (1999). Anthrax threats: A report of two incidents from Salt Lake City. *The Journal of Emergency Medicine*, 18(2), 229-232.
- U.S. Army Center for Health Promotion and Preventive Medicine. (August 2003) *Personal Protective Equipment Guide for Military Medical Treatment Facility Personnel Handling Casualties From Weapons of Mass Destruction and Terrorism Event*. Technical Guide 275.
- Waeckerle, J.F.; Seamans, S.; Whiteside, M.; Pons, P.T.; White, S.; Burstein, J.L.; Murray, R. (2001) Executive summary: Developing objectives, content, and competencies of the training of emergency medical technicians, emergency physicians, and emergency nurses

to care for casualties resulting from nuclear, biological, or chemical (NBC) incidents.

*Annals of Emergency Medicine*, 37(6), 587-601.

Wein, L.M.; Craft, D.L.; Kaplan, E.H. (2003). Emergency response to an anthrax attack.

*Proceedings of the National Academy of Sciences, USA*. 100:4346-51. [PMID: 12651951].

Wills, B.; Leikin, J.B.; Rhee, J.; Tameling, C.; Saeedi, B. (2008) Analysis of suspicious powders

following the post 9/11 anthrax scare. *Journal of Medical Toxicology*, 4(2), 93-96.

World Health Organization (WHO, 1970). Health Aspects of Chemical and Biological

Weapons— Report of a WHO Group of Consultants. (1970). Geneva, Switzerland.

Wrigley, B.J.; Salmon, C.T.; Park, H.S. (2003) Crisis management planning and the threat of

bioterrorism. *Public Relations Review*, 29, 281–290

## **APPENDICES**

## **APPENDIX A**

## **First Responder Survey: Anthrax Threat**

Please fill out the survey as accurately as possible. Do **NOT** include your name or organization's name. All information will remain strictly confidential and no identifiers will be kept. All information obtained will be used solely for the purpose of Drexel University's study.

1. What organization do you represent?
  - a. Fire
  - b. Police
  - c. Health Department
  - d. HAZMAT Response Unit
  - e. Other: \_\_\_\_\_
  
2. What organizational level do you represent?
  - a. Local
  - b. State
  - c. Federal
  - d. Other: \_\_\_\_\_
  
3. How would you classify the location of your organization?
  - a. Washington, D.C. area
  - b. New York City
  - c. Other urban area
  - d. Suburban
  - e. Rural
  
4. What sort of training have you received regarding anthrax threats? *Circle all that apply.*
  - a. Awareness level training – designed for responders who require the skills necessary to *recognize and report* a potential incident or who are likely to *witness or investigate* an event
  - b. Performance level training – designed for first responders who *perform tasks* during the initial response, such as safeguarding the public, rescuing, or decontaminating
  - c. Management and Planning level training – designed for *managers who build plans and coordinate* the response
  - d. HAZMAT training
  - e. I have not received any training.
  
5. If you received training, where did it take place? *Circle all that apply.*
  - a. In-residence, at my facility
  - b. A location other than my facility
  - c. On-line

6. If you received training, who provided the training? *Circle all that apply.*
- Someone from my facility
  - Someone from the Department of Homeland Security (i.e. FEMA's NETD program)
  - Someone from OSHA
  - Someone from NIOSH
  - Other: \_\_\_\_\_
7. What level protective gear would you wear if you were called in for an indoor white powder incident (i.e. envelope containing white powder and a threatening note)?
- Level A** – Positive pressure, full face-piece SCBA, completely encapsulating chemical-protective suit, inner and outer gloves, etc.
  - Level B** – Positive pressure, full face-piece SCBA, hooded chemical-resistant clothing, inner and outer gloves, etc.
  - Level C** – full-face or half-mask, air purifying respirators, hooded chemical-resistant clothing, inner and outer gloves, etc.
  - Level D** – work uniform
  - Remain outside affected area until a certified team is notified.
8. What level protective gear if you were called in for an outdoor exposure threat (i.e. white powder being sprayed from car and a threatening note)?
- Level A** – Positive pressure, full face-piece SCBA, completely encapsulating chemical-protective suit, inner and outer gloves, etc.
  - Level B** – Positive pressure, full face-piece SCBA, hooded chemical-resistant clothing, inner and outer gloves, etc.
  - Level C** – full-face or half-mask, air purifying respirators, hooded chemical-resistant clothing, inner and outer gloves, etc.
  - Level D** – work uniform
  - Do nothing until a certified team is notified.

*The next few questions ask about who is in charge of aspects of responding to an anthrax threat. This may vary depending on who has proper training and equipment. Part A asks you who IS in charge and Part B asks who SHOULD BE in charge. Circle your response.*

10. Sample Collection

a. Who is in charge of sample collection?

- Fire Department
- Police Department
- Health Department
- Whoever is first on the scene
- Other (please specify): \_\_\_\_\_

b. Who **should be** in charge of sample collection?

- Fire Department
- Police Department
- Health Department
- Whoever is first on the scene
- Other (please specify): \_\_\_\_\_

11. On-Scene Testing

a. If performed, who is in charge of on-scene testing?

- Fire Department
- Police Department
- Health Department
- Whoever is first on the scene
- Other (please specify): \_\_\_\_\_

b. Who **should be** in charge of on-scene testing?

- Fire Department
- Police Department
- Health Department
- Whoever is first on the scene
- Other (please specify): \_\_\_\_\_

12. Cordoning Off

a. Who decides which areas to cordon off?

- Fire Department
- Police Department
- Health Department
- Whoever is first on the scene
- Other (please specify): \_\_\_\_\_

b. Who **should** decide which areas to cordon off?

- Fire Department
- Police Department
- Health Department
- Whoever is first on the scene
- Other (please specify): \_\_\_\_\_

13. Evacuation

a. Who is in charge of evacuating potentially exposed people?

- Fire Department
- Police Department
- Health Department
- Whoever is first on the scene
- Other (please specify): \_\_\_\_\_

b. Who **should be** in charge of evacuating potentially exposed people?

- Fire Department
- Police Department
- Health Department
- Whoever is first on the scene
- Other (please specify): \_\_\_\_\_

14. Decontamination

a. Who is in charge of decontaminating potentially exposed people?

- Fire Department
- Police Department
- Health Department
- Whoever is first on the scene
- Other (please specify): \_\_\_\_\_

b. Who **should be** in charge of decontaminating potentially exposed people?

- Fire Department
- Police Department
- Health Department
- Whoever is first on the scene
- Other (please specify): \_\_\_\_\_



The following questions ask for your opinions. Circle 1 if you do not agree with the statement. Circle 5 if you agree completely. Mark N/A if you would not make this decision or it does not apply to you.

	Disagree		Neutral		Agree
15. I believe Anthrax is a major threat to the population our department serves.	1	2	3	4	5

16. Our department is prepared to handle a white powder threat or incident.	1	2	3	4	5
---	---	---	---	---	---

17. It is a priority that our department offer more training in regards to anthrax and bioterrorism threats/attacks.	1	2	3	4	5
--	---	---	---	---	---

**Notification**

18. I have been trained about who to notify (i.e. FBI, public health department, etc.) in the event of a white powder event?		YES	NO		
--	--	-----	----	--	--

19. I am confident in my decisions on notifying the correct groups (i.e. FBI, public health department, etc.) in the event of a white powder event.	1	2	3	4	5
---	---	---	---	---	---

N/A

20. It is a priority that there be additional training regarding notification.	1	2	3	4	5
--	---	---	---	---	---

**Cordoning Areas**

21. I have been trained on what areas to cordon off in the event of a white powder event.		YES	NO		
---	--	-----	----	--	--

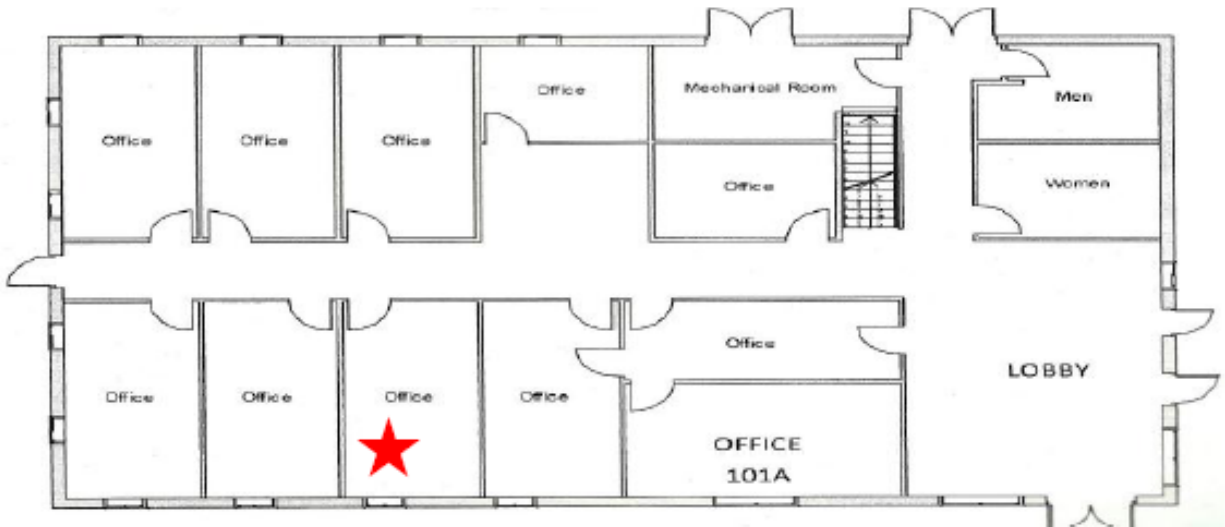
	Disagree		Neutral		Agree
22. I am confident in my decisions of which areas should be cordoned off.	1	2	3	4	5

N/A

23. It is a priority that there be additional training regarding cordoning off areas.	1	2	3	4	5
---	---	---	---	---	---



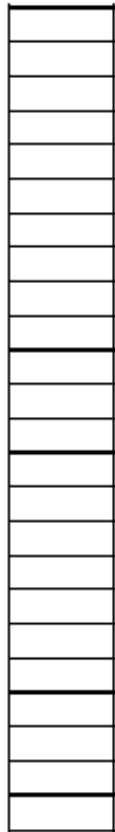
Each floor: 24.4m x 15.2m (80ft x 50ft)



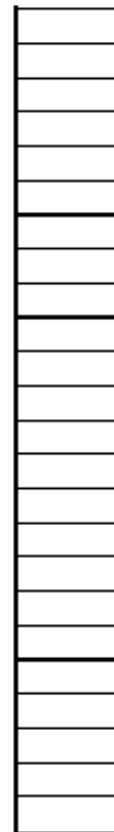
Building 1 block away



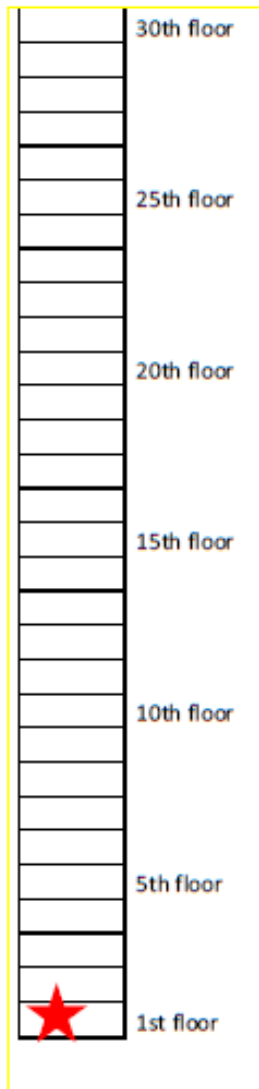
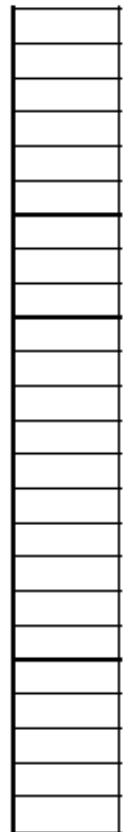
Buildings next door



Buildings next door



Building 1 block away



a) Have you been trained how to handle this type of scenario?      YES      NO

b) If yes, how comfortable are you with the training you've been given regarding this type of scenario?

<b>Not</b>					<b>Comfortable</b>	
<b>Comfortable</b>						
1	2	3	4	5		N/A

c) Where would you put on your personal protective equipment? \_\_\_\_\_  
\_\_\_\_\_

d) Do occupants of the room where the envelope was opened need decontamination?      YES      NO

e) Do occupants of the floor where the envelope was opened need decontamination?      YES      NO

f) Do occupants of the entire building need decontamination?      YES      NO

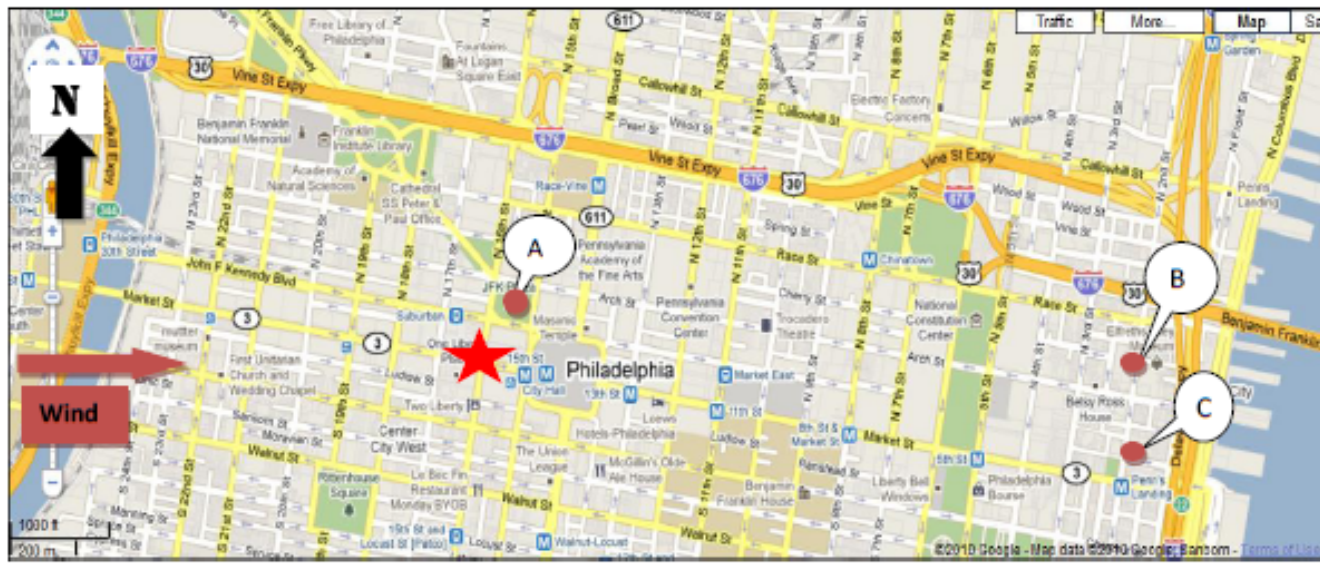
g) Where is the optimal location to perform decontamination (i.e. setting up washing stations)?  
\_\_\_\_\_

h) How much more likely are the people in the room where the envelope was opened to become ill from anthrax versus the people in the next room? \_\_\_\_\_

i) Do you feel that you need more training for this type of scenario?      YES      NO

Now think about an outdoor release of anthrax. Consider what you would actually do if you were called in as a first responder this attack. The red star represents the location the white powder was released into the outdoor environment.

**33. Scenario: Anthrax is sprayed in a community park at dusk: Love Park, Philadelphia PA.** Someone spraying pesticides on the plants in Love Park shouts, "I've just killed you all! This is anthrax I'm spraying!" Assume a 60° F air temperature and wind speed of 8.5 knots (10mph) from due west. Also assume that intelligence suggests anthrax was indeed released. When answering questions, do not consider buildings or traffic's influence on the dispersion of anthrax particles. Cross-hatch the HOT ZONE, circle the WARM ZONE, and place "X"s over the COLD ZONE.



- a) Have you been trained how to handle this type of scenario?      YES      NO
- b) If yes, how comfortable are you with the training you've been given regarding this type of scenario?
- |             |   |   |   |   |   |             |
|-------------|---|---|---|---|---|-------------|
| Not         |   |   |   |   |   | Comfortable |
| Comfortable | 1 | 2 | 3 | 4 | 5 |             |
- c) Where would you put on your personal protective equipment? \_\_\_\_\_
- d) How much more likely are the people in Love Park (about 50 feet from the release, Point A) to get ill from anthrax vs. people directly downwind a mile away, at Point B? \_\_\_\_\_
- e) How much more likely are the people at Point B (1 mile from release, directly downwind) vs. people at Point C (1000 feet south of Point B) \_\_\_\_\_
- f) Do you feel you need more training regarding this type of scenario?      YES      NO

---

**Thank you for your responses. Please return the survey to receive your gift card.**

If necessary, mail the completed survey to:

Dr. Patrick Gurian  
Drexel University  
Department of Civil, Architectural, and Environmental Engineering  
3201 Arch Street  
Philadelphia, PA 19104

If you are mailing this survey, please detach this page. Include the address you would like your gift card to be mailed to below:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Which gift card would you like?**

Amazon.com

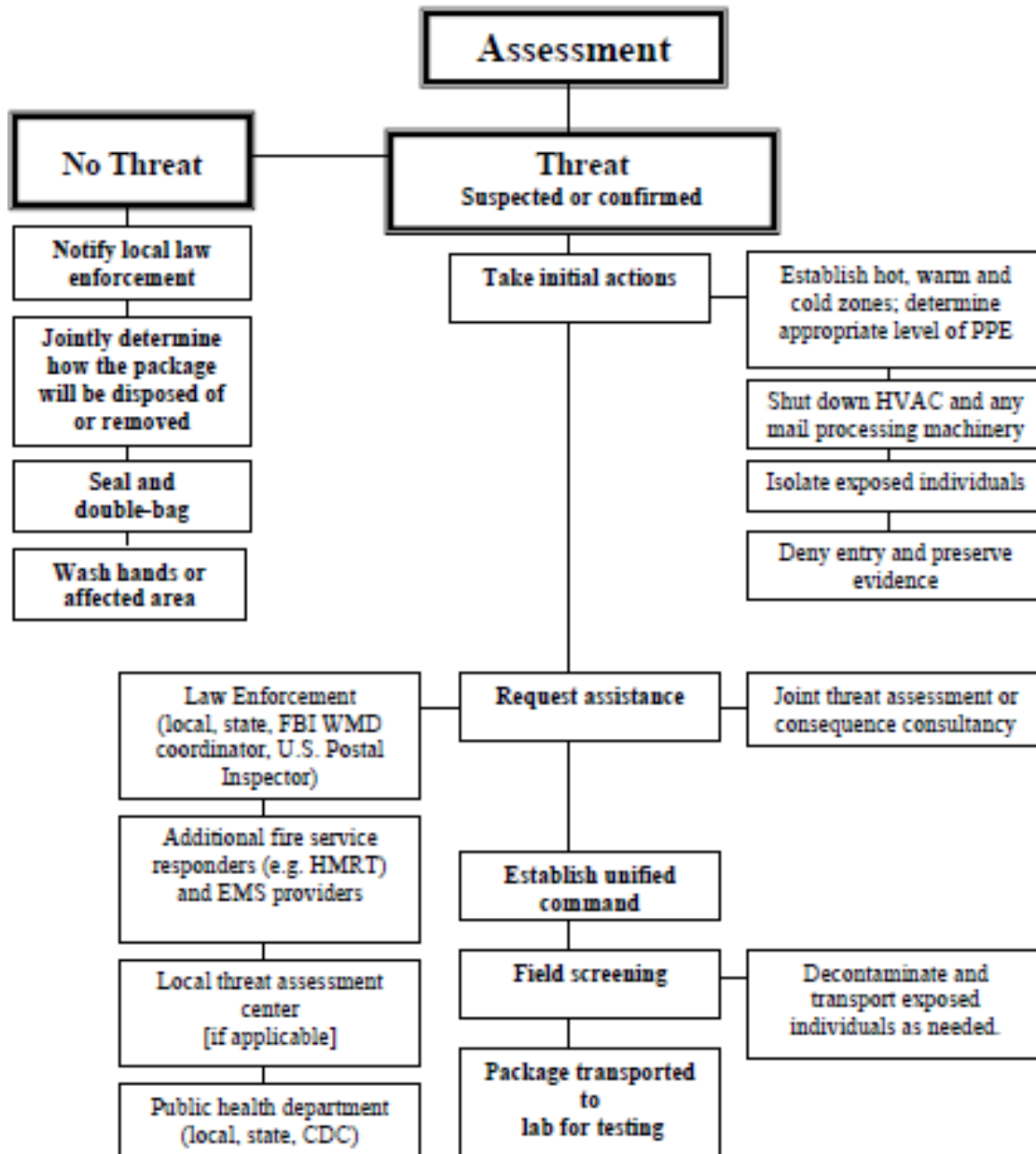
Starbucks

If you would like a copy of the results, please send an e-mail to [hg54@drexel.edu](mailto:hg54@drexel.edu).

## **APPENDIX B**



## FIRST RESPONDER DECISION MATRIX *Package with Suspicion of Biological Threat*





## **APPENDIX C**

<b>Information</b>	<b>Source</b>	<b>Reference</b>	<b>Link</b>
On-site testing	CDC	Notice to Readers: Use of Onsite Technologies for Rapidly Assessing Environmental Bacillus anthracis Contamination on Surfaces in Buildings. MMWR Weekly (2001), 50(48), 1087	<a href="http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5048a5.htm">http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5048a5.htm</a>
	CDC	Anthrax Q & A: Laboratory Testing	<a href="http://www.bt.cdc.gov/agent/anthrax/faq/labtesting.asp">http://www.bt.cdc.gov/agent/anthrax/faq/labtesting.asp</a>
	NIST	Imeida, J.; Harper, B.; Cole, K. D. (in press). Measurement of the Concentration of Bacillus Anthracis Spores by DNA Content: Comparison to Plate and Microscope Counts and the Use of Inactivated Materials. <i>Journal of Microbiological Methods</i> .	<a href="http://www.nist.gov/manuscript-publication-search.cfm?pub_id=830519">http://www.nist.gov/manuscript-publication-search.cfm?pub_id=830519</a>
Personal Protective Equipment	IAFF	Health, Safety, and Medicine Website	<a href="http://www.iaff.org/hs/resi/anthrax/PPE.htm">http://www.iaff.org/hs/resi/anthrax/PPE.htm</a>
	OSHA	Anthrax in the Workplace	<a href="http://www.osha.gov/dep/anthrax/matrix/index.html">http://www.osha.gov/dep/anthrax/matrix/index.html</a>
	U.S. Army Center for Health Promotion and Preventive Medicine	Personal Protective Equipment Guide for Military Medical Treatment Facility Personnel Handling Casualties from Weapons of Mass Destruction and Terrorism Events	<a href="http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&amp;doc=GetTRDoc.pdf&amp;AD=ADA451952">http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&amp;doc=GetTRDoc.pdf&amp;AD=ADA451952</a>
	NIH	Nicas, Mark PhD, MPH; Neuhaus, John PhD; Spear, Robert C. PhD Risk-Based Selection of Respirators Against Infectious Aerosols: Application to Anthrax Spores.[Article]	<a href="http://www.ncbi.nlm.nih.gov/pubmed/10914342">http://www.ncbi.nlm.nih.gov/pubmed/10914342</a>

Information	Source	Reference	Link
	CDC/HHS	Protecting Investigators from Exposure to <i>Bacillus anthracis</i> Using Personal Protective Equipment	<a href="http://biosalud.saber.ula.ve/db/salud/edocs/articulos/ProtectingFromExposure.pdf">http://biosalud.saber.ula.ve/db/salud/edocs/articulos/ProtectingFromExposure.pdf</a>
Scenarios: includes decontamination, dispersion information, and basic response procedures	Federal Interagency Community	National Planning Scenarios	<a href="http://publicintelligence.net/national-planning-scenarios-version-21-3-2006-final-draft/">http://publicintelligence.net/national-planning-scenarios-version-21-3-2006-final-draft/</a>
Healthcare Provider Information	CDC	Fact Sheet: Anthrax Information for Health Care Providers	<a href="http://www.bt.cdc.gov/agent/anthrax/anthrax-hcp-factsheet.asp">http://www.bt.cdc.gov/agent/anthrax/anthrax-hcp-factsheet.asp</a>
Decontamination	CDC	Meehan et al. (2004) Responding to Detection of Aerosolized Bacillus anthracis by Autonomous Detection Systems in the Workplace. MMWR, 53, 1-11	<a href="http://www.cdc.gov/mmwr/preview/mmwrhtml/rr53e430-2a1.htm">http://www.cdc.gov/mmwr/preview/mmwrhtml/rr53e430-2a1.htm</a>
	IAFF	Decontamination of Anthrax	<a href="http://www.iaff.org/hs/Resi/Anthrax/Decontamination.htm">http://www.iaff.org/hs/Resi/Anthrax/Decontamination.htm</a>
Treatment Guidelines	CDC	Anthrax: Exposure Management/Prophylaxis	<a href="http://www.bt.cdc.gov/agent/anthrax/exposure/">http://www.bt.cdc.gov/agent/anthrax/exposure/</a>
Sample Collection	GAO	Anthrax Detection: DHS Cannot Ensure that Sampling Activities will be Validated	<a href="http://www.fas.org/programs/bio/resource/documents/gao_anthrax_detect_dhs_cant_ensure_sampling_valid-test.pdf">http://www.fas.org/programs/bio/resource/documents/gao_anthrax_detect_dhs_cant_ensure_sampling_valid-test.pdf</a>
	CDC/NIOSH	Comprehensive Procedures for Collecting Environmental Samples for Culturing Bacillus anthracis	<a href="http://www.bt.cdc.gov/agent/anthrax/environmental-sampling-apr2002.asp">http://www.bt.cdc.gov/agent/anthrax/environmental-sampling-apr2002.asp</a>
	OSHA	What first response actions should be taken?	<a href="http://www.osha.gov/SLTC/etools/anthrax/first_response.html">http://www.osha.gov/SLTC/etools/anthrax/first_response.html</a>
Notification	FBI/DHS/HHS/CDC	Guidance on Initial Responses to a Suspicious Letter / Container with a Potential Biological Threat	<a href="http://www.bt.cdc.gov/planning/pdf/suspicious-package-biothreat.pdf">http://www.bt.cdc.gov/planning/pdf/suspicious-package-biothreat.pdf</a>

<b>Information</b>	<b>Source</b>	<b>Reference</b>	<b>Link</b>
	OSHA	What training requirements exist for workers involved in anthrax response and remediation?	<a href="http://www.osha.gov/SLTC/etools/anthrax/training.html">http://www.osha.gov/SLTC/etools/anthrax/training.html</a>
Public Health Response	CDC	Public Health Emergency Response Guide for State, Local, and Tribal Public Health Directors	<a href="http://www.bt.cdc.gov/planning/responseguide.asp">http://www.bt.cdc.gov/planning/responseguide.asp</a>

## **APPENDIX D**

## Draft

# Proposed Guidance for Protecting Responders' Health During the First Week Following a Wide-Area Anthrax Attack

## Background

### *Purpose*

The Department of Homeland Security requests your feedback on this document, "Proposed Guidance for Protecting Responders' Health Following a Wide-Area Anthrax Attack". Your feedback will assist us in finalizing this guidance informed by user experiences and operational feasibility. While overall comments are valued, critical feedback in the areas of defining tiers as a strategy for determining risk of exposure, the use of an activity based approach rather than occupational specialties, and feedback on options for ensuring appropriate medical countermeasures are immediately available to the responder community is sought.

This document provides policy recommendations for protection of personnel responding to a wide-area anthrax attack from exposure to *Bacillus anthracis* spores. A Federal interagency working group, consisting of subject matter experts in biodefense, infectious diseases, and occupational health and safety, has developed this draft consensus guidance regarding appropriate protective measures for responders in the immediate post-attack environment of an aerosolized anthrax attack. This proposed guidance statement reflects the most current understanding of the unique environment that will exist after a wide-area anthrax release. These recommendations will evolve with stakeholder input, scientific developments, and availability of new environmental monitoring techniques.

### *Wide-Area Anthrax Attack Scenario*

This guidance applies to a particular scenario: a wide-area anthrax attack in a large U.S. city. These recommendations may not be appropriate for all biological attack scenarios, or even for all anthrax attack

scenarios. A wide-area, outdoor aerosol attack employing *B. anthracis* spores would present different challenges than a smaller scale or indoor anthrax attack or attacks involving other agents. Specifically, these recommendations apply to a scenario in which a quantity of *B. anthracis* spores in a liquid or dried preparation is disseminated as a small-particle aerosol generated by a spraying device. The spores could be released from a single point or along a dissemination line from either a ground-based (e.g., truck mounted sprayer) or an airborne (e.g., crop-duster) delivery vehicle. The scenario assumes meteorological conditions that would favor maximum plume dissemination and could result in an affected area that could encompass hundreds of square miles and potentially expose hundred of thousands to spores. The assumptions used to address underlying uncertainties associated with this scenario are listed in Appendix 1.

### *The Response*

In the absence of rapid and effective public health intervention, the successful execution of a wide-area anthrax attack in a major metropolitan area could have disastrous effects. A well designed, exercised and rapidly executed response is necessary to minimize catastrophic effects. Untreated, the mortality of inhalational anthrax approaches 100 percent, but the timely provision of appropriate treatment can prevent illness and death. Post-exposure prophylaxis (PEP) with antimicrobials (antibiotics and vaccine)s continues to be the mainstay of protection post-exposure, – a level of protection that is further enhanced by pre-exposure vaccination in selected populations. Human and animal data suggest that PEP administration of antibiotics taken as directed can result in a much higher level of protection when started within 48 hours after exposure and before the onset of clinical symptoms.

Distribution and administration of antibiotics to a population at risk within 48 hours of attack increases the ability to save lives, maintain social order, avoid significant economic loss, ensure continuity of government, and preserve the public's confidence in government's ability to respond to an attack. Yet, the logistical challenges to an effective response in the wake of a wide-area anthrax attack are significant. Because antibiotic PEP must be initiated prior to the onset of clinical symptoms, there is a short window of opportunity to ensure their availability to those exposed. To complicate matters, we have no mechanisms available to accurately predict the at-risk population within an adequate timeframe. Current systems do not provide for highly detailed temporal or spatial resolution around the aerosol source, nor do models allow for rapid or remote characterization of an area that is likely to be contaminated.

The Federal Government has recognized that to minimize the effects of such an attack, two critical capabilities must be in place: First, the Nation must have the capability to rapidly distribute antibiotics to the entire affected population before clinical symptoms appear. (NOTE: for planning purposes, 48 hours post-exposure is used as a delivery target). Second, civil order must be maintained both to rapidly distribute antibiotics to the entire affected population and to ensure public safety and security.

With respect to the first critical capacity, the Strategic National Stockpile (SNS) contains sufficient quantities of antibiotics for PEP following an anthrax release. BioWatch is a U. S. Government system that provides a bio-aerosol environmental monitoring and early detection of biological attacks in our Nation's largest cities. However, current BioWatch technology leaves a 12 – 36 hour lag time between agent release and recognition of a BioWatch Actionable Result (BAR) for anthrax. That leaves only 12 hours to respond to the BAR and deliver PEP to the entire at-risk population.

Recognizing that local points of dispensing (PODs) may not be able to reach the entire at-risk population within 12 hours, an additional Federal program designed to rapidly distribute antibiotics was initiated in 2004. The program was designed to dispense to residences a short-term supply of antibiotics by U.S. Postal Service (USPS) postal carriers. Drills were conducted in 2006 and 2007 across two to three zip codes in each of three cities, Seattle, Boston, and Philadelphia. Postal carriers dispensed mock antibiotics to approximately 22,000, 36,000, and 55,000 housing units, respectively, in the three drills. In these operational drills, dispensing took only 6–9 hours. In addition to the time needed for delivery to residences, it will take time to move stocks from the SNS to the affected state(s), as well as the time needed to mobilize postal carriers and any security forces to assist in delivery to residences.

With respect to the second critical capacity, an effective response will rely on the actions of a large number of responders who will enter and work in the affected area. Mail carriers will need security escorts. Since plans for distributing PEP will likely vary across Cities Readiness Initiative (CRI) cities, the specific agencies or organizations that will provide security escorts will also vary (e.g. local police, National Guard under State active duty). As part of pre-planning strategy, entities should examine and make provisions to ensure security for those doing the distribution. Traditional first responders (law enforcement, fire, emergency medical services) will need to maintain civil order, and certain personnel working in critical capacities (power, water, telecommunications, etc.) will need to maintain critical services during the first 24 to 48 hours of the response. An effective response must address the protection of both sets of responders. Considerable planning and preparation is necessary to help ensure the appropriate safeguards are in place so responders are fully protected and confident that they are adequately protected when working in contaminated areas.

Guidance documents have already been developed for protecting responders engaged in environmental sampling and remediation, as well as for mail carriers delivering antibiotics as part of the USPS plan for residential delivery. Unified guidance for protecting other responders is now being proposed. This proposed guidance does not supersede existing guidance, but rather is intended to support ongoing efforts in planning and preparation, and expand coverage to similarly exposed responders. This proposed guidance will facilitate appropriate planning and should be refined as additional data become available.

*Definition of “Responders”*



Homeland Security Presidential Directive (HSPD) #8 defines first responders as

...individuals who in the early stages of an incident are responsible for the protection and preservation of life, property, evidence, and the environment, including emergency response providers as defined in section 2 of the Homeland Security Act of 2002 (6 U.S.C. 101), as well as emergency management, public health, clinical care, public works, and other skilled support personnel (such as equipment operators) that provide immediate support services during prevention, response, and recovery operations.

This proposed guidance also defines responders broadly. “Responders” here refers to a diverse set of individuals who will be critical to mitigating the potential catastrophic effects of a wide-area anthrax attack. This includes professional and traditional first responders (e.g., emergency medical personnel, firefighters, law enforcement, and HAZMAT personnel), public health and medical professionals, skilled support personnel, essential workers in critical infrastructure sectors, and certain Federal and private sector employees and individual volunteers assisting in activities such as distribution and dispensing of antibiotics for PEP.

## **Protecting Responders**

### *Overview*

While the general public (including some responders) may have been initially exposed to anthrax spores immediately following the attack, there will be many responders who as part of their duties may enter areas having increased risk of exposure. This risk can be limited through the appropriate use of personal protective equipment (PPE), decontamination and hygiene procedures, and the timely administration of antimicrobial PEP. Employers and/or organization sponsoring responders have an obligation to provide and pay for protection (e.g. PPE) and associated training to reduce responders’ exposure to the hazards.<sup>1</sup> Pre-planning strategies need to examine what protection may be necessary and how to ensure that it is readily available to responders for immediate use in the event of a wide area aerosol anthrax attack.

Protective measures available to responders who may become exposed to anthrax spores include (1) use of personal protective equipment (PPE), (2) antimicrobial PEP, and (3) vaccination (pre- and post-

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<sup>1</sup> For additional information, please see OSHA Standards 29 CFR 1910.120, 29 CFR 1910 Subpart I - Personal Protective Equipment and OSHA Document CPL 02-02-073 - Inspection Procedures for 29 CFR 1910.120 and 1926.65, Paragraph (q): Emergency Response to Hazardous Substance Releases.

exposure).<sup>2</sup> The primary objective for instituting these protective measures is to limit exposure and thus avert illness and death. Although PPE is usually designed to *prevent* exposure, in this setting PPE is intended to reduce the level of responder exposure (spore burden) in appropriate situations since a significant proportion of the cohort may have already been exposed. In addition, because the risk of secondary exposure is continuous and not definable, it may not be feasible to prevent responders effectively and completely from coming into contact with the hazard. Because prevention of exposure cannot be assured, even with PPE, medical prophylaxis is critically important as a foundation of protection.

Because the vaccine is not immediately effective, continuation of antimicrobial PEP until after the third dose of anthrax vaccine is administered is essential. Therefore, when employed appropriately, PEP with effective antibiotics combined with vaccination offers the best intervention for protection.

#### *Rationale for Recommended Protections*

Normally in hazardous materials response, the source or location of the hazard, contamination characteristics and locations are predictable and environmental testing can delineate areas of higher and lower concentration. In a typical setting, these data then form the basis for risk assessments and selection of appropriate protective measures. This traditional approach is not feasible for the wide area anthrax scenario for which this guidance is designed because of current sampling limitations, the need to get antibiotics to the entire affected population within 48 hours after the attack, and the potential geographic extent of the contamination. Geography or location within the affected area alone cannot be used as the basis for assessing responder risk.

However, even though we will have limited knowledge of contaminated areas and levels of risk, it is possible to develop an activity-based approach to classifying the potential risk of exposure for responders. Responder activities that are likely to increase exposure include: environmental sampling, forensics sampling, decontamination, and extensive travel within the potentially contaminated area. Risk of exposure increases with travel frequency and duration into one or multiple contaminated areas. To address concerns that the entire responder population would be at increased risk during the first week after the attack, a tiered approach to classifying presumed increased risk of exposure is recommended based upon qualitative assessment of the probability of exposure.

#### *Potential Exposure Level Tiers*

Risk stratification among responders can be performed through identification of activities that likely present the highest potential exposure levels to *B. anthracis* spores. Given the inherent uncertainties, a

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<sup>2</sup> While performing specific activities (e.g., sampling, investigation, decontamination, etc.) that place responders at the highest risk for exposure, administrative and engineering controls can also be effective.

balanced, prudent, and precautionary approach is necessary. It is important to note that these recommendations are activity-based rather than being based on traditional occupational duties. Activities may alter responders' tier groupings from day to day, and each responder and team leader should continuously re-assess activities to determine their activity tier. The guidance builds on internal protocols and procedures that were developed internally for USPS workers and guidance developed for those engaged in environmental sampling and remediation, and expands these protocols to other responders who are engaged in certain activities or who must travel frequently throughout the affected area immediately following the incident.

## Definitions

*TIER 1 – Highest Potential Exposure Levels During Responder Activities* – Highest potential exposure levels should be assumed for: a) activities associated with prolonged contact with potentially contaminated surfaces (e.g., sampling, etc.); b) activities that place responders in areas that are likely to have higher spore concentration for extended periods of time; c) activities performed in areas that witnesses identify as a release site; and d) activities in areas identified as contaminated through sample measurement. Responders engaged in these activities or working in these areas are likely to be subject to higher risk of exposure from environmental contamination and secondary aerosols. All responders in this category should be considered to have elevated risk of exposure.

Examples of Tier 1 activities include, but are not limited to: environmental sampling and characterization, HAZMAT decontamination/remediation, forensics sampling, and other activities proximal to the suspected release site or area documented to be contaminated.

*TIER 2<sup>3</sup> – Increased Risk of Exposure, but not Highest Potential Exposure Levels During Responder Activities* – Responders in this group are assumed to a) originate from within the affected area thus assumed to have been at least potentially minimally exposed prior to work activities and b) engage in extensive and/or frequent travel throughout the affected areas. Frequent travel increases the probability of moving through contaminated areas and therefore increases the likelihood of additional exposure and increased spore burden. Responders engaged in Tier 2 activities will likely be exposed to greater levels of environmental contamination and secondary aerosols during these activities, although these exposures would be expected to be less than those engaged in Tier 1 activities. Completion of the U.S. Postal Service (USPS) delivery of antibiotics will require continuous postal carrier and security escort travel across a large at-risk area during the first 12 hours; however, unlike some Tier 1 activities, the delivery of

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<sup>3</sup> Since contaminated spots will be noncontiguous with unknown locations, it is reasonable to suggest that for some time immediately after the primary aerosol dissipates frequent or prolonged movement outdoors is likely to increase the probability of traveling through multiple contaminated spots, thereby increasing exposure levels and spore burden. The more movement, the greater the likelihood is of increased exposure.

antibiotics will not necessarily require extended exposure in highly contaminated areas. Thus, the activities of postal carriers and their security escorts are representative of activities in Tier 2.

Examples of Tier 2 activities include, but are not limited to: postal carriers and security escorts involved in antibiotic distribution, EMS, fire, rescue, police, and traffic control not otherwise supporting Tier 1 activities.

*TIER 3 – Limited Risk of Exposure During Responder Activities* – Responders assigned to this tier: a) originate from within the affected area; b) may be required to travel to and from their workplaces or, during the execution of their duties, may be required to make short, infrequent trips; and c) primarily work indoors. In the absence of information to the contrary, it is assumed that although any travel within the at-risk geographic area may result in the inadvertent entry into higher-risk areas, short and direct trips do not carry the same probability of exposure as do Tier 2 activities.

Examples of Tier 3 activities include, but are not limited to personnel who may be required to report to work, may be required to travel to and from their workplaces, or who, during the execution of their duties, may be required to make short, infrequent trips (e.g., essential staff maintaining critical infrastructure/key resources (CI/KR), hospital staff, mission-critical local, State, and Federal Government personnel, POD volunteers).

## Recommendations for Responder Protection<sup>4</sup>

### Summary of Recommendations:

Protection	Tier 1	Tier 2	Tier 3
Antimicrobial PEP*	√	√	√
Pre-Event Vaccination	√	√	N/A
Post-Event Vaccination	√	√	√
Respiratory Protection	√	√	NA**
Nitrile Gloves	√	√ <sup>†</sup>	NA**
Protective Clothing	√	√ <sup>‡</sup>	NA**
Personal Decontamination/Hygiene	√ <sup>€</sup>	√ <sup>€€</sup>	√ <sup>€€</sup>

\*Pre-event placement should be considered for Tiers 1-3 emergency services and essential CI/KR workers who will need to immediately report to and remain on duty despite or because of an ongoing emergency.

\*\* Consider for specific situations assessed to represent increased risk.

†For responders handling multiple potentially contaminated surfaces

‡Consider uniform or clothing change policy. Consider protective garments for specific activities that may represent increased risk for contamination of garments.

€ Full personal decontamination

€€ As appropriate to the situation; at a minimum clothing change, laundering and personal shower (at shift end or daily)

- Tier 1** – Responders in this group will likely encounter higher exposure to spores, increasing the risk for inhalational or cutaneous anthrax.

### *Antimicrobial post-exposure prophylaxis (PEP)*

<sup>4</sup> Most existing human data regarding anthrax antimicrobial prophylaxis, treatment, or vaccination were gathered in studies of occupational populations, particularly active duty uniformed service members, and most animal model studies were designed with these populations in mind. While these protective measures may be relevant to professional responders, in a large-scale attack they may not be appropriate for all responders, such as volunteers, particularly those who are younger or older than most professional responders, and those who have certain medical conditions that may affect their susceptibility to disease or the effectiveness of protective measures.

All responders in the Tier 1 Group should begin antimicrobial PEP as early as possible and should continue for the recommended duration, depending on vaccination status (at least 60 days of antibiotics for previously unvaccinated and at least a 30 day course for those previously fully vaccinated<sup>5</sup> after the last exposure).

### *Vaccination*

Responders likely to fall within the Tier 1 Group during an event should receive priority to receive pre-event vaccination. Post-exposure, in addition to antibiotics, all responders in the Tier 1 Group who have not been vaccinated previously, and those requiring updated boosters, should receive anthrax vaccination. Please see Recommendation 4, below.

### *Personal Protective Equipment (PPE)*

In addition to antimicrobial PEP, responders in the Tier 1 group should adhere to existing recommendations related to the use of PPE when working in a contaminated environment. PPE includes appropriate respiratory protection (e.g., Powered Air-purifying Respirator – PAPR), protective garments, and gloves, as well as appropriate training and fit testing, and decontamination training. (Please see Appendix 6 for references containing guidance that is more detailed.)

### *Personal Decontamination/Hygiene*

The potential for and extent of contamination for people operating in a wide-area post-attack environment are currently unknown. With Tier 1 activities, protective clothing or other exposed gear is more likely to be contaminated and may be a source of further contaminant dissemination. Appropriate decontamination procedures are necessary. Locations/facilities for proper decontamination for this higher risk group must be determined (e.g., decontamination trailers) by the Incident Command. Once decontaminated, responders in the Tier 1 Group should correctly doff and dispose of protective clothing and respiratory protection. Undergarments worn under protective clothing should be laundered or disposed of after a shift of work is completed. Responders should shower with soap or undergo some other appropriate personal decontamination after a work shift.

- 2. Tiers 2 and 3** – Responders will need to act rapidly based on consistent training and preparation. As the response progresses, incident leadership may make site and activity-based decisions regarding the appropriate protective ensemble based on factors related to the specific event and additional knowledge obtained over the course of the event. It is critical that incident commanders, other incident leadership, employers, and public health authorities with jurisdiction to consider additional

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<sup>5</sup> The initial 6-dose vaccination series is complete and booster doses are up-to-date according to ACIP recommendations

information (such as sampling data, witnessed release locations, etc.) when selecting protective measures for responders following an attack.

#### *Antimicrobial post-exposure prophylaxis (PEP)*

All people in the Tier 2 and Tier 3 Groups should begin taking antibiotics as soon as possible and should continue for the recommended duration, depending on their vaccination status (at least 60 days for those previously unvaccinated and at least 30 days for those previously fully vaccinated after the last exposure).

#### *Vaccination*

Responders likely to fall within the Tier 2 Group in response to an event may be offered pre-event vaccination. Post-exposure, in addition to antibiotics, all responders in the Tier 2 Group who have not been previously vaccinated, and those without updated boosters, should receive anthrax vaccination. Please see Recommendation 5, below.

#### *Personal Protective Equipment (PPE)*

**Tier 2 – Extensive travel or remaining outdoors for extended shifts** – Responders involved in Tier 2 activities (frequent and/or long-term travel throughout the affected area) should be provided respiratory protection to reduce risk of exposure and potential inhalational burden. USPS responders (carriers participating in residential delivery of antibiotics) should adhere to existing USPS guidance regarding working in a contaminated environment. This guidance includes N95 respiratory protection, gloves, and uniform change provisions. Other Tier 2 responders (e.g., patrols, security, and rescue) should consider a uniform change provision similar to the USPS guidance. Tier 2 responders who do not wear uniforms (such as outdoor utility maintenance) should consider adding a uniform or clothing change policy; protective garments can be considered for specific activities that may represent increased contamination risk. Consistent with existing recommendations, all Tier 2 responders should use N95 (or more protective) respirators (with appropriate training and proper fit testing) while engaged in those activities as the minimum respiratory protection level to reduce the risk of inhalation of *B. anthracis* spores. Nitrile gloves should also be considered for Tier 2 responders handling potentially contaminated surfaces.

**Tier 3 – Limited travel** – Responders in this group originate from inside the affected area and will have many duties that are not likely to present risk of exposure as high as Tiers 1 and 2, but may require a specific PPE program. When specific conditions or activities indicate that there may be a significantly increased risk, responders and team leaders should consider the use of PPE (i.e., respirators, protective garments).

### *Personal Decontamination/Hygiene*

Personal decontamination procedures are not specified for this Tier. To mitigate potential risk, personal hygiene practices should be emphasized. Undergarments worn under protective clothing should be disposed of after a shift of work is completed or removed and laundered with commercially available laundry detergent and water or dry cleaning.

### **3. Outside responders temporarily entering the affected geographic area**

Responders who were not in the impacted region during an attack do not have the same baseline risk of exposure as responders who might have been in the area at the time of the attack. Furthermore, responders who do not reside in the attack area may only be exposed for a short time (e.g., some security escorts might only be at risk of exposure for the 12-24 hours that it takes to deliver the PEP). Responders who originate from outside the affected geographic area (and thus do not have prior exposure) and remain in the affected areas only briefly should be protected in a manner similar to Tier 1 or 2, depending on the activity. The recommended PPE ensemble for responders coming into the affected area includes appropriate respiratory protection (including fit-testing), uniform or clothing change (and protective garments in specific instances), gloves, appropriate training, decontamination, post-exposure antibiotics, and vaccine. Personnel and equipment should be decontaminated when exiting the affected area.

### **4. Occupational Safety and Health Medical Surveillance and Consultation**

Before using a respirator, responders must undergo medical evaluation to determine the employee's ability to use a respirator and be fit-tested for the respiratory protection they will use.<sup>6</sup>

The employer's emergency response plan must address emergency medical treatment and first aid. In addition, responders must be provided access to medical examinations and consultations should they become injured, develop signs or symptoms of exposure to hazardous substances, or experience adverse events associated with prophylaxis (29 CFR 1910.120(f)). Medical examinations and consultations must be provided as soon as possible following the incident, and at additional times if the physician determines it is necessary. In addition, incident commanders must ensure that responders receive adequate training based on expected duties. The training shall include information regarding risk of exposure, appropriate protective measures, and potential adverse events.<sup>7</sup>

### **5. Pre- and post-event vaccination**

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<sup>6</sup> For additional information, please see OSHA Standard 29 CFR 1910.134 Respiratory Protection.

<sup>7</sup> For additional information, please see OSHA Standard 29 CFR 1910.120 and OSHA Document CPL 02-02-073 - Inspection Procedures for 29 CFR 1910.120 and 1926.65, Paragraph (q): Emergency Response to Hazardous Substance Releases.



- Pre-event vaccination – In October 2008, the Advisory Committee on Immunization Practices (ACIP) re-examined its recommendations for pre-event anthrax vaccination for responders likely to be involved in an anthrax post-attack response. The committee recognized that while the risk of exposure for first responders to anthrax is low, it may not be zero. Although emergency and other responders are not recommended for routine pre-event anthrax vaccination, ACIP determined that it is allowable for first responder organizations to choose to offer pre-event vaccination on a voluntary basis. The vaccination should be administered according to the most recent FDA guidance<sup>8</sup> and the vaccination program implemented under the direction of a comprehensive occupational health and safety program.
- Post-event vaccination – Post-event, post-exposure vaccination is an essential component of protection for responders exposed to *B. anthracis* spores. Previously unvaccinated responders should receive the initial vaccine dose as soon as possible and should complete a course of at least the first 3 vaccinations in the series (at 0, 2, and 4 weeks).
- Vaccine Prioritization – In the event that anthrax vaccine stocks are insufficient to meet operational requirements, the responder community must be prepared to prioritize those most at risk of exposure. Criteria for determining priorities for vaccination will be developed by the Federal government to assist local decision makers.

#### **6. Pre-event placement of antibiotics for certain responders and critical workers**

The goals of pre-event placement of antibiotics are to ensure continuation of mission essential functions without the time lag burden of acquiring and distributing antibiotics, as well as lessening the volume of antibiotics that must be distributed post-event. As part of any planning effort, responsible parties should evaluate the feasibility of pre-event placement of antibiotics for responders (potentially including family members) who will need to immediately report to and remain on duty despite or because of an ongoing emergency.

The USPS strategy for residential delivery of antibiotics includes pre-event provision of antibiotics to postal workers and their family members. Using this as a model, local planners should consider which critical workers (and their family members) should be considered candidates for exercising this strategy. Such a strategy should include pre-event medical screening of this workforce (and their families) to ensure there are no medical contraindications to taking these antibiotics. Local planning should identify who will provide this screening (e.g. employers, public health, other). This critical workforce is represented within Tiers 2 and 3 of this document.

#### **7. Planning guidance and responsibilities of incident commanders and public health authorities**

Incident commanders, as part of a Unified Command or other incident leadership, employers, and public health authorities with jurisdiction have the ultimate responsibility for determining appropriate protective measures for responders and for the general public in the setting of an emergency. Comprehensive planning and training is essential to ensure that responders are protected while performing mission essential tasks.

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<sup>8</sup> The December 11, 2008 revision requires an intramuscular route of administration for the vaccine. Vaccine is administered in five (5) doses at 0, 4 weeks, and 6, 12, and 18 months (plus boosters).

One significant assumption contained within this guidance is that Federal, State, and local planners have incorporated appropriate logistical mechanisms to ensure timely availability of antimicrobial PEP and other protective measures for responders. Plans should consider local stockpiles or other mechanisms to ensure that responders will have immediate access to personal protective equipment and medical countermeasures if pre-placement in homes is not used. (See Recommendation 6, above).

Authorities should consider this guidance in formulating pre-event plans and incident-specific guidance and training, and arrange for Emergency Use Authorizations (EUAs) for the responding populations. However, they should be aware of the significant information gaps and assumptions inherent in this proposed guidance and that information available as an incident evolves may provide them with better information upon which to develop better guidance.

**8. Alignment of initial antibiotic PEP dispensing strategies and deployment of responders to minimize risk of exposure to responders and population**

Although recommendations regarding the preferred modalities for initial antibiotic dispensing during the first 48 hours following an attack are beyond the scope of this guidance, there are significant implications related to protecting responders. The USPS plan for rapid distribution of antibiotics is intended to save lives of the public. Since fewer responders are needed under this plan, a secondary benefit for locations utilizing this modality is the reduced number of responders exposed. As mentioned, drills exercising the USPS plan for residential delivery of antibiotics have been conducted in Seattle, Philadelphia, and Boston. The projected staffing requirements extrapolated from these drills to deliver antibiotics to all households in a metropolitan area in 6-9 hours are significantly lower than the total staffing required to complete the same task utilizing public health PODs. In addition, the USPS plan minimizes unnecessary travel within the affected area by advising people to remain in their homes; whereas the POD model requires the entire population (or heads of household) to travel to a POD, wait in line, receive their antibiotics, and travel back home. Poor characterization of environmental contamination, risk of exposure in the first days following an attack, additional immediate travel within the affected area by the much larger number of responders, and the required travel of the affected population to come to a POD for their medication following an attack potentially increases risk of exposure.

The USPS plan for residential delivery of antibiotics decreases the overall risk to responders by significantly reducing the immediate demand for conducting initial dispensing of antibiotics using PODs. This option also reinforces guidance to “remain indoors or at-home” for the general public to assist in maintaining order which will prevent unwarranted evacuation, unnecessary travel, and help to limit further contamination by or spread of anthrax spores.



## **Appendix 1 – Scenario, Impact, and Response Assumptions**

This proposed guidance is intended to facilitate planning for one particular scenario though parts of this guidance may be relevant to other scenarios. Building that scenario required making a variety of assumptions about the nature of the attack and the resulting environmental contamination. As specific information is gained about a given attack, these assumptions may change. Furthermore, the guidance may change based on changes in our understanding of the behavior of the contaminant, available monitoring technology, and our understanding of the efficacy of the protective measures recommended. Thus, this guidance it is not meant to supplant the judgment of incident commanders or responders on scene of an actual event, who may have access to specific data that can enable better decision making. The most important of the assumptions associated with this guidance are listed below:

### **Assumptions regarding attack scenario:**

- The release is outdoors, to a wide area, using anthrax aerosol
- Wide-area environmental contamination is possible; this contamination will be spotty, non-contiguous, and not predicted by models
- The strain of *B. anthracis* used in the attack has not been modified or engineered to express resistance to antibiotics in the Strategic National Stockpile (SNS) Naturally occurring strains of *B. anthracis* are susceptible to ciprofloxacin and doxycycline. Contingency plans to address the threat of enhanced agents will be addressed in a different forum
- The aerosol anthrax is not military grade weaponized
- The aerosol attack is covert and initial notification will occur after environmental sensors, disease manifestation, or credible forensic intelligence provide evidence of or detect the presence of *B. anthracis*.

### **Assumptions regarding ability to characterize environmental distribution**

- Environmental monitoring and forensic efforts is unable to provide timely information regarding the release, source strength, and scope/area of risk
- Modeling is unable to accurately predict the area of risk from primary aerosol exposure, but will be of value to incident commanders.<sup>9,10,11</sup>

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<sup>9</sup> Even in the days following the attack, empirical data suggest that current plume models may only help to predict areas of highest probability of contamination and cannot accurately predict the extent and scope of contamination because of microatmospheric variability, effect of urban or other structures, lack of knowledge regarding source strength and release dynamics, and the travel of people and vehicles through areas.

<sup>10</sup> In an outdoor attack, levels of exposure to re-aerosolized spores in contaminated areas are likely to be orders of magnitude lower than exposure levels at the time of the attack. Potential exposure levels from undisturbed contaminated environmental surfaces would be even lower.

<sup>11</sup> While the literature supports a protective effect of buildings from the primary aerosol, there are very scant data regarding building effect in the setting of persistent and low level contamination. It is unclear whether an indoor environment protects against or increases potential exposure in the post-attack period.

- There will be very limited knowledge of contaminated areas and levels of risk for the first week (or more) owing to the complexity of the problem and current (and foreseeable) capacity for sampling and testing
- Travel within the geographical area could increase the likelihood of initial or additional aerosol exposure by inadvertent entry into areas of higher contamination or more prone to aerosolization

**Assumptions regarding population exposure:**

- By the time an attack has been detected through BioWatch, people may have been traveling in and out of affected areas for 12 – 36 hours or more
- Everyone within this area is considered at some level of risk for secondary exposure for the entire duration of their presence in the area, although the specific risk is not predictable
- Commuting and traveling of people in and out of the potentially affected area will complicate risk assessment and increase contamination
- A large number of people in a broad geographical area will inhale potentially lethal doses of *B. anthracis* spores but it will not be possible to determine specifically which people are infected. All people in that area will require antimicrobial PEP immediately.

**Assumptions regarding response:**

- The use of anthrax vaccine in combination with antibiotics would be authorized under an Emergency Use Authorization following specific steps by the U.S. Government to declare a public health emergency (*Nightingale SL, Emerg Infect Dis, 2007*) or under an Investigational New Drug (IND) application in the absence of those actions
- The immediate dispensing of antibiotics to the population at risk may rely on the U.S. Postal Service (USPS) plan or other “push” methods that involves postal carriers with law enforcement escorts delivering antibiotics (time to dispense ranges from 8-9 hours). Other modalities (public health PODs, retail PODs, employer PODs) will begin operation following an attack but will likely require more time to become fully operational and complete their task of dispensing antibiotics to the population at risk
- Most responders originate from inside the at-risk geographic area, and therefore will have been at risk for exposure from the primary aerosol
- All public transportation in and proximal to the aerosol release will be affected
- Responders who originate from outside the affected geographic area will be moving from a status of essentially no likely exposure into an area that places them at continuous risk for exposure to *B. anthracis* spores through secondary aerosolization
- “Remain indoors or at-home” guidance may be issued to the population to enable distribution of antibiotics, assist in maintaining order, and prevent unwarranted evacuation and unnecessary travel; this guidance will be situation dependent and will realistically not be effective for more than 48 hours<sup>12</sup>

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<sup>12</sup> Avoiding unnecessary travel within the geographic area could reduce overall public health risk by reducing the likelihood that those who unknowingly have been in a low-risk area will unknowingly travel into a high-risk area.

- Despite the issuance of “stay at home” orders, large numbers of the general public may self-evacuate after notification of an attack or may have to travel out of doors to obtain antibiotics or essential supplies. Others may need to travel within the geographic area in their role as responders, to maintain uninterrupted essential services, and to sustain critical infrastructure
- In addition to traditional “first responders,” there are a number of other responders who will be critical during the first week following an anthrax attack including essential employees across critical infrastructure sectors who cannot abandon their responsibilities and must provide uninterrupted services immediately following an attack (e.g., hospital and nursing home staff, prison guards, airport security, border guards, and those staffing telecommunications, electrical power, water facilities)
- Most responders and essential personnel will potentially receive high enough doses to lead to development of inhalational anthrax for the entire time they remain in the region and may be at risk for developing inhalational anthrax for a period of time after they leave the potentially contaminated area, depending on the level of inhaled *B. anthracis* spores (spore burden)
- Demand for antibiotics will likely extend beyond the geographic boundaries of the affected area and could complicate efforts to provide them to those requiring them.
- Epidemiological trending/mapping will be undertaken but may not be able to fully assess the potential contaminated zones

## **Appendix 2 – Protective Measures**

The most effective way to protect responders is to prevent spores from initially entering the lung. Normally, this would be accomplished using primary interventions such as engineering controls (e.g., safe havens, isolation, and ventilation), proper use of personal protective equipment (PPE), work practice modifications, and limiting access and duration in the affected area. However, this scenario assumes there will be a 12-36 hour delay between the attack occurrence and recognition of the same. Therefore, primary controls for response personnel residing within the contaminated area will almost certainly not be implemented in time to prevent initial spore inhalation. For this scenario, these are adjunct measures to reduce the level of additional exposures as responders perform their duties.

Note that the ability to determine risk will be limited, and that it is likely that exposure will not be uniform for responders residing inside the affected area. It is probable that there will be significant differences in initial exposure amongst this responder group. Some local responders may not have been exposed at all during the attack (e.g., they live up wind, were indoors in a controlled environment, were out of town on the day of attack, or live in an unaffected area), and traveling into the hazard area would therefore increase in their risk. PPE and other controls for this sub group, and for the numerous unexposed responders arriving from outside the affected area, could be effective in preventing initial exposure if used according to these recommendations. However, because prevention of exposure cannot be assured, medical prophylaxis is of critical importance as a foundation of protection.

### *Personal Protective Equipment (PPE)*

Normally, PPE is considered a primary intervention because it prevents inhalation or skin contact with *B. anthracis* spores from occurring. Depending on the circumstances (tasks, duration, specific area), N95 or higher-rated respirators can provide significant protection from inhalation of *B. anthracis* spores, if the user is properly fitted to the respirator, wears the respirator properly and for the required durations, and the respirator is appropriately removed and discarded or decontaminated. If worn properly, powered air purifying (PAPR) or supplied air respirators (SAR) can offer increased respiratory protection against inhaling *B. anthracis* spores and are recommended for certain activities, including environmental sampling, conducting remediation activities, or when there may be aerosol-generating devices or activities.

### *Procedural and Engineering Controls*

Procedural and engineering controls can be effective when there is knowledge of what locations and activities could possibly constitute an increased hazard.

### *Antimicrobial Post-Exposure Prophylaxis (PEP)*

When inhaled into the lungs, *B. anthracis* spores germinate into active, growing bacteria that release toxin and cause the disease manifestations of inhalational anthrax. Spores generally germinate to cause disease within a few days, but some spores can remain dormant for weeks or months before germinating. The complex series of events that leads to germination is unclear, but antibiotics are only effective against actively growing organisms; they have no effect on dormant spores. For this reason, antibiotics are recommended for at least 60 days following the last potential exposure for previously unvaccinated individuals.

Unfortunately, compliance with taking antibiotics for extended periods can be challenging. In a study of antibiotic compliance following the 2001 attacks, completion of the full 60-day regimen ranged from 21-64 percent, depending upon location. Although a significant proportion of those who stopped taking antibiotics cited adverse events, only 0.3 percent of the 2,135 people followed after 30 days were determined to have serious adverse events associated with antibiotic use. Statistical analysis and anecdotal experience of antibiotic compliance after the 2001 attacks suggest that those who are indeed at significant risk (and those who perceive that they are at elevated risk) have significantly higher compliance rates.

Doxycycline and ciprofloxacin constitute the bulk of the oral antibiotics in the Strategic National Stockpile. Both are highly effective against *B. anthracis*, are licensed for use against anthrax, and are considered the two first-line agents of choice for anthrax. Human and animal data suggest that the use of an effective antibiotic taken as directed can result in nearly 100 percent protection when started within 48 hours after exposure and before the onset of clinical symptoms. Data from non-human primates support efficacy even after a dose > 1,500 times the 50 percent lethal dose (LD50). Modeling of exposure from spore-containing letters indicates that some people exposed to the letter in Senator Daschle's office may have been exposed to similarly high levels, and none that were promptly provided antibiotics (and later with vaccination) presented with clinical anthrax. When antibiotics are promptly initiated after exposure, failure in animal models has only been seen after cessation of antibiotic use, a phenomenon attributed to the long latency period of some spores in lung tissue.

The duration of antibiotic use is critical to effective protection. Animal data suggest that if an individual has no immune protection, antibiotics must be continued until virtually all inhaled spores have been cleared from the lungs, since only the vegetative form of the organism is affected. Currently, the number of remaining spores within the lungs cannot be accurately measured. Modeling of spore germination and clearance kinetics suggest that complete clearance may take longer than 60 days for large doses, and animal studies have found viable spores up to 90 days after exposure. Although data is lacking regarding antibiotic efficacy in the setting of repeated exposure to anthrax spores and the cumulative amount of spores inhaled, prudence and common sense support a second objective of minimizing the continued inhalational burden of anthrax spores with PPE. Recommendations for the use of PPE to ensure effective



achievement of this second objective requires an understanding of potential environmental contamination and risk of exposure. In the absence of information specific to contamination levels, it is prudent to believe that some activities may increase the probability of exposure, and that responders employ recommended use of protective equipment until additional information is available to suggest otherwise.

#### *Antimicrobial PEP and Pre and Post-Exposure Anthrax Vaccination*

The currently recommended course of antibiotics post-exposure is at least 60 days following last potential exposure in previously unvaccinated individuals. Following high-level exposures, some experts recommend a longer course in the absence of post-exposure vaccination. Pre-event vaccination with anthrax vaccine provides protection from all forms of anthrax. Antibiotics may still be recommended to those who have been fully vaccinated. If large doses of spores are inhaled, it is possible that spores may germinate, producing sufficient amounts of toxin to cause disease before an adequate immune response can be achieved. In the absence of definitive data to clarify the degree of protection provided by vaccination alone, the recommended duration of antibiotic use is 30 days for exposed individuals who have previously completed the primary anthrax vaccination series and who are current with boosters.

Although antibiotics should be given for a prolonged course, studies suggest that anthrax exposure followed by administration of antibiotics post exposure generates no significant protective immune response, leaving no residual protection. Anthrax vaccine, on the other hand, has been demonstrated to impart significant protective immunity against *B. anthracis*. All available data (predominantly from non-human primate studies and one small human clinical field trial) indicate that pre-event vaccination with the licensed U.S. anthrax vaccine, BioThrax (Emergent BioSolutions, Lansing, MI formerly known as anthrax vaccine adsorbed (AVA)), is effective in protecting against development of anthrax disease. Supplementing these data with additional non-human primate data focused on post-exposure prophylaxis, a PEP regimen of anthrax vaccine and antibiotics provides protection from developing inhalation anthrax even after completion of the recommended antibiotic regimen. CDC's Advisory Committee on Immunization Practices (ACIP) and independent expert committees and advisory bodies have concluded that the optimal means to prevent illness after suspected or confirmed inhalation exposure to aerosolized *B. anthracis* spores associated with a biological attack is post-exposure prophylaxis comprising a 60-day course of antibiotics in conjunction with anthrax vaccination in a three-dose regimen (0, 2, and 4 weeks). People who are engaging in longer term (weeks to months) potential exposure may require protection beyond that provided by antibiotics and post-exposure anthrax vaccine, and would benefit from a licensed regimen of pre-exposure vaccination to confer this longer-term protection. In 2000, ACIP recommended, "pre-exposure use of anthrax vaccine should be based on a quantifiable risk for exposure." ACIP reaffirmed that recommendation in 2008, and also permitted that likely responders can be offered pre-event vaccination. Working under the assumption that access to the contaminated area could be controlled after the initial incident, responders would not be expected to have longer-term potential for exposure, and antibiotics would be adequate to protect them. The scenario of this guidance assumes wide-area contamination, which would mean that local responders would be at risk for long-term exposure.

## **Appendix 3 – Antibiotic Dispensing to the General Public**

### *Multi-Layered Strategy for Dispensing Antibiotics Post Exposure*

Current efforts to accelerate dispensing focus on adjunctive modalities for quick push of antibiotics into affected communities. The Cities Readiness Initiative (CRI), started in 2004, is a Federally funded effort to prepare major U.S. cities and metropolitan areas to respond effectively to a large-scale bioterrorist event by dispensing antibiotics to their entire affected population within 48 hours of the decision to do so. The CRI project started in 21 cities and has grown to include 72 CRI Metropolitan Statistical Areas that encompass 490 counties in all 50 states. To help guide State local, territorial and tribal planners, the Department of Health and Human Services (HHS) has identified several dispensing modalities:

1. Pre-event placement of medications in households. Pre-event placement of caches of antibiotics (MedKits) in households that are to be reserved for use during a declared public health emergency. A pilot study was successfully conducted in St. Louis to test the feasibility of pre-event placement of MedKits in households.<sup>13</sup> This study showed that the vast majority (over 95%) of those households stored their kits properly. They returned stored kits to the study team intact and unopened. However, this study did not test each person's understanding of the instructions on the package. Overall, procedures need to be developed to validate proper storage, use, and shelf life of kits. In October of 2008, a Public Health Emergency Declaration was declared by the Secretary of Health and Human Services based on the established, material threat determination and consequences of a widespread attack with *B. anthracis* spores. This declaration allowed a request for an Emergency Use Authorization for the use of home MedKits pre-event for Postal workers. This provision of MedKits is currently under discussion with the Food and Drug Administration (FDA).
2. Pre-deployment of community-based caches of medications. Pre-deployment of antibiotics in community-based caches that will function as points of dispensing (PODs) might include churches, schools, large employers, or fraternal organizations within a community. This option may include the development of retail PODs (operated by businesses to provide antibiotics to their employees and the public) or closed PODs (operated by organizations to provide antibiotics to their employees and their family members).
3. Postal Plan: Home delivery of antibiotics by the United States Postal Service (USPS). The Postal Plan was conceptualized as a way of increasing the speed of dispensing of antibiotics and reducing the population surge at PODs. With this modality, mail carriers with security escorts deliver initial doses of antibiotics directly to homes.
4. Points of Dispensing (PODs). The PODs concept was initially developed to address the smallpox threat and is the public health preferred method of providing vaccine prophylaxis at designated dispensing locations for people who are currently healthy but may have been "exposed." As it relates to anthrax, the role of the POD has been extended to dispense antibiotics to affected members of a community. However, given the amount of time needed to establish and operate a fully functional POD, coupled with delay in detection mentioned earlier, the critical initial doses of antibiotics will likely not be able to be delivered to all those potentially infected within 48 hours of an attack.

The dispensing modalities outlined by HHS provide a framework for rapidly distributing antibiotics. It is apparent that any effective system will involve a mix of several modalities including traditional PODs,

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<sup>13</sup> <http://emergency.cdc.gov/agent/anthrax/prep/pdf/medkit-evaluation-summary-2007.pdf>

employer PODs, postal carrier distribution, and private sector retail chain distribution. The workload required to distribute countermeasure will include a varying mix of traditional responders and volunteers totaling, for a large metropolitan area, thousands of “responders” just for countermeasure distribution.

If the USPS Plan is used as a first strike capability for distributing and dispensing initial doses of antibiotics, then planning must include pre-event screening of USPS personnel and their families, provision of antibiotics to personnel and their families, personal protective equipment (PPE) availability, appropriate training, and proper fit-testing.

Countermeasure distribution will constitute only a fraction of the total response to a large anthrax attack. As noted earlier, responders will be involved in a variety of activities, including environmental sampling and characterization of the contaminated area, crime scene investigation and forensics, law-enforcement and security to maintain of civil order, and medical care. Furthermore, maintaining continuity of operations throughout the response will require personnel that operate and maintain critical infrastructure and key resources. Therefore, the actual number of responders in this scenario may exceed 100,000 in some large regions. It is a critical planning function for each sector to independently examine risk of exposure to their employees and plan, prepare, and stockpile accordingly.

Finally, it should be noted that the efficacy of an initial response will likely hinge upon the maintenance of calm and orderly reaction of the community. The distribution and dispensing of life-saving antibiotics relies on the smooth and effective operation of logistical and transportation systems and the throughput or flow of people (responders and the affected public) through systems that deliver antibiotics.

Psychological studies of humans in crisis situations and experience in previous disasters indicate that public confidence will remain high if there is perceived (1) open flow of accurate information, (2) effective government response, and (3) rapidly accessible antibiotics for all who require it. Additional studies suggest that nontraditional responders are more likely to report to and remain on duty if they and their families are provided adequate PPE in addition to PEP. Low public confidence in these areas may lead to panic and social disorder that likely may result in cascading consequences. This creates a tenuous balance upon which may rest the success of response. It is essential to have open, honest risk communication with the general public. People will be strongly urged to stay in place for up to 48 hours to ensure the roads are clear, responders can travel to the site, and medication (e.g., antimicrobial PEP, including antibiotics and vaccine) can be dispensed to individuals in the area.

#### **Appendix 4 - Using Anthrax Vaccine in a Post-exposure (post-event) Situation**

Anthrax vaccine is approved for post-exposure use to be administered under an Investigational New Drug (IND) protocol. This program provides the use of the licensed product, BioThrax, for the unapproved

indication of post-exposure prophylaxis using a shorter duration of time and fewer doses compared to the approved regimen. As outlined in the IND protocol, the post-exposure prophylaxis program is intended to provide a 3-dose regimen (0, 2 weeks, 4 weeks) of anthrax vaccine (BioThrax™, formerly known as AVA) as an emergency public health intervention to prevent inhalation anthrax among people exposed to potentially aerosolized *Bacillus anthracis* spores.

Post-exposure prophylaxis must include BioThrax in conjunction with 60 days of selected oral antibiotics. Two of these, ciprofloxacin and doxycycline, have been approved by the Food and Drug Administration (FDA) for this indication but the other, amoxicillin, has not. Therefore, the program is made available under an Investigational New Drug (IND) application to comply with regulations concerning the use of approved products for investigational indications.

All participants must sign an informed consent form before being allowed to enroll in the program. The program, consent form, and progress reports will undergo continuing review by CDC Investigational Review Board at least annually in accordance with Title 21, Code of Federal Regulations (CFR) Part 56.109. The currently approved protocol has been approved by the CDC IRB until November 2008.

In October, 2008 the Secretary of Health and Human Services declared under section 564(b)(1)(B)(C) an emergency based on: the determination of the Secretary of Homeland Security that there is a domestic emergency, or a significant potential for a domestic emergency, involving a heightened risk of attack with a biological agent anthrax; and the determination of the Secretary of Health and Human Services of a public health emergency under section 319 of the Public Health Service Act that affects, or has the potential to affect, national security, and involves the biological agent anthrax. CDC could request use of anthrax vaccine as a part of PEP through an Emergency Use Authorization (EUA) as a medical product for use in emergencies pursuant to section 564 of the Federal Food, Drug and Cosmetic Act. This EUA allows BioThrax™ to be used in combination with antibiotics to protect civilians, emergency response personnel, and health care providers who were exposed to anthrax spores or bacteria following an intentional release due to an act of bioterrorism or as the result of a public health emergency. An EUA has facilitates the rapid implementation of anthrax vaccine administration, thereby allowing more rapid administration to the appropriate populations at risk.

## **Appendix 5– Knowledge Gaps**

Additional study and information regarding the following items will allow for better characterization and allow for further refinement of anthrax protection guidance:

- Improved characterization of environmental hazards after wide-area release including:
  - Degree and extent of contamination (including resuspension and fate and transport)
  - Improved modeling to predict contamination
  - Risk of secondary re-aerosolization and activities to avoid to limit re-aerosolization
  - Duration and time kinetics of contamination
  - Impact of rain or other dilution factors on outdoor contamination
  - Indoor versus outdoor contamination characterization
  - Effects and determinants of cross-contamination via vehicle or human activity.  
Assessment of magnitude and evaluation of interventions to minimize cross-contamination.
  
- Required duration of antibiotic PEP including:
  - Variation with exposure dose
  - Variation with addition of anthrax vaccine
  
- Protective efficacy of vaccine in preventing inhalation anthrax including:
  - Contingencies not covered in current ACIP recommendations, e.g., when initial 6-dose series is incomplete, booster doses are not up to date
  - Post-exposure vaccine recipients who are eligible for pre-exposure vaccine by their activities
  - Local responders whose exposure potential may not be related to activities as much as by their living in a contaminated area
  - Multiple exposure levels and prolonged exposure
  - Using abbreviated or truncated vaccination regimens
  
- Safety and efficacy of alternative routes of anthrax vaccine administration to reduce adverse side effects
  
- The prioritization of vaccine either for logistical or inadequate supply needs
  
- Correlation of immune protection to enable research and predict risk
  
- Safety and efficacy of vaccine and antibiotic PEP in special populations
  
- Emergency Use Authorization application process for responder populations

- Efficacy, feasibility and technical requirements of improvised collective protection areas for responders coming from outside the hazard area and therefore not exposed to the primary dispersal (e.g., expedient isolation, safe havens)
- Method development for rapid human decontamination using low or no water techniques. Methods and guidance for determining the efficacy of decontamination.
- Development of rapid, effective decontamination capacity and capabilities necessary after a wide area release

Finally, this guidance should be reviewed in 18 months to assess the status of existing knowledge and decide whether updated guidance on protecting responders after a wide-area anthrax attack can be generated.

## **Appendix 6 – Additional References**

1. Interim Recommendations for the Selection and Use of Protective Clothing and Respirators Against Biological Agents, CDC, Oct 25, 2001.  
<http://www.bt.cdc.gov/DocumentsApp/Anthrax/Protective/10242001Protect.asp>
2. Protecting Investigators Performing Environmental Sampling for *Bacillus anthracis*: Personal Protective Equipment, CDC, Nov 6, 2001.  
<http://www.bt.cdc.gov/agent/anthrax/environment/investigatorppe.asp>
3. MMWR: Notice to Readers: Occupational Health Guidelines for Remediation Workers at *Bacillus anthracis*-Contaminated Sites—United States, 2001–2002, CDC, MMWR 2002 Sep 6;51(35):786-789.  
<http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5135a3.htm>
4. Guidance on Emergency Responder Personal Protective Equipment (PPE) for Response to CBRN Terrorism Incidents, DHHS (NIOSH) Publication No. 2008–132, June 2008. <http://cdc.gov/niosh/docs/2008-132/pdfs/2008-132.pdf>
5. Recommendations for the Selection and Use of Respirators and Protective Clothing for Protection Against Biological Agents, NIOSH Publication No. 2009-132, April 2009. <http://www.cdc.gov/niosh/docs/2009-132/>
6. Safety and Health Topics: Anthrax, Occupational Safety and Health Administration. <http://www.osha.gov/SLTC/bioterrorism/anthrax/index.html>
7. Technical Assistance for Anthrax Response Interim-Final Draft, EPA-National Response Team, July 2005. [http://www.nrt.org/production/NRT/NRTWeb.nsf/AllAttachmentsByTitle/A-47AnthraxTAD/\\$File/Anthrax\\_TAD\\_72905.pdf?OpenElement](http://www.nrt.org/production/NRT/NRTWeb.nsf/AllAttachmentsByTitle/A-47AnthraxTAD/$File/Anthrax_TAD_72905.pdf?OpenElement)
8. Comprehensive Procedures for Collecting Environmental Samples for Culturing *Bacillus anthracis*, NIOSH, Revised April 2002. <http://www.bt.cdc.gov/Agent/Anthrax/environmental-sampling-apr2002.pdf>
9. National Incident Management System, Department of Homeland Security, December 2008. [http://www.fema.gov/pdf/emergency/nims/NIMS\\_core.pdf](http://www.fema.gov/pdf/emergency/nims/NIMS_core.pdf)
10. National Response Framework, Department of Homeland Security, January 2008.  
<http://www.fema.gov/pdf/emergency/nrf/nrf-core.pdf>

