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Responding to Detection of Aerosolized *Bacillus anthracis* by Autonomous Detection Systems in the Workplace

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Summary

Autonomous detection systems (ADSs) are under development to detect agents of biologic and chemical terror in the environment. These systems will eventually be able to detect biologic and chemical hazards reliably and provide approximate real-time alerts that an agent is present. One type of ADS that tests specifically for Bacillus anthracis *is being deployed in hundreds of postal distribution centers across the United States. Identification of aerosolized* B. anthracis *spores in an air sample can facilitate prompt on-site decontamination of workers and subsequent administration of postexposure prophylaxis to prevent inhalational anthrax.*

Every employer who deploys an ADS should develop detailed plans for responding to a positive signal. Responding to ADS detection of B. anthracis *involves coordinating responses with community partners and should include drills and exercises with these partners. This report provides guidelines in the following six areas: 1) response and consequence management planning, including the minimum components of a facility response plan; 2) immediate response and evacuation; 3) decontamination of potentially exposed workers to remove spores from clothing and skin and prevent introduction of* B. anthracis *into the worker's home and conveyances; 4) laboratory confirmation of an ADS signal; 5) steps for evaluating potentially contaminated environments; and 6) postexposure prophylaxis and follow-up.*

Introduction

The risk for terrorist events involving the intentional airborne release of infectious agents has led to development of new approaches for sampling and testing ambient air both indoors and outdoors (*1*). One such approach is the use of an autonomous detection system (ADS) that combines automated air sampling and testing. An ADS continuously samples air that impinges in a buffer solution. An automated detection assay (e.g., a real-time polymerase chain reaction [PCR] test or an immunoassay) analyzes the trapped material at a defined sampling interval (e.g., every 1.5 hours). All ADSs under development have a way of alerting authorities of a positive signal. The result is an approximate real-time detection and alerting system.

One type of ADS, the Biohazard Detection System (BDS), was developed under contract with the U.S. Postal Service (USPS) specifically to detect aerosolized *Bacillus anthracis* spores. USPS plans to install BDS in approximately 300 mail processing and distribution centers (PDCs) across the United States. PDCs have high-speed mail-handling equipment that can aerosolize *B. anthracis* spores sent through the mail, as demonstrated during the 2001 anthrax attacks. USPS will install BDS devices on or near key equipment that processes incoming mail (e.g., advanced facer-canceller system machines). Identification of aerosolized *B. anthracis* spores in an air sample is necessary for prompt on-site decontamination of workers and subsequent postexposure prophylaxis (PEP) before the onset of symptoms and to interrupt the flow of contaminated letters or packages into the postal stream.

This report provides voluntary guidance for employers, state and local health departments, emergency responders, hospitals, health-care providers, and others preparing to use an ADS in a workplace with machinery or production facilities that might aerosolize *B. anthracis* spores mechanically.

The material in this report originated in the National Center for Environmental Health/Agency for Toxic Substances and Disease Registry, Office of the Director, Henry Falk, M.D., Director; National Center for Infectious Diseases, James M. Hughes, M.D.; the Division of Bacterial and Mycotic Diseases, Mitchell L. Cohen, M.D., Director; and the Bioterrorism Preparedness and Response Program, Charles A. Schable, M.D., Director; National Institute for Occupational Safety and Health, Office of the Director, John Howard, M.D., Director; and Office for Terrorism Preparedness and Emergency Response, Office of the Director, Joseph M. Henderson, M.P.A., Director.

Background

Characteristics of Anthrax

Anthrax is a zoonotic disease caused by the spore-forming bacterium *Bacillus anthracis*. *B. anthracis* spores remain viable in the environment for years, representing a potential source of infection. Anthrax occurs in humans in three clinical forms: inhalational, gastrointestinal, and cutaneous. Inhalational anthrax results from aerosolization of *B. anthracis* spores through industrial processing or intentional release. Gastrointestinal or oropharyngeal forms of the disease result from ingestion of infected undercooked or raw meat. Cutaneous anthrax is the most common type of naturally acquired anthrax infection and usually occurs after skin contact with contaminated products from infected animals. Historically, the case-fatality rate for cutaneous anthrax has been <1% with antibiotic treatment and 20% without antibiotic treatment (*2–4*). Case-fatality rates for inhalational anthrax are high, even with appropriate antibiotics and supportive care (*5*). Among the 18 cases of inhalational anthrax identified in the United States during the 20th century, the overall case-fatality rate was >75%. After the biologic terrorism attack in fall 2001 in which *B. anthracis* spores were released through the mail, the case-fatality rate for patients with inhalational anthrax was 45% (5 of 11 cases) (*5,6*). The incubation period for anthrax is usually <2 weeks; however, because of spore dormancy and slow clearance from the lungs, the incubation period for inhalational anthrax can be prolonged for months. This phenomenon of delayed onset has not been recognized for cutaneous or gastrointestinal exposures. Discharges from cutaneous lesions are potentially infectious, but person-to-person transmission has been reported rarely. Person-to-person transmission of inhalational anthrax has not been documented.

B. anthracis is one of the biologic agents most likely to be used as a weapon because 1) its spores are highly stable; 2) the spores can infect through the respiratory route; and 3) the resulting inhalational disease has a high case-fatality rate. In 1979 an unintentional release of *B. anthracis* spores from a military microbiology facility in the former Soviet Union resulted in 69 deaths (*7*). The anthrax outbreak after *B. anthracis* spores were distributed through the U.S. mail system in 2001 further underscores the dangers of this organism as a terrorist threat (*6*).

After a terrorist attack, exposures to *B. anthracis* spores can occur through primary and secondary aerosols. Primary aerosols are dispersions of particles in air resulting from a biologic agent's initial release, whether through a disseminating device or through handling of an agent-containing package (e.g., in mechanical processing of mail). Secondary aerosols result from disruption and resuspension of settled particles. Through agglomeration (to other spores or debris) or other changes, these settled particles might not retain the characteristics of the original material (*8*); consequently, resuspension can result in larger diameter particle aerosols and lower airborne concentrations, both of which decrease the risk for exposure when compared with primary aerosols.

Particle sizes of primary and secondary aerosols vary. Airborne particles ≤100 µm in size compose an aerosol, whereas particles ≥100 µm settle relatively quickly (*8*). Typical room air velocities exceed the settling velocities of extremely small particles (i.e., approximately 5 µm in diameter), and such particles therefore tend to remain airborne for prolonged periods (and can travel farther) before impacting or settling on a surface. Particles composed of single spores or small clusters of spores have diameters of a few micrometers (e.g., 5–10 µm) and move with general air-flow patterns without rapid settling. Resuspension of settled particles depends on such factors as particle size and the type of surface on which the particles settle. Although resuspension of certain settled particles requires substantial amounts of energy, lower energy activities (e.g., paper handling, foot traffic, mail handling, and patting of chairs) can reaerosolize settled *B. anthracis* spores (*9,10*). The clinical and epidemiologic presentations of anthrax after an intentional release vary by the population targeted, the characteristics of the spores, the mode and source of exposure, and other characteristics.

Response and Consequence Management Planning

After an ADS is installed, a positive signal indicating possible presence of a biologic agent requires a coordinated, swift, and effective response. Therefore, an ADS should only be installed if

- an aerosol-generating machine or production step in that workplace might result in the forceful mechanical aerosol dispersion of *B. anthracis* spores;
- a Laboratory Response Network (LRN) laboratory* can perform timely testing to confirm a positive ADS signal;
- the quality of the ADS device meets the specifications described in this report (see Laboratory Evaluation of a Positive ADS Signal);
- policies and procedures to maintain the device exist and are followed; and
- comprehensive planning has been conducted for responding to a positive ADS signal.

* LRN laboratories are those that participate in a network of public health laboratories meeting criteria specified by CDC in collaboration with partners. Additional information is available at http://www.bt.cdc.gov/lrn/factsheet.asp.

Every employer who deploys an ADS should develop detailed plans for responding to a positive signal (Box 1). Responding to ADS detection of *B. anthracis* involves coordinating responses with community partners and should include drills and exercises with these partners. Response planning should involve the following entities:

BOX 1. Facility plan guidelines for responding to a positive signal from an autonomous detection system (ADS) indicating possible presence of a biologic agent

Facility plans for responding to a positive ADS signal should include, at a minimum, the following components:

- Description of the facility in which the ADS is placed, including identification of all potentially aerosol-generating equipment and a description of the heating, ventilation, and air conditioning (HVAC) system and air-flow design.
- Immediate response protocols, including procedures for shutting down operations, turning off HVAC units, and evacuating personnel.
- Procedures to notify local emergency, law enforcement, and public health authorities.
- Arrangements for confirming the positive ADS signal by reanalysis in an LRN laboratory.
- Procedures to rapidly collect and transport the specimen to the LRN laboratory for confirmation.
- Accounting of
  - — personnel in the facility at the time of the signal, and
  - — personnel who left the site during the ADS air-sampling interval before the positive signal.
- Coordination with local emergency and law enforcement authorities to contact any persons who left the site during the ADS air-sampling interval before the positive signal.
- Procedures and agreements with local first responders to decontaminate potentially exposed employees.
- Arrangements with local public health authorities on procedures for postexposure prophylaxis.
- Crisis-communication plans, including communication channels and preplanned messages for employees and the media.
- Continuity of operations plans.
- Employee education and drills.
- Follow-up with potentially exposed workers.
- Preliminary planning for short- and long-term recovery (e.g., additional environmental sampling and decontamination of the facility [this depends on incident circumstances, lead federal agency decisions, and other factors]).

- **Local and state health departments.** Because health departments will provide guidance on prophylaxis, laboratory confirmation, and long-term follow-up for employees potentially exposed, they should be made aware of the presence of an ADS and should devise response plans in case of an alert.
- **Local first responders.** Because local first-response organizations (e.g., police, fire, hazardous materials, and emergency medical services [EMS]) are expected to respond to a suspected terrorist attack, facilities implementing ADSs should involve local first responders in response planning. Employers should also consider contacting the regional office of the U.S. Environmental Protection Agency, who will likely be involved in facility decontamination when necessary.
- **Local medical facilities.** Employees potentially exposed to *B. anthracis* spores might seek medical evaluation and treatment at local medical facilities even if they already have undergone decontamination, if appropriate, or have been started on PEP. In addition, any potentially exposed employees who believe they are experiencing symptoms related to the exposure or PEP should seek medical evaluation. Therefore, involving one or more local medical facilities in response planning is prudent. Relying on the local health department to provide guidance for these arrangements is also appropriate.
- **Law enforcement officials.** Terrorism is a federal offense and a worksite with a positive ADS signal is a potential crime scene. Therefore, any employer using an ADS device should inform the regional office of the Federal Bureau of Investigation (FBI) and state and local law enforcement officials about its installation and include them in response planning. Agreeing in advance with FBI and other law enforcement agencies which will be the lead agency during the initial response is essential. Clear command and control procedures are critical when responding to a potential terrorist event.
- **Local media representatives.** Communicating quickly and effectively with the public is essential. Therefore, employers should consider involving local media representatives as soon as an ADS is installed. Response plans should include a media-planning component, including pre-event development of messages, information packages, and designated spokespersons. Facility managers might prepare a tour and briefing for local media representatives so they understand what an ADS is, what the probable responses will be when a detection occurs, and whom to contact for information. This will increase the likelihood that media will contribute positively to the public health response in the event of a positive ADS signal.

"The wisest mind has something yet to learn."

George Santayana

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Immediate Response

When a positive ADS signal occurs,

- work activities should stop immediately;
- any potentially aerosol-generating equipment should be stopped and secured;
- HVAC units serving the production or processing area should be turned off (however, local exhaust ventilation on machines should be left on);
- personnel should be evacuated to safe locations (see Recommendations for Evacuation and Personal Decontamination);
- local and federal law enforcement officials and public health officials should be notified;
- all workers should be accounted for immediately to ensure their evacuation; and
- personal identification and contact information should be gathered.

Management and Decontamination of Workers Potentially Exposed to *B. anthracis*

Every employer who uses an ADS device is responsible for coordinating in advance personal decontamination procedures through agreements with collaborating partners (e.g., EMS or public health agencies). During pre-event planning, the employer should work with local first responders to ensure decontamination activities will be performed appropriately and in a timely manner.

Persons in a workplace containing an ADS device face three key exposure pathways of concern: 1) aerosolization; 2) direct contamination of skin, outer layers of clothing, and workplace surfaces; and 3) indirect contamination of a vehicle or home by spores transported by clothing or exposed skin. The occurrence of inhalational and cutaneous anthrax among postal workers during 2001 underscores the importance of addressing the first two exposure pathways. Limited information is available about the extent and likelihood of risk from off-site contamination; during the 2001 anthrax outbreak, this risk appeared minimal. Personal decontamination is intended to minimize the risk of off-site contamination and to prevent cutaneous anthrax; prevention of inhalational anthrax is addressed by PEP.

Potential for Transporting Contamination Off-Site

Home contamination from work-contaminated clothing has been well-documented for a number of substances (*11*). A

1995 review by CDC's National Institute for Occupational Safety and Health (NIOSH) documented cases in which substances were brought home inadvertently on work clothing. The majority involved such substances as lead, asbestos, beryllium, pesticides, and other chemicals in industrial, construction, agriculture, or cottage industry settings (*11*); two cases involved infectious agents. A task force identified critical gaps in knowledge regarding the magnitude of take-home exposures and their potential health consequences (*12*).

Minimal information exists about take-home exposures associated with *B. anthracis*. The only known cases of anthrax among family members of exposed workers are two cutaneous cases from the early 1900s involving spouses of wool sorters employed at English textile operations (*13*). In a 1978 naturally occurring outbreak of anthrax associated with a textile operation in North Carolina, one of four vacuum cleaner dust samples from the homes of textile-mill workers was positive for *B. anthracis*, indicating that workers carried spores home on their clothing. However, no cases of anthrax were reported among workers' families (*14*).

Although take-home exposure was not systematically studied during the 2001 outbreaks associated with the release of weaponized *B. anthracis*, the experiences of those cases might be relevant to ADS use. No anthrax cases occurred among family members of postal workers during the 2001 outbreaks, indicating that risk was low for inhalational and cutaneous anthrax for family members from contaminated clothing. The 2001 anthrax cases in media offices provided evidence that home contamination could occur from contaminated letters opened at work. For example, environmental surface swab samples were positive in residences of certain persons who came into direct physical contact with opened, contaminated letters in New York City [personal communication, Jeanine Prud'homme, M.S., New York City Department of Health and Mental Hygiene, New York, New York, February 14, 2004]. No environmental sampling was reported for possible home contamination among Capitol Hill workers associated with the opened letter to Senator Tom Daschle of South Dakota. However, off-site contamination by equipment and clothing occurred when members of the U.S. Capitol Police Hazardous Device Unit who had responded to the letter returned to their office. Environmental sampling located contamination in vehicles and office-space surfaces where equipment was handled. No anthrax cases were reported among family members from home contamination in any of these instances.

To prevent or minimize exposure to workers' families, occupational health standards and guidelines typically call for basic hygiene practices (e.g., leaving work clothing and shoes at the job site, washing, and, in certain cases, showering after work). Such precautions traditionally target employees who routinely work with harmful substances (e.g., lead and asbestos) and who can reduce take-home exposures to these occupational contaminants (*15*). Basic hygiene recommendations also exist for managing potential exposures after a *B. anthracis* attack against a civilian population. The current consensus statement recommends that "any person coming in direct physical contact with a substance alleged to be containing *B. anthracis* should thoroughly wash the exposed skin and articles of clothing with soap and water" (*16*). Although the risk of cutaneous anthrax from off-site transport appears low, because of gaps in knowledge about this risk, a positive signal from an ADS should elicit a conservative approach to personal decontamination (Box 2).

Recommendations for Evacuation and Personal Decontamination

The primary goal of using an ADS is to prevent inhalational anthrax through early recognition of and response to an exposure situation, including early initiation of PEP. Aerosolization or direct physical contact can result in deposition of spores on the outerwear of employees and subsequent transport off site. Because limited scientific data exist regarding *B. anthracis* and personal decontamination, these recommendations are based primarily on available information; general industrial-hygiene concepts, principles, and practices; analogy to other contaminants and industrial settings; and a prudent public health approach. These recommendations might change as information regarding the efficacy of control systems, decontamination methods, and safe work practices becomes available.

Employers, in consultation with first responders and public health departments, should determine exit routes and places of refuge. An outdoor refuge location might be considered but can be problematic because of weather, security, or other concerns. A physically separate building or space inside the potentially contaminated building might also merit consideration, by using the following criteria:

- An alternate indoor location should not share an HVAC system with the production area experiencing the positive signal.
- An alternate indoor location should not share an HVAC system with spaces where unexposed workers are located.
- Unexposed workers should be able to avoid exposure while evacuating the facility and should not pass through the production area experiencing the positive signal.
- Decontamination groups should be able to be segregated to the greatest extent possible to avoid cross-contamination and provide ready access to decontamination as required.

BOX 2. Interim guidelines for evacuation and personal decontamination of workers after a positive autonomous detection system (ADS) signal indicates presence of a biologic agent

Worker category	Evacuation/decontamination procedures
Group 1. Workers who did not enter the production area containing the ADS device during the sampling and testing period (e.g., 1.5 hours) before the positive ADS signal and who were not in an area that shares a heating, ventilating, and air conditioning (HVAC) system with the production area experiencing the positive signal	Evacuate; no special decontamination steps are needed.
Group 2. All workers who were present in the production area containing the ADS device during the sampling and testing period before the positive ADS signal or who were in an area that shares an HVAC system with the production area experiencing the positive signal	1. Evacuate immediately. 2. Remove potentially contaminated outer garments at the site. 3. Wash all areas of skin (e.g., face, arms, hands, and legs) exposed at the time of the positive ADS signal with mild soap and copious amounts of warm water. 4. Use replacement outer garments and shoes.
Group 3. Workers identified in advance as particularly at risk of exposure to a higher concentration of deposited spores as a result of direct physical contact with aerosol-generating equipment	1. Evacuate immediately. 2. Remove potentially contaminated garments at the site. 3. Take a shower at the site to wash all areas of exposed and unexposed skin with mild soap and warm water. 4. Use replacement outer garments, underwear, and shoes.

Workers should be categorized into three groups for evacuation and decontamination procedures (Box 2). Group 1 includes those workers who did not enter the production area containing the ADS device during the sampling and testing period (e.g., 1.5 hours) before the positive ADS signal and whose work locations do not share an HVAC system with the production area experiencing the positive signal. Group 2 includes all workers who were present in the production area containing the ADS device during the sampling and testing period before the positive ADS signal or who are located in any space that shares an HVAC system with the production area experiencing the positive signal. Group 3 includes all workers identified in advance as particularly at risk of exposure to a higher concentration of deposited spores as a result of direct physical contact with aerosol-generating equipment. Workers in these groups should be evacuated and decontaminated as follows:

- **Group 1.** Those workers who were not in the same production area as the ADS and who were not in an area that shares an HVAC system with the affected area do not require decontamination. They should be evacuated safely by pathways and to places of refuge separate from Groups 2 and 3.
- **Group 2.** Workers in the production area should evacuate immediately. They should take basic precautions to minimize any likelihood of off-site contamination from settled aerosols on the outer layer of worker clothing and on any exposed skin. Removal of outer garments and washing of skin (e.g. face, arms, hands, and legs) are basic steps to preventing inadvertent contamination of worker homes. Approximately 70%–95% of decontamination can be accomplished by removing outer clothing and shoes (*17–20*). Washing of exposed skin should also include washing of any exposed jewelry (e.g., rings, bracelets, necklaces, or wristwatches) or glasses. Contamination of inner clothing layers is not likely for these employees. Removed outer clothing should be bagged carefully and left at the facility pending final disposition.

  Upon arriving home, workers can shower and wash their hair to further reduce any contamination concerns. Showering with warm soap and water and cleaning systematically from the head down is widely considered the most effective and preferred method for removing hazardous substances from skin (*17,18,21,22*). One efficacy study of hand hygiene reported that washing 10–60 seconds with soap and water or using a chlorine-containing towel to wipe contaminated areas will eliminate 1.5–2 $\log_{10}$ of surrogate spores; conversely, waterless rubs with ethyl alcohol were not effective (*23*).
- **Group 3.** As part of coordinated pre-event planning, employers should identify the limited number of employees likely to experience a higher concentration of depos-

ited spores from direct physical contact with equipment that might be associated with *B. anthracis* aerosolization (e.g., USPS workers operating canceling machines and other mail-processing machines at and immediately downstream or upstream of the ADS device). Where feasible, Group 3 workers should take a separate path to a place of refuge where more extensive decontamination is planned. If any groups must exit by the same route, they should be identified and separated subsequently to minimize cross-contamination.

Because of the risk that inner clothing or skin might become contaminated when outer clothing is removed, Group 3 workers who performed high-risk tasks during the air-sampling and testing period before the ADS alert could be directed to a separate decontamination area to shower to wash all areas of exposed and unexposed skin or use other nonshower options listed later in this report. Using a separate decontamination space for this group will minimize cross-contamination.

Only those persons thought to be at risk of substantially higher levels of contamination as a result of direct physical contact with aerosol-generating equipment are candidates for the higher degree of on-site decontamination afforded by showers. If the employer review of job functions does not identify any such possibilities, that fact should be noted in the facility plan, and a supplemental decontamination step is not needed.

Logistical considerations for decontamination include the following:

- Replacement garments and shoes should be stored in an area that would be accessible after evacuation of the production area. This can include having employees bring a change of personal clothing and shoes for storage at appropriate locations, providing a supply of disposable clothing, or a combination of both.
- All clothing and shoes removed after evacuation should be placed in a plastic bag and remain on-site at a predesignated location pending LRN laboratory testing of the ADS sample, after which a decision can be made regarding final disposition.
- Evacuation and wash-up location(s) should be identified in advance.
- Extra decontamination measures for Group 3 should be arranged in advance. A facility might already have showers in a separate building that can be used in the event of an ADS signal. If not, employers should work with emergency responders to address this concern. Where logistical obstacles are severe, first responders and employers can evaluate nonshower options (e.g., misting of clothing or use of high-efficiency particulate air [HEPA] vacuums with appropriate nozzles designed to clean external clothing surfaces). The parties should consult with NIOSH or the Occupational Safety and Health Administration on procedural use of these alternatives.
- Employee training and drills can help allay employee anxiety about responding to a positive signal and improve the quality and efficiency of an actual response.
- Any workers who were on-site during the sampling and testing period but who went home in the period before the positive ADS signal during which aerosolized spores might have been present (which depends on sampling and testing intervals of the particular ADS), should be instructed to place their work clothing in a plastic bag for further disposition, wash exposed skin, and shower, if they would have been categorized as being in Groups 2 or 3.

Other general considerations include the following:

- Emergency-preparedness plans for certain facilities might include installation of local exhaust ventilation at pinch points (i.e., locations in the pathway where a letter or parcel is compressed by equipment) where aerosols can be generated. Using well-designed and maintained ventilation on all relevant processing equipment should capture aerosols as they are created and before workers inhale them or are contaminated by deposition of spores. This usually will reduce or even eliminate the need for personal decontamination of workers in Groups 2 or 3. Planners should consider the potential benefits of keeping HEPA-filtered local exhaust systems operating while general HVAC and other equipment are turned off. Employers can modify their response plans after such ventilation systems have been installed and successfully tested.
- Postal facilities using BDS units probably have already eliminated use of compressed air for maintenance cleaning. Nonpostal facility managers should examine maintenance procedures regarding use of compressed air and similar aerosol-generating practices.

Laboratory Evaluation of a Positive ADS Signal

A well-designed ADS has four attributes: 1) a stand-alone and contained configuration; 2) ability to collect a substantial volume of sample; 3) use of a detection technology requiring minimal manual attention; and 4) control procedures to ensure adequate assay performance, including lack of inhibition and reagent stability. Ideally, the assay used in an ADS will have extremely high positive and negative predictive values. Key factors for ensuring accurate and consistent results from ADS devices are development and implementation of main-

tenance plans with rigid quality-assurance controls. These plans should describe specific policies and procedures for use and maintenance of an ADS. If all these criteria are met, a high level of confidence can be ensured that a positive ADS signal represents a true *B. anthracis* aerosolization event.

Nevertheless, a positive ADS signal should be confirmed by an LRN laboratory using both PCR assay and culture. Policies and procedures for specimen management, including chain of custody, should be arranged in advance. Finally, persons should be identified and trained who can ensure correct collection and transport of the ADS specimen to the LRN laboratory.

Initial Environmental Evaluation

Environmental sampling in coordination with public health and law enforcement immediately after an ADS signal might be necessary to address both public health and law enforcement goals. The primary law enforcement goal is to assist the criminal investigation by finding the source of contamination. The immediate public health goal is to determine who is in need of PEP (in addition to those who were either in the production area or in a location that shared air-handling with the production area). For example, if a letter causes a positive ADS signal at a PDC, it would be important to ascertain which employees, if any, at other facilities through which the letter has passed, should be considered for PEP. Sampling the machine where the ADS is located to confirm a positive ADS signal might also be appropriate. Information about the extent of contamination at the facility is important but is a less-immediate need. Nasal swabs of potentially exposed workers to test for *B. anthracis* are not recommended.

General guidance, criteria, and recommendations for sampling of *B. anthracis*-contaminated areas are available elsewhere (*24*). Planning for environmental sampling activities before activating an ADS is necessary to ensure that

- appropriately trained and protected personnel are identified and available to conduct sampling and facility investigation;
- response personnel are certified in use of protective equipment (*25*) and personal decontamination before entering the facility;
- appropriate equipment and sampling supplies are available;
- pre-event notification and response protocols are established for receipt and rapid processing of samples;
- targeted sampling plans are developed, including identifying locations to sample to maximize the likelihood of finding contamination and to expedite results (sampling should use such methods as HEPA sock vacuum methods and wet wipes that maximize sensitivity and allow larger areas to be sampled [*26*]); and
- sampling plans take into consideration other locations through which the *B. anthracis*-containing package or item might have passed and whether sampling is needed in other facilities to make appropriate PEP recommendations for personnel at those sites.

Postexposure Prophylaxis and Follow-Up

Inhaled spores can remain dormant in the lungs or lymphatic system for weeks to months before germination (*27,28*). After germination in alveolar macrophages, vegetative organisms can replicate and cause symptomatic disease. Reported incubation periods have ranged from 1 to 43 days after initial exposure but can be affected by the dose of *B. anthracis* inhaled and the use of antibiotics (*1,5*). Delayed disease onset is not known to occur with cutaneous or gastrointestinal exposures.

Two methods exist to protect against *B. anthracis* after the spores have reached the vegetative state. The first is to have adequate levels of antibiotics in the bloodstream to kill vegetative bacteria. The second is to have adequate anti-*B. anthracis* antibodies in the bloodstream when vegetative bacteria appear. Two U.S. national advisory bodies have considered PEP strategies for preventing inhalational anthrax among persons exposed to aerosolized spores. Both groups, the Advisory Committee on Immunization Practices (ACIP) and the Johns Hopkins Working Group on Civilian Biodefense, concluded that on the basis of available data, the best means for preventing inhalational anthrax is prolonged antibiotic therapy in conjunction with anthrax vaccination (*29,30*). The 2002 Institute of Medicine report on anthrax vaccine safety and efficacy also concluded that on the basis of limited animal studies, anthrax vaccine administered in combination with antibiotics after exposure to *B. anthracis* spores might help prevent development of inhalational anthrax (*31*).

In PEP, antibiotics are initiated as soon as possible after actual or suspected inhalation of *B. anthracis* spores and anthrax vaccination is started to stimulate production of protective antibodies, so that by the time exposed persons complete their course of antibiotics, they will have sufficient antibodies to protect them against residual spores. Although the effect of delayed PEP or treatment on survival can only be approximated, mathematical models indicate that for each day PEP is delayed after an aerosol exposure, the case-fatality rate can increase by 5%–10% (*32*).

The available anthrax vaccine, BioThrax™ [BioPort Corporation, Lansing, Michigan], is not licensed for PEP, for use as a 3-dose PEP regimen, or for use in children. Therefore, a

postexposure regimen of antibiotics and anthrax vaccine can only be administered under an Investigational New Drug (IND) application as part of an emergency-health intervention. If the vaccine is released for use in emergency situations, CDC will provide the IND protocol for delivery and use in collaboration with state and local health departments. In conjunction with the 3-dose regimen of vaccine, 60 days of selected oral antibiotics (i.e., ciprofloxacin, doxycycline, or amoxicillin) should be administered to persons potentially exposed to aerosolized *B. anthracis* spores. The Food and Drug Administration has approved ciprofloxacin and doxycycline for use as PEP against anthrax. When no information is available about the antimicrobial susceptibility of the implicated strain of *B. anthracis*, initial PEP with ciprofloxacin or doxycycline is recommended for adults and children (*33–35*). Although fluoroquinolones and tetracyclines are not recommended as first-choice drugs among children because of adverse effects, these concerns might be outweighed by the need for early treatment of pregnant women and children exposed to *B. anthracis* after a terrorist attack. As soon as the organism's susceptibility to penicillin has been confirmed, prophylactic therapy for children and pregnant women should be changed to oral amoxicillin. *B. anthracis* is not susceptible to cephalosporins and trimethoprim-sulfamethoxazole; therefore, these agents should not be used for prophylaxis (*33–35*).

The incubation period to onset of clinical symptoms for inhalational anthrax can be as short as 24 hours (*5*). Therefore, after a positive ADS signal, confirmation should be obtained from an LRN laboratory and PEP started as soon as possible, preferably within 15 hours after onset of the collection period that yielded the positive signal. Additional data are needed on outcomes from inhalational anthrax where onsets of PEP varied after exposure to *B. anthracis*.

Pre-event planning should include measures to ensure timely transport and receipt of an LRN laboratory result. The decision to begin PEP should be made on the basis of risk for *B. anthracis* exposure, including likelihood of aerosol exposure to the powder (*1*), threat assessment in conjunction with law enforcement, validity of preliminary laboratory testing of the suspicious substance, and logistics of initiating an intervention. Epidemiologic and laboratory test data might indicate that certain persons started on PEP were not exposed and that PEP can be discontinued. Persons who potentially have been exposed to *B. anthracis* should be followed medically for signs and symptoms of disease; in addition, severe adverse events associated with postexposure antibiotics or vaccine

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should be identified and reported to local health authorities. PEP should proceed as follows:

- Positive LRN PCR assay — a 3-day course of prophylaxis is initiated.
- Negative LRN culture — prophylaxis is discontinued.
- Positive LRN culture — a 60-day course is completed and a 3-dose regimen of anthrax vaccine is initiated in accordance with IND protocols.

Every employer who uses an ADS device is responsible for coordinating in advance PEP distribution procedures through agreements with collaborating partners, including public health authorities. Planning should include arrangements for rapid access to an initial 3-day course of antibiotics to ensure that prophylaxis can begin as soon as possible after *B. anthracis* exposure has been confirmed by an LRN PCR assay. Antibiotics deployed from the Strategic National Stockpile (SNS) can take 12 hours to deliver after the federal decision to deploy.

Alternatives for securing an initial 3-day course of antibiotics near the PDC site might include maintaining an inventory on-site or making arrangements with local pharmacies, medical centers, or hospitals to maintain sufficient inventories on the employers' behalf. Which of these options is most appropriate will depend on local conditions and capacities (e.g., the number of potentially affected employees, logistics associated with release and recall of employees, and medical resources in the area). When addressing this concern, employers are strongly encouraged to work with their local public health departments to ensure that quantity and dosage requirements are met and that plans for rapid access and delivery are established and practiced through periodic drills.

Conclusion

Devices that detect agents of terrorism in the environment have the potential to decrease the time required to detect a terrorist event and therefore improve the potential for preventing illness and interrupting further exposure and contamination. In multiple U.S. cities, environmental detection systems (e.g., BioWatch) have been implemented to assist in detecting releases. These systems typically work by employing air-sampling filters, with the filter needing to be removed periodically and sent to a laboratory for testing. Use of an ADS, in which sampled air is tested internally, can decrease the lag time between release of an agent and its detection.

Although environmental detection devices are being deployed, the need to better assess their effectiveness should be considered, including studies to evaluate the benefit of these approaches in preventing terrorism-related illness. CDC will work with employers and state and local public health agencies to identify opportunities to do this. These recommendations will be revised and updated as new information becomes available. CDC will also continue to collaborate with employers and state and local public health agencies to ensure a swift and effective response to positive ADS signals.

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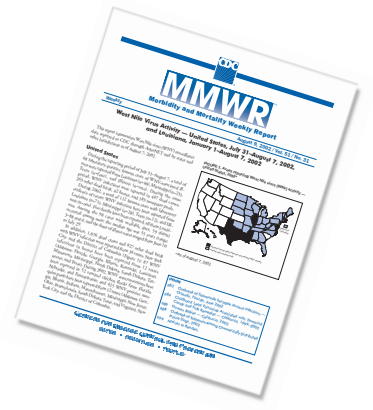

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