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# Bioterrorism: Anthrax, Sarin, and Smallpox
What Can Be Done

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## Bioterrorist Attacks

The use of biological weapons, living organisms that cause harm to humans, animals, or plants, has been noted throughout recorded history. Biological weapons are cheap, generally easy to make, and can often go undetected. This makes them the theoretical ideal weapon for terrorists. Though large attacks require a certain amount of sophistication, smaller attacks do not.

The evolution of bioterrorism response has undergone dramatic changes in recent years. Although historically bioterrorism and response to such attacks have been perceived to be within the bailiwick of governmental agencies such attacks have recently become of concern to industry as-well-as government. Bioterrorism response is no longer seen as being the responsibility of any single agency, organization, or level of government. It has become a combined effort of various levels and branches of government, as well as organizations that historically have no responsibility for emergency response. Never-the-less, the efforts of individual non-governmental organizations to establish an effective Incident Response Plan to these threats has proceeded slowly, mainly due to the fact that bioterrorist threats are threats against populations not organizations in the strict sense. While organizations can implement certain preventative measures such as air filtration and ventilation systems, the use of latex gloves to open mail, respirators and eye goggles, efforts to respond to an attack in progress that involves a biological or chemical agent is an attack that exceeds the responsive abilities of the organization as such attacks require at that point the intervention of medical and health organizations along with governmental agencies tasked with responsibility to respond to these attacks.

Recent events have focused the attention of the International Community on bioterrorist attacks that employ Anthrax (attacks utilizing the postal service within the United States in 2001-2002), Sarin (attacks by a radical organization within the subway in Japan and military use of sarin most recently by Saddam Hussein in highly lethal attacks against several Kurdish communities during the 19880s), and the threat of an epidemic brought on by smallpox or another similar highly contagious disease. Attention has also focused on the possibility of a terrorist attack involving a “Dirty Bomb” employing a non-nuclear device to spread radio-active debris throughout a large metropolitan region. It also goes without saying that security organizations continue to search for ways to mitigate what has been the terrorist attack of choice – the bomb. We are daily reminded of the difficulty in managing risks associated with the threats and vulnerabilities that societies face daily from the threat of attacks from bombs borne by various means.

A key point that facilitates success of bioterrorist attacks is that the attacker relies on the inability of defenders to effectively secure the means by which the threat is propagated usually this involves some natural environment for example atmospheric factors such as wind and the inability to “fence off” the atmosphere in order to deny access to the attacker. Air-borne, water-borne, or human carrier borne components in these attacks present unique and additionally difficult natural occurring vulnerabilities that further exploit the vulnerability of the human defender to pro-actively mediate and control the threat and/or the attack.

This study will focus on scenarios involving anthrax, sarin, and smallpox will be examined along with some of the major issues in incident response and control of these threats. The potential for the development of an effective Incident Response Plan (IRP), Disaster Response (DR), and Business Continuity (BC) Plan will be considered in light of these scenarios.

## Anthrax Scenario[1]

Anthrax Types:

Anthrax is a zoonotic disease caused by *Bacillus anthracis.* Anthrax is considered an effective bioterrorism agent because the bacterial spore (dormant form) is highly stable and storable, and because of the disease's relatively high lethality. Various strains of anthrax exhibit different levels of lethality.

There are three types of this disease: cutaneous anthrax, inhalation anthrax, and gastrointestinal anthrax.

Cutaneous anthrax develops when a bacterial organism from infected animal tissues becomes deposited under the skin. When a patient contracts cutaneous anthrax, there develops a small elevated lesion on the skin which becomes a skin ulcer, frequently surrounded by swelling or edema. The lymph gland near the lesion may also swell from the infection. If the lesion occurs on the neck or on or about the eye, it may cause complications. The incubation period for cutaneous anthrax is from one to seven days. When a patient does not receive an effective antibiotic, the mortality rate for cutaneous anthrax is 10-20%. With treatment, the mortality rate falls to less than 1%.

Inhalation anthrax develops when the bacterial organism is inhaled into the lungs. A progressive infection follows. Since inhalation anthrax is usually not diagnosed in time for treatment, the mortality rate in the United States is 90-100%.
(FAS, 2006c)

Gastrointestinal anthrax occurs when someone eats anthrax-contaminated meat. The disease usually develops within one week, and can affect the mouth, esophagus, intestines, and colon. The infection can spread to the bloodstream, and may result in death (Hurtado, 2005).

Attack Scenario:

Production: While cultivating anthrax from naturally occurring sources is relatively simple, producing an effective a form that can be used as a weapon is technically difficult. The anthrax spores must be specially processed to prevent clumping and allow for greater inhalation leading to a fatal infection.

[1] Scenario information has been adapted from information complied by the Federation of American Scientists in their Anthrax Fact Sheets (FAS, 2006c; Goodsell, 2006).

Delivery: As previously indicated humans can become infected with anthrax in three ways-ingestion, inhalation, and cutaneous (skin) exposure. A deliberate anthrax attack, however, would likely rely on inhalation since it is the most deadly. Finely milled powder and aerosolized spray anthrax are easily inhaled. A biological attack with anthrax spores delivered by aerosol would cause inhalation anthrax, an extraordinarily rare form of the naturally occurring disease.

Mechanism: Once in the body, anthrax becomes active, multiplies, and releases a three-part protein toxin of which one part is deadly to humans: the lethal factor. The lethal factor interferes with the normal functioning of the body's immune system cells.
(Goodsell, 2006; FAS, 2006c)

Effects of an Attack:

The disease begins after an incubation period varying from 1-6 days, presumably dependent upon the dose of inhaled organisms. Onset is gradual and nonspecific, with fever, malaise, and fatigue, sometimes in association with a nonproductive cough and mild chest discomfort. In some cases, there may be a short period of improvement. The initial symptoms are followed in 2-3 days by the abrupt development of severe respiratory distress with dyspnea, diaphoresis, strider, and cyanosis. Physical findings may include evidence of pleural effusions, edema of the chest wall, and meningitis. Chest x-ray reveals a dramatically widened mediastinum, often with pleural effusions, but typically without infiltrates. Shock and death usually follow within 24-36 hours of respiratory distress onset.

An epidemic of inhalation anthrax in its early stage with nonspecific symptoms could be confused with a wide variety of viral, bacterial, and fungal infections. Progression over 2-3 days with the sudden development of severe respiratory distress followed by shock and death in 24-36 hours in essentially all untreated cases eliminates diagnoses other than inhalation anthrax. The presence of a widened mediastinum on chest x-ray, in particular, should alert one to the diagnosis. Other suggestive findings include chest-wall edema, hemorrhagic pleural effusions, and hemorrhagic meningitis.

Remedies:

There are two primary modes of prevention of anthrax. For individuals who have been truly exposed to anthrax (but have no signs and symptoms of the disease), preventive antibiotics may be offered, such as ciprofloxacin, penicillin, or doxycycline, depending on the particular strain of anthrax. An anthrax vaccine is available to selected military personnel, but not to the general public. It is given in a 6-dose series. There is no known transmission of cutaneous anthrax from person to person. Household contacts of individuals with cutaneous anthrax do not need antibiotics unless they have also been exposed to the same source of anthrax. (Hurtado, 2005)

Historically, penicillin has been regarded as the treatment of choice, with 2 million units given intravenously every 2 hours. Tetracycline and erythromycin have been recommended in penicillin-sensitive patients. The vast majority of anthrax strains are sensitive *in* *vitro* to penicillin. However, penicillin-resistant strains exist naturally, and one has been recovered from a fatal human case. Moreover, it is not difficult to induce resistance to penicillin, tetracycline, erythromycin, and many other antibiotics through laboratory manipulation of organisms. All naturally occurring strains tested to date have been sensitive to erythromycin, chloramphenicol, gentamicin, and ciprofloxacin.

Vaccines are available against some forms of anthrax, but their efficacy against abnormally high concentrations of the bacteria is uncertain. A licensed, alum-precipitated preparation of purified *B.anthracis* protective antigen (PA) has been shown to be effective in preventing or significantly reducing the incidence of inhalation anthrax. Limited human data suggest that after completion of the first three doses of the recommended six-dose primary series (0, 2, 4 weeks, then 6, 12, 18 months), protection against both cutaneous and inhalation anthrax is afforded. As with all vaccines, the degree of protection depends upon the magnitude of the challenge dose; vaccine-induced protection is undoubtedly overwhelmed by extremely high spore challenge.

If there is information indicating that a biological weapon attack is imminent, prophylaxis with ciprofloxacin (500 mg orally twice a day), or doxycycline (100 mg orally twice a day) is recommended. If unvaccinated, a single 0.5 mL dose of vaccine should also be given subcutaneously. Should the attack be confirmed as anthrax, antibiotics should be continued for at least 4 weeks in all exposed.
(FAS, 2006c)

## Sarin Scenario[2]

General Information:

Sarin is a colorless, odorless, tasteless, human-made chemical warfare agent. It was originally developed in Germany in the 1930's as a pesticide. Sarin is a nerve agent that disrupts the functioning of the nervous system. Nerve agents are the most toxic and rapidly acting of all known chemical warfare agents. Sarin is highly toxic in both its liquid and vapor states.

Attack Scenario:

Delivery: Following the release of sarin into the air, people can be exposed to it through contact with skin or eyes. Sarin can also be inhaled as a gas. Sarin mixes easily with water, and since it is odorless, people would not be aware of sarin in drinking water. Furthermore, sarin in water can be absorbed through the skin.

Production: Sarin is made by mixing several commercially available chemicals in the right amounts and in the right sequence. It is debatable how easy it is for the layperson to synthesize sarin. It is somewhat complicated and dangerous to produce.

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[2] Scenario information has been adapted from information complied by the Federation of American Scientists in their Sarin Fact Sheet (FAS, 2006a).

Mechanism: Sarin disrupts the ability of the body to regulate nerve impulses. When this happens, both the voluntary and involuntary glands and muscles of the body are continually stimulated, leading to system fatigue. The victim will lose control over his bodily functions. Ultimately, the victim will fall into a coma and suffocate.

Effects of an Attack:

Effects: The first signs of sarin exposure are a runny nose, tightness in the chest, pinpoint pupils, eye pain, and blurred vision. The victim will then experience drooling, excessive, sweating, coughing, chest pain, diarrhea, increased urination, confusion, drowsiness, weakness, headache, nausea, and vomiting. Exposure to large doses of sarin will result in loss of consciousness, involuntary twitching and jerking, paralysis, coma, and eventually, death.

Remedies:

Treatment: There are antidotes to sarin, but they must be provided very soon after exposure to be effective. Clothing can retain sarin, so it must be removed. The victim should move quickly to fresh air. As quickly as possible after exposure, the victim should wash thoroughly with soap and water.

(FAS, 2006a)

## Smallpox Scenario[3]

Attack Scenario:

Smallpox is caused by the double-stranded DNA orthopoxviruses *Variola major* and *Variola minor.* The virus no longer occurs naturally. Under natural conditions, the virus is transmitted by direct (face-to face) contact with an infected case, by fomites, and occasionally by aerosols. Smallpox virus is highly stable and retains infectivity for long periods outside of the host. A smallpox attack would likely rely on victims inhaling *Variola* via an aerosol or through an infectious individual deliberately infected with the virus. Clothing, blankets, and other such material can harbor the virus for up to a week. Infection with *Variola* could be accomplished with as little as 10-100 viral particles.

Production: Two noted production methods include incubation inside the embryos of chicken eggs and culturing the virus with cells susceptible to infection.

Effects of an Attack:

Effects: Flu-like symptoms, including headache, fever, and fatigue, usually first occur 12 days after exposure. The infected person is also contagious at this stage. Within the next 4 days, the initial lesions containing *Variola* appear and spread to the arms, torso, and legs. Over the next two weeks, the virus continues to damage the body, particularly the immune and circulatory systems. When the last rash has scabbed over and fallen off, the person is no longer contagious. Permanent scars, blindness, and arthritis can result from the infection. Smallpox is

[3] Scenario information has been adapted from information complied by the Federation of American Scientists in their Smallpox Fact Sheets (FAS, 2006b and 2006d).

fatal in 30% of infections. In 2% to 6% of smallpox infections, lesions are classified as hemorrhagic, characterized by bleeding sores, or flat; where the lesions are soft and flat. The mortality rates for those types of infections are over 95%.

Remedies:

Treatment: The vaccine used to eradicate *Variola*, routinely used in the U.S. until 1972, prevents infections for an undetermined amount of time. It can also prevent or lessen smallpox if administered within four days of exposure. Mild to life-threatening risks are associated with the vaccine. No antivirals are available for unvaccinated individuals who contract the virus. While there is no specific treatment available although some evidence suggests that vaccinia-immune globulin is of some value in treatment if given early in the course of the illness. After the symptoms develop, medications, and intravenous fluid can be administered to make the patient more comfortable. Antibiotics can reduce potential secondary bacterial infections

*Vaccinia* virus is a live poxvirus vaccine that induces strong crossprotection against smallpox for at least 5 years and partial protection for 10 years or more. The vaccine is administered by dermal scarification or intradermal jet injection; appearance of a vesicle or pustule within several days is indication of a "take." Vaccinia-immune human globulin at a dose of 0.3 mg/kg body weight provides $\geq$70% protection against naturally occurring smallpox if given during the early incubation period. Administration immediately after or within the first 24 hours of exposure would provide the highest level of protection, especially in unvaccinated persons. The antiviral drug, Marboran afforded protection in some early trials, but not others, possibly because of noncompliance due to unpleasant gastrointestinal side effects.

Patients with smallpox should be treated by vaccinated personnel using universal precautions. Objects in contact with the patient, including bed linens, clothing, ambulance, etc. require disinfection by fire, steam, or sodium hypochlorite solution.
(FAS, 2006b and 2006d)

## Managing The Bioterrorism Response

Bioterrorism incident response management is unique in that much of the responsibility for an effective response relies heavily on the coordination with, and preparation of, the healthcare community in particular the Department of Health and Human Services Centers for Disease Control and Prevention (DHHS-CDC). While the predominant role of healthcare services is required for operational success in a bioterrorism event, all responders are expected to use and operate under the mandates of the National Incident Management System (NIMS) and the National Response Plan (NRP) (Costa).

Biological weapons and infectious diseases share several fundamental characteristics that can be leveraged to counter both of these threats more effectively. Both a bio-weapons attack and a natural pandemic, such as avian flu, can be detected in similar ways, and the effectiveness of any response to an outbreak of infectious disease, whether natural or caused deliberately by terrorists, hinges on the strength of the U.S. public health and medical systems — the network of federal, state, local, and private-sector entities responsible for the health of the nation's population. Natural pandemic outbreaks and bioterrorist attacks would place different stresses on these systems at the outset, yet the basic response and containment mechanisms would be essentially the same (Grotto, 2006).

Difficulty in establishing an effective Incident Response Plan (IRP) to manage a bioterrorist attack stems from several problematic issues including but not limited to:

- Magnitude of diverse incident responders – an incident will trigger responses from several different organizations at potentially many levels of government, business, or both. Coordination of efforts by these diverse organizations and authorities is a major logistical problem.
- Nature of an attack – the three scenarios demonstrate that if a threat agent is able to trigger an attack, then containment presents a series problem for any response team. The release of anthrax, sarin, or smallpox into an eco-system assures the attacker the likelihood of a high degree of success in the manipulation of the natural occurring vulnerabilities of the eco-system.
- A highly mobile population poses additional risk when coupled with the incubation period of many bio-threat agents. An infected individual could travel on several air-flights to a number of different cities across several countries exposing thousands to the biological threat all before the nature of the threat would be identified. An example is the recent history of the spread of severe acute respiratory syndrome (SARS).
- High costs associated with prevention or mitigation of an attack. The bio-chemical nature of these threats requires that an effective IRP must include a vast array of equipment:
    - to assure the containment of an air-borne attack using filters and ventilation equipment
    - to assure decontamination of air or water-borne attack agents specialized environmental suits and breathing equipment, specialized chemicals, solvents, and cleaning agents to neutralize the bioterrorist threat agent such as sarin.
    - relocation of populations in the event of a dirty-bomb, radio-active contamination

- Education and communal knowledge of the initial signs that an attack has occurred are critical.
    - It is imperative for quick containment of any bioterrorist attack that organizations have in place explicit measures that will allow for directly affected individuals to identify the threat and put in motion steps to contain it.
    - The fact that these threats require a high degree of specialized knowledge to correctly determine the threat poses a great impediment to early containment.
    - The ability to react to a physical substance such as the white powder that an anthrax attack might employ is more manageable than the orderless properties of many gaseous bio-chemical terrorist threats, such as sarin.
    - The incubation period of many diseases is prohibitive of any manageable early detection, containment, and control, such as SARS.
- Commitment of adequate financial resources -- as with any security policy and plan the assurance that adequate financing is available resides at the heart of implementation of the risk management.
- Exponential growth in sources of potential threats and threat agents – more governments globally have acquired the ability and capacity to develop biological and chemical sources of materials that lend themselves to the bioterrorist.

(Costa; Grotto, 2006; *Last Days On Earth*; Augustine, 2003; Rosenberg, 2002)

The effort to establish a viable Incident Response Plan to meet the challenges presented by the bioterrorist is different and definitely more complex then the challenges that the development of a successful IRP for a technologically orientated threat present. As has been demonstrated by the anthrax attacks, detection of the threat agents has proven to be an extremely vexing task, clean-up took considerable resources in terms of the time, neutralizing agents, and man-hours required to effective neutralize the threat and restore the compromised facilities to their pre-attack status. And, unfortunately there was a high human cost in that several individuals either died as a result of the attacks or have remained asymptomatic suffering continued symptoms after their proclaimed recovery.

A business or community that has endured an incident involving the implementation of a bioterrorist attack must consider that an essential aspect of any disaster recovery (DR) or business continuity (BC) planning must take into consideration the longevity that containment and decontamination has been found to take. The containment and decontamination of the federal buildings during the anthrax attacks took from a few weeks in the case of the Congressional buildings, to well over a year in the case of the Brentwood Postal facility in Washington, DC. As the postal facility demonstrated an organization will need to have the equivalent of a fully operational *Hot Site* available for immediate and long term use in order to maintain business continuity. Similar DR and BC will prove necessary for any response to a successful attack involving biological, chemical, or nuclear threat agents. While recovery from a minor incident although costly would in all likelihood be within an organizations budgetary means, recovery from a major disaster incident could easily prove to be devastating in terms of the costs associated with business continuity as the organization would have to literally recreate itself in terms of the physical plant and the hardware components of its information system. This is assuming that the organization had operationally secure backups of all its data, operating systems and necessary software ready to implement at its Hot Site.

Solution Approaches:

As the President's Council of Advisors on Science and Technology (Council) has determined in their report on combating terrorism, the recent studies of the experiences of first responders in terrorist events suggest a number of approaches to providing more appropriate equipment. First responders have indicated that the highest priorities for equipment development should be assigned to respirators that offer both practicality and comfort for extended use, escape hoods with an air supply for emergency medical service personnel, and thinner, yet effective, thermal protection gloves for firefighters. In particular, research and development for future personal protective equipment should strive for higher levels of protection while placing much greater emphasis on making it possible for responders to perform their emergency response duties with a minimum of equipment-related interference. In addition, techniques for faster and more accurate hazard monitoring should be developed to enable first responders to evaluate environments for themselves or to receive early hazard assessment information. Personal protective equipment selection decisions will require such information as long as equipment that is specific to a single hazard type continues to be used. Broader-spectrum personal protective equipment useful for a range of hazards needs to be developed, particularly for respiratory protection, which is obviously one of the most essential elements of protection. This might best be achieved in stages, with the initial stage being to develop and field equipment with an intermediate level of protection against a wider range of hazards than is now available while still meeting weight, flexibility and decontamination requirements at an affordable cost. Emergency-response "caches" managed at regional and national levels are needed and can be used to promote standardization. Federal agencies should be required to purchase the same equipment, or equipment that, at a minimum, is compatible with other equipment—unless there are sound and specific reasons for doing otherwise. Cost and logistical considerations dictate that this activity be coordinated with the Federal Response Plan and the Strategic National Stockpile program. Pre-disaster training should be conducted under more realistic, high-pressure conditions and should include the participation of engineering, construction and transportation personnel. Procedures are needed to permit the communication of accurate hazard information to responders as quickly as the nature of a hazard is determined. Finally, flexible and dynamic procedures need to be developed to insure an effective incident management authority that can quickly establish control at a disaster site, account for individuals working in dangerous environments and assure that the proper personal protective equipment is selected for use (Augustine, 2003).

Physical Approaches to Defense Against Bioterrorism:

The Council further determined that while the discussion thus far has dealt with medical or biological defenses against bioterrorism, there is also an important role for other approaches involving the physical sciences. To be harmful, a biological agent must reach its intended victim; however, in today's world, many of the most attractive targets for bioterrorism are cities with their large concentrated populations spending much of the time indoors. Many buildings already provide their occupants with filtered air since filters are a part of every heating, ventilating and air conditioning system. These filters can be upgraded to greatly reduce the level of air-borne biological contaminants. Upgrading to the highest commercial grade provides a concomitantly high degree of protection. Similar measures are possible for individual homes, and more advanced filtering capabilities can be developed. Filtering and other physical methods—

such as safe rooms—have an important strategic advantage over purely biological defenses. Filtering methods can be devised which will stop almost all particles larger than a specified size. If the particle is, for example, an anthrax spore or similar particle, the same filter will stop all such particles; however, each may require a different medical approach, and as the characteristics of the agent may not be known in advance, that medical approach may not be available. In addition, if filters are always in use, they provide automatic protection in advance of detection. Recent research has investigated the modification of certain plants to be responsive as sensors to various bioterrorist agents, with the plant turning a different color in the presence of the threat agent (Augustine, 2003; “Bioterrorism”, 2007).

Barbara Rosenberg in an analysis of the anthrax attacks notes that although biodefense has gotten a shot in the arm, it is important to understand that the goal of defending against bioweapons is not primarily public protection--which is largely impossible, as recent attacks demonstrated. It is rather "to allow the military forces of the United States to survive and successfully complete their operational missions ... in battle space environments contaminated with chemical or biological warfare agents," according to the annual report of the Department of Defense's Chemical and Biological Defense Program. Biological weapons are preeminently anti-population weapons. But it would be impossible to provide the entire country with protective suits, masks, detectors, shelters, training and vaccinations against the large and growing array of potential agents. In any event, vaccinations can have serious side effects and can be overcome if the dose of the pathogenic agent is large or if the agent has been engineered to evade the vaccine. Instead of protection, the civil defense response is entirely concerned with limiting the damage should an attack occur. There are also paradoxes here. Because of the rush to "do something," large amounts of government money are being thrown, without sufficient forethought, at research involving potential biological weapons agents. Scientists go where the money is, and we're now seeing a crowd of biologists lacking in relevant experience trooping to the trough (Rosenberg, 2002).

Conclusion:

As noted the bioterrorist attacker is primarily focused on population centers not the individual organization, in particular not a small business or non-governmental organization. That said an attack on a population center could be initiated with an attack on a small organization, such as the release of a biological or chemical agent at a sports arena contaminating a select group of individuals with the intention of using them as carriers of the contaminate to the larger population. The responses that such an organization could provide are greatly limited as it would be likely that without a prior warning or the use of special senor equipment that would alert to the threat the event would pass without anyone being aware that an attack had taken place, in particular if the threat agent were a biological that had an incubation period longer then the event itself. But, as noted such specialized equipment as special sensors that alert to biological or chemical threat agents are still very expensive and have a high maintenance cost.

Organizations are indeed undertaking steps to develop IRPs, DRPs, and BCPs, to the extent that such plans are able to address the vulnerabilities that are within the effective control of the organization. Such plans would include the use of filters and ventilation systems, ability to contain a contaminated area if the threat is recognized sufficiently early in the attack, measures to evacuate employees from a contaminated area again if the threat is recognized at an early point in the attack, designation of all pertinent responders within and outside the organization, along with explicit instructions as to the procedures that are to be followed at each step of response to an attack. However, as pointed out these are highly improbable "ifs" that do not give any consideration to the more serious aspects of bioterrorist threats – the medical issues. These aspects are beyond the scope and ability of an organization to address. They fall within the responsibility of the various governmental and increasingly private aspects of the national and international health community where efforts to develop appropriate plans are still in their infancy.

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