Fundamental Principles about Bioterrorism

The following discussion provides a useful framework for putting into perspective the enormous volume of information being disseminated regarding health and Bioterrorism. While there are clearly many agent-specific considerations in Bioterrorism, there are also some general biologic precepts and basic principles that are relevant to this subject matter. These will be addressed in reviewing:

- Nature of Organisms of Concern
- Where these Organisms are Found
- Dissemination of Organisms Leading to Exposure and/or Disease
- Prevention Methods that Don’t Work
- Prevention Methods that Work

Definition of Bioterrorism

It is important to know that Bioterrorism, as the following definition underscores, may have as a primary objective the creation of large scale panic, fear and social disruption. “Bioterrorism is the premeditated, unlawful use or threat of use of microorganisms or toxins derived from living organisms to produce death or disease in humans, animals, or plants which is intended to create fear and/or intimidate governments or societies in the pursuit of political, religious, or ideological goals.”

Nature of Organisms of Concern

The inventory of microbes subject to bioweaponry is quite extensive. Heading the US Centers for Disease Control & Prevention’s list are:

Anthrax bacteria, smallpox virus, tularemia bacteria, plague bacteria, botulism bacteria, hemorrhagic disease viruses.

Why? These can: 1. be easily disseminated or transmitted person-to-person; 2. cause high mortality and consume enormous public health & societal resources; 3. cause public panic and social disruption, and; 4. require special actions for public health preparedness.

These microbes vary in many respects. This makes it quite difficult to create a set of prevention actions which protects against all of them at once.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Transmit Man to Man</th>
<th>Infective Dose (Aerosol)</th>
<th>Incubation Period</th>
<th>Duration of Illness</th>
<th>Lethality</th>
<th>Persistence of Organism</th>
<th>Vaccine Efficacy (aerosol exposure)</th>
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</thead>
<tbody>
<tr>
<td>Inhalation anthrax</td>
<td>No</td>
<td>8,000-50,000 spores</td>
<td>1-6 days</td>
<td>3-5 days (usually fatal if untreated)</td>
<td>High</td>
<td>Very stable - spores remain viable for &gt; 40 years in soil</td>
<td>Not available to general public</td>
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<tr>
<td>Pneumonic Plague</td>
<td>High</td>
<td>100-500 organisms</td>
<td>2-3 days</td>
<td>1-6 days (usually fatal)</td>
<td>High unless treated within 12-24 hours</td>
<td>For up to 1 year in soil; 270 days in live tissue</td>
<td></td>
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<tr>
<td>Tularemia</td>
<td>No</td>
<td>10-50 organisms</td>
<td>2-10 days (average 3-5)</td>
<td>≥ 2 weeks</td>
<td>Moderate if untreated</td>
<td>For months in moist soil or other media</td>
<td></td>
</tr>
<tr>
<td>Smallpox</td>
<td>High</td>
<td>Assumed low (10-100 organisms)</td>
<td>7-17 days (average 12)</td>
<td>4 weeks</td>
<td>High to moderate</td>
<td>Very stable</td>
<td>Vaccine Stockpile Limited; No Production facility</td>
</tr>
<tr>
<td>Viral Hemorrhagic Fevers</td>
<td>Moderate</td>
<td>1-10 organisms</td>
<td>4-21 days</td>
<td>Death between 7-16 days</td>
<td>High for Zaire strain, moderate with Sudan</td>
<td>Relatively unstable</td>
<td>No vaccine</td>
</tr>
<tr>
<td>Botulism</td>
<td>No</td>
<td>0.001 mg/kg is LD50 for type A</td>
<td>1-5 days</td>
<td>Death in 24-72 hours; lasts months if not lethal</td>
<td>High without respiratory support</td>
<td>For weeks in nonmoving water and food</td>
<td></td>
</tr>
</tbody>
</table>

General principles of note include:
1- there are no “antibiotics” for the viral diseases in the group (smallpox, hemorrhagic viruses)--care is supportive and dependent on the body’s innate immune system for fighting an established infection;
2- effective vaccine is really only available for smallpox, the national stockpile is limited and production ceased more than 20 years ago;
3- respiratory route of exposure is paramount for this group--notwithstanding skin exposure for some such as anthrax;
4- organisms transmissible person to person magnify the impact of an instantaneous exposure by creating additional waves of exposures and disease;
5- there are no “warning properties” associated with microbial exposures, e.g. odor, skin or mucous membrane irritation.
6- disease causing potential after exposure depends on exposure and so-called “virulence” factors: e.g. route of exposure, dose of organism, number of organisms required for disease occurrence, microbial toxins production, underlying immune status of the individual, a person’s existing medical condition.

Where these Organisms are Found

All the organisms, except the smallpox virus, are found in nature. Some, like C. botulinum, are quite ubiquitous. Others, like the viruses that cause hemorrhagic fevers (Ebola, Marburg viruses) are found in sub-Saharan Africa, and only occasionally cause epidemics of fatal diseases in that area. Highly specialized laboratories that study these viruses also have limited numbers of virus colonies. Anthrax is known to be found in and on animals, which is why the cutaneous form of anthrax has a long history of disease among some animal handlers and wool workers. Although
these organisms occur in nature, they are usually found far from large civilian populations, are in a state in which they cause no harm, or are highly contained.

The smallpox virus has been eliminated in its natural state, and reserves of it are known to be stored in secure laboratories in the US and Russia. (There are rumors that other countries may have stores of the virus as well.)

**Dissemination of Organisms Leading to Exposure and/or Disease**

In order for any organism to cause disease in humans, it must enter the human body through portals of entry: the lungs, the skin and mucus membranes, the gastrointestinal tract. The organisms have to be introduced in such a manner that they can get to these portals in sufficient numbers to establish active infection in large numbers of people. There is both good news and bad news about this.

**Good News:**

- It is very difficult to introduce enough of these organisms to enough people to create a large scale epidemic. Although there was an initial concern that anthrax organisms could be spread over a large area by crop dusters, it is unlikely that the droplets from crop dusters would produce spores that are small enough (1-10 microns) to reach the right places in lungs of exposed individuals, to cause the most deadly form of anthrax, i.e. pulmonary anthrax.
- Delivery systems requirements are generally fairly sophisticated for effective, mass exposures.
- Some of these organisms are so infectious and deadly (hemorrhagic viruses, for instance) that bioterrorism would be at high risk for self-exposure from handling;
- Effective anti microbial treatments are available for the bacterial bioweapons when administered early.
- Effective respiratory protective devices are available.

**Not so good news:**

- We cannot get into the minds of terrorist to predict when, where and with what organisms they might strike.
- The absence of warning properties will result in cases of illness before we would know about the exposure having occurred--e.g. current anthrax experience in US.
- Effective respiratory devices only work when they are donned prior to exposure--so some “warning” or suspicion is imperative--often not the case.
Prevention Methods that Don’t Work

Respiratory Protection

In occupational health the use of respiratory protection is very common. Differences between the occupational environment and a bioterror incident are important, however. The following table shows why:

<table>
<thead>
<tr>
<th>Attribute of Environment/Use of Respiratory Protection</th>
<th>In Occupational Settings</th>
<th>By the Public against Bioterrorism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of environment</td>
<td>The environment is generally well characterized; when it is not well characterized, full body protection and self-contained breathing apparatus (SCBA) are used (e.g., firefighters)</td>
<td>The environment is not well characterized – therefore, it will not be known what respirator would be beneficial;</td>
</tr>
<tr>
<td>Timing of use of protection</td>
<td>Respiratory protection is donned before entering the environment that is hazardous</td>
<td>The exposure to the hazard will likely have already occurred before the respiratory protection is in place</td>
</tr>
<tr>
<td>Certified Respirators</td>
<td>Only respiratory protection that is certified for the environment in which it is used is protective</td>
<td>Respiratory protection generally available to the public is not certified, or cannot be certified given the uncertainties of exposure</td>
</tr>
<tr>
<td>Fit Testing and Training</td>
<td>The wearers of respiratory protection are fitted with personal devices that are known to seal the nose and mouth, and are trained in its use by persons knowledgeable in this</td>
<td>It is difficult to deliver en masse either proper fitting of personal respirators or training in their use</td>
</tr>
<tr>
<td>Skin protection</td>
<td>Steps are taken to assure that exposure through the skin portal is prevented, if such exposure is possible</td>
<td>No steps will be taken by the vast majority of people to prevent exposure through the skin (of special concern for chemical exposure)</td>
</tr>
</tbody>
</table>

Wide Use of Antibiotics

In humans antibiotics have two broad uses: 1. treatment of diseases caused by microorganisms (usually bacteria) that are sensitive to the drug; 2. prevention of diseases in individuals who are known or thought to have been exposed to such organisms. Less discriminant use of antibiotics can cause serious public health problems for the following reasons:

1- Development of resistant strains of bacteria

- In Mexico, where the use of antibiotics is not well regulated, there have been outbreaks of gastrointestinal disease from the bacteria E. Coli that cannot be treated by the usual course of antibiotics;
- In the US, strains of salmonella that are resistant to usual antibiotics are appearing, because of the use of antibiotics in animals for human consumption;
Multiple drug-resistant tuberculosis has gained a foothold in many countries, in part from the misuse of the many antibiotics that are needed to treat the disease. For prevention of the inhalation form of anthrax after exposure to spores, for instance, it takes up to 60 days of administration of antibiotics to assure that disease will not occur. Without a full course of preventive treatment, the likelihood increases that a drug resistant strain will develop.

2- Mis-allocation of Scarce Resources

The availability of antibiotics is not infinite. The hoarding and use of antibiotics by people not at high risk of any infection might deny antibiotics to those in need, or make such antibiotics unnecessarily more costly.

3- Side Effects

All medications have side effects. Ciprofloxacin, for instance, has minor and major side effects ranging from diarrhea and nausea to serious allergic reactions and problems with tendons and joints.

4- Limited “Shelf Life”

All medications lose potency over time. Taking antibiotics months or years after hoarding would be ineffective.

Prevention Methods that Work

As is often the case in protecting health, simple measures are often effective preventive interventions. These are:

- Staying informed -- monitoring credible news and authoritative sources for what is occurring will help one determine if his/her risk of exposure is no greater than that of the general population, or has increased because of some unique event;
- Following special guidelines -- authorities quickly develop guidelines for special populations at risk, as the risk is recognized. The most recent example are the guidelines for handling mail;
- Notifying local authorities of a suspected biological incident -- the local law enforcement and public health authorities, in conjunction with national authorities, have protocols for assessing whether a true incident has occurred, which would put persons in a higher risk category for exposure;
- Recognizing “flu” symptoms, but not overreacting -- the common causes are still the common causes.
Links

Here are some excellent links to more information:

Centers for Disease Control (CDC) Bioterrorism Website (http://www.bt.cdc.gov/)

Johns Hopkins Center for Civilian Biodefense Studies (http://www.hopkins-biodefense.org/)

Saint Louis University Center for the Study of Bioterrorism and Emerging Infections (http://www.slu.edu/colleges/sph/bioterrorism/index.html)

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