261e Microbial Bioterrorism

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Descriptions of the use of microbial pathogens as potential weapons of war or terrorism date from ancient times. Among the most frequently cited of such episodes are the poisoning of water supplies in the sixth century B.C. with the fungus *Claviceps purpurea* (rye ergot) by the Assyrians, the hurling of the dead bodies of plague victims over the walls of the city of Kaffa by the Tartar army in 1346, and the efforts by the British to spread smallpox to the Native American population loyal to the French via contaminated blankets in 1763. The tragic attacks on the World Trade Center and the Pentagon on September 11, 2001, followed closely by the mailing of letters containing anthrax spores to media and congressional offices through the U.S. Postal Service, dramatically changed the mindset of the American public regarding both our vulnerability to microbial bioterrorist attacks and the seriousness and intent of the federal government to protect its citizens against future attacks. Modern science has revealed methods of deliberately spreading or enhancing disease in ways not appreciated by our ancestors. The combination of basic research, good medical practice, and constant vigilance will be needed to defend against such attacks.

Although the potential impact of a bioterrorist attack could be enormous, leading to thousands of deaths and high morbidity rates, acts of bioterrorism would be expected to produce their greatest impact through the fear and terror they generate. In contrast to biowarfare, where the primary goal is destruction of the enemy through mass casualties, an important goal of bioterrorism is to destroy the morale of a society through fear and uncertainty. Although the actual biologic impact of a single act may be small, the degree of disruption created by the realization that such an attack is possible may be enormous. This was readily apparent with the impact on the U.S. Postal Service and the functional interruption of the activities of the legislative branch of the U.S. government following the anthrax attacks noted above. Thus, the key to the defense against these attacks is a highly functioning system of public health surveillance and education so that attacks can be quickly recognized and effectively contained. This is complemented by the availability of appropriate countermeasures in the form of diagnostics, therapeutics, and vaccines, both in response to and in anticipation of bioterrorist attacks.

The Working Group for Civilian Biodefense created a list of key features that characterize the elements of biologic agents that make them particularly effective as weapons (Table 261e-1). Included among these are the ease of spread and transmission of the agent and the presence of an adequate database to allow newcomers to the field to quickly apply the good science of others to bad intentions of their own. Agents of bioterrorism may be used in their naturally occurring forms, or they can be deliberately modified to deliver greater impact. Among the approaches to maximizing the deleterious effects of biologic agents are the genetic modification of microbes for the purposes of antimicrobial resistance or evasion by the immune system, creation of fine-particle aerosols, chemical treatment to stabilize and prolong infectivity, and alteration of host range through changes in surface proteins. Certain of these approaches fall under the category of *weaponization*, which is a term generally used to describe the processing of microbes or toxins in a manner that would ensure a devastating effect following release. For example, weaponization of anthrax by the Soviets involved the production of vast numbers of spores of appropriate size to reach the lower respiratory tract easily in a form that maintained aerosolization for prolonged periods of time and that could be delivered in a massive release, such as via widely dispersed bomblets.

The U.S. Centers for Disease Control and Prevention (CDC) classifies potential biologic threats into three categories: A, B, and C (Table 261e-2). Category A agents are the highest-priority pathogens. They pose the greatest risk to national security because they (1) can be easily disseminated or transmitted from person to person, (2) result in high mortality rates and have the potential for major public health impact, (3) might cause public panic and social disruption, and (4) require special action for public health preparedness. Category B agents are the second highest priority pathogens and include those that are moderately easy to disseminate, result in moderate morbidity rates and low mortality rates, and require specifically enhanced diagnostic capacity. Category C agents are the third highest priority. These include certain emerging pathogens to which the general population lacks immunity; that could be engineered for mass dissemination in the future because of availability, ease of production, and ease of dissemination; and that have a major public health impact and the potential for high morbidity and mortality rates. It should be pointed out, however, that these A,

TABLE 261e-1 KEY FEATURES OF BIOLOGIC AGENTS USED AS BIOWEAPONS

1. High morbidity and mortality rates
2. Potential for person-to-person spread
3. Low infective dose and highly infectious by aerosol
4. Lack of rapid diagnostic capability
5. Lack of universally available effective vaccine
6. Potential to cause anxiety
7. Availability of pathogen and feasibility of production
8. Environmental stability
9. Database of prior research and development
10. Potential to be "weaponized"

Source: From L Borio et al: JAMA 287:2391, 2002; with permission.

TABLE 261e-2 CDC CATEGORY A, B, AND C AGENTS

Category A
Anthrax (*Bacillus anthracis*)
Botulism (*Clostridium botulinum* toxin)
Plague (*Yersinia pestis*)
Smallpox (*Variola major*)
Tularemia (*Francisella tularensis*)
Viral hemorrhagic fevers
Arenaviruses: Lassa, New World (Machupo, Junin, Guanarito, and Sabia)
Bunyaviridae: Crimean-Congo, Rift Valley
Filoviridae: Ebola, Marburg
Category B
Brucellosis (*Brucella* spp.)
Epsilon toxin of *Clostridium perfringens*
Food safety threats (e.g., *Salmonella* spp., *Escherichia coli* 0157:H7, *Shigella*)
Glanders (*Burkholderia mallei*)
Melioidosis (*Burkholderia pseudomallei*)
Psittacosis (*Chlamydophila psittaci*)
Q fever (*Coxiella burnetii*)
Ricin toxin from *Ricinus communis* (castor beans)
Staphylococcal enterotoxin B
Typhus fever (*Rickettsia prowazekii*)
Viral encephalitis (alphaviruses [e.g., Venezuelan, eastern, and western equine encephalitis])
Water safety threats (e.g., *Vibrio cholerae, Cryptosporidium parvum*)
Category C
Emerging infectious diseases threats such as Nipah, hantavirus, SARS or MERS coronavirus, and pandemic influenza

Abbreviations: MERS, Middle East respiratory syndrome; SARS, severe acute respiratory syndrome.

Source: Centers for Disease Control and Prevention and the National Institute of Allergy and Infectious Diseases.