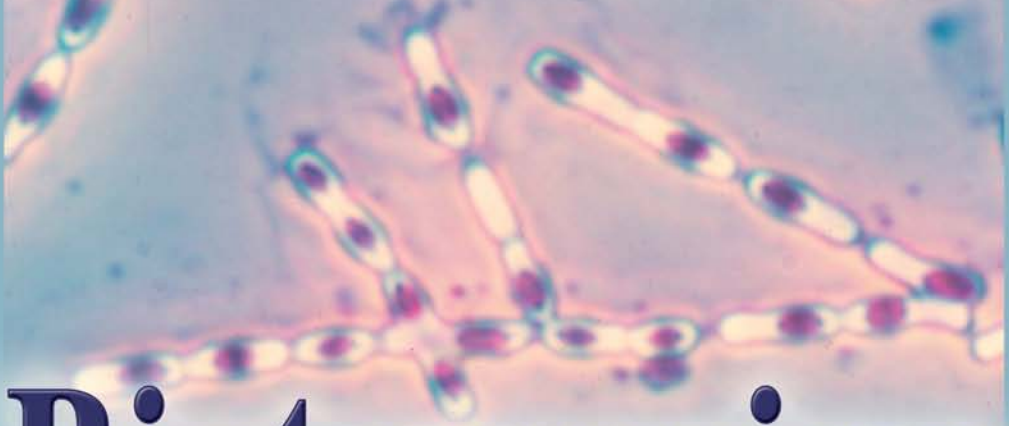
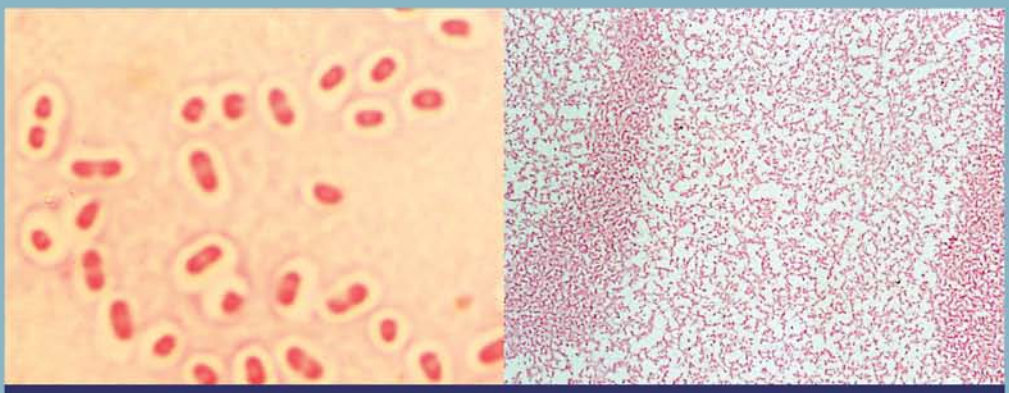


Bioterrorism

A Guide for Hospital Preparedness



Joseph R. Masci, M.D. and Elizabeth Bass

CRC PRESS

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Preface

Biological agents have played a potent but often overlooked role in the annals of warfare. Smallpox, plague, syphilis, and other devastating infectious diseases — intentionally or unintentionally introduced into susceptible populations — have dramatically influenced the course of human history. Despite many examples over the centuries in which military advantage was gained more through infection than arms and strategy, the potential use of biological agents as instruments of terror in peacetime has only recently been recognized and exploited.

The most dramatic example of such bioterrorism occurred in the U.S. in the autumn of 2001, only weeks after the terrorist assaults on the World Trade Center and the Pentagon, when spores of the highly infectious and lethal disease anthrax were intentionally spread through the mail. Although only 22 people were infected, including 5 who died, thousands sought medical attention. More than 250,000 prescriptions were written for prophylactic antibiotics, numerous post offices and the Hart Senate Office Building were shut down, and mail delivery to Congress was stopped for 6 weeks. The broad impact of this very limited attack revealed a potential for much greater devastation if a wider and more sustained effort at bioterrorism were to occur.

It also revealed vulnerabilities in several key areas. The hospital systems in the cities that experienced the attacks, New York, Washington, D.C., and Boca Raton, FL, were called upon to respond to a fearful population and inquisitive media while evaluating their own systems of triage and care for potential victims of the attack. Even far from the epicenters of the attacks, hospitals and laboratories faced extraordinary demands. In Illinois, for example, laboratories processed more than 1500 samples for anthrax between October 8 and December 31, 2001; none was positive.

The national public health apparatus, which traditionally guides the medical profession and the hospital system in handling epidemics, was thrown into a confusing maelstrom: It was required simultaneously to monitor the extent of the attack, investigate individual cases, provide laboratory assistance, coordinate efforts with political and law enforcement agencies, and inform and reassure the public. The effort consumed the services of more than 90% of the CDC's epidemiological investigation officers and much of its laboratory capacity. Only the limited scope of that attack, which stopped as enigmatically as it began, prevented a crippling crisis for America's health care system.

In the aftermath of the anthrax and 9/11 attacks, concerns about the vulnerability of our health care and public health systems rose quickly. To the surprise of many, this vulnerability had been recognized in surveys and national exercises in the years leading up to the 2001 attacks, spurring attempts to improve preparedness at the national level.

Now that the hypothetical possibility of bioterrorism has become a sobering reality, efforts to prepare for future attacks have intensified greatly at the local, state, and national levels. A nationwide campaign to immunize a portion of emergency "first responders" and hospital workers against smallpox was one of the most conspicuous, direct results of these efforts. Participation in the first phase of that campaign fell far short of plans, however, as medical, labor, and liability issues arose — a sign of the complexities that lie ahead for medical institutions and workers.

In many ways, the challenge facing hospitals in preparing for bioterrorism remains daunting. At a time when hospitals in major cities frequently face problems of overcrowding, increasing use of emergency rooms, and increasingly stringent quality standards, planning for a biological attack often seems like a fanciful luxury.

Perhaps the greatest challenge facing us is in finding the border between complacency and overreaction to the risk of bioterrorism. Complacency makes it more likely that any future attack will bring confusion, delays in critical decision making, unnecessary spread of contagious agents and, as a result, medical and social catastrophe. Overreaction carries the risk that we will squander funds and resources on unrealistic scenarios while more immediate health needs go unmet, at high human cost.

The ideal balance — one that prepares us so well that it helps prevent bioterrorism from occurring in the first place while strengthening our ability to prevent and treat naturally occurring disease — is far from clear.

In this book, we have attempted to provide guidance to hospitals, health care workers, public health authorities, and others interested in effectively preparing for bioterrorism. We have included data from national and regional exercises in assessing preparedness and suggestions for implementing lessons learned from these exercises, as well as a brief overview of the current standards of the Joint Commission on Accreditation of Hospitals and Healthcare Organizations. We have examined the impact on the health care system from past bioterrorism as well as naturally occurring outbreaks such as SARS. We have tried to identify areas of concern in our current state of preparedness.

We have also provided a concise discussion of the likely agents of biological attack, including clinical information and management of specific attack scenarios both in text form and in the format of so-called tabletop exercises. Sections addressing seldom-discussed topics such as the unique needs of children, communication with the press, and management of the psychological impact of an attack have also been included. Throughout the book we assume a basic knowledge of the functioning of general hospitals. Our intent is to enhance knowledge regarding the challenges faced by hospitals, and we have, therefore, omitted selected basic information about hospital operations not specific to bioterrorism.

Employing a synthesis of these data, guidelines, and collective experience, we have attempted to provide concrete strategies that hospitals can use to establish and maintain an attainable level of preparation. We hope that our book aids in this important mission as the health community tries to develop sensible and effective ways to meet the unknown risk we face from bioterrorism.

Authors

Dr. Joseph R. Masci, M.D., is director of the Department of Medicine at Elmhurst Hospital Center and professor of medicine at the Mount Sinai School of Medicine. He graduated from New York University School of Medicine. After an internship and residency in internal medicine at Boston City Hospital, he completed a fellowship in infectious diseases at the Mount Sinai Medical Center in New York. Since that time he has been a full-time faculty member at Elmhurst Hospital, the municipal hospital teaching affiliate of Mount Sinai School of Medicine.

In the field of bioterrorism and emergency preparedness, Masci currently serves as chairman of the Emergency Preparedness Council of the New York City Health and Hospitals Corporation and as a member of the hospital subcommittee of the New York City Department of Health Weapons of Mass Destruction Committee. He formerly served on the Bioterrorism Advisory Committee of the Office of the Mayor of New York City. He is also chairman of the Emergency Preparedness Committee of the Queens Health Network in New York City. He has lectured extensively to lay and professional audiences on bioterrorism and emergency preparedness.

His other primary area of interest is HIV/AIDS. He is the medical director of AIDS services for the Queens Health Network, chaired the health workgroup of the New York City Health and Human Services HIV Planning Council from 1998 until 2003, and sits on the Medical Care Criteria Committee and Physicians Prevention Committee of the New York State Department of Health AIDS Institute. In 1992 he received the Dr. Linda Laubenstein Award for HIV Clinical Excellence from the New York State Health Department. He has conducted clinical research in AIDS and is the author of three textbooks, *Outpatient Management of HIV Infection,* first and second editions (Mosby-Yearbook) and third edition (CRC Press).

Elizabeth Bass is a journalist, specializing in medical writing and editing. As science and health editor of New York *Newsday* for 6 years, she supervised projects that won top awards in their fields, including the Pulitzer Prize. She has served as deputy national editor of *Newsday* and has taught reporting and editing at the Columbia University Graduate School of Journalism. Bass was an associate editor of *Human Diseases and Conditions* (Charles Scribner's Sons, 2001), a contributor to *Encyclopedia of Science and Technology*, edited by James Trefil (Routledge, 2001), and a coauthor of *KidsHealth Guide for Parents: Pregnancy to Age 5* (Contemporary Books, 2002), with Steven A. Dowshen, M.D., and Neil Izenberg, M.D. At the time of the September 11, 2001, terrorist attacks and the subsequent anthrax attacks, she was senior project editor at *Newsday* and worked extensively on coverage of the attacks and their aftermath.

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To Jonathan Masci, our son

Section I

The Scope of the Problem

1 The Historical and Political Context of Bioterrorism Concerns

INTRODUCTION

On September 11, 2001, as the towers of the World Trade Center crumbled, doctors and nurses at several Manhattan hospitals paced outside their emergency departments next to lines of stretchers, waiting for the wounded who never came.

Public health authorities had other concerns. Minutes after jets hijacked by terrorists hit the skyscrapers, a 22-member National Guard unit from upstate Scotia, NY, was dispatched to New York City. By 8:30 P.M., it had set up its gear and was testing for biological agents and toxic chemicals.[1]

"The really difficult thing right now is not knowing if there is another shoe to drop," said Dr. Michael Osterholm, director of the Center for Infectious Disease Research and Policy at the University of Minnesota School of Public Health, to a reporter on September 11. "Has there been a biological agent released today?"[2]

The answer, all evidence indicates, was "no." But the attack on the World Trade Center and the Pentagon was so shocking in what it revealed — both about the vulnerability of U.S. society and about the deadliness of terrorists' intent — that it raised fears of another nightmare scenario: the use of biological agents to cause mass casualties. In the next two weeks, news outlets around the country ran stories quoting experts' opinions that the U.S. was vulnerable to a biological assault that could dwarf the 9/11 assaults.[3–9] Pharmacists reported heavy demand for ciprofloxacin by patients fearing an anthrax attack.[10]

In a column that ran September 12, 2001, former Defense Secretary William S. Cohen wrote:

> As horrific as yesterday's attacks were, we must be prepared for even worse. Americans must now think the unthinkable — that the next terrorist attack could well involve a contagious biological agent carried to our soil or airspace in a briefcase or bottle. We face opponents who are working diligently to become, in W. H. Auden's words, someone who "clutching a little case, walks briskly to infect a city whose terrible future may have just arrived."[11]

His words soon seemed prophetic. On October 2, three weeks after the World Trade Center and Pentagon attacks, a 63-year-old man, a newspaper photo editor, presented to a Florida emergency room with fever, vomiting, and confusion. Two days later, the diagnosis of inhalational anthrax was confirmed. He died the next

day.[12] For the first time in the U.S., anthrax, one of the most potentially dangerous biological weapons, had been used in a lethal assault.

The 2001 anthrax attack did not, thankfully, mark the arrival of Auden's "terrible future." In the end, it involved only 11 cases, with 5 deaths. But the events of 2001 heightened concern about bioterrorism in several ways. The September 11 assaults on the World Trade Center and the Pentagon showed that terrorists could carry out a technically sophisticated, well-coordinated long-range plan on U.S. soil. It showed they could devise a novel and unexpected technique. And perhaps most ominous, it seemed to confirm that they were eager to cause mass civilian casualties, without limit, rather than targeting their attacks more narrowly.

The October anthrax incidents showed that this long-feared pathogen could be prepared as a weapon and distributed by low-tech means — in this case, as letters sent through the U.S. mail. It showed that responding to even limited use of a deadly biological agent could have heavy economic and emotional costs. Moreover, it revealed weaknesses in the nation's medical and crisis management responses, as well as its law enforcement capacity.

Despite the events of September 11 and the subsequent U.S. invasions of Afghanistan and Iraq, no new evidence has emerged publicly as of this writing to indicate that nations or terrorist groups possess biological weapons or are working to develop them. Indeed, it appears that contentions that Iraq's Saddam Hussein had usable biological weapons — contentions that helped lead to war — were unfounded.

However, public health and civil authorities remain concerned about the chances of biological attack, as they were long before 2001. For more than a decade earlier, studies, tests, and real-world events had been raising concerns that use of biological agents by terrorist groups or by nations — although still highly unlikely — was becoming a more realistic possibility, a risk that the nation's medical system was ill-prepared to meet.

Among the reasons for concern are:

- Biological weapons are much more accessible, cheaper, and easier to produce than nuclear weapons, yet potentially could have comparable destructive power.
- Unlike other terror tools, biological weapons could be used covertly. This could increase their destructive effect, but also make it harder to catch or even identify the perpetrators, another factor that might encourage their use.
- Research into making pathogens more virulent and resistant for use as weapons was reported to have been underway in recent decades, and advancing genetic knowledge could make such attempts likelier to succeed.
- Even small-scale use of biological weapons with low-teach means, as seen in the anthrax attacks, can cause large-scale social, psychic, and economic dislocation.
- Aside from nations that may have weapons or the capability to make them, nonstate extremist factions, both foreign and domestic, have expressed interest in biological weapons over the years.

- Terrorists' tactics have grown more lethal in recent years, with an apparent greater willingness to cause mass civilian casualties and a greater reliance on suicide attacks, both tendencies that could make use of biological weapons more likely.
- Key sectors of society — including hospitals, public health authorities, first responders, and the public — are not well prepared to respond to a biological attack, although improvements are being made, rapidly in some areas and less rapidly in others.

A standard feature of emergency-management planning for hospitals is analysis of hazard vulnerability. With that in mind, this chapter presents information about several factors that hospital planners may want to consider when they think about how much priority their institution should assign to bolstering preparedness for a biological attack. The issues of hospital and public health vulnerability to biological agents are discussed in Chapter 2.

For hospital planners, the key question is unanswerable: How likely is a biological attack that would affect my hospital? The political and military intelligence to answer this question is not available to us and may not, in fact, exist. The safest answer — such an attack is unlikely, or highly unlikely, but certainly possible — is not particularly helpful, but it may be the best we can do.

EASE OF USE OF BIOLOGICAL AGENTS

Many biological agents, including some that can be effectively weaponized, are relatively inexpensive and available, with sources in biological supply companies, hospital and commercial laboratories, and in nature.[13] In small amounts, some are relatively easy to culture and to deliver, as shown by several small-scale events:

- In 1984, members of a religious cult called the Rajneeshees added *Salmonella typhimurium* to restaurant salad bars in Oregon, sickening 751 people. The cult operated a health clinic and state-licensed laboratory; members cultured the salmonella from "bactrol discs" purchased from a medical supply house, ostensibly for laboratory quality assurance testing.[14]
- In 1990, nine people in an Edinburgh apartment block became ill with giardiasis, apparently after an infected person intentionally contaminated water tanks on the roof.[15]
- In 1996, a hospital laboratory technician in Dallas used *Shigella dysenteriae* type 2 taken from a hospital lab to contaminate pastries she placed in a breakroom, sickening a dozen coworkers.[16]

In a suicide scenario, little technical skill would be necessary to disseminate pathogens. During World War II, for instance, Japanese germ warriors infected Chinese prisoners of war with typhoid and freed them to spread the illness. Similar techniques could be used with a few volunteers, or even one.

However, preparing and delivering biological agents in a manner sufficient to cause large numbers of casualties would require a far higher degree of knowledge and skill, as well as financial and technical resources.[13,17]

Some have speculated that weaponizing and delivering microbial pathogens on a large scale would be beyond the scope of terrorist groups, requiring the resources of a nation.[18] Nonetheless, many have expressed concern that the required know-how and equipment are increasingly available around the world.[19–21] As just one measure of how widely disseminated the relevant knowledge is, more than 42,000 people around the world are members of the American Society for Microbiology, most with graduate degrees in microbiology.[22] Along with rising levels of scientific education have come greater freedom of travel, wider dissemination of information through the Internet, and advancing use of bioengineering techniques — all developments that can deliver great benefits but that also can enable bioterrorists to strike.

The Case of Aum Shinrikyo

The experience of Aum Shinrikyo, the Japanese cult that released sarin gas in the Tokyo subway with deadly results in 1995, shows that despite the nightmare scenarios that can be devised, deadly dissemination of biological agents may not be easy. The cult had scientific resources; officials estimated Aum Shinrikyo had 10,000 members in Japan and 30,000 in Russia, many of them well educated, with scientific or technical training. About 1,400 of the Japanese adherents and 5,500 of the Russians were hardcore followers, living in Aum facilities. The cult had financial resources as well. Its net worth was estimated at $1 billion or more, with money raised through a chain of restaurants, a computer company, expensive training courses, tithing, and other means.[23]

Its biological attacks began in April 1990, when the sect made several attempts to spread botulinum toxin from a vehicle driving around government buildings in central Tokyo and at the U.S. Navy base in Yokohama. In June 1993, it again tried to spread botulinum. In addition, over 4 days in June and July 1993, it tried to aerosolize anthrax spores from the roof of an eight-story building that the cult owned in Tokyo. Experts have said that the anthrax strain was not virulent enough to have the intended effect, although pet deaths and odd smells and stains were reported at the time.[24] In March 1995, just before the sarin subway attack, preparations were made to release botulinum toxin in the Tokyo subway using attaché cases equipped with vents and blowers, to be triggered by the vibrations of the subway. The attack fell through, reportedly because the appointed cult member chose not to fill the cases.[24] No casualties were reported from any of Aum's bioterrorist attempts.

The biowarfare effort was led by a graduate-level microbiologist. The cult had two laboratories and was building a more advanced lab when it was raided after the sarin attack.[25]

In terms of the risks of bioterrorism, the ineffectiveness of Aum's efforts can be seen as reassuring: A well-funded and well-educated group of fanatics, working over a period of years with two of the deadliest biological agents, apparently were unable to harm a single person.

However, a less reassuring morale can also be drawn from the fact that a well-funded and well-educated group had no scruples about repeatedly attempting such a project — trying to indiscriminately unleash mass destruction through disease.

Having failed at bioterrorism, Aum turned to chemical weapons, with greater effect. In late 1993, the cult members began using sarin and VX nerve gas, targeting specific enemies in seven attacks within a year. In the worst of these, 7 people died and more than 100 were injured when cult members sprayed vaporized sarin for 10 minutes in June 1994 in a parking lot in the city of Matsumoto. Even after the Tokyo subway attack and the raids on Aum facilities that followed, the cult still sought to cause mass casualties, making two unsuccessful attempts to release hydrogen cyanide gas in the Tokyo subways.

The group, it might be noted, has continued to exist under the name Aleph. In 2002, it had 1650 followers in Japan, including 650 adherents living in group facilities, and 300 in Russia, according to Japan's Public Safety Investigation Agency, which by law monitors the group. In 2003, the Japanese justice minister said a danger remained that it could launch "indiscriminate mass killings."[26]

DIFFICULTY IN CONTAINING INFECTIOUS DISEASE OUTBREAKS

Concerns about intentional dissemination in recent years coincided with a series of novel outbreaks of infectious agents. Although occurring naturally, these outbreaks raised awareness of how global interconnections — in food supply, immigration, business, and leisure travel — can help enable an infectious agent, once it is loose in the world, to spread and thrive.

The catastrophic example of this has been HIV/AIDS, an illness that has blanketed the globe since it first was reported in 1981 as a mysterious disease of gay men in the U.S. By the end of 2001, 20 years later, there had been more than 60 million cases of this sexually transmitted retroviral illness. An estimated 40 million people around the world were living with HIV, and an estimated 14 million children of 14 years or younger had lost at least one parent to the disease, with the heaviest impact in Africa. In the U.S., an estimated 500,000 people had died of AIDS through 2002.[27–29] HIV's social and economic impact challenges comprehension. As just one measure, it is notable that life expectancy in sub-Saharan Africa, which would have been 62 without HIV, fell to 47 in 2001.[30]

More limited examples include the following:

- Severe acute respiratory syndrome (SARS): A respiratory illness caused by a previously unknown coronavirus, SARS-associated coronavirus (SARS-CoV), it was first seen in Asia in late 2002 and was recognized in February 2003. Before the outbreak ended in July 2003, it had spread to more than two dozen countries in Asia, Europe, North America, and South America, with severe social consequences. To contain the SARS outbreak, thousands of people were quarantined, schools were closed, international travel was restricted and, in some countries, mandatory

temperature-taking and surveillance were instituted. The disease spread largely in hospital settings, putting medical workers at risk, and in some cases stigmatizing them and their families. In East Asia, the World Bank estimated the direct economic impact to be between $20 billion and $25 billion.[31] As of July 31, 2003, a total of 8098 probable cases were reported to the World Health Organization, with 774 deaths, for a case fatality rate of 9.6%. Canada had 251 probable cases, including 43 deaths. The U.S. had 29 probable cases with no deaths. (For a discussion of the psychological impact of SARS on hospital staff, see Chapter 6.)

- West Nile virus: A flavivirus transmitted by mosquitoes that infects birds and horses, it had been seen in humans in Africa, Europe, the Mideast, Asia, and Oceana since it was first identified in Uganda in 1937. However, a human case had never been reported in North America until August, 1999, when a hospital-based physician in the New York City borough of Queens contacted the New York City Department of Health to report two patients with encephalitis.[32] Since then, outbreaks have grown each year in the U.S. In 2003, as of November 5, the Centers for Disease Control and Prevention (CDC) reported 8219 cases in 45 states with 182 deaths, a case fatality rate of 2.2%.
- Monkeypox: The first known cases of this disease outside Africa were reported in June 2003 in Wisconsin, Indiana, Illinois, and several other Midwestern states. They were linked to contact with prairie dogs that were believed to be infected by a giant Gambian rat, imported from West Africa where the disease is endemic, to be sold as a pet. Because the virus is related to smallpox virus, smallpox vaccine was used as prophylaxis. The CDC reported 72 suspect cases as of July 30, 2003, with 37 confirmed by laboratory results.

Unfortunate as these recent outbreaks have been, they can be seen as having strengthened the public health system's ability to respond to biological attacks, serving in effect as involuntary training exercises. The likelihood that other novel natural outbreaks will occur should be factored into hospital planners' considerations because the preparations made for bioterrorism could be expected to improve the hospital's ability to respond to natural outbreaks.

POTENTIAL DESTRUCTIVENESS OF BIOLOGICAL WEAPONS

Studies indicate that, if disseminated under optimal conditions, some biological agents have the potential to kill on a scale matched only by natural disasters or nuclear attack. This may be attractive to those seeking the maximum destructive capacity.

Conversely, it is believed that powerful psychosocial pressures militate against the use of biological weapons. It has been said that biological weapons, in their perversion of the age-old human quest to prevent and cure disease, are so morally

objectionable as to be almost taboo, especially for use by a nation.[33] The Biological and Toxin Weapons Convention of 1972, which banned nations from developing or retaining biological weapons for hostile purposes, declared that their use "would be repugnant to the conscience of mankind."[34] A total of 150 nations signed the convention.

If a nation or terrorist group were identified as having used biological weapons, it could expect to experience universal opprobrium and severe retaliation, with political consequences that could last many years. In addition, if a contagious agent were used, the offender nation might be unable to ensure the safety of its own people and allies. Powerful as these constraints may be, the attempted biological attacks by Aum Shinrikyo, described previously, indicate that they are not universally persuasive.

Projections of Destructive Power

In a 1993 report, the U.S. Congress' Office of Technology Assessment quantified the risks of weapons of mass destruction. It estimated that if a single aircraft released 100 kg of anthrax spores in a line-source while flying over Washington, D.C., on a sunny day with a light breeze, the attack could kill 130,000 to 460,000 people. If the release were made at night or on an overcast day, with a moderate wind, it could kill 420,000 to 1.4 million people. If the night were clear, the death toll would rise to 1 million to 3 million people.

By comparison, the report estimated that a hydrogen bomb delivered by missile to Washington, D.C., would kill 570,000 to 1.9 million people (Figure 1.1). "In principle, biological weapons efficiently delivered under the right conditions against unprotected populations would, pound for pound of weapon, exceed the killing power of nuclear weapons," the report said. "On the other hand, if warning is provided, effective civil defense measures are considerably easier to take against chemical and biological weapons than against nuclear weapons."[13]

The Office of Technology Assessment (OTA) report was perhaps the most frightening tally, but it was hardly the only one. Many authors have projected levels of illness and death from biological attack that would overwhelm existing medical resources, as shown in the examples that follow.

In 1997, scientists from the CDC published two models looking at the impact from intentional release of pathogens.

One model compared the economic and health impacts of three possible bioterrorism agents — *Brucella melitensis, Franciscella tularensis,* and *Bacillus anthracis* — if each pathogen were sprayed separately under optimal conditions on a 100,000 population suburb of a major city.[35] If no postexposure prophylaxis were administered, the following was projected: 50,000 cases of inhalational anthrax with 32,875 deaths; 82,500 cases of pneumonic or typhoidal tularemia with 6,188 deaths; 82,500 cases of brucellosis with 413 deaths (Figure 1.2).

Prompt postexposure prophylaxis could reduce these totals. Most dramatically, if prophylaxis were begun on the day of the release or the day after, it would reduce the number of deaths by more than two thirds in each of the three cases, the study projected.

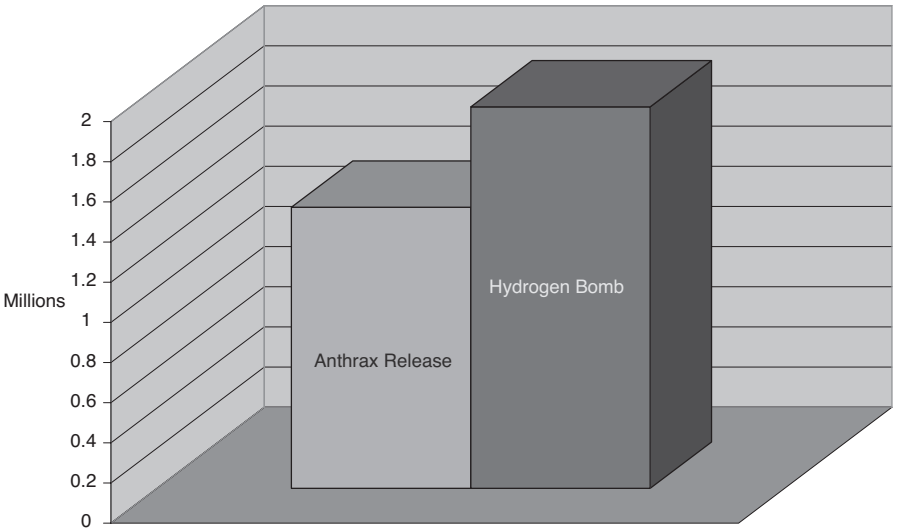

FIGURE 1.1 Projected deaths: anthrax atmospheric release vs. hydrogen bomb (Washington, D.C.). (From Jernigan, D.B. et al., OTA-ISC-559, U.S. Government Printing Office.)

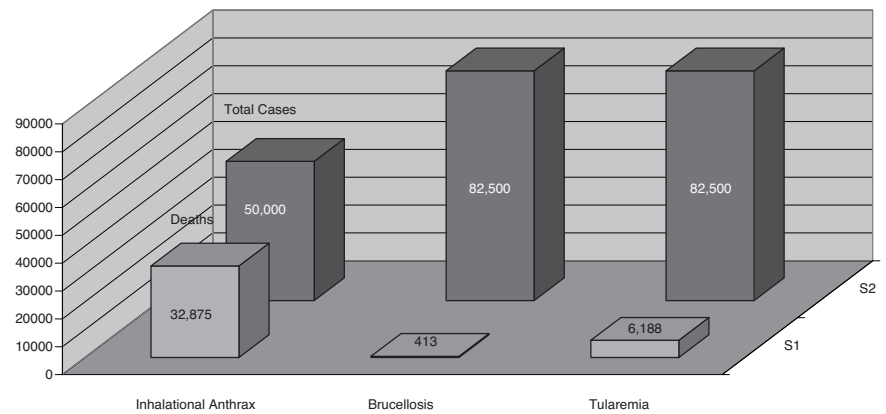

FIGURE 1.2 Effects of aerosol release over suburb of 100,000 population. (From Kaufmann, A.F., Meltzer, M.I., and Schmid, G.P., The economic impact of a bioterrorist attack: Are prevention and postattack intervention programs justifiable? *Emerg Infect Dis*, 3,

The other model projected the spread of smallpox, assuming an initial infection of 100 people.[36] The model assumed each person would infect three others, a higher rate than the historical average, but reasonable given the nearly total susceptibility of the U.S. population in the post-smallpox vaccination era. The model concluded that a combined vaccination and quarantine campaign would stop the outbreak in 365 days if the vaccination effort reduced transmission by a third and the daily quarantine rate reached 25%. In that scenario, 4200 cases of smallpox would occur.

Tests of Biological Agents or Simulants

Indications of the destructive power of biological weapons were also provided by hundreds of tests of biological weapons and dispersal systems that the U.S. military secretly conducted from 1943 to 1968. Although relatively few details of these tests have been made public, some results from the studies are known:

- In the so-called Shady Grove tests, conducted in 1964, Marine Corps bombers sprayed *Pasturella tularensis* and *Coxiella burnetti*, the etiologic agent of Q fever, into the air off Johnson Atoll in the Pacific, where boats bearing rhesus monkeys were arrayed in a line 100 miles long. In the biggest release, a plane sprayed a line of agent for 32 miles; it remained infectious more than 60 miles downwind.[37]
- In 1964, Air Force jets sprayed staphyloccal enterotoxin B over Eniwetok Atoll, earlier the site of nuclear bomb tests; monkeys were placed on the atoll and on boats. As reported in *The Biology of Doom: The History of America's Secret Germ Warfare Project,* an unclassified paragraph in the final report on the test stated, "The agent proved to be stable and did not deteriorate during storage, aerosolization, or downwind travel. A single weapon was calculated to have covered 2400 square kilometers, producing 30 percent casualties for a susceptible population under the test conditions. No insurmountable problems were encountered in production-to-target sequence."[37] The 2400 square kilometers covered by the weapon in that test is almost three times the area of New York City. If such a weapon were sprayed over a major city under optimal conditions, it theoretically could cause millions of casualties.
- Scientists from the Army's Special Operations Division, its germ-warfare unit, also explored simpler ways to spread pathogenic organisms. In 1966, Army testers went into the New York City subway system and dropped lightbulbs filled with powdered *Bacillus globigii*, an organism genetically related to the anthrax bacillus, on sidewalk ventilation grills and onto the tracks as trains sped along. The powder from the shattered bulbs aerosolized in clouds that were pulled along behind the trains. The Army's report on the exercise concluded: "A large portion of the working population in downtown New York City would be exposed to disease if one or more pathogenic agents were disseminated covertly in several subway lines at a period of peak traffic."[38]

The Sverdlovsk Accident

The models of biological attack and projected casualties listed above have provided an insight into the potential devastation that such attacks could cause. Real-life confirmation of the dangers of biological weapons was provided in 1979 when an outbreak of anthrax followed an accidental release of spores of *Bacillus anthracis* in the Soviet city of Sverdlovsk (now Ekaterinburg) and killed about 65 people over a 6-week period.

For years afterward, Soviet authorities claimed the illnesses represented cases of intestinal anthrax caused by consumption of contaminated meat. However, in 1992, just after the dissolution of the Soviet Union, Russian President Boris Yeltsin — who coincidentally had been the Communist Party chief for Sverdlovsk at the time of the outbreak — confirmed in general terms U.S. suspicions that the cases represented inhalational anthrax caused by an accident at a military facility.[39]

American scientists visited the area and reported in 1994 that most victims had worked or lived in a narrow zone extending from the facility to the southern city limit. Farther south along the zone, they found, livestock died of anthrax. "The zone paralleled the northerly wind that prevailed shortly before the outbreak," they reported.[40] Their findings were consistent with an airborne release from the military facility.

According to Ken Alibek, a high-ranking Soviet biological warfare official who defected to the U.S. in 1992, anthrax spores were accidentally released from the facility, a biological weapons factory, when workers failed to replace a clogged filter that had been removed from an exhaust pipe that vented anthrax-contaminated air.[41] Had the wind been blowing toward the city, casualties would have been much higher, Alibek maintained.[42]

The episode served as ominous confirmation both of the Soviets' long-hidden germ warfare activities and of the deadly power of aerosolized anthrax. Although by all accounts accidental, the Sverdlovsk incident was regarded as a model of how an intentional release might work.

SOCIAL AND ECONOMIC BURDENS OF BIOTERRORISM

Biological weapons may be attractive to terrorists because infectious-disease outbreaks can cause major economic and social disruption and psychic dislocation. This was amply demonstrated in the recent series of novel infectious disease outbreaks, especially SARS fever. Responding to a pathogen — or even to the false threat of a pathogen — can be costly for public security and health agencies even when little or no damage is done to the public health. That was the case with a series of anthrax hoax letters sent to abortion clinics in the 1990s, as discussed in the following subsection.

Potential biological agents need not even target humans to be economically and socially costly. In 2001, Britain experienced a natural outbreak of foot-and-mouth disease, a highly contagious viral disease of cattle and other hoofed animals. The outbreak led to the slaughter of more than 6.5 million farm animals, postponement of national elections, mobilization of troops, cancellation of many activities, banning of British meat imports, and widespread psychological trauma. It cost the British economy a total of more than £8 billion (the equivalent of more than $11.3 billion at the time).[43,44] The virus that causes foot-and-mouth, an apthovirus in the family Picornaviridae, is considered a potential agent of agricultural terrorism.

Costs of the Anthrax Incidents of 2001

The anthrax attacks of 2001 provided a vivid example of the disproportionate social and economic costs that biological weapons can inflict.

In the October 2001 anthrax attacks, in which envelopes containing powdered anthrax spores were sent through the U.S. mail, 22 people became ill (half with inhalational anthrax and half with cutaneous anthrax) and 5 people died out of a U.S. population of 285 million.[45] By comparison, in the same month the CDC tallied 2790 deaths from pneumonia or influenza in 122 U.S. cities.[46]

Four anthrax-contaminated pieces of mail were found — letters to Senators Thomas Daschle of South Dakota and Patrick Leahy of Vermont, to NBC news anchor Tom Brokaw and to the *New York Post*. Other letters are believed to have contained or been cross-contaminated with anthrax spores but were not recovered. There was no use of multiple or contagious or antibiotic-resistant organisms, the features that figure in the most-feared scenarios.

At the time, of course, it was impossible to predict how widely the mail had been contaminated and how many anthrax cases would eventually emerge. In response to the handful of cases, health officials prescribed 60 days of antibiotic prophylaxis for about 10,000 people.[47] But prescriptions for ciprofloxacin and doxycycline rose by about 250,000 in October, reflecting far wider concern.[47a]

Essential mail delivery to Congress was suspended for 6 weeks, and the Hart Senate Office Building was evacuated. The Brentwood postal distribution center in Washington, D.C. remained closed for 2 years. In early 2004, the Hamilton Township (New Jersey) facility was still closed, and mail to Congress was still being irradiated, causing delays in delivery and some destruction of documents.[48]

Hundreds of millions of dollars were spent on responding to fearful individuals, testing white powders, examining mail, and testing and cleaning up postal facilities and other public and private buildings around the country. Cleanup of Capitol Hill cost the Environmental Protection Agency $27 million.[49] Shortly after the attacks, Congress appropriated $587 million to the U.S. Postal Service for protection of employees and screening and sanitizing of mail, as well as repair of facilities damaged on September 11.[50] The Postal Service planned to spend far more than that — a total of $1.366 billion by September 2005 — on emergency preparedness, almost all of it related to bioterrorism. That included $268.8 million to clean up and restore its Brentwood (Washington, D.C.) and Hamilton Township (New Jersey) distribution centers, as well as other facilities; $426.7 million for a biohazard detection system; $635.7 for ventilation and filtration upgrades; and $16 million for a mail irradiation facility for Washington, D.C.[51]

For the health system, a sampling of the response provides some sense of scale:

- Public health laboratories that are part of the CDC's Laboratory Response Network for Bioterrorism tested about 1 million environmental specimens and more than 125,000 clinical specimens.[52]
- The CDC's Emergency Operations Center responded to 11,063 bioterrorism-related telephone calls from October 8 to November 11, 2001. Of these, 882 calls were referred for follow-up investigation, including 226 that