AVOIDING THE PLAGUE: AN ASSESSMENT OF US PLANS AND FUNDING FOR COUNTERING BIOTERRORISM

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Center for Strategic and Budgetary Assessments

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Executive Summary

The terrorist attacks of September 11, 2001, sparked grave concern that the United States might be struck by terrorists armed with weapons of mass destruction (WMD). Typically, policymakers and analysts include nuclear, biological, chemical, and radiological weapons in this category. Of these WMD, biological agents may pose the greatest danger. Like nuclear weapons, biological weapons can, under the right circumstances, cause massive casualties. Compared to nuclear weapons, however, biological weapons may be substantially easier to acquire.

To be sure, the ease with which a terrorist group could acquire and effectively use biological weapons to inflict mass casualties has been overstated by some. Moreover, for practical reasons many terrorist groups (and perhaps most of the largest and most capable groups) may be disinclined to employ any weapon to cause mass casualties. Nevertheless, for planning purposes, it is prudent to assume that, in the foreseeable future, one or more terrorist groups will acquire the means to use biological weapons to cause mass casualties, and be inclined to launch such an attack.

Biological weapons consist of toxins, non-contagious and contagious bacteria and viruses, and, potentially, genetically-engineered "designer" agents. The most dangerous—though, in the near-term, probably least likely—biological weapon would be a contagious, highly virulent designer agent.

In order to combat the threat posed by bioterrorism, the United States is pursuing an approach consisting of the following three elements:

- Preventing terrorists from acquiring biological weapons or the means of effectively employing those weapons to cause mass casualties, through non-military means;

- Defending against a terrorist attack with biological weapons, once it has been launched, through the use of various measures capable of detecting, protecting against, and mitigating the effects of such an attack; and

- Attacking and destroying terrorists' biological warfare capabilities through preventive or retaliatory operations.

Altogether, federal spending directly related to preventing and defending against a possible attack with biological weapons currently (fiscal year 2007) amounts to about $8 billion a year. This represents an increase of some 330 percent in real (inflation-adjusted) terms from the level of funding provided for these programs and activities prior to the terrorist attacks of 9/11. Far more is spent annually acquiring and supporting the kinds of military capabilities that might be used to conduct an attack against a bioterrorist site. However, since almost all of these capabilities would also be used to carry out combat operations against the many other targets the US military might be required to strike, these costs cannot reasonably be attributed solely to combating bioterrorism.

Adopting a multifaceted approach to combating bioterrorism makes sense. However, current policies, programs and activities do not, in some cases, adequately address the challenge posed by bioterrorism, either as that threat exists today or as it is likely to develop in coming years. It should be possible to address some of these gaps and shortfalls by shifting resources both within and between different program areas. In part, this is because a significant amount of waste and inefficiency appears to have accompanied the rapid increases in biodefense funding that occurred in the immediate aftermath of 9/11. But substantially improving U.S. efforts to combat bioterrorism will also likely require some increase in the overall level of funding provided for these programs and activities.

Given existing data limitations, the level of secrecy that understandably surrounds some areas related to bioterrorism, and other factors, it is impossible to provide a precise estimate of how much additional funding would be needed to create a substantially more robust US capability to combat bioterrorism. However, evidence suggests that an additional $1–5 billion a year might usefully be allocated to this mission, primarily to expand the development of medical countermeasures, and broad-spectrum therapeutics in particular.

Although adequately addressing the threat posed by bioterrorism probably requires some increase in funding levels, simply providing additional money will not, by itself, ensure an effective defense. To at least as great an extent, successfully countering the threat posed by bioterrorism will depend on overcoming structural, organizational, and other largely non-budgetary challenges.

If the United States is to meet the bioterrorist challenge effectively in coming years, it will have to both better fund and organize the three elements that comprise its approach to combating this threat.

Prevention

The most effective way to combat bioterrorism is to prevent terrorists from ever acquiring a biological weapons capability in the first place. Non-military measures aimed at preventing the proliferation of biological agents and, particularly, the spread of such capabilities to terrorist groups include: security initiatives at US and foreign biological laboratories, arms control agreements and other cooperative international measures, and export controls. Altogether, 2007 federal funding for non-military preventive bioterrorism efforts totals some $146 million. This is only a tiny fraction of the amount of funding provided either for defensive bioterrorism programs and activities, or for capabilities related to attacking bioterrorist targets.

Perhaps more so than in any other area related to combating bioterrorism, even relatively modest increases in funding and programmatic changes related to preventive measures could yield significant dividends in terms of improving US security. The following changes are among the potentially most cost-effective:

- **Facilities and Personnel Security:** Overall, security at biological laboratories and other facilities ranges from excellent to appalling. Security in the United States could be improved by requiring all laboratories that handle highly virulent biological agents to meet the standards applied to Department of Defense facilities and, in the case of physical security, even higher standards—including the use of two-person, two-key locks to safeguard dangerous pathogens. The United States should also try to persuade other countries to adopt similar standards (perhaps as part of an international agreement), as well as

a code of ethics for biological technicians and scientists. The cost of these improvements and initiatives might be as little as several million dollars annually.

- **Biological Weapons Convention (BWC):** While it is unclear whether a BWC verification protocol can be negotiated that would be both acceptable to all parties and effective, an effort to reach such an agreement should be made. A protocol that allowed for access to existing or suspected facilities where biological weapons-related work might be conducted (including no-notice inspections) could go far toward improving biosecurity worldwide. Implementing such a protocol might cost the United States some $70 million a year.

- **Export Controls:** The cornerstone of international efforts to control biological agent-related exports is the Australia Group, an informal association that includes the United States and 38 other countries. To improve the effectiveness of this regime, this group's membership should be expanded to include most, or possibly all, of the members of the BWC, and especially China. Likewise, efforts should be made to transform the export controls and procedures agreed to as part of the Australia Group framework from advisory guidelines, to mandatory requirements. Strengthening these controls would require additional funding of perhaps a few million or, at most, tens of millions of dollars annually.

- **Threat Reduction:** The United States currently funds a number of programs aimed at preventing biological weapons proliferation. The largest and most long-standing such effort is focused on the former Soviet Union. In recent years, however, the United States has also begun to provide some support for similar programs in Libya and Iraq. Notwithstanding the existence of a variety of political, bureaucratic, and other obstacles, these efforts appear to represent prudent and cost-effective investments for the United States, and should be continued.

Defense

If efforts to prevent terrorist acquisition and employment of biological agents prove inadequate, it may be possible to limit (perhaps greatly) the number and severity of the casualties resulting from a biological weapons

attack through the use of a range of defensive countermeasures, including the development and stockpiling of effective vaccines and antidotes. Far more is spent on various programs and activities focused on these defensive tasks than is spent on preventive efforts. Altogether, 2007 federal funding for defensive bioterrorism efforts amounts to some $7.9 billion.

Defensive countermeasures can be divided into a half dozen different important missions and capabilities, some of which could benefit from programmatic changes and increases in funding. They include:

- **Isolation:** The ability to effectively isolate infected individuals is critical to preventing the spread of contagious biological agents. Hospitals should be required to add filters and/or air sterilization equipment to their air conditioning systems. An effort should also be made to design and build affordable portable blower units that could under-pressurize rooms and sterilize exhaust air, enabling more hospital rooms, and perhaps other spaces, to be used during a crisis to isolate contagious patients. Consideration should also be given to creating mobile isolation units.

- **Physical Protection:** If isolation fails, as it likely will in many cases, significant protection against aerosol transmission—the most common method of disseminating contagious biological agents—can be obtained at very low cost by the use of masks. To improve capabilities in this area, the government should encourage each family to purchase at least two masks for each person in the household, and the government should stockpile at least a comparable quantity. A realistic red-team exercise should be carried out to determine if the number of masks currently stockpiled and the existing distribution system are adequate. The cost of purchasing these additional masks would probably run between $100 million and $600 million, while such a red-team exercise would likely cost, at most, tens of millions of dollars.

- **Vaccines and Therapeutics:** Vaccines are drugs that give people immunity to a disease, while therapeutic drugs are designed to cure a disease. Both types of drugs represent critical components of any strategy to counter biological weapons. It is unclear whether current US efforts to develop and acquire vaccines and therapeutics are adequate. In particular, there is reason to believe that the United States may not be focusing sufficient energy or resources on developing broad-spectrum

therapeutics, which could provide varying levels of protection against a range of possible threat agents and might, in particular, prove to be the best defense against highly virulent designer agents. Although an expanded program to acquire broad-spectrum therapeutics is almost certainly merited, there is enormous uncertainty surrounding both how large such an effort should be (e.g., how many different therapeutics should be developed and how many treatment doses should be acquired) and how quickly this expanded effort can and should be implemented. Depending on answers to these questions, the level of funding required could range from as little as $1 billion to as much as $5 billion a year, or perhaps even more. The United States should quickly assemble a team of experts to help resolve—or, at least, bound—these programmatic uncertainties and provide guidance for this initiative. It is likely that some significant, and possibly dramatic, increases in funding will be required to implement this effort.

- **Facilitization:** Having adequate numbers of laboratories to research and develop various countermeasures to biological weapons is critical to the success of U.S. efforts to combat bioterrorism. Some expansion of U.S. laboratory capacity is clearly needed. Nevertheless, the currently planned massive expansion of U.S. laboratory capacity, triggered by the events of 9/11, may be excessive, wasteful and perhaps even dangerous. The National Academy of Sciences should be directed to promptly study, and report on, this question. It is possible that some of the funds allocated to expanding this capacity could be used more effectively to support other programs related to combating bioterrorism.

- **Detection and Characterization Systems:** The successful use of isolation, physical protection and medical countermeasures depends, in large part, on receiving timely warning. Thus, the acquisition of effective biodetectors is critical to the success of the overall US effort to combat bioterrorism. Unfortunately, it is unclear whether efforts to develop such capabilities are being adequately funded. Biodefense funding in both the Defense Advance Research Projects Agency (DARPA) and the Department of Homeland Security's (DHS) science and technology (S&T) program—which are responsible for most biodetector development—has declined over the past several years. Given the vital importance of these programs, these funding reductions should be re-evaluated.

Although additional funding should probably be provided to improve US defenses against a bioterrorist attack, success will also rest on a willingness to make structural and organizational changes. In particular, the US response to past disasters such as Hurricane Katrina, as well as simulated biological weapons attacks, argues for two such changes:

- **The US response must be federalized.** Successful, counterbioterrorism efforts will involve existing state, county, and local capabilities. However, authority for managing the response to a bioterrorist attack must reside, ultimately, with the federal government. Given the potential for mass casualties, multi-city (and state) attacks, and contagious pathogens that do not respect state boundaries, failing to give preeminent authority to federal officials could prove disastrous.

- **Senior officials must participate regularly in realistic bioterrorism exercises.** The only way to avoid, potentially disastrous, mistakes and confusion in the event of a bioterrorist attack is to require that high-level officials, including the president, participate regularly in realistic simulations of such an attack.

Attacking Bioterrorist Targets

The ability to conduct strikes aimed at destroying or disrupting bioterrorist capabilities is also an important element in the US approach to combat bioterrorism. Although the US military is highly capable in terms of its ability to precisely hit targets, its ability to effectively detect and identify targets is considerably less robust. These deficiencies are especially significant in the case of counterbioterrorism, since biological weapons facilities may be very small, and indistinguishable from other, benign facilities. In addition, such facilities may be relatively easily relocated. As a result, opportunities for the US military to attack bioterrorist sites and personnel may be both fleeting and rare.

Nevertheless, if the opportunity arises, strong consideration must be given to this option, even if—or perhaps especially if—the opportunity for a preventive strike materializes. Given the possibility that a bioterrorist attack against the United States could cause mass casualties, the United States certainly cannot foreswear this option.

In order to enhance its ability to target bioterrorist sites, the US military needs to improve its intelligence capabilities. Among other things, this probably means concentrating greater resources on human intelligence (HUMINT) or, perhaps more importantly, ensuring that existing HUMINT capabilities are adequately focused on the bioterrorist threat. In addition, the United States should develop an advanced-technology incendiary version of the Massive Ordnance Penetrator munition, to improve its ability to attack hardened underground biological weapons facilities.

Whatever the merits of the US invasion of Iraq in 2003, the action has left the United States in a far weaker position—in terms of generating international support for a future preventive strike against suspected bioterrorist sites—than it was in immediately after the attacks of 9/11. However, the BWC, which precludes the acquisition or use of biological weapons by the 171 signatories of the treaty, may strengthen the US case, in the court of world opinion, for conducting a preventive strike.

As noted above, the forces and weapon systems that would be used to attack bioterrorist sites—including bombers and other combat aircraft, special operations forces (SOF), reconnaissance aircraft and other support capabilities—could also be used to carry out combat operations against many other targets the US military might be required to engage (e.g., conventional ground, air or naval forces, or other kinds of WMD targets, such as nuclear weapons-related facilities). Thus, the cost of supporting these capabilities—which amounts to tens of billions of dollars annually—cannot reasonably be attributed solely to the mission of combating bioterrorism.

Strengthening US efforts to combat bioterrorism

In the past century, the technology of armed conflict was dominated by a sequence of transformational weapons beginning with machine guns and ending with nuclear explosives and precision-guided conventional weapons—all designed primarily to destroy enemy forces or war-supporting industries. Biological weapons are not well suited to those purposes. They are too slow to act and too difficult to control, and they do not damage equipment or facilities.

But for 21st century terrorists who want to target civilian populations, biological agents are in some ways ideal. While not as destructive as superpower arsenals consisting of thousands of thermonuclear weapons, a highly lethal biological agent would be easier for a terrorist group to acquire and might be capable of causing far more casualties than a low-yield nuclear fission weapon—the kind of nuclear weapon terrorist groups are most likely to acquire for the foreseeable future. Moreover, an attack with a highly lethal biological agent would likely cause many times more casualties than an attack conducted with chemical or radiological weapons.

The bad news is that, given the highly lethal nature of some biological agents, the spread of biotechnology and related industries and expertise, and the interest of some terrorist groups in causing mass casualties, there is little prospect that the United States will be able shield its population entirely from bioterrorist attacks. The good news is that a robustly funded and effectively organized effort to combat bioterrorism—through preventive and defensive measures, and occasional attacks on bioterrorist targets—could go far toward limiting the severity of the bioterrorist threat. Enacting the funding increases and other changes outlined in this report would be an important first step on the road toward achieving this more effective—albeit necessarily imperfect—capability.

Chapter 1:
Overview of Bioterrorism Threat

In many respects, biological weapons pose the greatest potential terrorist threat to the United States. Like nuclear weapons—and unlike chemical and radiological weapons, which are also often referred to as "weapons of mass destruction," or WMD—biological weapons can, under the right circumstances, cause mass casualties.[1] Compared to nuclear weapons, biological weapons are substantially easier to acquire.

The ease with which a terrorist group could acquire and effectively use biological weapons to inflict mass casualties has been overstated by some. Nevertheless, the threat of biological weapons being used by terrorist groups against targets in the United States should be one of great concern for policymakers.[2]

Biological weapons can usefully be divided into four different categories:

- **Toxins** are poisonous chemicals made by living organisms, but are not alive themselves. Although toxins can be highly lethal, they are unlikely to make effective weapons of mass destruction because they

[1] This chapter draws heavily from Steven M. Kosiak, Homeland Security, Terrorism and Weapons of Mass Destruction: A Diagnostic Assessment (Washington, DC: CSBA, March 2004), pp. 43–66.

[2] This paper focuses on the threat biological weapons pose to humans. It does not discuss the potential for terrorists to target crops and livestock. "Agro-terrorism" could have a significant impact on the US economy. Britain's experience with the mad cow and foot-and-mouth diseases suggests that, if effectively executed, terrorists could cause over tens of billions of dollars in damage through such an attack. "Dissecting the Challenge of Mad Cow and Foot-in-Mouth Disease," *Agricultural Outlook* (August 2001), p. 4.

generally must be injected or ingested in order to be effective. As a result, their use seems confined to individual assassinations.[3]

- **Non-contagious biological agents,** unlike toxins, are living organisms. The best known such agent is the anthrax bacterium. These agents are much more dangerous than toxins because they reproduce inside the human body and can generally enter the body by being inhaled through the mouth or nose. However, these biological agents typically cannot be spread directly from one person to another.

- **Contagious biological agents,** as the name suggests, are living organisms like smallpox or influenza viruses that can be transmitted from one person to another. In this case, the organism reproduces itself in the infected person and that person becomes a carrier capable of infecting others. This makes these agents potentially far more lethal than non-contagious agents such as anthrax.

- **Genetically-engineered "Designer" agents** are artificially modified organisms. They could be either non-contagious or contagious. Such weapons represent potentially the most lethal kind of biological agents. Smallpox, for example, is a highly contagious disease for which there is no cure. But there is an effective vaccine. It would be much more difficult to develop, in a timely way, medical countermeasures against threats about which we know nothing until they are employed.

Lethality

Biological weapons are potentially extraordinarily lethal, primarily because of their ability to reproduce themselves in large numbers. That said, several important caveats are important to keep in mind. First, there is a substantial, indeed generally dramatic, difference between the *theoretical* lethality of various biological agents and the levels of lethality likely to be achieved in practice. Second, while there is widespread agreement that biological weapons can be extremely deadly, the number of casualties caused by their use can vary greatly, depending on a wide variety of factors, such as the weather and effectiveness of the delivery method.

[3] The most notable such use of a toxin was in 1978, when a Bulgarian dissident living in London was jabbed in the leg by an umbrella weapon that injected ricin (a castor bean derivative), causing death several days later.

Third, although all agree that biological weapons can be extremely lethal, there is nevertheless considerable disagreement and uncertainty over the precise number of casualties likely to result from their use, even holding environmental and other factors constant.

In theory, the potential lethality of some biological weapons is truly staggering. For example, one gram (a single paper clip weighs about half a gram) of the bacterial agent anthrax, theoretically, could kill 100,000 or more people.[4] In practice, far larger quantities of biological agents would be needed to inflict mass casualties—although estimates of just how much biological agent would be required vary widely. By one estimate, 50 kilograms of anthrax released over an urban area would be expected to kill some 100,000 people.[5] By comparison, in a 1993 report, the Office of Technology Assessment (OTA) estimated that 100 kilograms of anthrax released over Washington, DC, might kill anywhere from 130,000 to 3 million people.[6] Other US government reports have indicated that it could take over 2,000 kilograms of aerosolized anthrax to produce the large casualty figures projected in the OTA study.[7]

Contagious biological agents could prove far more lethal. As discussed in more detail later in this chapter, a single infected individual could spark an epidemic or pandemic that could in a matter of weeks, potentially lead to millions or even tens of millions of casualties—though, as in the case of any biological weapons attack, the lethality of such an attack would depend critically on the specific virus used. Natural pandemics of the past provide a chilling indication of how devastating a terrorist attack with a contagious biological agent could be. The Spanish influenza, for example, that swept across the United States during 1918–1919 killed some 675,000 people, and left another 20–40 million dead around the world.[8]

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4 Richard Danzig, Catastrophic Bioterrorism: What Is To Be Done? (Washington, DC: Center for Technology and National Security Policy, National Defense University, August 2003). Other estimates place the number of theoretically possible lethal doses contained in a single gram of anthrax at as many as 10 million. Office of Technology Assessment (OTA), Technologies Underlying Weapons of Mass Destruction (Washington, DC: US Government Printing Office, 1993), p. 78.

5 Anthony H. Cordesman, Terrorism, Asymmetric Warfare, and Weapons of Mass Destruction: Defending the US Homeland (Westport, CN: Praeger, 2002), p. 152.

6 OTA, Proliferation of Weapons of Mass Destruction: Assessing the Risks (Washington, DC: US Government Printing Office, August 1993), p. 54.

7 Cordesman, p. 153.

8 Molly Billings, "The Influenza Pandemic of 1918," Stanford University, http://www.stanford.edu/group/virus/uda/

Estimates of the lethality of particular biological agents tend to vary widely. There are several reasons for this phenomenon. Because there has (fortunately) been little or no actual experience with most of these biological agents beyond laboratory testing against animals, scientific opinion differs concerning the amount of various agents required to infect and kill human targets. For example, estimates of what constitutes a lethal dose of anthrax for a human range from 2,500 to 55,500 spores.[9] The lack of real world experience and limitations inherent in testing have similarly led to substantial uncertainty concerning how much of a particular agent would have to be disseminated to effectively cover a given area, how the release of an agent would be affected by different environmental forces, such as wind and rain, or features of urban terrain, and a wide range of other factors that could affect the performance and effectiveness of the agent.

In addition, even assuming that highly accurate models for predicting the lethality and behavior of biological weapons were available, estimates could still vary dramatically, depending on the particular assumptions made about the efficiency of weapons delivery and environmental conditions. The potential impact of varying these assumptions can be seen in OTA's estimates of the casualties likely to result from an anthrax attack on Washington, DC. To derive its range of estimates, OTA developed three slightly different scenarios. In each scenario, OTA assumed that 100 kilograms of anthrax spores would be delivered from an airplane flying a "highly efficient" flight pattern. But in one scenario the attack was assumed to occur on a clear, sunny day, with a light breeze—the worst kind of weather for this type of attack. Another scenario assumed the attack would occur on an overcast day or night, with moderate wind—better, but still less than ideal weather for such an attack. And the last scenario assumed that the attack would be made on a clear, calm night—the ideal weather for a biological weapons attack. OTA estimated that these three scenarios would result in, respectively, 130,000–460,000, 420,000–1.4 million, and 1–3 million deaths.[10]

Another important caveat about the wide range of casualty estimates noted above is that in many cases the estimates appear to assume that the biological weapon is a highly virulent strain of the agent, that it has not lost any of its potency during storage or during transport, and that it would be effectively and efficiently disseminated. These may be appropriate assumptions to make if the potential attacker is a country

9 Ibid., p. 154.

10 Proliferation of Weapons of Mass Destruction, p. 54.

with a highly developed biological weapons capability, but they may not be appropriate in the case of terrorist groups or other non-state actors. As will be discussed later in this chapter, acquiring and effectively employing biological weapons to produce mass casualties requires accomplishing a series of steps of varying levels of difficulty. If success is not achieved at any one of the points along this path, the resulting casualties are likely to be a small fraction of what they would otherwise be. Indeed, if failure occurs anywhere along the line, such an attack could result in relatively few, or even zero, fatalities.

On the other hand, casualties could be even greater than those cited above for an anthrax attack if multiple sites were attacked or, perhaps in the worst case, a contagious designer agent was instead used. According one observer, "Making a gram of readily aerosolized anthrax spores…is a technical challenge, but, once production is accomplished, it is a much lesser challenge to make 1 kilogram. And it is not a significant challenge for a terrorist organization that can make a kilogram to make 10 or 100 kilograms."[11] Combined with the ability to conduct biological weapons attacks covertly, this may create a substantial "reload" capacity for a terrorist group that can successfully acquire such weapons,[12] allowing the group to strike again after some days or weeks. Rather than simple reload, an even more severe threat would be a salvo, striking multiple targets at the same time. And of course salvos, like single shots, can be reloaded.

As lethal as the Spanish influenza pandemic of 1918–19 was, it paled in comparison to, for example, the hemorrhagic plague that repeatedly swept across Europe in the Middle Ages. When that plague struck Europe in 1347, it is estimated that half of the continent's population was killed.[13] It is possible that a contagious designer agent could have a similar or even more devastating effect today.

Nor do studies of the effects of hemorrhagic plague and other past pandemics, or simulations of a modern bio-attack on a small number

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11 Ibid., p. 1.

12 Ibid.

13 Christopher Duncan and Susan Scott, *"Return of the Black Death: The World's Greatest Serial Killer*," (John Wiley and Sons, 2005). Duncan and Scott, a zoologist-demographer team, make a persuasive case that this most devastating plague was hemorrhagic, which is viral and spread from person to person, rather than bubonic which is bacterial and spread by fleas and rats. Among other evidence, they find that cutting off human traffic in/out of a village effectively prevented the invasion/exportation of the disease, and such isolation would have been ineffective against rats. Additionally, the reported symptoms (red spots rather than swollen black lymph nodes) were consistent with hemorrhagic rather than bubonic plague.

of American cities, accurately reflect the synergistic effects of a major bio-attack in the 21st century. Unlike European society seven hundred years in the past, a modern industrial society is highly organized and interdependent over large geographical areas.

The Oklahoma City bombing and the attacks of 9/11 were directed at, respectively, only one and two targets. The resources of the entire nation were available to remediate the attack and support the victims. Although Hurricane Katrina was a single-area disaster that strained the nation's resources, nevertheless the rest of the nation was undamaged and able to function normally.

What is frequently overlooked in WMD attack studies is the compounding effect of salvo synergism. The probable damage from simultaneous WMD attacks on, say, Chicago and Seattle might be approximately equal to the sum of separate attacks on those two points. But the probable damage from a simultaneous attack on tens of high-value targets would be far greater than the sum of its parts.

For example, a disabling attack that infected a significant proportion of oil refinery workers nationwide would deny farmers the fuel to operate their farms, and truckers their ability to transport goods. As a result, serious food shortages could develop. In turn, disabling attacks on pharmaceutical plant workers, electrical plant operators, and similar critical personnel would exponentially compound the crippling effect of oil refinery shutdown. Modern industrial plants, relying on highly efficient just-in-time delivery of components and supplies, are particularly vulnerable to disruptions anywhere in the chain. And for the twenty-first century terrorist, biological weapons may be the most profitable route to creating such a dangerous attack synergism.

Medical Treatment and Other Countermeasures

Biological weapons, if properly produced, stored and delivered, can cause casualties comparable to—or even perhaps in excess of—the levels achievable with terrorist nuclear weapons. But the lethality of biological weapons can in many cases be greatly reduced if warning or sensor systems enable appropriate steps to be taken prior to, during or soon

after an attack. Since biological agents must generally be inhaled to cause infection, protective masks can frequently provide an effective defense. Populations can also be vaccinated against some biological threats. In other cases, taking therapeutics within a few hours or days of exposure can greatly reduce the incidence of infection. In the event of outdoor dispersal of biological agents, simply staying indoors can dramatically reduce the risk of infection.

Untreated, the mortality rate for individuals effectively exposed to airborne anthrax is on the order of 90 percent.[14] However, if medical treatment could be provided to victims of an anthrax attack within 24–48 hours of exposure, the mortality rate would decline dramatically—perhaps to as little as 10 percent, assuming immediate administration of antibiotics.[15] Similarly, untreated smallpox has an overall mortality rate of 30 percent, and leaves another 60–80 percent of those exposed permanently disfigured.[16] By contrast, a smallpox vaccination administered in advance or within 96 hours after an attack is likely to protect almost all exposed persons.[17]

Unfortunately, while effective medical treatment is, theoretically, available to counter many types of biological weapons, in practice, effectively administering such treatments may be difficult. One problem is that stockpiles of many vaccines are inadequate. Another problem is that some vaccines may pose a risk to certain segments of the population. For example, because of the risk of complications or possibly even death, some 20–60 million Americans (e.g., individuals with immune deficiencies, pregnant woman and small children) might not be appropriate candidates for receiving a smallpox vaccination in peacetime.[18] (Once a smallpox epidemic is rampant, concerns about adverse reaction to vaccination will be less salient.) Among the greatest problems associated with the use of protective masks and providing effective medical treatment in the event of a biological weapons attack is the likely lack of warning we face today. It may prove impossible to accurately identify the agent used, or even that an attack took place, until it is too late to prevent mass casualties.

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14 Danzig, p. 7.

15 Richard A. Falkenrath, Robert D. Newman, and Bradley A. Thayer, America's Achilles' Heel: Nuclear, Biological, and Chemical Terrorism and Covert Attack (Cambridge, MA: MIT Press, 1998), p. 155.

16 William J. Bicknell, M.D., and Kenneth D. Bloem, "Smallpox and Bioterrorism: Why the Plan to Protect the Nation is Stalled and What to Do," *CATO Institute Briefing Papers*, September 5, 2003, p. 3.

17 Danzig, p. 15.

18 Ibid.

Accurately and rapidly identifying and characterizing a biological weapons attack is made difficult by the fact that individuals exposed to the agent may not develop symptoms for several days or even a week or more. On average, for example, persons exposed to smallpox will not manifest symptoms until 12 days after initial exposure, by which time it is too late for vaccination.[19] Moreover, once symptoms appear, they may at first be difficult to distinguish from symptoms related to various naturally occurring and less consequential diseases. For instance, persons infected by aerosol anthrax initially present flu-like symptoms. Improving capabilities to rapidly identify and characterize a biological weapons attack are among the most pressing requirements for effectively addressing the threat posed by such weapons. Effectively responding to a biological attack would be made especially difficult if a terrorist group were to release biological agents simultaneously and/or in rapid succession in a number of different locations around the country (the salvo and reload problems mentioned earlier), or if a new, genetically-engineered designer agent—which the medical and scientific communities would not previously have had the opportunity to study and evaluate—were used.

Acquisition and Employment

There is considerable disagreement and uncertainty among specialists concerning the relative ease (or difficulty) of acquiring and effectively employing biological weapons with presently available technology. There is general agreement that most states, including many developing nations, could produce and effectively use biological weapons to cause mass casualties. In a 1993 report, for example, OTA concluded that biological weapons:

> would be relatively easy and inexpensive to produce for any nation that has a modestly sophisticated pharmaceutical or fermentation industry. Indeed, mass-production methods for growing pure cultures are widely used in the commercial production of yogurt, beer, antibiotics, and vaccines. Nearly all the equipment needed for the production of pathogens and toxins is dual-use and widely available on the international market, increasing the potential for concealing illicit activities under the cover of legitimate production.[20]

[19] Ibid.

[20] *Technologies Underlying Weapons of Mass Destruction*, p. 8.

The OTA report further noted that "a supply of standard BTW [biological and toxin warfare] agents for strategic attacks against wide-area civilian targets (e.g., cities) would be relatively easy to disseminate using crude delivery systems such as an agricultural sprayer"[21] and that such an attack could cause "large casualties over a wide area."[22]

There is, however, substantial disagreement concerning the ease with which non-state actors, such as terrorist groups, could produce and effectively employ biological weapons—especially biological weapons capable of causing mass casualties. Some have argued that the task would be relatively simple:

> Only modest microbiologic skills are needed to produce and effectively use biologic weapons....Production costs are low, and aerosol dispersal equipment from commercial sources can be adapted for biologic dissemination. Bioterrorists operating in a civilian environment have relative freedom of movement, which would allow them to use freshly grown microbial suspensions (storage reduces viability and virulence). Moreover, bioterrorists would not be constrained by the need for precise targeting or predictable results.[23]

As in the case of other forms of WMD, the ability of terrorists to acquire biological weapons may also be enhanced by the growing number of scientists and technicians trained in related fields, the spread of computers and other analytical tools, and the availability of technical experts left unemployed or underemployed after the collapse of the Soviet Union.

Nevertheless, other observers have argued that it would be very difficult for a terrorist group operating without the support of a state sponsor to manufacture highly lethal biological weapons and effectively employ them to cause mass casualties. In a 1999 report, the General Accounting Office concluded that:

> ... terrorists working outside a state-run laboratory infrastructure would have to overcome extraordinary

[21] Ibid., p. 73.
[22] Ibid., p. 94.
[23] Arnold F. Kaufmann, Martin I. Meltzer, and George P. Schmid, "The Economic Impact of a Bioterrorist Attack: Are Prevention and Postattack Intervention Programs Justifiable?," Emerging Infectious Diseases, Vol. 3, No. 2, April–June 1997, p. 1, www.cdc.gov/ncidod/eid/vol3no2/kaufman.htm.

> technical and operational challenges to effectively and successfully weaponize and deliver a biological agent to cause mass casualties. Terrorists would require specialized knowledge from a wide variety of scientific disciplines to successfully conduct biological terrorism and cause mass casualties.[24]

Most difficult of all would probably be the acquisition of highly lethal genetically-engineered designer agents—which would require a significantly greater level of technical expertise.

Producing and effectively employing a biological agent involves a number of steps of varying levels of difficulty. First, a virulent strain of some biological agent must be obtained. Second, a quantity of the agent must be produced from this seed stock. Third, the agent must be "stabilized." That is, the agent must be processed into a form that will allow it to survive storage, transportation and dissemination. Fourth, it must be integrated with a delivery system capable of effectively disseminating the biological agent. The paragraphs below provide a brief description of these four steps, and focus especially on some of the obstacles a terrorist group would have to overcome to successfully acquire and employ a biological weapon capable of producing mass casualties. As discussed toward the end of this section, in the case of contagious diseases, such as smallpox, it may be possible to circumvent—at least to a limited extent—some of these steps.

Acquiring the Biological Agent

Some biological agents are relatively easy to obtain. Pathogenic organisms, for example, can be cultured from infected wild animals (e.g., plague in rodents), living domestic animals or their remains (e.g., Q fever in sheep and anthrax in cattle), and spoiled food.[25] Stocks of many microbiological pathogens can also be purchased from various supply houses by scientists around the world. Legislation enacted since 1996, and especially after

[24] General Accounting Office (GAO), "Combating Terrorism: Need for Comprehensive Threat and Risk Assessments of Chemical and Biological Attacks," September 1999, p. 162.

[25] *Technologies Underlying Weapons of Mass Destruction*, p. 84.

9/11, has significantly reduced the ease with which dangerous pathogens can be purchased from culture collections in the United States. However, it appears that access remains relatively open in many other countries.[26]

Still, some biological agents (particularly smallpox, which is overtly stored in only two heavily protected locations) are difficult to obtain.[27] Moreover, while obtaining generic seed stocks of certain biological agents may be relatively easy, obtaining or creating a virulent strain of the agent (capable of causing disease and injury to humans, especially on a mass scale) can be much more difficult. Many experts believe that obtaining or (in the case of a designer agent) creating an infectious and virulent culture for the seed stock is the greatest hurdle that would be faced by terrorists attempting to acquire a mass-casualty producing biological weapons capability.[28]

Manufacturing the Agent

Assuming a sufficiently virulent biological agent can be acquired, the next step for a terrorist group would be to produce a quantity of the agent sufficient to cause mass casualties. Acquiring the growth media and equipment needed for the production of the biological agent would be relatively easy. Nearly all the equipment is dual-use and widely available. According to OTA, an "industrial fermentation plant suitable for conversion to BTW agent production could be built for about $10 million. In such a 'no-frills' facility, bacteria could be grown in standard dairy tanks, brewery fermenters, or even in the fiberglass tanks used by gas stations."[29] Others have estimated that the costs of equipping a facility for the production of biological agents in quantities sufficient to inflict mass casualties would be

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[26] Raymond A. Zilinskas, "Biological Attacks: Lessons of September and October 2001," Chemical and Biological Weapons Nonproliferation Program, Center for Nonproliferation Studies, Monterey Institute of International Studies, September 12, 2002, pp. 2–3.

[27] General Accounting Office (GAO), "Combating Terrorism: Need for Comprehensive Threat and Risk Assessments of Chemical and Biological Attacks," September 1999, p. 13.

[28] Cordesman, p. 164.

[29] *Technologies Underlying Weapons of Mass Destruction*, p. 86.

substantially less, amounting to anywhere from $200,000 to $2 million.[30] While not trivial, such sums would clearly be within the means of some terrorist groups.

Although the equipment required is relatively simple and widely available, the process of manufacturing biological agents involves some technical hurdles. These hurdles include, for example, the danger of infecting production workers, creating genetic mutations that may lead to the loss of potency, and contaminating the agent with other microbes that may reduce its potency or even kill the agent.[31] Slight mistakes in the growth media, temperature or other aspects of production can cause failure.

Stabilization of the Agent

Most biological agents and toxins tend to break down and become ineffective relatively rapidly if they are not kept in a protected environment (anthrax is a notable exception). Thus, unless they are to be used within a few days of production, they must be converted into a more stable and survivable form. There are three basic approaches to stabilizing biological agents and toxins: freeze-drying, using chemical additives, and microencapsulation (coating particles of the agents with a thin coat of protective material).[32] Processing the agent into a mud-like "slurry" is relatively simple. But this slurry must be continuously refrigerated until it is used,[33] and can be inconvenient and dangerous to store and transport.[34] Freeze-drying the agent has at least two important advantages. First, the agent is converted to a small cake of dried material that can be easily stored and transported. Second, dry biological agents can be milled into very fine particles, significantly increasing the potential potency of the agent and the ease with which it can be delivered. However, freeze-drying and milling the agent are technically very challenging and dangerous tasks. As a result, some experts doubt that a non-state actor, such as a terrorist group, would be capable of producing biological agents in dry form. On

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[30] Assessing the Threat, p. 23. In an experiment code-named Project Baccus, scientists working for the US Department of Defense were reportedly able to establish a facility capable of producing biological weapons, using off-the-shelf commercial equipment, at a cost of about $1 million. NovaOnline, NOVA #2815, at www.pbs.org/wgbh/nova/transcript/281bioterror.html.

[31] *Technologies Underlying Weapons of Mass Destruction*, p. 88.

[32] Ibid., pp. 93–94.

[33] *Assessing the Threat*, p. 24.

[34] *Technologies Underlying Weapons of Mass Destruction,* p. 93.

the other hand, the idea that only a state weapons program could produce such sophisticated and potent biological agents has been seriously called into question by the anthrax attacks of 2001. At least some experts believe that the anthrax powder used in those attacks (and delivered through the mail) was made by an individual or group using relatively simple methods, inexpensive equipment and limited expertise.[35]

Dispersing the Agent

The most effective way to disseminate non-contagious biological agents is to create an aerosol cloud consisting of suspended microscopic particles of the agent, which will be easily inhaled. Respiratory infection is by far the most deadly means by which a biological agent can infect an individual. For example, untreated inhalation anthrax is fatal in about 90 percent of cases, compared to 5 percent of skin anthrax cases.[36] To be effective, the particles must be between 1 and 5 microns in diameter. Larger particles (which can be caused by electrostatic "clumping" of smaller particles) tend to be trapped in the phlegm and passages of the respiratory tract, while smaller particles are exhaled, rather than retained in the deep lung tissue.[37] The failure to create particles of the right size can dramatically reduce the lethality of a biological agent. In one experiment it was found that the number of bacterial cells needed to kill half of the guinea pigs exposed to the agent increased from 3 cells per animal for particles of 1 micron, to 6,500 cells for particles of 7 microns.[38]

The most efficient way to create a biological aerosol cloud is through the use of a sprayer or other aerosol-generating device. Though easier to produce, biological agents in liquid slurry form are more difficult to aerosolize effectively than agents in dry form. Unless the slurry is extremely pure, material is likely to settle at the bottom of containers and cause the sprayer or other aerosol dissemination device to clog.[39] It is also more difficult to generate particles of the right size with a liquid slurry than with a dry agent. In addition, the process of aerosolization (e.g., being forced

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35 "Probe: Anthrax Likely Made Simply, Cheaply in US," *Newsday*, April 12, 2003, p. A21.

36 *Technologies Underlying Weapons of Mass Destruction*, p. 95.

37 Ibid.

38 Ibid., p. 96.

39 First Annual Report to the President and Congress of the Advisory Panel to Assess Domestic Response Capabilities for Terrorism Involving Weapons of Mass Destruction, *Assessing the Threat*, December 15, 1999, p. 25

through the nozzle of a sprayer) places a variety of mechanical stresses on the agent. According to one estimate, the process of aerosolization is likely to kill 90 percent of the microorganisms present in a slurry.[40] Moreover, once airborne, biological agents decay as a result of exposure to sunlight, oxygen, pollutants, turbulence, and other environmental factors. Rates of decay, once airborne, range from about 10–30 percent per minute for some agents to 2 percent per minute for others.[41] Dry disseminated aerosols are more resistant to these stresses than wet aerosols.[42] But, as noted earlier, some experts believe that producing biological agents in dry form is beyond the capability of most terrorist groups. Furthermore, building a device capable of effectively disseminating dry particles in the 1- to 5-micron range would, in itself, represent a significant technical challenge for a terrorist group.[43] In sum, as one observer put it, "Aerosol dissemination of biological agents requires exquisite skill, because of the numerous factors, many of them poorly understood, that can affect delivery of the agent."[44]

As in many other areas related to the possible acquisition and use of biological weapons by terrorists, expert opinion appears to be divided on the question of how difficult it would be for a terrorist group to disseminate a biological agent effectively. As noted earlier, in its 1993 study, OTA concluded that "a supply of standard BW agents for strategic attacks against wide-area civilian targets (e.g., cities) would be relatively easy to disseminate using crude delivery systems such as an agricultural sprayer"[45] and that such an attack could cause "large casualties over a wide area."[46] But others have noted that most off-the-shelf sprayers are not designed to generate sufficiently small particles or have low throughput rates, and that modifying these devices would be a difficult and delicate task.[47] For this and the other reasons cited above, many observers argue that acquiring the means, knowledge and skills needed to disseminate non-contagious biological agents effectively in a way that would cause mass casualties would be extremely difficult for most terrorist groups and other non-state actors.

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40 Ibid., p. 25.

41 Amy E. Smithson and Leslie-Anne Levy, *Ataxia: The Chemical and Biological Terrorism Threat and the US Response* (Washington, DC: The Henry L. Stimson Center, 1999), p. 55.

42 *Technologies Underlying Weapons of Mass Destruction*, p. 97.

43 Smithson and Levy, p. 25

44 W. Seth Carus, "Biological Warfare Threats in Perspective," *Critical Reviews in Microbiology*, 24(3), 1998, pp. 149–55.

45 *Technologies Underlying Weapons of Mass Destruction*, p. 73.

46 Ibid., p. 94.

47 *Technologies Underlying Weapons of Mass Destruction*, p. 54.

One way to minimize some of the problems associated with disseminating biological agents would be to use them in a contained area. One option would be to disseminate a biological agent through a heating and air-conditioning ventilation system. In this case, for example, the agent would not be exposed to sunlight, thereby reducing its rate of decay. However, other environmental forces (e.g., heat and humidity) and mechanical stresses (e.g., the pressure of air being forced through the ventilation system) would be present and would cause similar decay.[48] According to some experts, because of these and other difficulties, a terrorist group would need to have substantial technical information about the targeted building and knowledge of aerodynamics for such an attack to succeed.[49] Alternatively, an improvised aerosol generator might be used to disseminate a biological agent in a theater or other enclosed space.

Contagious Diseases

Another way to avoid the difficulties associated with aerosol dissemination of biological agents would be for a terrorist group to employ a contagious agent and rely on simple human-to-human contact to spread the disease. According to one expert:

> Initiating an epidemic within the target population with a contagious virus would not be difficult. The easiest method probably is for the attacker to use the biological equivalent of a suicide bomber; i.e., a person who has been deliberately infected with a contagious agent and dispatched to the target population before disease symptoms appear.[50]

Moreover, in the case of a contagious agent there would be little or no need to produce large quantities of the agent, or to stabilize the agent to survive storage and transportation—since a single infected individual, or a handful of infected individuals, might prove sufficient to spread the

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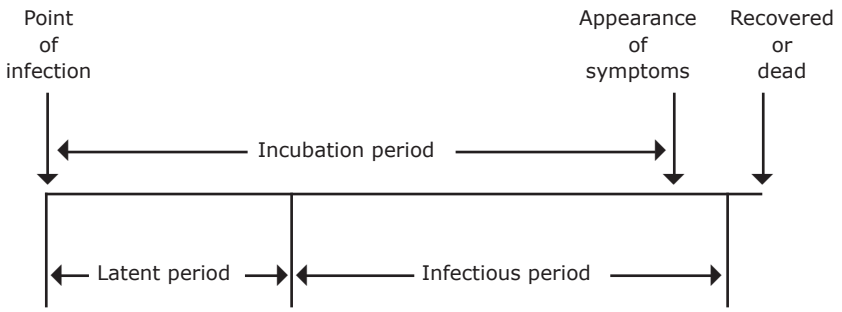
48 Smithson and Levy, p. 56.

49 Ibid.

50 Raymond A. Zilinaks, "Biological Attacks: Lessons of September and October 2001," Chemical and Biological Weapons Nonproliferation Program, Center for Nonproliferation Studies, Monterey Institute of International Studies, December 12, 2002, p. 5.

disease, and they could be infected within a few hours of manufacturing the agent. Consider the generic timeline shown in Figure 1.[51]

Figure 1: Timeline for Contagious Disease



The length of each segment varies widely from disease to disease. One critical factor is how long the carrier is infectious but non-symptomatic. This is the period in which the carrier is himself a stealthy biological weapon. But equally important is the rate of transmission. HIV, for example, has a very long "bioweapon" period, lasting many years. But it would not be an effective bioweapon because of its slow[52] rate of transmission.

Among known or partially-known agents, 1918 pandemic influenza, or a modification thereof, is probably the best suited to a suicidal carrier. Such a carrier would have an assured weapon period of one or two days, with a high transmission rate. How many people he or she could infect, or cause to be infected, would depend upon the tactics used, but it is reasonable to assume it could be a very high number.

For biodefense purposes, prudent planning should presume that such an optimized designer agent might be in the hands of a terrorist group within a decade or several decades, and that it might be used.

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[51] From Christopher Duncan and Susan Scott, *Return of the Black Death* (John Wiley and Sons), p. 141–142.

[52] By peacetime standards, of course HIV has an alarmingly rapid rate of transmission. But for purposes of a bioterrorist whose gratification probably requires visible result of his attack within days or weeks, the years-long incubation period of HIV presumably renders it unattractive as a weapon.

While contagious biological agents may hold the greatest potential for causing mass casualties, the use of such an agent would also pose several challenges for a terrorist group.

First, if only one or a small number of infected individuals were used to spread the agent initially, the disease would spread much more slowly than it might if aerosol dissemination were effectively used. For example, while relying on a traveling infectious individual coughing in the faces of persons with whom she or he had extended contact might result in the infection of hundreds of other individuals within a relatively short time,[53] an efficient aerosol dissemination of the smallpox virus could plausibly lead to the immediate infection of perhaps hundreds of thousands of individuals.[54] The bioterrorist would thus have a choice: He could use an aerosol attack to rapidly infect large numbers of victims in a limited area, but risk that the infection would be contained by ring vaccination. Or he could use infected individuals in multiple airports to create an outbreak that would start more slowly but be far more difficult to contain.

Second, contagious agents are far more dangerous to work with in the laboratory than other biological agents—putting the terrorists themselves at risk. Third, and perhaps most importantly, once a contagious agent is released its spread cannot be controlled. It could relatively quickly spread to neutral or friendly populations, or even the attackers themselves. And the fact that the outbreak might spread across borders could greatly increase the possibility that use of the biological agent would trigger broad international condemnation, and support for strong retaliatory measures.

Other means of disseminating biological agents, such as through food or water, are unlikely to prove effective for mass casualty attacks. These approaches are problematic for a number of reasons. Among other things, they would generally require large quantities of an agent to offset dilution effects and are often vulnerable to normal hygienic measures. For example, it would be very difficult to use a city's water system to effectively deliver a biological agent because the agent would be greatly diluted (unless massive quantities of it were used), naturally broken down when exposed to the water, and further damaged by the effects of chlorination.[55]

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53 Danzig, p. 6.
54 Ibid., p. 14.
55 Falkenrath, p. 120.

Comparison with Other WMD

Biological weapons and the dangers associated with bioterrorism are often discussed in the context of the threat posed by WMD more broadly. Typically, four types of weapons are classified as WMD. These consist of nuclear, biological, chemical and radiological weapons. Although, from the terrorists' perspective, each of these weapons may possess some advantages and disadvantages, for a variety of reasons, biological terrorism may constitute the weapon of choice. This is because biological weapons, unlike chemical and radiological weapons, are capable of reproducing and causing truly mass casualties, and because acquiring a highly lethal biological weapons capability it likely to be substantially easier for a terrorist group than acquiring a similarly lethal nuclear weapons capability.

In terms of the ability to inflict mass casualties, biological weapons represent a far more dangerous threat than do chemical weapons. Pound for pound in stockpile, biological weapons can be hundreds to thousands of times more lethal than the most deadly chemical agents. In theory, for example, a dose of 0.001 micrograms (one millionth of a gram) of botulinum toxin per kilogram of body weight is sufficient to kill a person. By comparison, the lethal dose for VX, the most deadly form of nerve gas, is about 15 micrograms per kilogram of body weight.[56] In the same study in which OTA estimated that an attack against Washington, DC, using 100 kilograms of anthrax could cause 130,000 to 3 million deaths, OTA estimated that an air-delivered attack with 1,000 kilograms of nerve gas (sarin, which is notably less lethal per unit weight than VX), could cause 300 to 8,000 fatalities.[57] Even more importantly, chemical weapons do not multiply. A small quantity of live biological weapon will reproduce within the victim's body and, in some cases, reproduce much further as it is transmitted from victim to victim. In the latter case the initial quantity of weapon, which is critical for a chemical attack, becomes almost irrelevant to a bio-attack so long as it exceeds the infectivity threshold. As noted earlier, a single individual infected with a contagious biological agent could conceivably spark a pandemic that could kill millions or even tens of millions of people.

Radiological weapons—devices designed to cause death, injury and contamination through the dispersal of radioactive material, rather than through a nuclear detonation—are even less unlikely than chemical weapons to cause mass casualties comparable to those possible with

[56] Cordesman, p. 151.
[57] *Proliferation of Weapons of Mass Destruction*, p. 54.

nuclear or biological weapons. The number of people killed is likely to be limited to no more than several hundred from long-term cancer risk[58] and, even in the worst case, such weapons are probably incapable of causing tens of thousands of deaths.[59]

Like biological weapons, nuclear weapons are capable of causing truly mass casualties. Unlike biological weapons, such weapons are also capable of causing enormous physical destruction. Fortunately, even small single-stage nuclear weapons would probably be substantially more difficult for a terrorist group to acquire. The greatest obstacle to any non-state actor would be acquiring the fissile material needed to construct a nuclear weapon. Production of such material is probably beyond the reach of any terrorist group. Designing a large two-stage thermonuclear weapon is technologically very demanding. A greater danger is that a terrorist group could acquire a nuclear weapon or fissile material from an existing nuclear power by theft or through the black market. Even if a terrorist group were able to acquire a nuclear weapon, depending on the yield of the device, it might prove significantly less lethal than a highly virulent biological weapon.

A bio-attack cannot equal the cataclysmic damage that would have resulted from a Cold War superpower nuclear exchange, which would have destroyed essential infrastructure at the same time it killed tens of millions of people. But such thousands of thermonuclear weapons are not within the reach of terrorists today, and probably never will be. The cost and technological demands would be prohibitive, the facilities needed would be too large and observable, and the time needed to produce sufficient fissile material would be too long and the pressure and opportunity for a preventive U.S. strike would be too high. Much more likely is that a terrorist group would acquire one or perhaps several relatively small, Hiroshima-size[60] nuclear weapons. The nuclear bomb dropped on Hiroshima on August 6, 1945, had a yield of about 12.5 kilotons (equivalent to the explosive energy of 12,500 tons of TNT). It killed about 68,000 people and injured another 76,000.[61] This is far less than the hundreds of thousands or millions of casualties that could result from a highly effective biological weapons attack.

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58 Michael A. Levi and Henry C. Kelly, "Weapons of Mass Disruption," *Scientific American,* November 2002.

59 *Assessing the Threat*, p. 33.

60 Simple gun-type fission weapons in the 10- to 15-kiloton yield range are the least technologically demanding.

61 *Proliferation of Weapons of Mass Destruction*, p. 46.

This is certainly not to argue that US policymakers and planners should be unconcerned about the threat posed by nuclear terrorism, or even chemical or radiological terrorism. The detonation of even a single, small nuclear weapon could cause far more casualties than the attacks of 9/11, as well as cause far greater physical destruction. Such an attack would also have an enormous potential to cause economic disruption, among other things because of the potential for people in other US cities to panic and flee. And although the consequences and repercussions of a terrorist attack using chemical or radiological weapons would likely be substantially less dramatic, they could nonetheless be severe. The point of the above discussion is simply that, as dangerous as these other threats undoubtedly are, because of their unique combination of being both potentially highly lethal and relatively easy to acquire, biological weapons in many respects pose the greatest threat of all.

Offense-Defense Balance

In evaluating the extent and nature of the threat posed by bioterrorism, or any other threat, it is useful to consider the relative balance between offensive and defensive capabilities. In some areas of warfare the offense is currently relatively more dominant, and in other areas the defense is more dominant. This balance can, and does, change over time. A comprehensive evaluation of the balance between the acquisition and offensive use of biological weapons, on the one hand, and bioterrorism countermeasures, on the other, is beyond the scope of this report. However, even a cursory examination of this balance suggests that the balance—at least at present—is heavily weighted toward the offense.

The traditional textbook advantages of the offense are initiative and surprise. The offense has freedom to decide when, where, and how to strike. If circumstances change as he is preparing his attack, he can change his timing, location, and method. He knows his attack plan; the defense presumably does not and thus is caught by surprise.

Another advantage of the offense, in the case of bioterrorism is that, technologically, bioterrorism is inherently a dynamic force against an inherently static target. As noted earlier, because of the spread of the pharmaceutical and related industries, as well as biotechnology expertise, it will, over time, inevitably become easier for terrorist groups to acquire

biological weapons. By comparison, human vulnerability to various biological agents is relatively fixed (though, admittedly, this vulnerability can be mitigated, to some extent, through the development of vaccines and other countermeasures).

Another potentially significant advantage of the bio-offense is that, tactically, the bioterrorist can choose not only the when and the where of his attack; he can choose the what. In the near term, technological limitations will almost certainly confine a bioterrorism attack to known biological agents, which number in the low tens. But in the mid term (perhaps 20 years) civilization may be faced with an attack by genetically-engineered designer agents about which we have no previous knowledge and for which no specific countermeasures are at hand.

Still another advantage is that biological weapons capabilities are the most difficult to identify and monitor remotely. To build and stockpile a large force of nuclear weapons requires large and conspicuous facilities. Chemical weapons major-attack stockpiles are measured in tons. In contrast, as discussed earlier, a major biological attack can be conducted with weapons measured (at least in theory) in grams, and the facilities needed to produce biological weapons are difficult to distinguish from those that produce innocent pharmaceuticals—indeed, their operations are identical until the final stages that determine whether the product is Dr. Jekyll or Mr. Hyde.

A further advantage that may reside with terrorist groups is their level of commitment and, to some extent, wartime mindset. Although their motives were, by American standards, horrible and bizarre, the terrorists who attacked on 9/11 and continue to carry out (often suicidal) attacks, especially in the Islamic world, have demonstrated a high level of commitment to their goals.

Against these considerable advantages of the offense, the main advantage of the defense would appear to be the massive resources the United States and the rest of the civilized world have at their disposal in terms of funding, facilities, equipment and expertise. Unfortunately, because of the great lethality of some biological weapons that may be within the reach of terrorist groups, as well as the other advantages likely to accrue to the offense in this case, massive overmatch may be required for the defense to succeed. Presently, this overmatch is more potential than actual. It needs to be made actual.

The Historical Record and Future Prospects

The preceding discussion illustrates that there is no consensus among experts concerning the ease with which a terrorist group might be able to acquire and effectively employ biological weapons to produce mass casualties. However, history (or at least the historical record that is publicly available) would seem to suggest that obtaining this kind of biological weapons capability is extremely difficult.

The most obvious evidence supporting this conclusion is that, to date, terrorist use of biological weapons has resulted in only about half a dozen deaths worldwide. According to one estimate, between 1910 and 1999 there were no confirmed deaths due to bioterrorism, and only one incident that resulted in injuries—the 1984 lacing with Salmonella bacteria of a number of restaurants in The Dalles, Oregon, by the Rajneeshee religious cult, which made 752 people ill.[62] Another source estimates that there were two deaths caused by bioterrorism between 1975 and 2000.[63] By far the worst confirmed incident involving biological weapons—measured in terms of fatalities—was the anthrax attack of 2001, in which 5 people were killed and 17 injured by a series of anthrax-laced letters sent by an unknown perpetrator.[64]

The conclusion that acquiring and effectively employing biological weapons to cause mass casualties poses extremely difficult challenges for terrorist groups is also suggested by the experience of the Japanese cult, Aum Shinrikyo. This group spent five years actively attempting to acquire and use both biological and chemical weapons. Aum Shinrikyo had substantial financial resources, apparently amounting to at least several tens of millions of dollars, and possibly far more. It also had access to modern equipment and significant scientific expertise. Among other things, when the cult was finally closed down in 1995, police "seized large amounts of equipment for cultivating bacteria and viruses,

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62 The incident had its origins in a conflict between the Rajneeshee cult and the government of Wasco County, Oregon.

63 Ibid., p. 64.

64 In February 2004, a quantity of the biological agent, ricin, was found near the offices of Senator Bill Frist, the Senate Majority Leader. No deaths or injuries were caused by the incident. Ricin, though a deadly poison, is a relatively ineffective biological weapon. It does not spread from person to person, like smallpox, and higher concentrations of the agent are needed to cause death than in the case of live biological agents such as anthrax.

electron microscopes, a huge supply of culture media, and an extensive library that discussed potential agents such as botulinum toxin and the microorganisms that cause cholera and dysentery."[65] Japanese authorities believe that the group was able to produce anthrax and botulinum toxin, and was developing Q fever.[66] Moreover, between 1990 and 1993, Aum Shinrikyo reportedly attempted to use biological agents on at least nine occasions, with at least four of those incidents involving attempts to kill large numbers of civilians.[67] In the end, however, the group's efforts came to naught. None of its attacks with biological agents apparently led to any casualties.

Aum Shinrikyo's team of scientists encountered numerous problems in their work. Some believe that the group's greatest failure was its inability to acquire a sufficiently virulent strain of anthrax.[68] Others point to problems in the manufacturing process or the methods used to carry out the attacks.[69]

Another terrorist group with substantial resources that has shown a serious interest in biological weapons is al Qaeda. According to the Central Intelligence Agency (CIA), "Bin Ladin has a sophisticated BW [biological weapons] capability. In Afghanistan, al-Qaeda succeeded in acquiring both the expertise and the equipment needed to grow biological agents, including a dedicated laboratory in an isolated compound outside of Kandahar."[70] The CIA believes that al Qaeda is still seeking to acquire biological weapons (as well as chemical, radiological, and nuclear weapons).[71] However, there is no evidence that al Qaeda has, to date, actually succeeded in acquiring a biological weapons capability, let alone the capability to use biological weapons to produce mass casualties. Moreover, a recent Bush Administration report, which quotes a captured senior al Qaeda operative as saying that bin Laden decided to seek assistance from Iraq after he concluded that his group could not produce biological (or chemical) weapons on its own, suggests that the difficulties involved in acquiring a biological weapons capability have, even in the recent past, proven substantial even for large and well-financed terrorist groups.[72]

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65 Ibid., p. 213.
66 Ibid.
67 Cordesman, p. 149.
68 Ibid., 164.
69 Ibid., 149.
70 Tenet, pp. 4–5.
71 Ibid., p. 4.
72 The Sun-Herald and the Sydney Morning Herald, August 9, 2003, www.SMH.com.au.

That said, we cannot overlook the fact that the technological challenges of developing, producing, and using a bioweapon are inherently static, while worldwide biotech capability is improving exponentially. The key question is whether civilization can reverse this trend by rendering effective terrorist bioweapon capability more difficult to achieve.

Is a Mass-Casualty Bioterrorist Attack Likely?

Some observers argue, based in part on the fact that no major terrorist attacks have been carried out against the United States since 9/11, that the terrorist threat has been exaggerated. These arguments have been made both with regard to terrorism generally, and to bioterrorism in particular.[73] Perhaps the most articulate analyst to make the case that, in recent years, the terrorist threat has been overstated is John Mueller. In a highly publicized article in *Foreign Affairs*[74] Mueller asks why there have been "neither a successful strike nor a close call in the United States since 9/11." He considers six hypotheses:

- post-9/11 countermeasures have foiled all attempts,
- tighter border controls have kept terrorists out,
- US counterattacks in Afghanistan have greatly weakened al Qaeda,
- the conflict in Iraq has tied down terrorists to such an extent that they are unable to conduct foreign operations

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[73] The most detailed and best researched advocacy of basing our response on the demonstrated threat is probably "Assessing Biological Weapons and the Bioterrorism Threat," Strategic Studies Institute of the Army War College, http://www.strategicstudiesinstitute.army.mil/pubs/display.cfm?PubID=639 by Milton Leitenberg, whom this writer has known for many years and found to have perceptive and valuable insights on other national security issues.

[74] "Is There Still a Terrorist Threat?" John Mueller, *Foreign Affairs,* Vol. 85, no. 5, September/October 2006, http://www.foreignaffairs.org/20060901facomment85501/john-mueller/is-there-still-a-terrorist-threat-the-myth-of-the-omnipresent-enemy.html.

- Muslim Americans are sufficiently "American" that they do not provide a base of support for terrorists, and

- Al Qaeda has spent the past five years biding its time while preparing a Big One.

Mueller cites reasons for plausible doubt of each hypothesis, rejects each in turn, and concludes that "A fully credible explanation for the fact that the United States has suffered no terrorist attacks since 9/11 is that the threat posed by homegrown or imported terrorists—like that presented by Japanese Americans during World War II or by American Communists after it—has been massively exaggerated. Is it possible that the haystack is essentially free of needles?... The results of policing activity overseas suggest that the absence of results in the United States has less to do with terrorists' cleverness or with investigative incompetence than with the possibility that few, if any, terrorists exist in the [United States]."

Mueller concludes his argument by pointing out that "The total number of people killed since 9/11 by al Qaeda or al Qaeda-like operatives outside of Afghanistan and Iraq is not much higher than the number who drown in bathtubs in the United States in a single year, and the lifetime chance of an American being killed by international terrorism is about one in 80,000—about the same chance of being killed by a comet or a meteor."

In terms of bioterrorism in particular, some analysts have likewise pointed to a number of factors, beyond technological or operational obstacles, that might lead terrorist groups to forego the acquisition and employment of such weapons—or at least the use of biological weapons in a way that could cause mass casualties. There are a number of reasons why a terrorist group might believe that a mass-casualty producing attack would fail to serve its own interests and, indeed, could prove highly counterproductive.

Among other things, a terrorist group might worry that a bioterrorist attack that caused mass casualties would severely undermine the group's legitimacy—in the eyes of both foreign governments and even its own constituency—as a potential governing authority. It might also be concerned that such an attack would trigger a serious crackdown against the group by local authorities, sanctions by the international

community, or a devastating retaliatory strike or broader military campaign against the group (as happened to the Taliban and al Qaeda after the attacks of 9/11).[75]

In addition, as noted earlier, operational concerns might be expected to greatly limit the attractiveness to terrorists of contagious biological weapons—potentially the most lethal variety of biological agent. A highly lethal virus could easily spread worldwide, including to the country or subnational entity from which it was initiated. Moreover, the public health capability in most Islamic and other developing countries—where the terrorists are most likely to reside or come from—is likely to be far below Western standards. As a result, it is quite possible that a terrorist attack against the United States by al Qaeda, for example, using smallpox or another lethal and highly contagious agent, would kill far more Muslims than Americans. The backlash could well be stronger than the frontlash.

Hope for the Best, Prepare for the Plausible

Hopefully, the skeptics are correct, and terrorists will continue for many years to come to be stymied in their attempts to acquire biological weapons capable of causing mass casualties, or, for a variety of reasons, self-deterred from either acquiring or using such weapons to cause mass casualties. Unfortunately, the fact that no terrorist group has, as yet, acquired highly lethal biological weapons, or at least effectively used them to inflict mass casualties, provides no guarantee that terrorists will continue to be frustrated in their attempts to acquire and use this capability.

It is impossible to predict with any certainty if or when a terrorist group might succeed in these efforts and threaten, or attack, the US homeland. However, despite the continued existence of some serious obstacles, the chances that a terrorist group will obtain a mass-casualty biological weapons capability is clearly growing. As the OTA noted in its 1993 report, "A fundamental problem in countering the proliferation of biological and toxin weapons is the fact that much of the necessary

[75] For a discussion of various incentives and disincentives that might motivate terrorist groups considering the use of biological weapons and other WMD, see Steven M. Kosiak, *Homeland Security, Terrorism and Weapons of Mass Destruction* (Washington, DC: CSBA, 2004), pp. 21–29.

know-how and technology is dual-use, with legitimate applications in the commercial fermentation and biotechnology industries."[76] And these capabilities and know-how have only expanded and spread further over the past decade.

At a minimum, it seems probable that in coming years a growing number of terrorist groups will acquire at least a limited biological weapons capability. Because of public fears about biological weapons, even an attack that resulted in only a relatively small number of deaths and injuries could cause widespread panic and generate enormous publicity for a terrorist group. The potential for small-scale incidents to have such an effect is well illustrated by the 2001 anthrax attacks. Although only five people were killed and 17 injured as a result of the letter-borne anthrax attacks, the attacks disrupted mail delivery and cost the US Postal Service, alone, some $5 billion.[77] Moreover, it is quite possible that—given the spread of relevant technology and expertise—in the foreseeable future a terrorist group will acquire both a biological agent capable of causing mass casualties and the means of effectively disseminating this agent.

Such a capability could be used in an attempt to coerce a government to adopt a particular policy or take a particular action, or possibly even to deter it from attacking a terrorist group thought to posses this capability. But whatever the rationale, at some point it may be inevitable that a terrorist group will acquire not only the capacity, but the inclination, to employ biological weapons to cause mass casualties. The conclusion of John Mueller and others that the absence of a major terrorist attack against the United States since 9/11 provides strong evidence that such an attack is unlikely can be faulted on a number of grounds:

- It is heavily based on speculation about histories he may not know.
- There may be classified counter-evidence—including foiled attacks—of which the US government is aware but those without the relevant clearances are unaware.
- There may be significant bioterrorist activities of which only terrorists are aware.

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[76] *Technologies Underlying Weapons of Mass Destruction*, p. 84.

[77] "Postal System Asks for Help With Financial Losses," Online News Hour, November 8, 2001, www.pbs.org/newshour/updates/november01/postal_anthrax_11-8.html.

Perhaps the greatest criticism of Mueller's conclusions is that they are based on a survey of past experience. Given the potential for even a single bioterrorist attack to cause mass casualties, and the rapid and ongoing spread of bioweapons technology and expertise, it is difficult to take too much comfort in any historical survey as a predictor of the future.

Likewise, given the stakes involved, it may be a mistake to take too much comfort in the notion that terrorist groups will be self-deterred from acquiring and using bioweapons to cause mass casualties. Attempting to understand the thought processes and motivations of terrorist groups is, to say the least, a complex and imperfect undertaking. It may be that for those terrorist groups that are capable of developing a mass-casualty producing biological weapons capability, the negatives of making such an attack will generally outweigh the positives. But it is difficult to have high confidence in this conclusion. To some extent, terrorists do not appear to be "outcome-maximizers," but simply driven by their own delusions bearing no necessary connection to reality:

- Timothy McVeigh apparently believed that by bombing a federal building he would convince the American people that the US government could not protect them, and they would therefore turn against it. The implication that the people would then ask to be led by the murderers is, of course, compoundedly bizarre. But that seems to have been his belief.

- Similarly, Osama bin Laden apparently believed that killing several thousand Americans would cause the United States to "disunite." In fact, it had the opposite effect, enormously boosting the previously sagging political stock of President Bush and causing the most eminent newspaper in France to headline "We Are All Americans."

- Even more bizarre was the belief of Shoko Asahara, head of Aum Shinrikyo, that he was actually giving an enormous gift to the innocent civilians he killed with sarin nerve agent in the Tokyo subway, because by helping him overthrow the government and gain power they would be richly rewarded in Heaven.

It could be that in the future, as understanding about the limitations and potential dangers associated with biological weapons—and contagious biological agents in particular—becomes more widespread, such weapons

will become less attractive to terrorist groups. But the idea that a more sophisticated understanding of biological weapons will lead to restraint on the part of terrorist groups is questionable.

At the peak of the Cold War, the Soviet Union was not a strategically naïve government. It possessed one of the world's two leading nuclear arsenals, and had thoroughly developed doctrine governing their use. Yet the Soviet Union not only produced smallpox, it produced smallpox by the ton. It weaponized smallpox for delivery by SS-18 ICBMs, the largest ballistic missiles ever made. Although an attack using grams of smallpox could, cause extreme devastation, each SS-18 could carry 375 kilograms of viral suspension, which would cover an area of about 100 square kilometers[78]—from which, of course, it would multiply and spread, possibly globally.

Why would the Soviet Union take such action?

- Its smallpox could not have been intended for deterrence; a deterrent can only be effective if known to the enemy, and the Soviet smallpox program was a closely and effectively held secret.

- Nor could smallpox have been intended for a disabling first strike. It would have been incapable of that mission. The time lag for a smallpox attack would be measured in days or weeks after impact, whereas the time lag for U.S. missile retaliation would be measured in minutes.

- Nor would it have made sense for ICBM-borne smallpox to have been stockpiled for use in a retaliatory strike launched in response to a U.S. attack, since the Soviet missile force could have caused more casualties if armed with nuclear warheads—and, in contrast to the case with ICBM-borne smallpox, nuclear-armed ICBMs aimed at the United States would have posed no threat to the Soviet Union.

One possible explanation is that Soviet bioweapons officials were not well aware of the intricacies of the superpower WMD standoff, and simply did not think through the consequences of their programs. But, among

[78] Jonathan Tucker, *Scourge: The Once and Future Threat of Smallpox* (New York: Grove Press, 2001), p. 156. In reality, the core infected area would be many times larger because of the dispersion pattern of the MIRV warheads, which on a large ICBM is more than a hundred miles long. There would initially be uninfected areas in the spaces between the warheads, but they would not likely remain uninfected for long.

other things, this fails to explain why the leaders of the Soviet Strategic Rocket Forces, who were well versed in the intricacies of WMD "theology," accepted smallpox into their warheads.

The fact that the former Soviet Union, a sophisticated superpower with no apparent (or even, perhaps, imaginable) need for biological weapons—and a legally-binding, public commitment, through the Biological Weapons Convention (BWC), to forgo such weapons—chose to carry out a massive biological weapons program, should act as a caution to those who believe that terrorists might be self-deterred from acquiring biological weapons or employing them to cause mass casualties.

A simple hypothetical may be instructive. Assume a highly contagious engineered virus that does not become less virulent as it spreads, and that kills 80 percent of those infected in advanced countries. Hypothesize that in the Islamic world, because of lower sanitation and public health standards, mortality is 95 percent. Since one of Osama bin Laden's objectives is to establish himself as leader of the Islamic world, surely he would not want to make himself a pariah in that world by killing 95 percent of its inhabitants?

Perhaps. But might he reason that such a bio-attack would debilitate the United States to such an extent that its presence in the Islamic holy land of Saudi Arabia would be impossible to maintain? Might bin Laden feel that 95 percent Muslim mortality is a price worth paying to rid Saudi Arabia of Americans? Insane, yes. But, given the sometimes bizarre thought process that seems to have motivated past terrorist attacks and the experience of the Soviet bioweapons program, it is difficult to conclude that such a scenario is implausible.

Nothing in this discussion is intended to denigrate the critically important work of dissuading and diverting terrorists by every political, economic, and psychological means possible. But at the end of the day, if the means for carrying out a mass casualty attack can be attained by terrorists, nothing can be ruled out. There is no limit to, and no way to predict, the reasons that terrorists can and may concoct to justify mass murder.

Those wishing to explore the issue further might read the 2003 religious fatwa titled "A Treatise on the Legal Status of Using Weapons of Mass Destruction Against Infidels" by Shaykh Nasir bin Hamd al-Fahd, a prominent Saudi cleric:

> *"Anyone who considers America's aggressions against Muslims and their lands during the past decades will conclude that striking her is permissible on the basis of the rule of treating one as one has been treated. No other argument need be mentioned. Some brothers have totaled the number of Muslims killed directly or indirectly by their weapons and come up with a figure of nearly ten million ... If a bomb that killed ten million of them and burned as much of their land as they have burned Muslim land was dropped on them, it would be permissible, with no need to mention any other argument. We might need other arguments if we wanted to annihilate more than this number of them."* [79]

At the end of the day, it is impossible to know whether a terrorist group that acquired the capability to conduct a biological weapons attack that could cause mass casualties would actually do so. Ultimately, intentions and capabilities are two different dimensions of the bioterrorist threat. It is certainly possible that a terrorist group that acquired such a capability would not actually use it—just as the Soviets never used their capability. But given the history of groups such as Aum Shinrikyo, and the willingness of al Qaeda and other terrorist groups to kill large numbers of innocent civilians with conventional attacks, for planning purposes it seems only prudent to assume that if terrorists have a bioweapon capability, they will use it.

Federal Funding for Counterbioterrorism Programs

A wide range of different federal departments and agencies are responsible for carrying out programs and activities aimed at countering bioterrorism. In some cases these efforts are focused solely on the threat posed by biological weapons, but in other cases they support other missions as well—such as countering chemical, radiological and nuclear weapons attack. As a result of this overlap and various data limitations, it is impossible to

[79] For discussion of this fatwa, see Lewis A. Dunn, "Can Al Qaeda be Deterred from Using Nuclear Weapons," Center for the Study of Weapons of Mass Destruction Occasional Paper #3, July 2005, p. 10.

estimate precisely how much funding has, historically, and is, currently, being provided for combating bioterrorism in particular. Nevertheless, it is possible to estimate the level of resources allocated to this mission area at least roughly.

Overall, fiscal year (FY) 2007 funding for programs and activities relatively closely related to countering and combating biological weapons amounts to some $8 billion.[80] Table 1 provides an estimate of funding levels for those programs and activities among the main federal departments and agencies involved in these efforts. Four general observations can usefully be made about these funding levels and trends.

First, overall funding for programs and activities focused on countering biological weapons grew dramatically in the immediate aftermath of the terrorist attacks of 9/11. Between 2001 and 2004, annual funding in this area grew by nearly $6 billion—representing a real (inflation-adjusted) increase of some 330 percent. However, over the past three years, annual funding for these efforts has stayed essentially flat in real terms.

Second, although at least 11 federal departments and agencies play a role in combating biological weapons, three departments account for the vast majority of the funding provided for this mission. Over the past seven years, the Department of Health and Human Services, alone, has accounted for over half (53 percent) of total federal funding in this area. Most of the remaining funding for combating bioterrorism has been allocated to the Departments of Defense (24 percent) and Homeland Security (13 percent).

Third, the greatest growth over the FY 2001–04 period was in civilian departments and agencies. While Department of Defense biodefense funding grew by some 35 percent in real terms over this period, funding for civilian biodefense efforts experienced roughly a nine-fold increase. Prior to the terrorist attacks of 9/11, US biodefense efforts were focused far more on protecting US military forces that might encounter an opponent

[80] Here and in other instances where FY 2007 funding levels are cited in this report, unless otherwise noted, the figures cited are based on the Bush Administration's FY 2007 *request*. At the time this report was drafted, Congress had not yet completed work on many of the appropriations acts which fund these programs and activities. Thus, the final, actual funding levels could differ from those cited in this report. However, history suggests that the differences are likely to be quite modest.

Table 1: Federal Funding for Bioweapons Prevention and Defense, by Agency, FY 2001–07

(in millions of dollars)[1]

Department or Agency	FY01 Actual	FY02 Actual	FY03 Actual	FY04 Actual	FY05 Actual	FY06 Estimate	FY07 Request	FY01–FY07
USDA	7[a]	42[a]	204	111	298	253	322	1,237
Commerce[a]	3	4	4	7	6	6	6	36
Defense (DoD)	1,030	1,313	1,528	1,480	1,665	1,952	1,691	10,659
Energy[a] (DoE)	46	94	7	6	7	13	6	179
Health & Human Services (DHHS)	324	2,980	4,035	3,703	4,147	4,088	4,259	23,536
Homeland Security (DHS)			119[a]	1,960	720	1,355	1,434	5,588
State	39	71	67	67	67	71	78	460
Veterans Affairs (VA)	N/A	N/A	27	23	9	10	9	78
EPA[a]	N/A	187	133	131	107	129	183	870
National Science Foundation (NSF)	0	17	26	27	27	27	28	152
Postal Services	175	587	0	0	503	0	0	1,265
Total	**1,624**	**5,295**	**6,150**	**7,515**	**7,556**	**7,904**	**8,016**	**44,060**

a These are estimates.

[1] Center for Arms Control and Nonproliferation, "Federal Funding for Biological Weapons Prevention and Defense, Fiscal Years 2001–2007," p. 1. Available at http://www.armscontrolcenter.org/resources/fy2007_bw_budget.pdf.

armed with biological weapons than on protecting American civilians from a bioterrorist attack. The funding trends of the past six years reflect, in part, a shift in focus toward greater emphasis on protecting civilian populations.

Fourth, the federal budget for combating bioterrorism is very small compared to either the overall budget for homeland security (about $58 billion in 2007) or the budget for national defense (some $513 billion in 2007, excluding funding for the wars in Iraq and Afghanistan).

Table 2 shows FY 2001–07 funding for one particular component of the US program for combating bioterroism: biodefense research and development (R&D). In budgetary terms, R&D probably represents the largest single category of funding in this program. Overall, US funding for biodefense R&D—focused on the development of new vaccines, therapeutics, detectors, protective masks, and other critical technologies—has totaled about $18 billion over the past six years. The FY 2007 total is some $3.3 billion. Consistent with the pattern in the overall budget for combating bioterrorism, the greatest shares of this R&D funding are allocated to the Departments of Health and Human Services (50 percent) and Defense (34 percent).[81]

The trends in funding for biodefense R&D also closely parallel trends in the overall budget for countering biological weapons. Between FY 2001 and FY 2004, funding in this category grew by some 360 percent in real terms. Since then, funding for biodefense R&D has remained essentially flat. Moreover, as in the case of the overall budget for combating bioterrorism, by far the greatest growth has occurred among civilian departments and agencies. During the FY 2001–04 period, DoD funding for these programs increased by about 50 percent in real terms, while civilian departments and agencies experienced nearly an eighteen-fold increase. Finally, just as the overall budget for the Department of Defense far exceeds the total funding provided for combating terrorism, the Defense Department's R&D budget far exceed the total amount spent on biodefense R&D. At $3.4 billion, the FY 2007 biodefense R&D budget is equivalent to less than 5 percent of the Defense Department's overall R&D budget.

[81] These shares are based on total FY 2001–07 funding.

Table 2: Research, Development, Testing, and Evaluation Funding for Biodefense

(in millions of dollars)[1]

Department or Agency	FY01 Actual	FY02 Actual	FY03 Actual	FY04 Actual	FY05 Actual	FY06 Estimate	FY07 Request	FY01–FY07
Facilities								
USDA	7	30	143	0	121	58	0	359
DoD						21	29	50
DHHS	0	92	743	0	149	30	25	1,039
DHS	0	0	30	108	68	23	0	229
Facilities Subtotal	*7*	*122*	*916*	*108*	*338*	*132*	*54*	*1,677*
Programs								
USDA	0	9	12	20	29	34	72	176
DoD-Army		17	19	22	19	16	15	108
DoD-DARPA	146	172	158	142	155	148	112	1,034
DoD-CDBP	405	596	639	701	714	1,048	958	5,061
DoD Subtotal	*551*	*785*	*816*	*865*	*888*	*1,212*	*1,085*	*6,202*
DHHS-FDA	6	46	53	53	57	57	57	329
DHHS-CDC	18	18	18	N/A[a]	N/A	N/A	3	57
DHHS-NIH	53	198	810	1,821	1,593	1,655	1,770	7,900
DHHS Subtotal	*77*	*262*	*881*	*1,874*	*1,650*	*1,712*	*1,830*	*8,286*
DHS-S&T[b]			89	306	223	226	202	1,046
DOE	40	85	N/A	N/A	N/A	6	N/A	131
VA	N/A	N/A	27	23	9	10	9	78
EPA-S&T[c]	0	7	67	66	54	65	92	351
NSF	0	17	26	27	27	27	28	152
Programs Subtotal	*668*	*1,165*	*1,918*	*3,181*	*2,880*	*3,292*	*3,318*	*16,422*
Research Total	**675**	**1,287**	**2,834**	**3,289**	**3,218**	**3,424**	**3,372**	**18,099**

a N/A: No Information Available.

b Based on estimate that 60% of Biological Countermeasures portfolio funding in FY2004–07 is devoted to RDT&E.

c Estimate based on comparison of White House and EPA budget documents, suggesting that approximately 50% of EPA homeland security funding is for programs clearly related to biodefense R&D in FY2006 and FY2007.

[1] Center for Arms Control and Nonproliferation, "Federal Funding for Biological Weapons Prevention and Defense, Fiscal Years 2001–2007," p. 3. Available at http://www.armscontrolcenter.org/resources/fy2007_bw_budget.pdf.

Approaches to Combating Bioterrorism

Although expert opinion is divided about current and near-term capabilities and intentions, longer-term trends seem clearly to point toward a growing—rather than receding or even stable—bioterrorist threat. Thus, for planning purposes, it seems only prudent to assume that some terrorist group will eventually acquire the capability to conduct a mass-casualty attack with bioweapons. Given the potentially devastating nature of such an attack, under plausible, relatively near-term scenarios, it also seems clear that the United States should be actively and vigorously pursuing a comprehensive approach to countering bioterrorism.

There are three general approaches to countering bioterrorism that could be pursued by the United States and the broader international community. These consist of:

- **Preventing** terrorists from acquiring biological weapons or the ability to effectively employ those weapons to cause mass casualties, through the use of non-military means[82];

- **Defending** against a terrorist attack with biological weapons, once it has been launched, through the use of various measures capable of detecting, protecting against and mitigating the effects of such an attack; and

- **Attacking** and destroying terrorists' biological warfare capabilities through preventive or retaliatory offensive operations.

In practice, a robust and effective strategy and program for countering bioterrorism would probably have to make use of a combination of all three of these approaches. And the United States is, in fact, pursing each of these approaches.

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[82] Military means of accomplishing this same goal, by launching preventive strikes against bioterrorist sites or personnel, are included in the "Attacking" approach to combating bioterrorism.

Each of the next three chapters of this report focuses on one of these three different (though admittedly, overlapping[83]) approaches. For each approach, these chapters provide a description and discussion of:

- The challenges and opportunities that confront policymakers and planners;

- The most critical specific policies and programs the United States is currently pursuing, and the major federal departments and agencies involved in these efforts; and

- To the extent possible, the level of funding the United States is allocating to specific programs, and what the trends have been in recent years.

Each of these chapters also includes a discussion of the adequacy of current policies and funding levels, and a set of recommendations concerning both how the allocation of resources might be improved, and how policy, structural and other non-budgetary changes could likewise improve the prospects for success.

[83] The existence of such overlap can be seen, for example, in the fact that the acquisition of improved US capabilities to defend against a biological weapons attack, or to attack bioterrorist sites, might help dissuade some terrorist groups from acquiring biological weapons in the first place—thereby contributing to the "preventive" approach to countering bioterrorism.

Chapter 2:
Preventing Bioterrorism

The most effective way to combat bioterrorism is to prevent terrorists from ever acquiring a biological weapons capability in the first place. This chapter describes and discusses a range of non-military preventive measures that are currently being pursued by the United States to guard against bioterrorism.[84] It includes both a general overview of the relevant issues, and a discussion of specific US policies, programs and activities, including those linked to broader international efforts. This chapter also includes an estimate of the total amount of federal funding provided for these tasks, as well as, to the extent possible, a breakdown of that funding among different programs, departments and agencies.

As discussed in Chapter 1, there is considerable disagreement among experts as to how difficult it would be for a terrorist group to acquire both a highly lethal biological agent and the means of employing that agent in a way that could cause mass casualties. Unfortunately, it is clear that the obstacles confronting a terrorist group seeking such an agent and such a capability are much less daunting and formidable than they could and should be.

[84] Military means may also be employed to accomplish this goal (e.g., by launching preventive strikes against bioterrorist sites or personnel). This issue is discussed in Chapter Four, "Attacking Bioterrorist Targets."

Table 3: Funding for Preventive Bioterrorism Programs
(in millions of dollars)[85]

Department or Agency & Programs	FY01	FY02	FY03	FY04	FY05	FY06	FY07 Req.	FY01–FY07
USDA-APHIS: Select Agents—Plants & Animals					3	3	5	11
DoD-CTR: BWPP	12	17	55	68	69	61	68	350
DHHS-CDC: Selected Agents Programa	5	5	5	5	5	5	5	35
DHHS-NIH: NSABB				0.5	1	1	1	4
State: Non-proliferation Programs	35	67	52	50	50	52	56	363
Commerce: Export Controlsb	3	4	4	7	6	6	6	35
DoE: Export Control & GIPPb	6	9	6	6	7	7	6	47
Prevention Total	61	102	122	136	140	134	146	845

a Unlike USDA, HHS and CDC do not explicitly provide a number for the amount of money that the Select Agents Program receives. Based on USDA numbers and the FY02 numbers (from GAO-03-315R "CDC Select Agent Program" from 11/22/02), we estimate that CDC's Select Agent Program received about $5 million for each fiscal year.

b Please refer to a more detailed analysis and explanation of the Department of Commerce's and the Department of Energy's funding numbers in the section under "Other Government Agencies."

Altogether, according to publicly available data, 2007 federal funding for preventive bioterrorism efforts will total some $146 million. The level of funding provided for these efforts has grown substantially since 2001, roughly doubling in real terms over the past six years—with most of that growth occurring in the first few years after 9/11. As shown in Table 3, funding for bioterrorism programs is spread among about a half-dozen different departments and agencies. However, the vast majority of this funding (85 percent in 2007) is allocated to the Defense and State departments.

Programs focused on preventing bioterrorism currently account for less than 2 percent of total unclassified federal funding for combating

[85] Center for Arms Control and Nonproliferation, "Federal Funding for Biological Weapons Prevention and Defense, Fiscal Years 2001–2007," p. 4. Available at http://www.armscontrolcenter.org/resources/fy2007_bw_budget.pdf.

bioterrorism, and represent only a tiny fraction of the amount of funding provided either for defensive bioterrorism programs and activities (discussed in Chapter 3), or for capabilities related to attacking bioterrorist targets (discussed in Chapter 4). There is no reason to believe that funding in this area needs to be increased to anything approaching the levels provided for these other areas. However, it may make sense to increase funding for a number of preventive programs and activities.

Fortunately, the level of funding required to implement these changes would be extremely modest, compared to the level of funding provided either for other kinds of biodefense programs, or for other defense and national security programs more broadly. Implementing all of the new or expanded preventive bioterrorism initiatives described below would require increasing annual federal funding in this area by tens of millions of dollars. Conversely, while the cost of making these changes would be modest, the benefits could be enormous. Moreover, in the area of preventive measures, as well as other means of countering bioterrorism, some of the most important improvements depend as much, or more, on policy changes as on funding increases.

Critical programs and activities related to preventing the proliferation of biological agents and, particularly, the spread of such capabilities to terrorist groups, include[86]:

- Facilities and Personnel Security
- The Biological Weapons Convention (BWC)
- Export Controls
- Threat Reduction Assistance to Other Countries

The remainder of this chapter consists of a discussion of each of these four areas, including recommendations concerning future funding levels and other possible changes.

[86] The Proliferation Security Initiative (PSI) is also aimed at preventing terrorist acquisition of biological agents. However, since its enforcement involves the use of force (e.g., stopping and boarding ships at sea), it is discussed in Chapter 4.

Facilities and Personnel Security

Although a terrorist group armed with a highly lethal biological agent may be able to inflict more casualties than a group armed with a small nuclear weapon, security at biological labs, pharmaceutical plants, and related facilities is generally inadequate, and often effectively non-existent. Similarly troubling is the lax security surrounding scientists, technicians and other personnel working in the biotechnology field, and the ease with which terrorists may be able to access this expertise. As noted in Chapter 1, the United States has enacted laws over the past decade, and especially since 9/11, that have, for example, made it more difficult to purchase dangerous pathogens from culture collections in this country. However, there are still serious gaps in biosecurity in the United States, and much more serious gaps in many other countries.

The danger that a terrorist group might use a bomb or other explosive device to damage or destroy a biotechnology laboratory or manufacturing facility in order to cause the release of a biological agent is slim. Modern industrial societies possess large quantities of very toxic chemicals, which are used for a wide range of commercial purposes, and stored at numerous, largely unprotected, sites. For example, each year the United States produces more than 13 million tons of chlorine for industrial uses including bleach and disinfectant[87] Chlorine was one of the major chemical weapons of the First World War. In concentrations of one part per thousand, it is lethal within minutes. It can be effectively dispersed through the use of an explosive charge. As a result, an attack with an aircraft or a missile on a chlorine chemical plant, or even an attack against a train—with its totally unguarded tank cars carrying tons of chlorine—using an improvised explosive device (IED), would be a attractive options for terrorists.

In contrast, there are no large quantities of biological weapons located in the United States at laboratories, manufacturing facilities or storage sites—because, unlike chlorine and many other dangerous chemicals, these agents are illegal and have no commercial application. The BWC permits the possession of such agents only for the purpose of developing countermeasures against them, and these are held only in gram quantities in secure conditions deep inside buildings. It is unlikely that a 9/11-type suicide attack with an aircraft, or another kind of explosive attack, would be able to penetrate to the biological agent storage locations, break open the storage vials, and effectively scatter the biological agent—among other

[87] Chlorine Chemistry Council, http://www.c3.org/chlorine_knowledge_center/sustain_econ.html

things, because if such an attack did penetrate to the agent storage area, the heat of the explosion would almost certainly kill the agent.

That said, it is remotely possible that a hardy agent such as anthrax or tularemia could survive such an attack, or possibly even a less hardy agent if stored in containers on the periphery of the attack. But even if an attack were to cause the dispersal of a dangerous biological agent, the basic nature of biological terrorism would work against itself. The effectiveness of a biological weapons attack, at least if it is intended to cause mass casualties, depends in large part on the incubation (non-symptomatic) period beginning clandestinely. In that case, by the time a victim shows symptoms, it is often too late to treat him or her. In contrast, an explosive attack on a biological lab, by definition, could not be clandestine. It would immediately be known that people living in the area may have been exposed to a certain agent, and there would be adequate time for treatment. If treated in the first two or three days after exposure,[88] anthrax and tularemia can be readily cured with antibiotics.[89]

Although the danger from an explosive attack on a biological laboratory is small, such an attack does not represent the only, or probably even the greatest, threat related to biological laboratories. Because of shortcomings in security, scientists or other personnel working in the biotechnology field, relevant knowledge and expertise, and perhaps even dangerous pathogens themselves, may become available to bioterrorists.

Overall, pathogen security ranges from excellent to appalling. Highly virulent pathogens are as dangerous as weapons-grade fissile material, and should be subject to comparably effective security precautions. They are not.

Even in the most advanced countries, too often there is a presumption among scientists that in effect, "science is good and we're good people, therefore it's impossible for us to do anything that isn't good for humanity." This presumption is reinforced by the fact that a scientist's

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88 Verbal communication between the author and Dr. Jean Guillemin, author of *Anthrax: The Investigation of a Deadly Outbreak* (University of California Press, Berkeley, 1999).

89 Why, then, did people die of anthrax following its accidental release from the Sverdlovsk bioweapons plant in 1979? Because the Soviet officials tried to cover their mistake and pretend that nothing untoward had happened. Nobody was given antibiotics for anthrax. As a result, at least 68 people died very unpleasant and totally avoidable deaths.

career trajectory—as well as eminence among peers, salary, and book and lecture fees—often correlates directly with the technological elegance of his or her work. Given this reward structure, it is not surprising that many scientists tend to play down matters of responsibility to society when those responsibilities threaten to impair the conduct of their work, and the advancement of their careers.

One of the most dramatic examples of biosafety failure occurred in 1978, when Dr. Henry S. Bedson, head of the Medical Microbiology Department at the University of Birmingham, surreptitiously continued to work with live smallpox viruses after World Health Organization (WHO) inspectors had found his laboratory's equipment and procedures inadequate and had recommended that the deficiencies be corrected, or the facility closed. His containment failed. Janet Parker, a photographer working on the floor above, contracted smallpox and died within a month. Due to the Birmingham health authorities' relatively prompt isolation of Ms. Parker, plus a massive dose of good luck, the smallpox was fortunately not transmitted to anyone else. Unfortunately, biosecurity and biosafety clearly remain serious problems at home and abroad.

Both physical and personnel security is relatively high at Department of Defense laboratories, and those on contract to DoD. In both cases, the facilities must follow the Defense Department's Biosurety Plan when dealing with so-called "select agents," which consist of organisms and toxins identified as having clear biological weapons potential.[90] Access requires investigation roughly equivalent to that required by a Secret clearance.[91] There must be a minimum of three separate access controls, including at least one that is monitored around the clock and one that requires ID card access. In addition, the select agent must be under video surveillance at all times.

By comparison, the protection of select agents is much less intense at non-DoD government and contractor laboratories. All non-DoD domestic laboratories that work with select agents must register with the US government. The door to the select agent storage space must be locked, and there must be a security plan in place. However, there are no specifications for either the lock or the plan. Likewise, to be granted

[90] 42 Code of Federal Regulations, sec 73.12, see http://frwebgate2.access.gpo.gov/cgi-bin/waisgate.cgi?WAISdocID=677514117448+9+0+0&WAISaction=retrieve.

[91] LtCol Gretchen Demmin, USAMIRIID, discussion with author, November 13, 2006.

unaccompanied access to a select agent storage space, a person need only undergo an FBI background check. That access will be denied if it is found that the person has been convicted of a felony, dishonorably discharged from the military, is listed on a terrorism database, or is a citizen of a country listed by the State Department as sponsors of terrorism. While constructive, this background check falls far short of DoD's personnel clearance procedures.

This degree of relatively open access would be considered unthinkable in the case of fissile nuclear material. But a vial containing a few grams of Marburg virus, for example, can potentially kill more people than a few kilograms of fissile material. Certainly the virus is easier to conceal and use. The present lax, loosely regulated handling of select agents is a disaster waiting to happen. A dangerous select agent could be stolen from a facility by a laboratory worker who is secretly allied with or bribed by a terrorist organization, by a worker who, for his or her own reasons, decides to attempt to commit mass murder, or it could be released simply as result of personal carelessness.

Another serious biosecurity problem concerns the publication of information that might be of use to terrorists seeking to acquire biological weapons. A 2003 study by the Defense Threat Reduction Agency[92] surveyed technical articles published in four months' issues of three eminent and highly respected U.S. scientific journals. One in six of the articles were found to have some relevance to the development of bioweapons. Four were found to be "highly relevant."

Recommendations

While the risks associated with physical and personnel security at biological laboratories and other facilities cannot be eliminated, they can and should be greatly reduced. A major step in this direction would be to require all domestic laboratories working with select agents to meet present DoD standards for both physical and personnel security. Moreover, existing physical security measures even at DoD facilities may not be adequate. As a result, it would be prudent to strengthen those measures to require

[92] Defense Threat Reduction Agency, "Quantification of Open Source Research Publications in Biological Sciences for Biological Weapons Development Utility," June 16, 2003.

two-person, two-key access to any select agents. This would be a simplified version of the practice long in effect at U.S. ICBM Launch Control Centers. Whereas the present DoD system can be defeated by a single individual with malign intent developed after passing the security clearance process or deceiving the process, a two-person, two-key system would require two such persons working in conspiracy in the same installation at the same time, which is statistically far less probable.

The cost of instituting this improved security would be relatively modest. According to one estimate, as little as $200,000 per laboratory might be sufficient for the physical measures.[93] It is estimated that there are some 300[94] non-DoD laboratories and other facilities in the United States that handle select pathogens. This implies that total costs for making these improvements would amount to some $6 million. Secret-equivalent background checks are estimated to cost about $1,000 per person to conduct. The number of individuals who typically work in such a facility and have access to select agents is perhaps 25. This implies total costs of approximately $7–8 million for background checks. Even if these estimates for implementing improved physical and personnel security are too low, unless they are off by a very wide margin the costs would be extremely modest—compared with the magnitude of the threat poor biosecurity poses and US spending on other national security programs and activities

Although implementing these measures in the United States would result in a major improvement in biosecurity, it would hardly eliminate the problem of poor biosecurity. Since work on select agents is being done in many countries, effective solutions must be global. A good starting point for improving security at biological laboratories and other facilities outside the United States would be for the international community to agree to adopt a standard set of security requirements for operating such facilities. Grotto and Tucker[95] recommend that such a set of international guidelines include:

- An agreed list of "select agents" (or a set of clear, uniform criteria for designating them) that serves as the basis for regulation;

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93 Verbal communication from microbiologist Richard Ebright, Rutgers University, October 31, 2006.

94 This can only be a rough estimate because of multiple uncertainties, including incomplete reporting.

95 Andrew J Grotto and Jonathan B. Tucker, "Biosecurity — A Comprehensive Action Plan," Center for American Progress, http://www.americanprogress.org/issues/2006/06/b1816853.html

- Rules for registering and licensing facilities that work with select agents;

- Minimum standards and procedures for controlling access to pathogens, including physical security measures;

- Accounting mechanisms to track pathogens that are stored, used in experiments, transferred, or exported;

- Procedures for checking the trustworthiness of scientists and technicians who wish to work with select agents; and

- Establishing uniform standards for pre-funding review of dual-use research proposals and publications that may have significant BW application.

Given the critical importance of effective biosecurity, the United States should not only vigorously pursue an international agreement that includes such guidelines, but work to ensure that the specific provisions are as strong and rigorous as possible. The US position in negotiating such an agreement would be substantially strengthened if the United States entered the negotiating process having already begun to implement similar such measures within this country.

Biosecurity could also be improved if scientists, technicians and others working in the field were better educated concerning bioethics and related areas. There is currently no general requirement that life sciences researchers know (or care) anything about bioethics, or be aware that their work could be put to malevolent use. Dr. Bedson no doubt thought he was doing the "right thing" when he surreptitiously continued his work on smallpox. So too, perhaps, did the Soviet scientists who worked on their country's massive biological weapons program in the 1970s and 1980s. Requiring relevant personnel to receive training in bioethics would hardly guarantee that no such abuses would occur in the future, but it would certainly reduce the likelihood.

The US government is beginning to address this shortcoming. The Department of Health and Human Services has created, under the National Institutes of Health, the National Science Advisory Board for Biosecurity (NSABB).[96] This board, now in its third year, consists of 25 expert voting

[96] http://www.biosecurityboard.gov/

members, plus ex-officio non-voting representatives from more than a dozen different government agencies, including the Departments of Defense, Agriculture, State, and Commerce; the Environmental Protection Agency; and the Intelligence Community. Among the NSABB's functions is preparing a code of conduct for scientists and laboratory workers. The goals of this effort are commendable. However, the code of conduct would be only advisory and, in any case, is limited to domestic application.

Grotto and Tucker[97] have advocated a more ambitious proposal. They recommend that an international requirement be established that would require graduate students in the life sciences to take a course or module on the risks of misuse of research results, and to sign a professional code of conduct. A better option might be to develop a standard course curriculum, including an exam, which would be required for all degrees—undergraduate as well as graduate—in the life sciences. Ideally, this measure would be further strengthened by including a continuing education requirement to cover those life scientists who received their education prior to the institution of this curriculum requirement. A notional course for this task has been developed by the microbiologist Graham Pearson, and is available online at http://www.armscontrolcenter.org/resources/biosecurity_course/ .

The United Nations, or some other international organization, might be the best institution to develop this kind coursework and testing requirement, given the importance of achieving broad buy-in and acceptance from as many countries as possible. The NSABB's annual budget related to its bioethics work is about $1 million. While an international process attempting to develop a broader set of standards and related requirements would need substantially greater funding, those costs would presumably still be quite modest, perhaps in the millions or tens of millions of dollars. Moreover, those costs would not have to be covered entirely by the United States, but should be shared among a range of participating countries.

Notwithstanding the critical importance of getting other countries to adopt greatly improved physical and personnel biosecurity measures, efforts to forge internationally agreed upon standards should in no way stand in the way of making progress in those areas in the United States. Improved security measures should be adopted and implemented as quickly as possible. If necessary, they can be modified later to reflect international standards.

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97 Grotto and Tucker, op. cit, p. 14.

Biological Weapons Convention (BWC)

The BWC,[98] adopted in 1972, is an important, albeit flawed, element in the existing international regime aimed at preventing the acquisition of biological weapons. Under the terms of the BWC, signatory countries agree not to develop, produce, stockpile, acquire, retain, or transfer biological weapons. Transfer of bioweapon materials is also prohibited. (Use of biological weapons was earlier prohibited by the 1925 Geneva Protocol.) A total of 171 countries have signed the BWC, including most of the countries generally considered to be of greatest concern in terms of biological weapons acquisition and proliferation (see Figure 2).

Unfortunately, the BWC does not include any implementation or verification measures. As such it can provide no guarantee that governments, or private groups or individuals residing within the borders of signatory countries, are not pursuing biological weapons capabilities. This is clearly a major limitation of the treaty.

The lack of a verification protocol is due in large part to the strong resistance to such measures by the Soviet Union at the time the BWC was negotiated.[99] After the collapse of the Soviet Union, negotiations on a BWC verification protocol were conducted for many years. They were terminated by the Bush Administration in 2001.

As noted in Chapter 1, it is now clear that, for decades, the Soviet Union conducted a massive biological warfare program in clear violation of the BWC. Moreover, there is strong evidence that, as glasnost gained momentum, the Soviet Ministry of Defense hid its biological weapons program from top leaders, including Gorbachev,[100] and explicitly lied about it to them. The Russian government now claims to have no offensive bioweapons programs. Indeed, even in light of the brutal conflict with Chechnya, it is difficult to see what use Russia would have for such programs.

However, Russia refuses to open up for inspection a range of sites that its Ministry of Defense admits were formerly bioweapons laboratories. In the absence of inspections, and in the absence of any alternative

[98] U.S. Department of State, "Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction", http://www.state.gov/t/ac/trt/4718.htm

[99] www.fas.org/nuke/control/bwc/text/bwc.htm

[100] Mangold and Goldberg, op.cit., p. 42.

explanation for the Russian government's refusal to open its facilities, it is impossible to discount entirely the possible existence of an ongoing Russian offensive biological weapons program (albeit one that is much smaller than that which existed in the 1970s and 1980s). Moreover, given the present state of disorder in Russia, it is plausible that the retention of a biological weapons capability is a continued act of defiance by the Ministry of Defense against the central government. One potentially important benefit of a BWC verification protocol would be the right it would give the international community to inspect these (presumably "former") biological weapons sites in Russia.

Unfortunately, even if we now presume Russian willingness, in principle, to accept an effective BWC verification regime, there are a number of other significant obstacles to the negotiation of a BWC verification protocol. Perhaps the most serious of these is the opposition of the US biotech industry. The biotech industry is innovative and fast-moving; commercial success depends upon rapid development and marketing of new products, and on large sales of these products in a narrow window of time before competitors emerge with similar products. As a result, the biotech industry is highly sensitive to the possibility that industrial espionage would accompany any inspections regime. Negotiating a verification protocol that would be both effective and acceptable to industry would be a daunting task.

Before concluding this discussion of the BWC, it is worth noting that, even in the absence of an effective verification protocol, the treaty may play an important role in helping to constrain the proliferation of biological weapons. This is because the treaty has helped to create and sustain an international norm against such capabilities. In addition to placing at least a moral barrier in the path of signatory countries that might seek a biological weapons capability, if it can be shown that a country legally bound by the BWC has violated the treaty, either by developing biological weapons or by allowing such weapons to be developed on its soil, the violation may provide an important justification for international sanctions or even preventive attack on suspected biological weapons sites. Put another way, by helping to place biological weapons beyond the moral, legal, political, and diplomatic pale, the BWC opens up avenues for counterbioterrorism that otherwise might not be available.

In this regard, it is worth noting as well that a number of countries that might be of particular concern—either because of their links to

terrorist groups or the danger that their governments might be replaced by extremist Islamic regimes—have ratified, or at least signed, the BWC. A ratified treaty is binding national law in the ratifying country, as well as international law. It remains in effect regardless of changes in government, unless the government explicitly executes the process of abrogation. Moreover, under the terms of the Vienna Convention, countries that have signed, but not yet ratified, a treaty are legally committed to take no steps that would prejudice ratification (see Figure 3). In the case of the BWC, this means that they are barred from irreversible steps including BW use. BW research and development, including design of new production facilities are also irreversible, and therefore have been foresworn by these states.

In contrast, if there were no BWC, biological weapons might be considered as legitimate as automatic rifles. Any nation or substate actor could research, develop, test, produce, and use them as if they were just another garden-variety class of weapons.

Lastly, treaty or no treaty, as a policy matter the United States appears committed to never again having an offensive biological weapons program. So the BWC's only impact is to constrain other people's weapons. Disputes over how much the BWC gains the United States should not obscure the fact that for this country, it's "no pain, some gain."

Recommendations

It is unclear whether it will ever be possible to negotiate a BWC verification protocol that will be both acceptable to all parties and effective in providing a useful measure of additional security. Efforts to negotiate such a protocol should, however, at least be attempted. A verification protocol that allowed for meaningful access to existing or suspected facilities where biological weapons-related work might be conducted (including no-notice inspections) could go far toward improving biosecurity worldwide.

Notwithstanding the difficulties noted earlier, the Clinton Administration's failure to negotiate a verification protocol should not be taken as conclusive evidence that it is impossible. Industry support is essential to agreements of this type. The Chemical Weapons Convention,

for example, became ratifiable only because of vigorous support by the Chemical Manufacturers' Association. An unfortunate exchange of letters between Vice President Al Gore and the Pharmaceutical Research and Manufacturers of America (PhRMA) led to strong antipathy between the Clinton Administration and PhRMA. Most of this tension appears to have resulted from a poor choice of words on both sides.[101] A new administration would not be burdened by this baggage and could conceivably reach agreement with PhRMA. Getting the approval of this group could substantially improve the prospects for successfully concluding a verification protocol.

Implementation of a BWC verification protocol would have some relatively modest budgetary implications. Extrapolating from the experience with the verification regime now in effect for the Chemical Weapons Convention, a reasonable estimate of budget requirements for BWC verification would be on the order of $300 million annually, of which the U.S. share would be about $70 million, according to the United Nations formula. If the regime is effective, this would be money very well spent.

If, despite good faith efforts, an agreement on a BWC verification protocol cannot be reached, consideration should be given to the use of other kinds of incentives to open up access to at least some of the sites of greatest concern, particularly the former biological weapons laboratories in Russia.

[101] Not-for-attribution briefings to the State Department Arms Control and Nonproliferation Advisory Board, of which this writer was Executive Director, 2000.

Figure 2: Countries Which Have Ratified the BWC

(Countries of present or significant future concern are in **boldface**)

Afghanistan
Albania
Algeria
Antigua and Barbuda
Argentina
Armenia
Australia
Austria
Azerbaijan
Bahamas
Bahrain
Bangladesh
Barbados
Belarus
Belgium
Belize
Benin
Bhutan
Bolivia
Bosnia-Herzegovina
Botswana
Brazil
Brunei Darussalam
Bulgaria
Burkina Faso
Cambodia
Canada
Cape Verde
Chile
China
Colombia
Congo
Costa Rica
Croatia
Cuba
Cyprus
Czech Republic
North Korea
Democratic Republic of the Congo
Denmark
Dominica
Dominican Republic
Ecuador
El Salvador
Equatorial Guinea
Estonia
Ethiopia
Fiji
Finland
France
Gambia
Georgia
Germany
Ghana
Greece
Grenada
Guatemala
Guinea-Bissau
Holy See
Honduras
Hungary
Iceland
India
Indonesia
Iran
Iraq
Ireland
Italy
Jamaica
Japan
Jordan
Kenya
Kuwait
Kyrgyzstan
Lao People's Democratic Republic
Latvia
Lebanon
Lesotho
Libya
Liechtenstein
Lithuania
Luxembourg
Malaysia
Maldives
Mali
Malta
Mauritius
Mexico
Monaco
Mongolia
Morocco
Netherlands
New Zealand
Nicaragua
Niger
Nigeria
Norway
Oman
Palau
Pakistan
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Poland
Portugal
Qatar
Republic of Moldova
Republic of Korea
Romania
Russian Federation
Rwanda
Saint Kitts and Nevis
Saint Lucia
Saint Vincent and the Grenadines
San Marino
Sao Tome and Principe
Saudi Arabia
Senegal
Serbia [and Montenegro]
Seychelles
Sierra Leone
Singapore
Slovakia
Slovenia
Solomon Islands
South Africa
Spain
Sri Lanka
Sudan
Suriname
Swaziland
Sweden
Switzerland
Tajikistan
Thailand
Macedonia
Timor Leste
Togo
Tonga
Tunisia
Turkey
Turkmenistan
Uganda
Ukraine
United Kingdom
United States
Uruguay
Uzbekistan
Vanuatu
Venezuela
Viet Nam
Yemen
Zimbabwe

Figure 3: Countries Which Have Signed, But Not Yet Ratified, the BWC

(Countries of present or significant future concern are in **boldface**)

Burundi
Central African Republic
Côte d'Ivoire
Egypt
Gabon
Guyana
Haiti
Liberia
Madagascar
Malawi
Myanmar
Nepal
Somalia
Syria
United Arab Emirates
Tanzania

Export controls

Export controls can also play an important part in helping to prevent the acquisition of biological weapons by terrorist groups. Export controls on commercially sensitive items (that is, items for which the primary purpose is economic) are administered by the Commerce Department, while those affecting weapons (that is, items for which the primary purpose is security-related) are administered by the State Department's Bureau of Political-Military Affairs. However, since the United States has no biological munitions and exports no commercially sensitive biological weapons technology, conventional export controls play a minimal role in the biological weapons context. Controls on biological weapons-related items fall under the State Department's Office of Chemical and Biological Weapons Threat Reduction (ISN/CB) of the Bureau of International Security and Nonproliferation (ISN), working through the Australia Group (discussed below).

The US government recognizes that unilaterally administered export controls on biological weapons-related material would, at best, be of only marginal usefulness. Since only the United States currently has the resources and technology needed to develop and produce such advanced conventional weapons as, for example, the F-22 fighter aircraft and the Virginia-class submarine, unilateral restraint could have a meaningful impact on the proliferation of such weapons. Such is not, unfortunately, the case with biotechnology. Advanced biotechnology is widely distributed and available around the world. If the United States were to refuse to export a biotech item, a comparable item would be available from another source, typically within a year or two at most. As a result, meaningful controls on biological weapons-related exports can only be achieved multilaterally.

Fortunately, a multilateral framework for addressing these kinds of export controls already exists, in the form of the Australia Group.[102] This is an association, now entering its third decade, of 39 BWC-member governments plus the European Commission. The Australia Group's focus on preventing the proliferation of both chemical and biological weapons and associated technologies is particularly useful in dealing with bioweapons exports because, as discussed above, the BWC itself presently has no follow-up, verification, or enforcement provisions. Figure 4 lists, along with the United States, the other members of the Australia Group.

Figure 4: Members of the Australia Group

Argentina	Germany	Turkey
European	Luxembourg	Czech Republic
Commission	Spain	Ireland
South Korea	Bulgaria	Norway
Romania	Greece	Ukraine
Australia	Malta	Denmark
Finland	Sweden	Italy
Latvia	Canada	Poland
Slovak Republic	Hungary	United Kingdom
Austria	Netherlands	Estonia
France	Switzerland	Japan
Lithuania	Cyprus	Portugal
Slovenia	Iceland	United States
Belgium	New Zealand	

While the Australia Group is technically an informal organization, it operates in a highly systematic and rigorous manner. Working in close consultation, and pooling their knowledge, the members of the group have been able to successfully agree upon a list of biological agents that should be controlled (see Figure 5), as well as develop uniform guidelines and minimum practices and controls for certain technologies.

[102] http://www.australiagroup.net/index_en.htm

Figure 5: Biological Agents on Australia Group Control List[103]

Viruses

V1 Chikungunya virus
V2 Congo-Crimean hemorrhagic fever virus
V3 Dengue fever virus
V4 Eastern equine encephalitis virus
V5 Ebola virus
V6 Hantaan virus
V7 Junin virus
V8 Lassa fever virus
V9 Lymphocytic choriomeningitis virus
V10 Machupo virus
V11 Marburg virus
V12 Monkey pox virus
V13 Rift Valley fever virus
V14 Tick-borne encephalitis virus (Russian Spring-Summer encephalitis virus)
V15 Variola virus
V16 Venezuelan equine encephalitis virus
V17 Western equine encephalitis virus
V18 White pox
V19 Yellow fever virus
V20 Japanese encephalitis virus
V21 Kyasanur Forest virus
V22 Louping ill virus
V23 Murray Valley encephalitis virus
V24 Omsk hemorrhagic fever virus
V25 Oropouche virus
V26 Powassan virus
V27 Rocio virus
V28 St. Louis encephalitis virus
V29 Hendra virus (Equine morbillivirus)
V30 South American hemorrhagic fever (Sabia, Flexal, Guanarito)
V31 Pulmonary and renal syndrome-hemorrhagic fever viruses (Seoul, Dobrava, Puumala, Sin Nombre)
V32 Nipah virus

Rickettsiae

R1 *Coxiella burnetii*
R2 *Bartonella quintana (Rochalimea quintana, Rickettsia quintana)*
R3 *Rickettsia prowazeki*
R4 *Rickettsia rickettsii*

Bacteria

B1 *Bacillus anthracis*
B2 *Brucella abortus*
B3 *Brucella melitensis*
B4 *Brucella suis*
B5 *Chlamydia psittaci*
B6 *Clostridium botulinum*
B7 *Francisella tularensis*
B8 *Burkholderia mallei (Pseudomonas mallei)*
B9 *Burkholderia pseudomallei (Pseudomonas pseudomallei)*
B10 *Salmonella typhi*
B11 *Shigella dysenteriae*
B12 *Vibrio cholerae*
B13 *Yersinia pestis*
B14 *Clostridium perfringens*, epsilon toxin producing types2
B15 *Enterohemorrhagic Escherichia coli*, serotype O157 and other verotoxin-producing serotypes

[103] The Australia group specifies that "Biological agents are controlled when they are an isolated live culture of a pathogen agent, or a preparation of a toxin agent which has been isolated or extracted from any source, or material including living material which has been deliberately inoculated or contaminated with the agent. Isolated live cultures of a pathogen agent include live cultures in dormant form or in dried preparations, whether the agent is natural, enhanced or modified. An agent is covered by this list except when it is in the form of a vaccine." Australia Group "List of Biological Agents for Export Control," see http://www.australiagroup.net/en/control_list/bio_agents.htm

Toxins and toxin subunits

T1 Botulinum toxins
T2 *Clostridium perfringens* toxins
T3 Conotoxin
T4 Ricin
T5 Saxitoxin
T6 Shiga toxin
T7 *Staphylococcus aureus* toxins
T8 Tetrodotoxin
T9 Verotoxin and shiga-like ribosome inactivating proteins
T10 Microcystin (Cyanginosin)
T11 Aflatoxins
T12 Abrin
T13 Cholera toxin
T14 Diacetoxyscirpenol toxin
T15 T-2 toxin
T16 HT-2 toxin
T17 Modeccin toxin
T18 Volkensin toxin
T19 Viscum Album Lectin 1 (Viscumin)

Fungi

F1 *Coccidioides immitis*
F2 *Coccidioides posadasii*

Genetic Elements and Genetically-Modified Organisms:

Genetic elements that contain nucleic acid sequences associated with the pathogenicity of any of the agents in the list.

Australia Group guidelines call for member governments to deny transfers of any listed items if they judge that the items are intended to be used in a biological weapons program, or for bioterrorism, or for diversion to other entities. Importantly, these guidelines provide specific operational details concerning a number of topics that are addressed only generically in the BWC, such as the specific agents to be regulated and how their possession is to be confined to defensive research.

The Australia Group meets formally only once a year, for three days. To an observer unfamiliar with multilateral operations, this may seem like a trivial and far too minimal schedule. In fact, however, as is the case with many multilateral operations, the formal meetings are only the most visible part of the process. A great deal of additional work is carried out "back channel," on an ongoing intersessional basis.[104]

Notwithstanding the important contribution made by the Australia Group in preventing the acquisition of biological weapons by either states or terrorist groups, the regime suffers from at least two serious shortcomings. First, at present, the group is essentially a "country club"

[104] For example, at the 2005 meeting the United States asked that 22 additional select agents be added to the Australia Group list. A working group was formed and, after a year of intersessional negotiation, three agents (*Coccidioides immitis, Coccidioides posadasii*, and verotoxin and shiga-like ribosome inactivating proteins) were added to the Australia Group list.

of well-behaved governments. It is extremely useful for these countries to administer export controls on biological agents in a coordinated and uniform manner, and in a way that helps foster the adoption of best practices. In the end, however, too many countries, including many with substantial and growing biotechnology sectors, remain outside the Australia Group.

Not only do these gaps in membership reduce the effectiveness of the export controls administered by the members of the Australia group, but the fact that the membership of the group is largely limited to Western, developed countries has generated resentment among non-member states. Specifically, some non-member states have accused the Australia Group of dividing the world into "haves" and "have-nots," in the manner of the Nuclear Nonproliferation Treaty. Since the members of the Australia Group have no biological weapons, this analogy and criticism is faulty. Nevertheless, the resentment is real, and it has helped to limit the Group's ability to influence exports by non-members.

A second limitation of the Australia Group is that, even within the group, good behavior is not compulsory. Although the members attempt to coordinate their controls and administer them in a consistent and uniform manner, ultimately, the implementation of the export controls it is left to the judgment of each individual member.

Recommendations

Efforts to strengthen the existing regime of biological agent-related export controls should focus on addressing the two limitations of the Australia Group noted above. To wit, the group's membership should be substantially expanded to include most, or possibly all, of the members of the BWC. Priority should be given, in particular, to gaining the participation of China.[105] Likewise, efforts should be made to transform the export controls and procedures agreed to as part of the Australia Group framework from advisory guidelines to mandatory requirements.

[105] China's economic significance is rapidly increasing in many areas, including biotechnology. China is also at a crossroads in terms of whether it will become more of a problem-solving, than problem-creating, member of the international community. Bringing China into the Australia Group could constitute a useful step in this direction.

The best approach would probably involve enacting these requirements through domestic legislation in each signatory country. Eventually, these export control measures might evolve into a protocol to the BWC. But, for the near term, that process, which may prove unnecessarily slow and cumbersome, should be avoided. If a new or existing member state refuses to legislate some of the Australia Group guidelines, this will point a finger of suspicion at that country, which might ultimately lead to UN sanctions or to a preventive strike (see Chapter 4).

US participation in the Australia Group generates no significant budgetary requirements. As Table 3 shows, total federal agency funding for the administration of export controls directly related to biosecurity currently amounts to only some $12 million a year.[106] This level of resources appears to be adequate. However, given the very low level of resources currently allocated to administering these export controls, if it were deemed necessary to substantially intensify or expand these efforts it would presumably be possible to do so with the addition of millions or, at most, tens of millions of dollars.

Threat Reduction Programs

The United States currently funds a number of programs aimed at preventing biological weapons proliferation in foreign countries. The largest and most long-standing such effort is focused on the former Soviet Union. In recent years, however, the United States has also begun to provide some support for similar efforts in a few other countries. This section provides a brief overview of the most important of these programs, which are those run by the Departments of State and Defense.

As discussed earlier, the Soviet Union conducted a massive bioweapons program for decades, and the former Soviet republics remain a focus of significant concern. A very large number of Soviet scientists who worked on offensive biological weapons programs during the Cold War are now deprived of that source of income, and there is a real risk that some of these individuals will turn their abilities to the service of al Qaeda or other terrorist organizations. Anecdotal reports indicate, not surprisingly, that well-funded terrorist groups have been shopping for former Soviet bioweapons expertise. Most disturbingly, a 2003 survey of

[106] This figure includes Commerce Department export controls ($6 million) and DoE export control and GIPP programs ($6 million).

Russian weapons scientists (not confined to bioweapons) found that 20 percent of them would consider working for proliferant states, including North Korea, Syria, Iran, and Iraq.[107]

In the case of almost all of the programs involving the former Soviet republics, the perennial debate centers on how much of the funding is lost to waste, fraud, inefficiency, and abuse—which plague operations there on a far larger scale than in the West.[108] The power of the Russian Mafia, particularly in Moscow and St. Petersburg, governmental corruption, excessive bureaucracy, lack of transparency, and substandard safety practices, all contribute to the problem of effectively engaging and assisting the former Soviet republics on the issue of biosecurity.

According to various experts,

> The lack of conformity with international biosafety and security standards by Russian and CIS [Commonwealth of Independent States] institutes is a leading factor in Western industry avoiding cooperation with them on pharmaceutical and biotechnology development. Training and certification efforts are being funded by Western governments, and are greatly appreciated by Russian and CIS recipients … There is very limited funding input from private entity partners in the biological area in Russia and the CIS. Therefore, there is a growing recognition that commercial ventures alone are not the sole or even best conduit to redirect biological scientists. Efforts to pull industry into ventures in these areas have largely been unsuccessful as the numerous regulatory, safety[,] … security, and political challenges in these nations loom as serious impediments … While the Russian side asserts that cooperation with bio-industry is the pathway to transforming their institutes, much more needs to be done to make industry aware of the opportunities, and

[107] U.S. Department of State, "Nonproliferation of WMD Expertise," http://www.state.gov/t/isn/c12265.htm

[108] In no sense should anything in this paper be read as a blanket condemnation of these societies. This writer has had extensive professional contact with former Soviet scientists and diplomats, and found many of them to be of the highest ability and integrity. But as they will freely admit, they operate in a culture that presents significant challenges.

> the Russian side needs to project to the West a more inviting environment. In most cases, industry has opted out of Russia in favor of investing in more promising countries like India and China, where facilities are more transparent, access is less restricted, and the sites have achieved, or are nearing, compliance with international biosafety standards.[109]

Notwithstanding these serious concerns, limitations and complexities, the massive size of the former Soviet biological weapons program, and the continuing danger that Russian bioweapons expertise and technology (or possibly even biological weapons themselves) will be acquired by a terrorist group, leaves the United States with little choice but to engage Russia in this critical area. In fact, in many respects, this engagement has, to date, been highly productive.

The centerpiece of US efforts within the former Soviet Union has been the Cooperative Threat Reduction (CTR) program. Originated as part of the Nunn-Lugar act of 1991,[110] the goal of this program is to work with former Soviet states to eliminate excess former Soviet WMD capabilities by deactivating and destroying excess and/or illegal WMD weapons, materials, and facilities, and by transitioning former WMD scientists and other workers to remunerative civilian work. The principal sponsors of this firmly bipartisan and visionary measure were Senators Richard Lugar (R-IN) and Sam Nunn (D-GA). In 2003, Congress authorized the expansion of this program to countries outside of the former Soviet Union. Sen. Barack Obama (D-IL) took over functional leadership of the Democratic side of the Nunn-Lugar program beginning in 2005.

The principal focus of Nunn-Lugar legislation has been on securing and eliminating former Soviet nuclear weapons and fissile material. A secondary focus has been on the destruction of chemical weapons and facilities. Stemming the proliferation of biological weapons technology and expertise has generally received third priority.[111]

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[109] Derek Averre, Kenneth Luongo, Maurizio Martellini , *Advancing International Cooperation on Bio-Initiatives in Russia and the CIS* , RANSAC conference report May 12, 2006, http://www.ransac.org/index.asp

[110] See Sen. Lugar's highly informative 2005 report and historical account, http://lugar.senate.gov/reports/Nunn-Lugar_Report_2005.pdf

[111] In 2005, a Lugar-Obama conventional disarmament initiative was also added to the program.

In August 2005, after more than a year of negotiation, Senators Lugar and Obama brokered a Nunn-Lugar Cooperative Threat Reduction agreement[112] between the United States and Ukraine to upgrade the security of pathogens stored at laboratories throughout Ukraine. It will also provide U.S. assistance to Ukrainian collection and research on anthrax and tularemia, which are two potential biological weapons agents that also create significant natural health issues in Ukraine.[113, 114]

The Defense Threat Reduction Agency (DTRA) operates the CTR program. The component of the CTR program focused on the threat posed by biological weapons is the Biological Weapons Prevention Program (BWPP).[115] Funding for this program currently amounts to some $68 million annually. This program supports security and safety upgrades at former Soviet laboratories conducting research on dangerous pathogens. This includes identifying and implementing structural improvements to enhance biosafety and biosecurity. Of equal importance, this program works with former Soviet republics to concentrate the storage of such dangerous pathogens at a smaller number of sites. This effort includes a military-to-military program in Kazakhstan and Uzbekistan to consolidate dangerous pathogens and monitor storage sites for theft, diversion, accidental release, or terrorist use.

Among the most important types of assistance provided to the former Soviet republics are programs aimed at preventing former Soviet bioweapons scientists from helping other states or terrorist groups acquire biological weapons. For example, the BWPP includes a Cooperative Biological Research (CBR) program designed to encourage former biological weapons scientists to pursue peaceful and profitable activities. Its stated objectives are to:

- Prevent the spread of biological weapons expertise from the former Soviet republics, and preempt the potential "brain drain" of scientists to rogue states;

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112 Lugar, op. cit.

113 forUm News, "Anthrax has been found in Khmeinitsky region, Ukraine," June 2, 2006, see http://en.for-ua.com/news/2006/06/02/112143.html

114 Gurycova D: "First isolation of Francisella tularensis subspecies > tularensis in Europe." *Eur J Epidemiol 1998: 14:797-802.,* see http://www.sld.cu/pipermail/farmepi-l/2005-December/001372.html

115 This should not be confused with the BioWeapons Prevention Program, which is an international Non-Governmental Organization also using the initials BWPP.

- Increase transparency at former Soviet biological institutes and encourage higher standards of openness, ethics, and conduct among scientists;

- Provide US access to this scientific expertise in order to enhance its preparedness against biological threats;

- Provide opportunities for transferring biological weapons pathogens to the United States for additional study, in order to strengthen public health capabilities and for forensics reference; and

- Refocus research priorities and projects at biological weapons institutes in the former Soviet republics toward peaceful purposes.

The State Department is also responsible for implementing a range of assistance programs and other activities related to preventing the spread of bioweapons expertise from the former Soviet republics. Total State Department spending on Nonproliferation of WMD Expertise (NWMDE), has averaged about $50 million annually in recent years, and currently amounts to about $53 million. This includes funding on efforts related to nuclear weapons and chemical weapons scientists, as well as biological weapons expertise.

The State Department currently operates three international programs under the NWMDE umbrella that are closely related to preventing, or at least discouraging, former Soviet bioweapons scientists from assisting either rogue states or terrorist groups.

One important element of the State Department's NWMDE effort is the Bio Industry Initiative (BII).[116] The goal of this program is to facilitate partnerships between US and Russian pharmaceutical companies. The 2007 budget request included $13 million for the BII. This represents a dramatic increase from the level provided in previous years—including the 2006 budget of $7 million and average annual funding of some $3 million for the 2002–05 period. This increased funding has, in effect, come at the expense of the Science Centers program (see below). The BII has two objectives: converting former Soviet biological weapons facilities and technology to peaceful purposes, and engaging former Soviet weapons scientists in civilian drug and vaccine development, focusing in particular

[116] http://www.state.gov/t/isn/rls/fs/24242.htm

on the threat posed by highly infectious diseases. This year will, hopefully, mark a turning point for the program, as BII begins conversion of former bioweapons facilities in Russia and Georgia.

Another major component of the NWMDE initiative is the Bio-Chem Redirect Program.[117] This program is designed to engage individual former Soviet biological weapons and chemical weapons scientists in long-term, unclassified civilian research projects with US collaborators. American participants in this effort include HHS, the United States Department of Agriculture (USDA) and the Environmental Protection Agency (EPA). In addition to activities in Russia, this program funds activities in Kazakhstan, Georgia, Armenia, Uzbekistan, and Ukraine. The 2007 request included $17 million for this program, roughly the same level of funding provided in 2006. Particularly noteworthy is the projected conversion to health-related biotech facilities of laboratories located at the infamous Vector (one of the two legal smallpox repositories in the world) and Obolensk complexes.

The third element of the State Department's NWMDE effort with the potential to help stem the flow of bioweapons (and other WMD-related) expertise from the former Soviet republics is the Science Centers initiative.[118] This consists of two intergovernmental bodies, one in Moscow and one in Kiev, created for the purpose of funding peaceful research opportunities for former Soviet weapons scientists. Countries that currently contribute funding to these centers include not only the United States, but also Canada, Russia Ukraine, Japan, the European Union, Kazakhstan, Belarus, Georgia, Uzbekistan, Armenia, the Kyrgyz Republic, Norway, Finland, and South Korea.

The US contribution to these centers averaged about $30 million annually over the 2000–05 period. In 2006, the US contribution fell to $21.5 million, with $22.7 million included for the program in the administration's 2007 request. Altogether, member state funding has exceeded $500 million for over 2,000 projects, reportedly involving more than 50,000 former Soviet scientists.[119]

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[117] http://www.state.gov/t/isn/rls/fs/32398.htm

[118] http://www.state.gov/t/isn/pp/c8498.htm

[119] The number of participating scientists may be overstated, as some scientists receive multiple grants and may be double or triple counted.

The Science Centers program, which has been in operation for well over a decade, is now being phased out.[120] The original concept behind the Science Centers was, in part, that it was better to pay former Soviet biological weapons scientists, and other WMD-scientists, to do anything at all (or even nothing at all), so long as the pay made it possible for them to feed their families without going into the employ of rogue states or terrorists. Now, however, the program has been sufficiently successful that it is focusing more sharply on moving the former biological weapons scientists into permanent civilian bioscience positions. Within that context, there is concern among some observers that some of the scientists remaining in this program are not trying to move toward independent sustainability and wean themselves from Science Center grants.

In addition to threat reduction programs focused on the states of the former Soviet Union, as noted earlier, in recent years the United States has expanded its efforts to involve some countries outside the former Soviet Union. Specifically, the State Department is now beginning programs to engage bioscientists from Iraq and Libya, with seed funding totaling about $3.5 million.

Since the program in Iraq is significantly hampered by the inability to restore and maintain security and infrastructure in that country, it has yet to be fully defined, much less implemented. For the present, it is confined to activities such as enabling Iraqi scientists to travel to and participate in international conferences, and supplementing their income. The relationships thus built could, among other things, prove helpful in relocating these scientists to responsible nations rather than nations under the sway of fundamentalist Islamist influences with possible links to terrorist groups.

Libya, on the other hand, is not plagued by domestic disorder and is showing encouraging promise. The Libyan government appears to have made a sincere decision to depart the dark world of international terrorism and to seek the sunlight of peace and prosperity. However, this program is still in the concept formulation stage. Thus, it is too early to reach any conclusions concerning the success of this effort.

In addition to these new programs in Iraq and Libya, the United States is investigating a further expansion of international biosecurity

[120] Commentary in this section primarily reflects the verbally stated views of highly qualified experts who request non-attribution

programs. Among other things, because of concern about avian flu, the number of BioSafety Level (BSL) 3[121] laboratories throughout the world is proliferating. There is reason for concern that pathogen collections located in these laboratories, and in the less advanced countries most immediately threatened by avian flu more generally, will not be adequately secured against bioterrorist theft. The US government is formulating a cooperative plan to work with governments in these areas to provide adequate pathogen security.

Recommendations

Notwithstanding the existence of variety of political, bureaucratic and other obstacles, overall, US efforts to improve biosecurity in the states of the former Soviet Union and other countries appear to represent prudent and cost-effective investments. As such, these efforts should be continued. In particular, it is necessary to maintain a significant level of engagement to remove incentives for bioweapons and related scientists to collaborate with Iran or countries, or terrorist groups, of concern.

Funding for both the Department of Defense and Department of State threat reduction programs appears to be sufficient and appropriate. In light of the large degree of overlap between the two programs, Congress may want to fund an examination by the National Research Council, or perhaps the Government Accountability Office, to determine whether combining the civilian programs could eliminate redundancy and improve overall efficiency. However, given the low budget levels associated with these efforts, compared to other national security programs and activities, and their potentially very high payoff in terms of improved security, if necessary, a certain amount of inefficiency or even waste may be tolerable.

Among the various threat reduction programs currently being funded, the BII program represents perhaps the most promising initiative. The BII program has a sound history, and the funding increase appears to be well directed. While providing additional funding for 2007 would be premature, it should be seriously considered for expanded funding in follow-on years if the 2007 experience is successful.

[121] BSL 3 laboratories are suitable for handling agents such as tuberculosis and avian flu. See the explanation of the four BioSafety levels provided in Figure 6 in Chapter 3.

Presuming some success in Iraq or Libya, the Department of State should consider applying lessons learned there to South Asia, elsewhere in the Middle East, and North Korea. While it is tempting to write off North Korea as a rogue state ruled by a hopelessly insular, corrupt, and perhaps irrational dictatorship, we should not exclude the possibility that a program could be designed that would be both effective and acceptable to North Korea. At this point it is too early to discuss specific budgets for these programs. However, given the level of funding provided for the programs in Iraq and Libya, annual budget levels in the tens of millions of dollars might go far toward expanding these efforts to other countries.

Chapter 3:
Defending Against Bioterrorism

If efforts to prevent terrorist acquisition and employment of biological agents fail, it may still be possible to limit (perhaps greatly) the number and severity of the casualties resulting from a biological weapons attack through a range of defensive countermeasures. Such countermeasures include:

- Medical countermeasures;
- Detect-to-warn capabilities; and
- Crisis management capabilities of the government and the medical community at all levels.

This chapter includes a concise overview and description of each of these activities, focusing on the most critical policy and programmatic questions. As in the previous chapter, each section also includes one or more recommendations for improving US efforts.

Far more is spent on defensive countermeasures than is spent on the preventive efforts discussed in the previous chapter. Altogether, 2007 federal funding for defensive bioterrorism efforts amounts to some $8 billion, compared to about $146 million for preventive measures. In other words, of the total funding provided for these two approaches to countering the threat posed by bioterrorism, about 98 percent is allocated to defensive countermeasures.

Although this chapter concludes that additional funding should be provided for various defensive bioterrorism efforts, as in the case of preventive measures, improving bioterrorism defenses is not simply a

matter of providing additional money. Perhaps even more so than in the case of preventive measures, improving the capacity of the United States to defend effectively against a bioterrorist attack will depend at least as much on making structural, organizational, attitudinal, and other changes. This chapter includes a discussion of the most critical of these primarily non-budgetary challenges, as well as recommendations for improving US capabilities in these areas, especially those related to effective response and consequence management.

Medical Countermeasures

Medical countermeasures can be divided into four categories:

- Isolation
- Physical Protection
- Vaccines and Therapeutics
- Facilitization

Isolation involves separating uninfected people from the disease agent. This practice extends back many centuries, most notably to the Middle Ages. At that time, towns uninfected by hemorrhagic plague refused to allow travelers to pass through their gates and, in some heroic cases, infected towns and villages voluntarily isolated themselves from contact with the outside world until the plague had passed and only the dead and the immune remained.[122]

Isolation is a relatively straightforward procedure against a non-contagious agent such as anthrax. Once exposed people, clothing, vehicles, and other items have been decontaminated, they simply need to be removed from the contaminated area. Infected people do not need to be separated from uninfected people, since the infection will not spread from the former to the latter.

Isolation is far more difficult and complex against a highly contagious agent such as smallpox. The problem becomes not merely technical and

[122] Susan Scott and Christopher Duncan, op.cit.

operational, but political as well, in that every infected person is both a constituent (and a beloved family member of other constituents), and a lethal threat to everyone with whom he or she comes into contact.

Isolation has strong advocates in the medical community today. One authority writes:

> Posters with dramatic photographs of florid smallpox cases should be distributed widely. No suspicious patient should be admitted to or even knowingly examined at a general hospital, even one with isolation facilities and an already vaccinated staff. Alternative dedicated facilities, even National Guard field hospitals, should be identified and activated at first diagnosis. Limited numbers of preselected (preferably older, previously vaccinated) field investigators, diagnostic laboratory personnel, caregivers, and paramedics and some law-enforcement personnel should be recruited, vaccinated, and committed to serve wherever necessary in the event of an introduction.[123]

In this context a 1970 incident in Meschede, Germany, is instructive.[124] In that case, a young German electrical engineer contracted smallpox in Pakistan and became symptomatic upon returning to Meschede. He was placed in an isolation room in an isolation hospital. The underlying vaccination rate in the community was already high, and everyone in the hospital was quarantined and re-vaccinated. Nevertheless, this single patient (who survived) infected 18 others, including one man who mistakenly walked into the hospital lobby, turned around, and left.

How did the disease spread despite the isolation procedures? The hospital had adopted a common-sense rule that anyone who saw the face of an infected person was considered to be exposed. Yet many cases broke out several floors above the patient's room, among patients and staff who had never seen the infected person.[125]

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[123] Thomas Mack., "A Different View of Smallpox and Vaccination," *New England Journal of Medicine* 348 (5), 460–463, January 30, 2003 http://www.ph.ucla.edu/epi/bioter/differentviewspox.html

[124] Massachusetts Medical Society, http://www.massmed.org/Content/NavigationMenu2/ClinicalAspectsofBioterrorism/SmallpoxIncidents/default.htm

[125] Toyin Ajayi, "Smallpox and Bioterrorism", Stanford Institute of International Relations, 1966a, http://www.stanford.edu/group/sjir/3.2.02_ajayi.html

Subsequently, the hospital hired a smoke-generation expert who produced smoke with particles approximating the physical behavior of smallpox. As the hospital staff watched in horror, the smoke drifted out of the window of the primary patient's room, and was carried by convection currents up the outside hospital wall and into open windows several floors above.[126] Today, with hospitals typically air-conditioned, we can expect the windows to be closed. But, in this case, the exhaust air may still pose a danger. In laboratories certified to work with smallpox and comparable agents, all exhaust air is filtered and sterilized. This is not the case with most hospitals. And it is certainly not the case with National Guard field hospitals. This means that many regular hospitals could prove ineffective in isolating diseases during an outbreak, and that National Guard field hospitals—which can be very helpful in responding to other types of emergencies—would be of limited effectiveness in these circumstances.

Recommendations: In order to improve its ability to quickly and effectively isolate infected individuals in the event of a biological weapons attack, the United States needs to greatly expand its stock of effective isolation units. This means that hospitals should be required to add filters and/sterilization equipment to their air-conditioning systems to ensure that no biological agents can escape from the hospital to the outside world. An effort should also be made to design and build affordable and portable blower units that could underpressurize rooms and, possibly by compression heating, sterilize exhaust air. This would enable a variety of spaces to be used, during a crisis, to isolate contagious patients. Consideration should also be given to creating mobile isolation units equipped with these blowers and filters to be used at National Guard field hospitals or similar emergency response facilities. At a minimum, a high priority should be placed on evaluating the cost and utility of such units, with the Defense Advanced Research Projects Agency possibly taking the lead in this effort.

Physical Protection

If isolation fails, as it likely will in many cases, some degree of protection against aerosol transmission—which is the most common method of transmission for most contagious biological agents—can be obtained at encouragingly low cost by the use of masks.[127]

[126] "Meschede Hospital Outbreak 1970, http://www.dmc.org/smallpox/presentations/Mothershead-Smallpox_files/frame.htm#slide0258.htm

[127] Lawrence M. Wein, "Face Facts", *New York Times*, October 25, 2006.

Industrial respirators cost from one to several dollars each; surgical masks cost approximately ten cents each. Generally, the more expensive the mask the better the filtration, the better the seal around the edges, and the less comfortable it is to wear. Since a mask that is not actually worn is useless, it appears that for most people, certainly for children, the cheaper and more comfortable masks are the better choice.

American industry does not have the capacity to produce a national supply of masks in the few days a bio-attack would allow. The Centers for Disease Control and Prevention has stockpiled 74.3 million respirators and 45.5 million surgical masks. Unfortunately, given the difficulties associated with quickly and efficiently distributing these masks—under circumstances that would likely encourage hoarding, panic, and disorder—and with the US population now topping 300 million, there is good reason to believe that this stockpile might be insufficient.

Recommendations: To improve the ability of the United States to protect its population from biological attack, by contagious agents in particular, it should take two steps, the costs of which, although uncertain, would likely be quite modest:

- Institute a public education campaign encouraging each family to stock at least two masks for each person in the household; and

- Conduct realistic red-teamed exercises to test if both the number of masks currently stockpiled and the existing distribution system are adequate.

The cost of purchasing additional masks would probably run between $100 million and $600 million. A red-team exercise to test the adequacy of the stockpile of masks and the distribution system would likely have relatively modest costs.[128]

[128] A preliminary survey of relevant high-level executives suggests that retail chain groceries, club pharmacies, and private community-based health service providers might cooperate effectively in distributing equipment and supplies during an actual crisis. Onora Lien, Beth Maldin, Crystal Franco, and Gigi Kwik Gronvall, "Getting Medicine to Millions: New Strategies for Mass Distribution" *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science Vol4, number 2, 2006,* http://www.liebertonline.com/doi/pdf/10.1089/bsp.2006.4.176?cookieSet=1. However, this capability needs to be realistically tested.

The eminent microbiologist Dr. Mathew Meselson[129] has suggested another, extremely low cost, form of mask protection. In one study he and his colleagues covertly videotaped audiences and found that a person typically touches his or her nose one way or another about 17 times per hour. From this finding, Meselson suggests that direct "nose-to-nose" aerosol transmission may not be the most common means of transmission. Instead of the victim directly inhaling the contagious agent from an infected person, a more common means of transmission may be from the infected person's nose to his or her hand to some object (doorknob, desk, etc.) that another person then touches, with that person subsequently touching his or her nose and thereby transmitting the agent. As such, he regards shaking hands as an abominable practice that should be categorically prohibited in any epidemic situation. He also concludes that there is value in any mask, however improvised and technically permeable, so long as it simply discourages the wearer from touching his or her nose.

In turn, Meselson's findings suggest that, during a crisis, the government should institute an education campaign via radio and television on the use of improvised masks. Doing so would not only be intrinsically beneficial, but would also reduce pressure toward a panic rush to buy manufactured masks. Prior to such a crisis, however, the government needs to have developed and tested an effective approach to implementing such an educational campaign. The cost of such an effort would be negligible.

Vaccines and Therapeutics

Vaccines are drugs that give people immunity to a disease. By contrast, therapeutics are drugs that are designed to cure a disease; they include antibiotics and antivirals. Vaccines and therapeutics will be critical components of any strategy to counter biological weapons. Some vaccines are entirely effective and present no complications. But the situation is more complex in other cases Smallpox vaccine, for example, will inevitably cause approximately nine deaths per million applications. It is, therefore, not recommended for general use during peacetime. But following a terrorist attack involving smallpox, such peacetime inhibitions would likely greatly diminish or disappear. Notwithstanding the small risks of complications and even death associated with the use of smallpox vaccine, under such circumstances "ring" vaccination around the infected area, as

[129] Personal communication with the author, November 12, 2006.

well as vaccination of medical personnel and other first responders, would be the most prudent course.

The US government has stockpiled doses of smallpox vaccine sufficient to cover 100 percent of the American people. But the same cannot be said in the case of many other diseases.

The pharmaceutical industry cannot, and should not, be expected to solve this gap in vaccine stockpiles on the basis of normal commercial practices. To bring a new pharmaceutical to market typically costs some $1 billion for basic development and certification.[130] Production, storage, and distribution costs vary widely, but another $1 billion represents a ballpark estimate of the costs typically associated with these activities.

While the probability of some kind of biological weapons attack is high, the probability of attack with any particular agent is low. No pharmaceutical company would be responsible to its stockholders if it spent on the order of $2 billion, plus periodic replenishment costs, to develop and produce a vaccine for which the probability of a market is low. On the other hand, the US government would be irresponsible if failed to take steps to acquire an array of pharmaceuticals to protect its citizens against the range of plausible biological agents that could be used in a terrorist attack.

Therapeutics constitute a second drug-based line of defense against biological agents. Like some vaccines, some therapeutics can also have potentially serious side effects. However, since they are, by definition, intended to be used only when an attack with biological agents is already under way, this is generally much less of a concern. The level of effort needed to develop therapeutics to counter specific diseases, as well as the costs associated with such efforts, is also similar to the case with vaccines. As such, the US government cannot and should not depend on the pharmaceutical industry to develop and produce such therapeutics.

There are basically two different approaches to the development and acquisition of vaccines and therapeutics that the United States could follow

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[130] In 2001, the Tufts Center for the Study of Drug Development estimated that the typical new drug had research and development costs of $802 million. Tufts E-News, "The Ballooning Price Tag," December 4, 2001, www.tufts.edu/communications/stories/120401BallooningCosts.htm. Even assuming those costs have, since then, grown only at the rate of inflation, this suggests average costs today (2007) of some $1 billion.

in order to prepare for a biological weapons attack: search for designer solutions or broad-spectrum solutions. The difference between these two approaches can perhaps best be demonstrated by considering how each would seek to respond to the ultimate biological weapons challenge: a genetically engineered and highly virulent contagious virus or bacteria about which we know nothing until it is used against us.

One way to address the dangers posed by such a threat would be to focus on the acquisition of drugs designed to counter the specific threat, and to reduce the "bug-to-drug" time. This would require developing the capability to analyze the DNA of a newly discovered biological agent and then develop a countermeasure in perhaps two months rather than the present ten years. Such a technological superhighway through the biotech infrastructure would be an immense step forward for peacetime medicine. It would require, among other things, massive supercomputing capability and undoubtedly, very high funding levels. Although providing a high confidence estimate of the costs of such an effort is beyond the scope of this report, a plausible estimate is that it would cost $50–60 billion over about ten years.[131]

Aside from the high costs that would likely be associated with an effort focused on developing designer solutions, it is far from clear that such a strategy would be effective for the purpose of countering bioterrorism. To develop a drug is one thing; to set up a production line, produce the drug in tens of millions of doses, and distribute it in time to be useful against a raging pandemic is another thing entirely. For a vaccine that must be administered within a few days of exposure, this time line is certainly too long. For a therapeutic, it also risks being too long, particularly for an initial attack. It is more likely to be effective against a reload attack, depending on the speed of transmission and speed of reload. But, even in the case of therapeutics, it would probably be defeatable by a terrorist group's use of the rapid reload tactic, especially if the terrorists also varied the agent used in each attack.

Given these limitations, a better solution would probably be to focus the greatest efforts on developing and stockpiling an array of broad-spectrum antibiotics and antivirals long before such an attack takes place. Because these therapeutics would be developed prior to an actual attack

[131] Dr. Andrew Feldman, Johns Hopkins Applied Physics Laboratory, direct communication with the author, October 25, 2006.

(unlike designer solutions developed in the immediate aftermath of an attack), they would have to be developed without knowledge of the specific characteristics of the agent. As a result, in strictly clinical terms, they would probably not have the same theoretical level of capability against particular designer threats as would designer solutions. However, this downside would be more than offset by the fact that such broad-spectrum solutions would be available for immediate use, while designer solutions would, in practice, be all too likely to arrive too late. Another advantage of broad-spectrum solutions is that, as the term suggests, even a single such therapeutic would have at least some level of effectiveness against a broad range of potential threats.

The cost of acquiring broad-spectrum solutions would, as with designer solutions, be potentially very high. As noted earlier, developing a new drug typically costs on the order of $1 billion. Since broad-spectrum therapeutics are, in some ways, more technically challenging, development costs might be another 20–100 percent higher in this case,[132] resulting in total costs of $1.2–$2 billion. If these efforts were conducted on a classified basis, the costs might be expected to rise by perhaps another 25 percent, leading to total development costs of roughly $1.5–$2.5 billion.

Not knowing the nature of the new broad-spectrum antibiotics and/or antivirals to be developed, it is impossible to know how many doses would need to be produced. But based on the production costs of other, existing drugs, a reasonable estimate might be $1–2 billion. It is also impossible to know how many different broad-spectrum therapeutics would need to be

[132] These estimates were derived by the author based on non-attributable discussions and communications with several academic scientists and a representative of a major pharmaceutical company. They also seem consistent with the finding that "biotechnology products," which require more extensive development efforts than traditional pharmaceuticals, cost an average of $1.2 billion to develop ("Average Cost to Develop a New Biotechnology Product is $1.2 Billion, According to Tufts Center for the Study of Drug Development," *Tufts Center for the Study of Drug Development, News and Events*, November 9, 2003, http://csdd.tufts.edu/NewsEvents/NewsArticle.asp/newsid=69) and other estimates, which suggest that the total cost of developing a new drug could be as much as $2 billion. (See, for example, a 2003 study by Bain & Co., which estimated total costs per drug of $1.7 billion. This is equivalent to $1.9 billion in 2007, assuming the general inflation rate, and well over $2 billion, assuming the higher inflation rate that has traditionally affected pharmaceuticals. Rick Mullin, "Drug Development Costs About $1.7 Billion," Chemical and Engineering News, Vol. 81, No. 50, December 15, 2003, p. 8, http://pubs.acs.or/cen/topstory/8150/print/8150notw5.html).

acquired to provide sufficient coverage of the full range of biological agents that could be developed by terrorists. If we assume, notionally, that a total of ten different drugs would have to be developed and produced, the total cost of acquiring these broad-spectrum therapeutics would be projected to reach about $25 billion[133] in the low-end case and $45 billion[134] in the high-end case.[135]

As noted earlier, for planning purposes, it seems prudent to assume that terrorists might acquire a highly virulent designer agent sometime within the next decade to several decades. Assuming total costs of $25–45 billion and a schedule ranging from 10–20 years for completing all ten therapeutics, [136] the annual costs of implementing an expanded effort to acquire broad-spectrum therapeutics could range from just over $1 billion a year, assuming the low-end estimate is correct and the effort were carried out over the next two decades, to roughly $5 billion a year, if the high-end estimate is assumed to be correct and the effort were carried out over the next ten years.[137]

Presently, drugs intended to counter biological weapons are developed and purchased by the government through Project BioShield. This program funds development efforts primarily through the National Institute of Allergy and Infectious Diseases of the National Institutes of Health, a division of the Department of Health and Human Services. BioShield is also used to purchases drugs and medical supplies for the Strategic National Stockpile, which would be drawn upon in the event of a bioterrorism attack. With BioShield funding currently totally about

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[133] This estimate assumes $1.5 billion in development costs and $1 billion in production costs for each of the ten drugs.

[134] This estimate assumes $2.5 billion in development costs and $2 billion in production costs for each of the ten drugs

[135] These estimates might overstate likely costs, given the possibility that such an effort would create substantial economies of scale. On the other hand, they could understate those costs if such an effort generated the need to create substantial additional development and manufacturing capacity in the pharmaceutical industry.

[136] The average drug currently takes some 12 years to develop. Tufts E-News, "The Ballooning Price Tag." Thus, ten to twenty years seems like a reasonable estimate of the amount of time that might be needed to develop a complex broad-spectrum therapeutic.

[137] This represents only a very rough estimate. Costs could be lower if, for example, fewer than ten drugs needed to be developed. Conversely, costs could be substantially—even dramatically—higher if, for example, the ten drugs were developed sequentially, each on an accelerated (e.g., five-year) schedule.

$1 billion per year, it is clear that moving ahead with the acquisition of a range of different broad-spectrum therapeutics, and doing so on an accelerated schedule, would require a dramatic increase in the budget for BioShield or a replacement program.[138]

In addition to scientific, technological and budgetary considerations, the development and use of vaccines and therapeutics to counter the threat of bioterrorism raises some critical tactical and ethical questions.

The tactical issue is whether the vaccines and therapeutics created specifically for counterbioterrorism should be kept secret. If potential bioterrorists know of the existence of such countermeasures they can focus on acquiring biological agents outside the covered spectra. However, revealing the existence of countermeasures could deter an attack and force the terrorists back to the drawing board, delaying the attack in a process that could, potentially, be repeated ad infinitum.

The deterrent effect caused by announcing the existence of medical countermeasures also raises the question of whether it might even make sense to, in some cases, falsely claim that countermeasures had been successfully developed—thus possibly deterring terrorist use of a threat agent that actually would have worked had it been used. In order to be most persuasive, such fake countermeasures should probably appear to be leaked, or discovered by spying, rather than openly announced.

The best tactic might be to combine the covert stockpiling of real vaccines and therapeutics, with the practice of occasionally revealing fake countermeasure, thus creating double uncertainty for potential bioterrorists.

Keeping the existence of vaccines and/or therapeutics secret would, of course, raise a number of significant ethical issues. Among the most difficult would be the question of what to do in the event of a natural

[138] BioShield has been subject to severe criticism because of its dispersed authority, back-end-loaded payment structures, and technical and management problems in its initial flagship project, the VaxGen anthrax vaccine. See for example ABC News Health, "Anthrax Dispute Suggests BioShield Woes", October 1, 2006, http://abcnews.go.com/Health/wireStory?id=2512978. Legislation to correct BioShield's deficiencies and replace it with a Biomedical Advanced Research and Development Agency (BARDA) within HHS, by Reps. Mike Rogers (R-MI) and Anna Eshoo (D-CA) in the House and Sens. Richard Burr (R-NC) and Edward Kennedy (D-MA) was passed by Congress in the final days of the 2006 session.

outbreak[139] of a disease that could only be effectively countered by the use of one of the secret drugs. In the Second World War, the Allies, at times, allowed friendly personnel to be killed because saving them would have revealed the fact that the Allies had broken the Japanese and German codes. Today the question might be: should a million civilians be allowed to die to keep the existence of a new vaccine or therapeutic secret? A hundred civilians? One civilian?

One possible solution would be to re-label the secret drug as a slight variation of an existing medicine, allow it to be used to counter the outbreak, and then have it quietly withdrawn. Obviously, the administration of a drug that is described as being something other that what it is also raises a host of safety, feasibility, and ethical issues.

Recommendations: Given the widely varied nature of the biological agents that might be used by terrorists in an attack against the United States, and the strengths and weaknesses of various approaches to developing, producing and distributing different types of medical countermeasures, it undoubtedly makes sense to take a multifaceted approach. Overall, however, for the reasons discussed above, the United States should probably focus the greatest effort on developing broad-spectrum solutions involving different kinds of therapeutics.

The discussion above suggests that conducting an accelerated effort to acquire a wide range of new broad-spectrum therapeutics could be very costly—with total costs ranging from roughly $1 to $5 billion a year, or possibly more. Recommending a specific level of funding for these efforts is impossible because of the great uncertainty surrounding these cost estimates—which, in turn, are due to a wide range of uncertainties concerning not only the cost of developing individual therapeutics, but the total number of different broad-spectrum therapeutics that should be developed, as well as the number of doses of each of these drugs that would need to be produced and stockpiled. It is also unclear how quickly these countermeasures need to be developed.

[139] The ability to effectively distinguish between natural and weapons-only pathogens is significant and increasing rapidly. Extensive research is being conducted to catalog the DNA of naturally-occurring pathogens and laboratory strains. For example, the anthrax spores mailed to various Senate offices in 2001 was quickly identified as the "Ames" strain, which is a laboratory strain not found in nature. As a result, investigators were able to rapidly conclude that the anthrax in question was a bioweapon.

In order to help resolve—or, at least, bound—these uncertainties, the United States should assemble a team of experts to immediately begin considering these and related questions. The findings of this team should then be used to provide more precise guidance for this initiative. Ultimately, however, it is likely that some significant, and possibly dramatic, increases in funding will be required.

Although less critical, the US government also needs to create a group to begin examining questions related to the use of secrecy and the release of false information related to countering bioterrorism. Scientists will tend to oppose secrecy and the spreading of false information; counterterrorism officials and expert will tend to favor the use of these measures.[140] Both sides, as well as other constituencies, should be represented in this study group, with the final decision made by, and responsibility accepted by, the president.

Facilitization

Having adequate numbers of laboratories that can conduct research and development of various countermeasures to biological weapons is critical to the success of US efforts to combat bioterrorism. Biological laboratories are categorized into four safety levels (see Figure 6).

[140] In the present political environment, a balanced evaluation is difficult. A study group appointed by the National Academy of Sciences would likely be weighted in favor of the scientific view; a presidentially-appointed commission would risk being unscientific. One possibility would be to appoint a commission chosen equally by the leadership of the two parties in Congress. Another would be to resurrect the 9/11 Commission, which operated with remarkable nonpartisanship and dedication to the national interest. The 9/11 commission would, of course, need to hire expert biomedical staff to support its investigation.

Figure 6: Biosafety Level Definitions (BSL)[141]

	BSL-1	BSL-2	BSL-3	BSL-4
Applicable for	Undergraduate and secondary education labs, where work is with "defined and characterized strains… not known to consistently cause disease in healthy humans"	Clinical, diagnostic, and teaching labs where research is primarily with "any human-derived" and other materials that are hazardous if exposed to skin or mucous membranes or if ingested; not transmissible through air	Facilities in which "work is done with indigenous or exotic agents with a potential for respiratory transmission, and which may cause serious and potentially lethal infection."	Research with "dangerous and exotic agents that pose a high risk of life-threatening disease… transmitted via the aerosol route and for which there is no available vaccine or therapy."
Examples of types of agents	*Bacillus subtilis , E. coli*	HIV, salmonella, anthrax	*M. tuberculosis*, highly pathogenic avian influenza A (H5N1)	Ebola virus, smallpox, Marburg virus
Practices and training	Standard microbiological practices	Limited access; biohazard warning signs; special practices for waste decontamination and disposal	BSL-2 practices, plus controlled access; waste decontamination; decontamination of lab clothing	BSL-3 practices, plus change of clothing before entrance; shower on exit; complete decontamination of material; special training
Safety equipment (primary barrier)	No special equipment necessary (besides standard gloves, lab coats, and protective eyewear)	Standard gloves, etc; Class I or Class II biological safety cabinets (BSCs) for physical storage and containment of agents	BSL-2 equipment (especially BSCs and enclosed chambers); possible respiratory protection	Class III BSCs; or Class I/II BSCs and full-body, air-supplied, positive pressure personnel "space suits"
Lab facilities (secondary barrier)	Open bench top sink for hand washing	BSL-1 facilities, plus availability of autoclave for decontamination	BSL-2 facilities, plus self-closing, double-door access; non-recirculated air; negative airflow into lab	BSL-3 facilities, plus separate or isolated building/zone; specialized supply and exhaust air, vacuum, and decontamination systems

[141] Analysis of Boston Public Health Commission's Proposed Biological Laboratory Regulations, Center for Arms Control and Nonproliferation, February 27, 2006.

It is widely recognized that BSL-3 and BSL-4 capacity in the United States is, at present, insufficient. That said, some observers also believe that the currently planned expansion of US capacity is excessive and wasteful, at best, and probably hazardous as well.

According to one estimate,[142] the United States needs about a 50 percent expansion of its BSL-3 and BSL-4 laboratory capacity, but is planning an expansion that would increase that capacity twenty-fold. Critics argue that such a large number of laboratories is unnecessary. For example, in a crisis, samples of biological agents are likely to be flown to a laboratory for analysis. In the context of the overall time cycle for responding, whether the sample must be flown 100 miles or 1,000 miles is likely to be of little significance. Moreover, excess capacity is possibly dangerous because it will inevitably result in more people handling more dangerous agents in more places under more systems of supervision—all of which will increase the risk of an accident or terrorist acquisition of an agent.

Critics argue that this excessive expansion of laboratory facilities derives from the FY 2003 appropriations acts, in which, in response to 9/11, Congress bestowed large undifferentiated biodefense appropriations upon various agencies—presenting them with a "use it or lose it" situation in which the only way to commit the funding before it expired was to obligate it for expensive, long-term facility construction. High-BSL labs are the most expensive laboratories to construct. The specific location of the new BSL-3 and BSL-4 labs was then determined more on the basis of individual member interest (that is, "pork") than national need.

The cost of BSL-3 and BSL-4 laboratories is difficult to estimate precisely because they usually become the core of large and expensive building complexes outside the BSL spaces themselves. But, as a rough estimate, a BSL-3 lab itself typically costs about $100,000 to build and $200,000 per year to operate, while a BSL-4 lab costs about ten times as much as a BSL-3 laboratory.

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[142] For example, Dr. Richard Ebright of Rutgers University, Dr. Mathew Meselson of Harvard University, direct communications with the author during October–November 2006.

Recommendations: Given the concerns raised above, Congress should direct the National Academy of Sciences to rapidly study, and report on, the question of how much additional BSL-3 and BSL-4 capacity is needed, and where it is needed. It is possible that the funds allocated to these facilities could be better used elsewhere, for example, for the development of broad-spectrum therapeutics.

Detection and Characterization Systems

The development of new and improved biodetectors is one of the most challenging and vigorously explored areas of science today. There are several levels of capability that can be useful in detecting biological agents.

The first stage of biodetection might be called "detect to warn." In this stage, the goal is simply to determine whether there is a dangerous biological agent approaching, so that efforts can be made immediately to either destroy the threat or, alternatively, to prevent any contact with the threat by keeping, or moving, people out of harm's way.

At the other extreme, contamination and exposure have already occurred, and the nature of the threat must be characterized precisely. Through the use of Polymerase Chain Reaction (PCR) technology, which is rapidly improving, a very small sample of DNA can be quickly reproduced, so that it can be analyzed and precisely diagnosed.

Technically, the greatest challenge is to design a detector that is small (a few pounds), able to sample and analyze a very wide variety of threat agents within a few minutes, affordable, and simple enough to be used effectively by public safety personnel. Such a device does not yet exist, but efforts to develop this capability are currently being pursued by a variety of different contractors and laboratories that are approaching the problem from multiple directions. Hopefully, these efforts will soon bear fruit, and the United States will be able to field a system capable of both detecting and characterizing biological weapons attacks effectively.

A more enduring challenge may be the pervasive peacetime mentality under which detectors will be used. In the course of numerous biodetection conferences attended by this writer during the 2003–2005 period, the

theme overwhelmingly stressed by government representatives was that detectors must provide essentially no "false positives"—that is, they must not generate false alarms. Unfortunately, a detector designed, or set, to minimize the number of false positives inevitably increases the risk of "false negatives"—that is, the likelihood that a real attack will not be detected, with potentially disastrous consequences.

This attitude reflects country's peacetime mentality vis-à-vis a possible bioterrorist attack. If a detector were, for example, to issue a false positive warning in a major airport, it would force a costly evacuation and short-term shutdown of the airport. Moreover, as a result, future warnings might very likely tend to be disregarded, or the airport management might demand removal of the detector altogether.

If, on the other hand, a detector were to suffer a false-negative reading, leading to large numbers of casualties, the dynamic would likely be reversed, at least temporarily: under these circumstances, the public and the electorate might demand no false negatives at any cost.

The best way to minimize the risk of both false positives and false negatives—beyond the obvious answer of designing and producing higher quality detectors—is to rely on multiple phenomenology. Specifically, this means using two or more detectors that operate on different principles, for example, mass-spectrometry and PCR.

Recommendations: The acquisition of effective biodetectors is critical to the effectiveness of US efforts to combat bioterrorism. The successful use of isolation, physical protection and medical countermeasures as means of countering attacks with biological agents, to a large extent, depend on receiving timely and accurate warning. Advanced biodetector research and development is primarily funded by the Department of Homeland Security Advanced Research Projects Agency (DHSARPA), which is housed in the DHS Science and Technology (S&T) directorate, and by the Defense Advanced Research Projects Agency (DARPA). Notwithstanding the importance of these programs, over the past few years, funding for biodefense in both DARPA and DHS S&T has declined, while DARPA's Immune Buildings program has run out of funding. These funding reductions should be re-evaluated.

Structural, Organizational and Other Challenges

While effectively defending against a potential bioterrorist attack will likely require increasing funding for a range of programs and activities, providing additional money will not, by itself, ensure an effective defense. Successful defense against a bioterrorist attack will also depend on overcoming structural, organizational and other (largely) non-budgetary challenges. This can be seen most clearly, and disturbingly, by looking at how such challenges have caused the US response to past emergencies—both simulated and real—to fail and, all too often, fail catastrophically.

Fortunately, the United States has not yet had to respond to a bioterrorist attack that threatened to produce mass casualties. A number of exercises have, however, been conducted to test US response capabilities, some of which have involved former or current senior government officials. Unfortunately, the results strongly suggest that the US response to an actual bioterrorist attack would be dangerously chaotic and disorganized. They also demonstrate that some of the most severe shortcomings cannot be effectively addressed by simply devoting more money to bioterrorist defenses.

Dark Winter and Other Bioterrorism Exercises

One of the most revealing simulations of US bioterrorism response capabilities was the Dark Winter exercise conducted in June 2001 by the Johns Hopkins Center for Civilian Biodefense Strategies, the Analytic Institute for Homeland Security, and the Oklahoma National Memorial Institute for the Prevention of Terrorism.[143]

As the Figure 7 shows, the persons participating in this exercise had occupied high and relevant offices.

[143] Tara O'Toole, Michael Mair, and Thomas V. Inglesby, "Shining Light on 'Dark Winter'" Center for Civilian Biodefense Strategies, Johns Hopkins University, Baltimore, Maryland, http://www.journals.uchicago.edu/CID/journal/issues/v34n7/020165/020165.html?erFrom=7001610300485931078Guest

Figure 7: Roles and Players in *Dark Winter*

Role	Player	Biography
President of the United States	Sam Nunn	Former Chairman, Senate Armed Services Committee
National Security Advisor	David Gergen	Former Counselor to the President
Director of the Central Intelligence Agency	R. James Woolsey	Former CIA Director
Secretary of Defense	John White	Former Secretary of the Army
Chairman, Joint Chiefs of Staff	General John Tilelli (USA, Ret.)	Former CINCKOREA
Secretary of Health and Human Services	Margret Hamburg	Former Assistant Secretary of HHS
Secretary of State	Frank Wisner	Former Under Secretary of State
Attorney General	George Terwilliger	Former Deputy Attorney General
Director, Federal Emergency Management Agency	Jerome Hauer	Former Emergency Management Director for New York City and Indiana
Director, Federal Bureau of Investigation	William Sessions	Former FBI Director
Governor of Oklahoma	Frank Keating	Incumbent Governor of Oklahoma
Press Secretary to Governor Frank Keating (Oklahoma)	Dan Mahoney	Gov. Keating's Press Secretary
Correspondent, NBC News	Jim Miklaszewski	NBC News Correspondent
Pentagon Producer, CBS News	Mary Walsh	CBS News Producer
Reporter, British Broadcasting Corporation	Sian Edwards	BBC Reporter
Reporter, The New York Times	Judith Miller	New York Times Reporter
Reporter, Freelance	Lester Reingold	Freelance Reporter

The Dark Winter simulation began with a simultaneous release of smallpox in Atlanta, Oklahoma City, and Philadelphia, directly infecting 3,000 people. The simulation assumed a transmission ratio of 10; i.e., each infected person would infect ten others.[144]

Smallpox spreads in "generations," with about ten days of latency between each spurt of transmission. Vaccination is only effective in the roughly first five days after exposure, which is well before symptoms appear.

Dark Winter assumed that 12 million usable doses of vaccine were available nationwide. These were quickly exhausted, leaving the NSC to consider major travel restrictions.

Twelve days into the scenario, the second generation of victims was beginning to appear nationwide and the US medical system was completely overwhelmed. Projections indicated 30 million cases by the fourth generation, with no end in sight to the "hockey stick" exposure curve (caused by the exponential rate at which the disease would spread).[145] Forcible restrictions on citizens were imposed, with the NSC considering martial law. But by then it was too late. The infection was nationwide.

With no solution in sight, the exercise was terminated on Day 13 as the second generation of victims was beginning to appear.

In retrospect, the designers of the study drew these conclusions:

1. Leaders are unfamiliar with the character of bioterrorist attacks, available policy options, and their consequences.

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[144] This assumption has generated considerable controversy, which we will not deal with here because our purpose is to examine defense against the full gamut of bioweapons and is not confined to the specific nature of smallpox.

[145] This is not to say that a single outbreak of a contagious disease would, even in the absence of effective countermeasures, necessarily spread globally. There would be some reduction in the transmission factor as a higher proportion of each infected person's contacts would be immune or already-infected people, or the dead, rather than new, vulnerable contacts. In addition, there is ample record of the spread of contagious disease tapering off as random mutation causes it to lose virulence. (See, for example, DM Collins, RP Kawakami, GW de Lisle, L Pascopella, BR Bloom and WR Jacobs Jr, "Mutation of the Principal σFactor Causes Loss of Virulence in a Strain of the Mycobacterium tuberculosis Complex," Proceedings of the National Academy of Sciences, Vol 92, p. 8036–8040.) Whether that would happen in a particular bioattack depends on the nature of the agent, climate, and other considerations.

2. After a bioterrorist attack, leaders' decisions would depend on data and expertise from the medical and public health sectors.

3. The lack of sufficient vaccine or drugs to prevent the spread of disease severely limited management options.

4. The US health care system lacks the surge capacity to deal with mass casualties.

5. To end a disease outbreak after a bioterrorist attack, decision makers will require ongoing expert advice from senior public health and medical leaders.

6. Federal and state priorities may be unclear, differ, or conflict; authorities may be uncertain; and constitutional issues may arise.

7. The individual actions of US citizens will be critical to ending the spread of contagious disease; leaders must gain the trust and sustained cooperation of the American people.

8. Current organizational structures and capabilities are not well suited for the management of a BW attack. Major fault lines exist between different levels of government (federal, state, and local), between government and the private sector, among different institutions and agencies, and within the public and private sector. These "disconnects" could impede situational awareness and compromise the ability to limit loss of life, suffering, and economic damage.

Of these eight conclusions, it is noteworthy that only two (numbers 3 and 4) involve areas where simply providing additional funding might be key to improving the effectiveness of the US response to a bioterrorist attack. The other six relate to primarily non-budgetary challenges.

Among the most pointed of these was the tension between federal and state authority revealed during the exercise. Although disease pathogens do not respect state boundaries, when the question of quarantine and isolation arose, Oklahoma Governor Frank Keating, playing himself (and doubtless reflecting the views of many governors), was adamant that decisions concerning these matters rested firmly in hands of state officials.

> My fellow governors are not going to permit you to make our states leper colonies. We'll determine the nature and extent of the isolation of our citizens....You're going to say that people can't gather. That's not your [the federal government's] function. That's the function, if it's the function of anybody, of state and local officials.[146]

The existence of these and other critical tensions and problems likewise plagued decision makers involved in a series of three government bioterrorism exercises conducted beginning in 2000. Named TOPOFF (top officials), these exercises were originally generated by 1998 legislation mandating a series of simulations involving top federal, state and local officials who would have key roles in responding to a WMD attack. The one about which the most useful written commentary is available is TOPOFF 1, held in May 2000. Some feel for the chaotic nature of the response in TOPOFF 1, which involved a simulated bioterrorist attack on Denver, can be gleaned from the following commentary.

> Although the state public health agency was cited by some of the senior health participants as the agency with the highest authority in the exercise, two other participants in the exercise said that it was not clear who was in charge. Another observer said that the FBI was operating under the assumption that the State Attorney General's office was the organization with highest authority because this is the ranking state office to which the FBI reports in a crisis.
>
> Decision-making processes were problematic. The governor's committee operated by very large conference calls, at times including as many as 50 to 100 persons, which led to inefficiency, indecisiveness, and significant delays in action. Many of the participants in the calls had never worked with or even met each other. At times, it was not clear who was in charge of the call. The calls were literally running one into the next, taking people out of their usual roles and putting them on the telephone. There was a clear tension between the need to make the right public health decisions and the need to make decisions urgently ...

[146] Tara O'Toole, Michael Mair, and Thomas V. Inglesby, "Shining Light On 'Dark Winter,'" Clinical Infectious Diseases, 2002; 34, p. 985. See http://www.journals.uchicago.edu/CID/journal/issues/v34n7/020165/020165.html?erFrom=6835099016729185631Guest

> The next category of lessons surrounded priorities and logistics for distributing resources. With local sources of antibiotics depleted relatively early in this exercise, initially there was no consensus about priorities. This was partially addressed by the governor's committee when it decided to offer antibiotic prophylaxis to EMS officials, police officers, hospital workers, and their families. The decision to treat families was intended to maintain medical and emergency responders' willingness to work knowing their families are at home protected with antibiotics. However, decisions about priorities quickly became much more complicated as the epidemic spread. (A key question was whether it was justifiable to give prophylaxis to family members who were not exposed, if that meant denying it to exposed persons not related to health workers.) There was disagreement on which antibiotics should be given and whether they should be given only to contacts of plague patients or to the general population. There was disagreement as to the prevailing strategy for prioritization.
>
> 'Decisions made on Saturday were reversed on Sunday morning, then reversed again Sunday afternoon,' commented one individual. 'Reversing decisions back and forth is the antithesis of crisis management and efficient decision-making,' another observer remarked. 'The time frame that public health is accustomed to dealing with is not what is needed for bioterrorism. In [this type of crisis], one needs to make decisions quickly. You don't have the luxury of time to do more research.'[147]

Another illuminating, and disturbing, bioterrorism exercise was the Atlantic Storm simulation conducted on January 14, 2005. Atlantic Storm was a real-time seven-hour table-top exercise conducted in Washington, DC, by the Center for Biosecurity of the University of Pittsburgh Medical Center (UPMC; http://www.upmc-biosecurity.org) and the Center for Transatlantic Relations of the Johns Hopkins University (http://transatlantic.sais-jhu.edu). Figure 8 lists the participants and their roles. As was the case with Dark Winter, participants were active or former high-level officials well-equipped to play their roles.

[147] Thomas V. Inglesby, Rita Grossman, and Tara O'Toole, A Plague on Your City: Observations from TOPOFF, Clin Infect Dis. 2001 Feb 1;32(3):436–45. Epub 2001 Jan 29, http://www.journals.uchicago.edu/CID/journal/issues/v32n3/001347/001347.web.pdf?erFrom=6090867033894651102Guest

Figure 8: Roles and Players in *Atlantic Storm*

Role	Player	Biography
Prime Minister of Canada	Barbara McDougall	Former Foreign Minister of Canada
President of the European Commission	Erika Mann	Member of the European Parliament
Chancellor of Germany	Wemer Hoyer	Member of the German Bundestag, Former Deputy Minister of Foreign Affairs of Germany
President of France	Bernard Kouchner	Member of the European Parliament, Former Minister of Health of France, Founder of Médecins Sans Frontières
Prime Minister of Italy	Stefano Silvestri	Former Deputy Minister for Defense of Italy
Prime Minister of the Netherlands	Klass de Vries	Former Minister of Interior of the Netherlands
Prime Minister of Poland	Jerzy Buzek	Member of the European Parliament, Former Prime Minister of Poland
Prime Minister of Sweden	Jan Eliasson	Ambassador of Sweden to the U.S., Former Undersecretary General for Humanitarian Affairs at the United Nations
President of the United States	Madeleine Albright	Former Secretary of State of the United States
Prime Minister of the United Kingdom	Sir Nigel Broomfield	Former Ambassador of the UK to Germany
Director-General, World Health Organization	Gro Harlem Brundtland	Former Prime Minister of Norway, Former Director-General of the World Health Organization

In the Atlantic Storm scenario, smallpox had been released in transportation hubs and centers of commerce in six major North Atlantic cities, including New York and Los Angeles. US vaccine stocks were sufficient for 100 percent of the US population, but global stocks would only cover 10 percent of the world's population. Of the countries participating in the exercise, the United States, United Kingdom, Germany, France, and Netherlands had enough vaccine for 100 percent coverage, while stocks were sufficient for only partial coverage in Canada (20 percent), Italy (10 percent), Sweden (10 percent), and Poland (5 percent).[148]

[148] These figures reflect actual national stockpiles at the time of the exercise.

As was the pattern in the previous exercises discussed above, highly capable officials thrown into such a novel and stressing environment did not perform well.

> *Atlantic Storm* showed that a set of highly accomplished political leaders were largely unfamiliar with the political and strategic stakes that might be associated with biological attacks or natural pandemics—for example, how to respond to mutual defense requests, how to balance national interests with the objective of ending an international epidemic, and the like—and they were not prepared to respond effectively at the pace and on the scale demanded by the crisis.[149]

Hurricane Katrina and Other Natural Disasters

Although the United States has no experience dealing with an actual bioterrorist attack that threatens to cause mass casualties, it does have experience responding to other kinds of major disasters. Unfortunately, these experiences provide little reason for any greater optimism concerning the US ability to effectively respond to a bioterrorist attack. The numerous failings of the US response to Hurricane Katrina in August 2005 have been discussed at great length elsewhere, and will not be repeated here. It is, however, worth noting that in the case of Katrina, as with the bioterrorism simulations discussed above, lack of sufficient resources was far from the only, or perhaps even the most important, shortcoming.

As in the case of the bioterrorism exercises, the chaos and ineffectiveness that marked the US response to Hurricane Katrina resulted largely from structural, organizational and other largely non-budgetary problems. Among the most highly publicized examples of disorganization was one recounted by *The New York Times*:

> It was the third night after Hurricane Katrina drowned

[149] Bradley T. Smith, Thomas V. Inglesby, Esther Brimmer, Luciana Borio, Crystal Franco, Gigi Kwik Gronvall, Bradley Kramer, Beth Maldin, Jennifer B. Nuzzo, Ari Schuler, Scott Stern, Donald A. Henderson, Randall J. Larsen, Daniel S. Hamilton, and Tara O'Toole "Navigating the Storm: Report and Recommendations from the *Atlantic Storm* Exercise," *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science*, Volume 3, Number 3, 2005, p. 261.

> New Orleans, and Gov. Kathleen Babineaux Blanco needed buses to rescue thousands of people from the fetid Superdome and convention center. But only a fraction of the 500 vehicles promised by federal authorities had arrived.
>
> Ms. Blanco burst into the state's emergency center in Baton Rouge. "Does anybody in this building know anything about buses?" she recalled crying out. [150]

As she spoke, hundreds of locally-owned school buses were sitting in parking lots unattended and being slowly submerged by water.[151]

Another example of how shortcomings in planning and organization can have as devastating an impact on response capabilities as insufficient funding can be found in the response to Hurricane Rita, which hit Houston less than a month after Hurricane Katrina devastated New Orleans. One of the primary evacuation routes out of Houston was Interstate 45. The outbound lanes of I-45 quickly became a 17-mile parking lot, while the inbound lanes were vacant. The Governor of Texas then ordered contraflow—that is, the inbound lanes were to be switched to outbound flow. Reversing traffic flow so that people can go in the direction in which they badly want to go would not seem to be a difficult task. Yet it took 27 hours to implement the contraflow. For 27 hours, the American people could watch news coverage of a disaster in the outbound lanes sitting placidly next to the wide open spaces of the inbound lanes.

Recommendations

A number of lessons might be drawn from the experience gained in various bioterrorism simulations conducted over the past few years and in real life responses to major natural disasters like Hurricane Katrina. Some of these relate to the need to devote greater resources to certain programs and activities. For example, in each of the bioterrorism exercises discussed above, response capabilities would have been improved had the

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[150] "Breakdowns Marked Path From Hurricane to Anarchy," *The New York Times*, September 11, 2005. See http://select.nytimes.com/search/restricted/article?res=F20615FF3B550C728DDDA00894DD404482

[151] Ibid.

United States and (in the case of Atlantic Storm) other countries spent more money on developing and stockpiling vaccines. However, the most obvious lessons from these exercises and real world experiences appear to relate, at least as much, to the need for structural, organizational and other changes.

One lesson concerns the need to federalize the US response to a bioterrorist attack. An even clearer and more prominent lesson is that the United States needs a realistic and robust program of bioterrorism exercises, especially for high-level decision-makers. Absent these changes the US response to a future bioterrorist attack is likely to prove woefully inadequate no matter how much money is added to solve the various programmatic shortcomings discussed earlier in this chapter.

Federalize Authority

Disease pathogens do not respect state boundaries. Contagious disease transmission and the utility of countermeasures against it are no different in Oklahoma than in Texas, Nebraska, or Kansas. Moreover, even in cases where non-contagious agents (such as anthrax) are involved, there is the potential for mass casualties and the real danger that an attack on one city will be followed by attacks in other cities and states (the "reload" capability discussed in Chapter 1). Given these realities, final authority and responsibility for directing US. bioterrorism efforts, including response and consequence management activities, must reside with the federal government.

This authority must be established in law. Upon declaration that the United States is under WMD attack, the law must require that all military, public safety, and health agencies immediately fall under federal control. Passage of such legislation will not be legally or politically simple. But it is far better to hash out these issues in the cool of peacetime than in the blistering heat of a bioterrorist attack.

The supremacy of federal authority must also be extended to certain pre-emergency programs and activities. Among other things, this means that federal standards must be imposed on communications systems to ensure effectiveness and interoperability. This too will require overcoming a long tradition of state and local control in certain areas, and strong views against federalizing such authority in some quarters.

An example of how strong the opposition is to imposing federal standards on communications equipment, even among some federal officials, is demonstrated by the remarks of Adm. James Loy, who was a top official at the DHS until January of 2006. Reportedly Adm. Loy stated that it would be "Orwellian to impose such standards."[152]

Require Realistic and Frequent High-Level Exercises

A concert violinist rehearses intensely for years before her first major solo performance. A baseball player does intense spring training every year before the real season. A fighter pilot rehearses air-to-air combat intensely in order to fly like a veteran ace in his first real combat. Any capable person in these and many other occupations well understands that practice is critical to success, and that the lack of practice can lead to catastrophic failure. But presidents do not rehearse dealing with bioterrorist attacks, any more than Gov. Blanco had rehearsed dealing with buses. As things stand now, in dealing with a future bioterrorist attack, presidential authority will be in the hands of a rookie heading a team made up largely of novices.

Visualize the emergency meeting in the White House Situation Room. Information arriving is spotty, incomplete, and constantly changing. But it portrays a picture that is bad and getting worse. The president needs to make decisions that could mean life or death for millions of Americans. All of the options are bad. Should quarantine and/or isolation be enforced? How rigorously? To what degree should transportation be restricted or shut down? How should supplies, vaccines, and therapeutics be allocated? There is disagreement between the scientists, the military, the intelligence experts, and the domestic security experts. Within each group, there is internal disagreement.

The president does his best to sort through the information and the conflicting recommendations. But as former CIA Director James Woolsey observed in the Dark Winter exercise, "we are in a world we haven't ever really been in before."[153] In such a world, the president is not equipped to choose the least worst of the alternatives before him.

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[152] PBS Frontline interview with Louisiana Gov. Kathleen Blanco, Oct. 12, 2005. See http://www.pbs.org/wgbh/pages/frontline/storm/interviews/blanco.html

[153] Tara O'Toole, Michael Mair, and Thomas V. Inglesby, "Shining Light on 'Dark Winter,'" *Clinical Infectious Diseases* 2002:34 P979. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11880964&dopt=Citation

The best way to avoid this kind of situation is—to the extent possible—to immerse high-level officials, including the president, in realistic simulations of bioterrorist attacks, so that that if and when they are confronted with a real bioterrorist attack they will be able to operate, if not perhaps as seasoned veterans (there are limits as to how much even the best simulation can capture the tensions, stress and complexities of real world events), at least not as rookies in a state of shock.

To ensure adequate practice among senior officials, legislation should be enacted that would require that the president, and the other high-level officials who would constitute the response team in the event of a real bioterrorist attack, periodically take part in realistic bioterrorist exercises. This does not mean simply continuing with the TOPOFF series of simulations. Although providing some valuable lessons, these exercises have suffered from some serious shortcomings. Perhaps most importantly, they have not adequately involved top officials, or operated under sufficiently stressful conditions. Getting the most of these exercises requires a far more rigorous and serious effort. This means:

- Simulations lasting at least three days, held twice yearly. Participation by all relevant cabinet officials, governors—the real people, not surrogates—and other key personnel should be required.

- The president or vice president should lead the exercise.

- The experience must be total immersion, to induce realistic fatigue. A round-the-clock exercise would be best, but the minimum should be twelve hours per day.

Given the tight schedules and often overwhelming workloads of the president and other senior government officials (including state and local as well as federal officials), scheduling and carrying out such high-fidelity exercises on an ongoing basis will undoubtedly prove burdensome. But in this, as in many other areas of life, there is simply no substitute for them. And, unlike almost any other area, in this case the failure to practice—and to practice through realistic exercises that involve the president and other senior decision-makers—could have catastrophic consequences.

Chapter 4:
Attacking Bioterrorist Targets

Another important element in the US repertoire of capabilities to counter bioterrorism is the ability to destroy or disrupt terrorists' biological warfare assets through preventive or retaliatory offensive operations. For a variety of reasons, chiefly the small-to-nonexistent signatures of biological weapons stockpiles and development facilities, the opportunity for the US military to attack bioterrorist sites and personnel are likely to be rare. Conducting strikes against bioterrorist targets located in foreign countries may also create difficult political and diplomatic conditions.

Nevertheless, if the opportunity arises, strong consideration must be given to this option, even if—or perhaps especially if—the opportunity for a preventive strike materializes.[154] Given the possibility that a bioterrorist attack against the United States could cause mass casualties, the United States certainly cannot and should not foreswear this option. That said, maintaining the viability of this option also requires that, through diplomatic and other efforts, the United States seek to minimize—to the extent practicable—any negative international fallout from such an operation.

Estimating how much the United States spends annually to support its ability to carry out offensive strikes against bioterrorist targets is even more difficult than estimating federal funding for preventive and defensive measures aimed at combating bioterrorism. This is because the forces and

[154] Preemptive attacks are those carried out in the face of what is believed to be an imminent attack by the other side (in this case, a biological weapons attack by terrorists). By contrast, a preventive attack does not necessarily presume that an attack by the other side is imminent. Indeed, a preventive attack might be carried out before the other side has fully acquired the capability, or the intention, to launch an attack. Given the difficulty of finding bioterrorist sites, and the magnitude of the danger posed by such weapons, it would not generally be prudent to wait until a biological weapons attack was imminent to strike such a site—rather the site should generally be hit as quickly as possible after it is located and identified.

weapon systems that might be most heavily relied upon to conduct such an attack—including bombers and other combat aircraft, special operations forces (SOF), reconnaissance aircraft and other support capabilities—could also be used to carry out combat operations against a wide range of other targets the US military might be required to engage (e.g., conventional ground, air, or naval forces, or other kinds of WMD targets, such as nuclear weapons-related facilities). Although it is impossible to provide a precise estimate of spending on these capabilities, the amount likely totals tens of billions of dollars annually, even if the types of forces that might be used in such attacks is construed relatively narrowly.[155]

As in the case of the previous chapters on preventive and defensive policies and programs aimed at countering bioterrorism, this chapter includes both a description of current policies, programs and activities, and recommendations for changes in each of these areas. However, in this case, because most of the capabilities relevant to attacking bioterrorist targets are more or less generic capabilities equally—and in many cases better—suited for destroying or disrupting conventional targets, as well as other types of WMD, this chapter does not attempt to provide a comprehensive assessment of these capabilities or their costs.

Instead, the discussion in this chapter focuses primarily on policy and use-of-force issues pertaining particularly to the question of whether and how such capabilities should be employed against bioterrorist targets (with these conclusions also being relevant, to varying degrees, in the case of other WMD targets).

This chapter first discusses the military and political challenges that would confront the United States in contemplating and carrying out an attack on bioterrorist targets, especially in the case of a preventive strike. It then discusses a number of recommendations concerning how such attacks—if deemed necessary and appropriate—should be made. Lastly, this chapter includes a brief discussion the Proliferation Security Initiative (PSI), a multilateral effort aimed at interdicting shipments of WMD and missile components, before they reach US shores.

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[155] The annual cost of equipping, operating and supporting US special operations forces alone amounts to some $10 billion (this includes a proportional share of overhead and indirect operations and support costs).

Military Challenges

The US military's precision-strike capabilities have improved dramatically over the past decade-and-a-half. Some notion of the extent to which this capability has grown can be seen by comparing the increasing share of air-delivered ordnance that has been accounted for by precision-guided munitions (PGMs) in recent conflicts. In the 1991 Gulf War, PGMs accounted for some 8 percent of the bombs dropped. By the time of the 1999 war in Kosovo the share reached 29 percent. And most recently, during the initial (conventional) phase of the war in Iraq, PGMs accounted for some 64 percent of the air-delivered ordnance.[156] Moreover, the already immense US precision-strike conventional capability will be further improved in coming years, among other things by the deployment of Trident II submarine-launched ballistic missiles with conventional warheads, as well as the acquisition of new, smaller and more accurate air-delivered PGMs designed, among other things, to reduce collateral damage.

Unfortunately, the ability of the US military to effectively detect, identify, characterize, and track targets is considerably less robust than its ability to attack and destroy targets. The 1999 bombing of the Chinese embassy in Belgrade is a prime example of this deficiency. A B-2 bomber armed with PGMs worked perfectly, scoring direct hits on the assigned target. But due to spectacularly defective intelligence, the assigned target, which the mission planners believed to be a warehouse, turned out to be the Chinese embassy.

These deficiencies in US intelligence capabilities are especially significant in the case of counterbioterrorism. Biological weapons facilities may be very small and indistinguishable from benign facilities. Unlike chemical and nuclear weapons facilities, biological facilities do not necessarily give off chemical, radiological, or isotopic emissions that can be monitored by external air, water, or ground sampling. In some cases, a very small DNA alteration is all that distinguishes a harmless legitimate research organism from a highly virulent biological agent.

In addition, because of their small size, biological weapons facilities may be relatively easily relocatable. Even more importantly, the personnel operating these facilities can escape if given even a moment's notice. And the same characteristics that make the location of a biological weapons target difficult to detect and identify, make it even more difficult to remotely determine if the target has been functionally destroyed.

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[156] Steven M. Kosiak, *Matching Resources With Requirements: Options for Modernizing the US Air Force* (Washington, DC: CSBA, 2004), p. 53.

Notwithstanding these difficulties, signals intelligence and other national technical means of intelligence gathering can, on occasion, provide valuable information concerning actual or incipient biological weapons programs. Among other things, such intelligence might help identify the construction of laboratories and the ordering or manufacture of specialized equipment.

That said, the key to effective counterbioterrorist intelligence is human intelligence (HUMINT). Biological weapons programs may not give off characteristic emissions and may not require electronic communications, but they cannot avoid the need for skilled and educated personnel to do their work. The level of effort, as well as funding, allocated to HIMINT is highly classified.[157] It is clear, however, that US HUMINT activities currently suffer from at least one shortcoming that might critically impede the effectiveness of its efforts to combat bioterrorim, as well as terrorism more generally—a shortage of Arabic speaking analysts and operatives.[158]

As a result of these deficiencies in existing intelligence and detection capabilities, and the inherently small signature associated with bioterrorist sites and personnel, the opportunities for the US military to attack such targets are likely to be rare. Increasing these opportunities will require making significant improvements in US intelligence capabilities.

Political challenges

Contemplating and executing an attack on bioterrorist sites would also require addressing and overcoming a number of political and diplomatic

[157] HUMINT activities absorb a relatively small fraction of the overall US intelligence budget. According to the Intelligence Authorization Act of 1998, for example, HUMINT accounted for a "single digit" percentage of the overall US intelligence budget in that year. (*HR 105–135 Part 1, Intelligence Authorization act of 1998*, http://thomas.loc.gov/cgi-bin/cpquery/?&sid=cp1056zbJJ&refer=&r_n=hr135p1.105&db_id=105&item=&sel=TOC_68979&). However, given the large size of the overall intelligence budget, reportedly amounting to $44 billion in 2005 (Paul Bedard, "This Time We Know Who the Leaker Is," *US News and World Report*, November 14, 2005, www.usnews.com/usnews/politics/whispers/articles/051114/14whisplead.htm), total funding for HUMINT could still amount to billions of dollars.

[158] Dan Ephron. "Smart, Skilled, Shut Out: Intel Agencies are Desperate for Arabic Speakers, So Why do they Reject Some of the Best and Brightest," *Newsweek*, January 6, 2006, www.msnbc.msn.com/id/13392191/site/newsweek/

challenges, especially in the case of a preventive strike. International support for such an attack, as well as cooperation and assistance from US friends and allies, would be most likely to be forthcoming if the United States were able to gain prior approval for the action from the UN Security Council. And, in some exceptional cases it may be possible to do so. However, such approval is generally likely to be difficult or impossible to get. More importantly, given the need for speed and secrecy, in practice, it would probably rarely make sense to even seek such approval.

The support of the UN provided important diplomatic cover for US and allied forces during the 1991 Persian Gulf war. That support was, in turn, in large part generated by the fact that Saddam Hussein had crossed his country's border to invade another state. Such visible and unambiguous aggression is rare, and differs markedly from the kind of evidence that is likely to be available in the case of a suspected bioterrorist site.

Moreover, lining up support for a preventive strike against a bioterrorist site is likely to consume precious time. Gaining international support in 1991 was an overt process that took months—a delay that was not of great consequence for the success of the operation. But since, to be effective, a preventive strike against a bioterrorist target would require essentially total surprise, it would have to be carried out quickly and covertly. The critical need for secrecy also suggests that efforts to acquire prior approval from the UN Security Council for such an attack, or even narrower international support (e.g., among important US allies in the region), should be held to an absolute minimum, and in some (and perhaps even most) cases foregone entirely.

In short, although the 1991 Gulf War may provide a useful template for how the United States should seek international support when it is contemplating the use of force in many instances, it probably does not provide an effective template for those rare instances when it is considering a preventive strike against bioterrorist targets.

Unfortunately, the political and diplomatic challenges confronting US policymakers and planners pondering or preparing for a unilateral strike against bioterrorist targets are compounded by the weak position the United States currently occupies in terms of international opinion. Comment on the wisdom or necessity of the US invasion of Iraq and subsequent operations in that country is well beyond the scope of this report. But one of the consequences of that action—including the essentially unilateral approach the Bush Administration took to executing

the operation, the inability to find any WMD stockpiles in Iraq, and the widespread perception that pre-war intelligence was filtered to support politically-determined ends—is that it may have severely damaged the US ability to secure international support for any kind of preventive attack.

According to a recent Pew Research survey,[159] even the citizens of major US allies, such as the United Kingdom, Germany, France, and Spain,[160] believe that the US invasion and ongoing occupation of Iraq represents a greater threat to peace than does the totally unscrupulous regime in North Korea. This is a very long fall from September 12, 2001, when the French newspaper *Le Monde* headlined "We Are All Americans."

Against the significant political and diplomatic challenges outlined above, the United States does have at least one factor weighing in its favor: the BWC's prohibition against the acquisition and use of biological weapons by signatory states and, more broadly, the international norm against biological weapons which the BWC has helped to foster. As discussed in Chapter 1, the lack of an effective verification protocol greatly reduces the usefulness of the BWC as a barrier to bioweapons proliferation, and bioterrorism in particular. However, by helping to place biological weapons beyond the moral, legal, political, and diplomatic pale, the BWC may help legitimize preventive strikes against bioterrorist targets.

Recommendations

The following section provides a few brief suggestions concerning the use of offensive operations to counter the threat posed by bioterrorism.

- **If there is clear, compelling intelligence confirming the existence and location of a bioterrorist site, strong consideration should be given to launching a preventive strike.** Unlike nuclear weapons, since biological weapons are illegal, under international law, they cannot be publicly flaunted as status symbols. The real possibility that an attack with biological weapons could cause mass casualties, combined with the extreme difficulty of detecting and identifying bioterrorist sites, means that should the opportunity for

[159] "America's Image Slips, But Allies Share U.S. Concerns Over Iran, Hamas," Pew Global Attitudes Project, June 13, 2006, http://pewglobal.org/reports/display.php?ReportID=252

[160] These were the countries Pew surveyed.

such a strike arise, generally it should be seized—even if the attack must be carried out unilaterally.

- **Efforts should be made to improve US intelligence capabilities focused on bioterrorism.** The weakest link in the US ability to successfully launch preventive attacks against bioterrorist sites is the difficulty of detecting, locating and identifying such sites, and doing so in a timely manner. Planned improvements in air, space-based and other technical intelligence and reconnaissance assets can help improve these capabilities. However, more than anything else, enhancing the US capability to detect and identify bioterrorist facilities and personnel probably means focusing greater resources on HUMINT or, perhaps more importantly, ensuring that existing HUMINT capabilities are adequately focused on the bioterrorist threat. The US intelligence community also needs to increase its capacity in Arabic-speaking analysts and agents, an area where, as noted earlier, is currently suffers a critical shortfall.[161] Given the classified nature of funding for intelligence programs in general, and HUMINT activities in particular, it is impossible to provide an estimate for how much, if any, additional funding is needed in this area.

- **If multiple bioterrorist sites have under control of a single state or subnational group have been identified, they should be attacked simultaneously.** Successful preventive attacks against a subset of a terrorist group's biological weapons capabilities (or a rogue state's biological weapons sites), may be enough to convince the group (or country) to get out of the biological weapons business. But alternatively, it may create a use-it-or-lose it reaction leading to attempts to use any remaining biological agents against the United States or its allies. Thus every attempt should be made to simultaneously attack all known bioweapons assets of the targeted group or country.

- **Ground forces should probably be deployed.** Although bombers and other aircraft may well play an important role in attacking bioterrorist sites, the traditional American preference for reliance

[161] One way the US intelligence community might be able to increase is capacity in Arab-speaking analysts and operatives is by making greater use of Iraqi immigrants. As a result of the deteriorating situation in Iraq, the number of educated Iraqis leaving, or wanting to leave, the country has grown dramatically over the past few years. SABRINA TAVERNISE and ROBERT F. WORTH, "Few Iraqis Are Gaining U.S. Sanctuary," *New York Times*, January 2, 2007, http://www.nytimes.com/2007/01/02/world/middleeast/02refugees.html?_r=1&oref=slogin.

on airpower alone is unlikely to represent the optimal choice for this mission. Air strikes can target buildings very well. They cannot find and target a vial in the third basement of a building. They cannot examine each room to locate each piece of equipment of interest. And they cannot provide damage assessment down to the vial level, which is essential. Thus, to ensure the effectiveness of an attack on a bioterrorist site, "boots on the ground" should be used when feasible. These forces should consist of Special Operations teams skilled not only in stealth and forcible entry, but including microbiologists capable of recognizing all biological agents and related technologies of interest. Using specially trained and equipped ground troops for such an attack also would reduce the, already probably very low, risk that such an attack could inadvertently result in the release of some of the biological agent.[162] Given the critical importance of US special operations forces for combating terrorism, the Bush Administration's plan to increase the size of those forces by one-third may make sense, and consideration should be given to the new Congress' announced intention to double the size of Special Operations forces.[163] However, more important than increasing the overall size of these forces is ensuring that a sufficient number of biological warfare teams are assembled.

- **Adapt advanced incendiary weapons for use by ground forces.** The Department of Defense is currently developing High Temperature Incendiary-J-1000 incendiary munitions[164] specifically for use against biological weapons targets.[165] The J-1000 uses a two-stage reactive and palletized mix of titanium boron lithium perchlorate that burns at 10000F for many minutes with low overpressure. High temperature and long burn time are needed to ensure that any biological agents within a large indoor of underground volume are destroyed. Low overpressure is desirable to prevent any agent from

[162] As discussed in the "Facilities and Personnel" section of Chapter 2, it is highly unlikely that a bomb or other explosive device used against a laboratory would cause the release of a biological agent. But it is not impossible. For political and diplomatic, as well as humanitarian, reasons we should take every possible measure to avoid being the cause of a biological weapons release on foreign soil.

[163] House Democrats, "A New Direction for America," p. 6. http://www.democraticleader.house.gov/pdf/thebook.pdf

[164] GlobalSecurity.org, "HTI-J_1000 High Temperature Incendiary J-1000." See http://www.globalsecurity.org/military/systems/munitions/hti.htm.

[165] "Killer Heat," *Special Operations Technology Online Edition*, Vol. 4 Issue 1, Feb 19, 2006. See http://www.special-operations-technology.com/article.cfm?DocID=1343

being ejected from the high-temperature area where it might survive and infect the nearby population. Another advantage of this weapon is that, through its burning, the J-1000 creates monoatomic chlorine and fluorine gas as well as hydrochloric and hydrofluoric acid, all of which offer collateral disinfectant properties (chemical disinfectants such as chlorine dioxide or hydrogen peroxide, by themselves, would not be sufficient because of their inability to destroy or penetrate vials or other containers). The J-1000 is currently being developed for the Joint Air-to-Surface Standoff Missile (JASSM), Joint Stand-Off Weapon (JSOW), and Joint Direct Attack Munition (JDAM) air-delivered weapons. It should also be developed in a satchel charge version for use by Special Operations Forces. The cost of producing such a version would be quite minimal.

If for some reason a boots-on-the-ground attack is not feasible, but a preventive attack is nevertheless judged essential, the next best solution is probably a unitary deep-penetrator combined munition, in which kinetic energy and/or a precursor explosive warhead gains access to the volume of interest, and a J-1000 thermal warhead destroys it. Such combined-effects munitions are permitted by Protocol 3 of the Convention on Conventional Weapon, which prohibits use of most types of incendiary weapons.[166]

Among current US programs, the munition most suitable for this mission is the Massive Ordnance Penetrator (MOP)[167] now being developed.by the Boeing and Northrop Grumman Corporations for the US Air Force.[168] The MOP is a 30,000-pound weapon that can be carried only by B-2 or B-52 bombers.[169] It is expected to provide an-order-of-magnitude improvement over existing weapons against deeply buried, hardened targets. It will penetrate 200 feet of 5,000 pounds per square inch reinforced concrete and, in its basic iteration, is designed to deliver a 6,000 high-explosive payload.

AJ-1000 incendiary variant of this weapon should be developed. Several versions of the incendiary MOP should be evaluated, including:

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166 http://www.dod.mil/acq/acic/treaties/ccwapl/artbyart_pro3.htm

167 "Massive bomb to MOP up deeply buried targets," *Jane's Defense Weekly,* 19 July 2004, http://www.janes.com/defence/news/jdw/jdw040719_1_n.shtml

168 http://www.globalsecurity.org/military/systems/munitions/dshtw.htm

169 Barbara Starr, "'Bunker busters' may grow to 30,000 pounds," CNN.COM, July 21, 2004, http://www.cnn.com/2004/US/07/20/big.bomb/

- A unitary MOP combining an initial explosive shaped charge with a J-1000 incendiary.

- A binary MOP system consisting of two MOPs, with the first creating a precursor entrance passage for the incendiary-bearing second MOP. The precursor could be a basic MOP, or it could have an explosive warhead specifically designed to maximize the penetration and effectiveness of the following incendiary.

- Attack plans using multiple MOPs. Among other things, efforts should be made to determine the optimal intervals between strikes, which might range from a few seconds to a half hour.

In order to address the political and diplomatic consequences of this attack with totally "clean hands," the United States should ratify Protocol 3 of the Convention on Conventional Weapons, which prohibits various other uses of incendiary weapons.[170]

- **Eliminate all essential biological weapons assets.** In many, if not most, cases, the most critical biological weapons assets in the hands of terrorists will be neither the agents nor the facilities; these can be replaced. The key asset is the biological weapons technology in the minds of the scientists and technicians whose services the terrorist group has obtained. Scientists and technicians working on biological weapons are essentially war criminals, engaged in attempted mass murder, in violation of national and international law. In the event of an attack on a bioterrorist site, every effort must be made to capture or, if capture proves impossible or impractical, to kill the personnel employed in the project.

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[170] The 1980 Incendiary Weapons Protocol was created in reaction to the use of napalm during the Vietnam War. It permits the use of incendiary weapons as part of "combined effects" munitions including penetrators, explosives, etc. The United States has ratified the main Convention, as well as Protocol 1 dealing with nondetectable fragmentation weapons and Protocol 2 dealing with landmines. Ratification of Protocol 3 has been recommended by the Department of Defense, since it permits use of incendiaries for the purpose discussed here, but it has not been submitted to the Senate for approval. In the opinion of this writer, who served as Deputy Chief Negotiator to the Convention on Conventional Weapons in the Clinton Administration, a binary munition consisting of an initial penetrator with or without an explosive, followed immediately by an incendiary, would be permissible under the Incendiary Weapons Protocol.

Proliferation Security Initiative (PSI)

The United States has been engaged in multilateral forcible counterproliferation activities under the Proliferation Security Initiative since 2003 (see Figure 9). The purpose of the PSI is to enable member states to interdict air, sea, or land transport believed to be illicitly carrying WMD or missile components.

Figure 9: Members of the Proliferation Security Initiative

Canada
United States
Denmark
France
Germany
Italy
Netherlands
Norway
Poland
Portugal
Russia
Spain
Turkey
United Kingdom
Australia
Japan
Singapore

Additionally, the United States has signed ship-boarding agreements with Liberia, the Marshall Islands, Panama, and Croatia whose flags of convenience are flown on many ships.

The PSI, which in the United States is directed by the National Security Council, operates on the "broken tail light" principle, through which a relatively trivial violation is used to stop and examine a ship suspected of carrying WMD or related equipment. Unfortunately, the PSI is constrained by several severe limitations and, at this point, can more accurately be considered a concept or an activity, than a program. It has no dedicated staff, budget, equipment, database, or offices, either as an international entity or in its participant nations. It also has no clear legal authority to seize cargo. Although reportedly 11 shipments have been stopped through the PSI, details on those stoppages are not publicly available.

Finally, because biological agents can be stored in small containers and lack a signature (such as heat or radiation) that can be used in detection, it is highly unlikely that a biological agent would, in any case, be found in a ship search. As a result, this approach would probably only result in the intercept of a biological weapons capability if a member of

the crew, with knowledge of its whereabouts, were to cooperate in the search—which may be unlikely unless the crew has already been infiltrated by US (or allied) agents or informers.

Because of the limitations inherent in detecting biological agents hidden aboard aircraft, ships and other means of transportation, interdiction efforts are unlikely to prove very effective at countering bioterrorism. It may still make sense to strengthen and expand the PSI and other related efforts, but the primary motive in that case would probably be to assist in countering other forms of WMD—which are less easily concealed. That said, if the United States and the broader international community do move to strengthen this regime—which could well happen following a large-casualty bio-attack anywhere—the chance that a terrorist group could successfully bring highly lethal biological agents into the United States could be made more difficult.

Conclusions

Expert opinion is divided on the question of how quickly and easily a terrorist group could acquire a mass-casualty-producing biological weapons capability. Producing and employing a biological agent essentially involves four steps—acquiring a lethal strain of some agent, manufacturing a quantity of the agent, "stabilizing" the agent so that it can survive storage and transportation, and disseminating the agent. Failure at any of these stages could prevent or render ineffective an attempt to use biological weapons. On the other hand, it may be inevitable—given the spread of relevant technology and expertise—that some terrorist group will eventually acquire a highly lethal biological weapons capability. Of greatest concern is the prospect that a terrorist group will someday acquire a highly contagious and virulent agent.

Expert opinion is also divided on the question of how likely it is that a terrorist group, even if it could overcome existing technical barriers, would be inclined to launch a biological weapons attack that could cause mass casualties. For a variety of reasons, including fear of retaliation and concerns about alienating world opinion, most terrorist groups might be disinclined to conduct such an attack. On the other hand, lessons from the past suggest that at least some terrorist groups might well calculate that a mass casualty bioweapons attack would serve their interests. Under these circumstances, it seems clear that the United States should be actively and vigorously pursuing a multifaceted approach to countering bioterrorism.

As discussed in this report, to effectively counter this threat, the United States will need to pursue a combination of three different approaches, focused on:

- Preventing terrorists from acquiring biological weapons or the means of effectively employing those weapons to cause mass casualties;

- Defending against a terrorist attack with biological weapons, once it has been launched, through the use of various measures capable of detecting, protecting against and mitigating the effects of such an attack; and

- Destroying or disrupting terrorists' biological warfare capabilities through preventive or retaliatory offensive operations.

Federal spending directly related to the first two of these approaches—preventing and defending against a possible attack with biological weapons—has grown, in real terms, more than four-fold since the terrorist attacks of September 11, 2001, and currently amounts to some $8 billion a year. The United States spends even more each year on the broad range of offensive military capabilities, such as Special Operations Forces and long-range strike aircraft, which might be used in preventive or retaliatory strikes against bioterrorist sites. However, since these forces are capable of carrying out a broad range of other important military missions as well, their costs cannot reasonably be attributed specifically to the mission of combating terrorism.

Notwithstanding these dramatic funding increases, this report suggests that there are a number of programs and activities focused on combating bioterrorism that could benefit from greater funding. Equally importantly, however, this report notes that successfully countering the threat posed by bioterrorism will also depend on overcoming structural, organizational and other largely non-budgetary challenges.

As discussed in Chapter 2, efforts to prevent bioterrorism could be improved if the United States were to:

- strengthen both physical and personnel security at US biological laboratories and other facilities;

- encourage other countries to make similar improvements, in part through the development of an international code of ethics for scientists working in the biotechnology field;

- negotiate a verification protocol to the BWC;

- expand and strengthen the Australia Group's export control regime governing biological agents and biotechnology;

- continue to support threat-reduction efforts in the Russia and other states of the former Soviet Union; and

- possibly expand those efforts to other countries of concern.

Chapter 3 likewise discussed a range of possible improvements in defensive bioterrorism countermeasures. These improvements include significantly increasing the US capability to isolate persons infected with contagious biological agents by upgrading hospitals and acquiring equipment that could allow other spaces to be converted to isolation units, and expanding American access to masks, which can provide effective physical protection against contagious biological agents in many cases. The most significant, and potentially costly, change discussed in this chapter (and in this report) is the initiation of an expanded and accelerated effort to develop and acquire a range of broad-spectrum therapeutics, which probably represents the most effective means of countering highly virulent designer agents. While deriving a precise estimate is beyond the scope of this report, a reasonable, albeit only very rough, estimate is that such an effort could require $1–5 billion a year, or possibly even more.

Chapter 3 also noted that for US biodefense capabilities to be effective, the United States must make clear that, in this area, the federal government holds ultimate authority—in terms of organizing both preparations for and responses to a bioterrorist attack. In addition, this chapter strongly recommends that legislation be enacted that would require high-level officials, including the president, to participate regularly in realistic simulations of such an attack.

Finally, Chapter 4 of this report discusses the role that offensive strike capabilities can play in US efforts to combat bioterrorism. Among the most important conclusions of this chapter are that, while opportunities are unlikely to arise often, if and when they do strong consideration should be given to attacking bioterrorist sites even if—or perhaps especially if—the opportunity for a preventive strike materializes. This chapter also recommends that the United States develop an advanced-technology incendiary version of the Massive Ordnance Penetrator to deliver about three tons of intense incendiary payload deep into a hardened underground biological weapons facility without scattering the biological agent.

Implementing most of the changes described in this report would not—in the context of an overall budget for national security that currently

exceeds half a trillion dollars annually—require significant increases in funding. In most cases the additional costs would probably range from millions of dollars to, at most, hundreds of millions of dollars a year.[171] The only change discussed in this report that would likely demand substantial additional resources would be the initiative to develop a variety of broad-spectrum therapeutics. And even additions of $1–5 billion a year appear relatively small when compared to the levels of funding provided to other areas of national security, and to Department of Defense programs in particular. As such, given the potential for a bioterrorist attack to inflict mass casualties, possibly measured in the hundreds of thousands or even millions, expenditures of this magnitude would appear to represent a prudent investment.

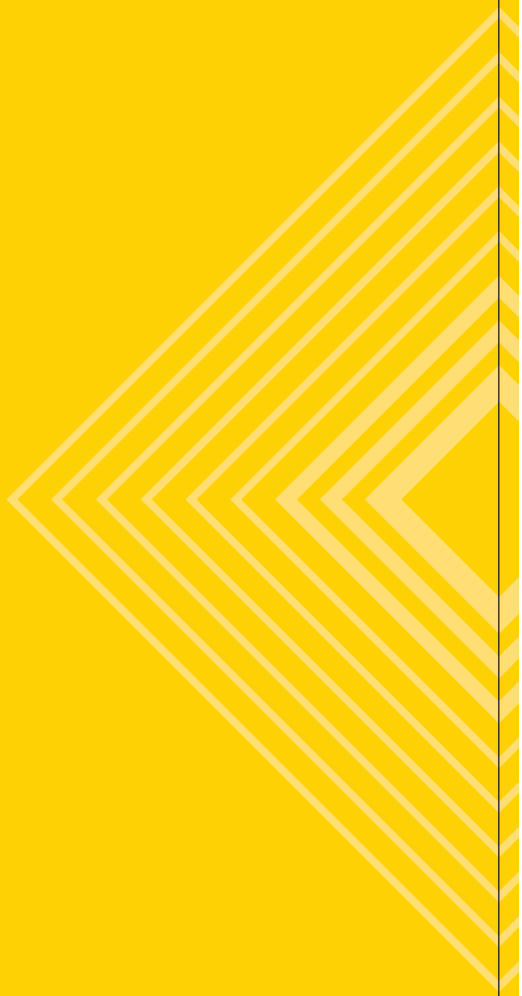
[171] It is possible that making some improvements in intelligence capabilities related to combating bioterrorism, discussed in Chapter 4, could require higher levels of funding. But, given the classified nature of such funding, as noted in that chapter, no effort was made in this report to estimate those costs.

Glossary

BII	Bio Industry Initiative
BSL	BioSafety Level
BTW	Biological and Toxin Warfare
BW	Biological Weapons
BWC	Biological Weapons Convention
BWPP	Biological Weapons Prevention Program
CBR	Cooperative Biological Research
CDC	Centers for Disease Control and Prevention
CIA	Central Intelligence Agency
CIS	Commonwealth of Independent States
CSBA	Center for Strategic and Budgetary Assessments
CTR	Cooperative Threat Reduction
CWC	Chemical Weapons Convention
DARPA	Defense Applied Research Projects Agency
DHHS	Department of Health and Human Services
DHS	Department of Homeland Security
DoC	Department of Commerce
DoD	Department of Defense

DoE	Department of Energy
DTRA	Defense Threat Reduction Agency
EMS	Emergency Medical Services
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FBI	Federal Bureau of Investigation
FDA	Food and Drug Administration
GAO	Government Accountability Office
HIV	Human Immunodeficiency Virus
HSARPA	Homeland Security Applied Research Projects Agency
ICBM	Intercontinental Ballistic Missile
IED	Improvised Explosive Device
ISN/CB	US State Department's Office of Chemical and Biological Weapons Threat Reduction, in the Bureau of International Security and Non-proliferation
JASSM	Joint Air-to-Surface Stand-off Missile
JDAM	Joint Direct Attack Munition
JSOW	Joint Stand-Off Weapon
MoD	Ministry of Defense
NIH	National Institutes of Health
NSABB	National Science Advisory Board for Biosecurity
NSC	National Security Council
NSF	National Science Foundation
NWMDE	Non-proliferation of WMD Expertise

OTA	Office of Technology Assessment
PCR	Polymerase Chain Reaction
PGM	Precision-Guided Munitions
PhRMA	Pharmaceutical Research and Manufacturers of America
PSI	Proliferation Security Initiative
R&D	Research and Development
RDT&E	Research, Development, Testing, and Evaluation
S&T	Science and Technology
SOF	Special Operations Forces
UN	United Nations
USDA	US Department of Agriculture
USPS	US Postal Service
VA	Department of Veterans Affairs
WHO	World Health Organization
WMD	Weapons of Mass Destruction



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