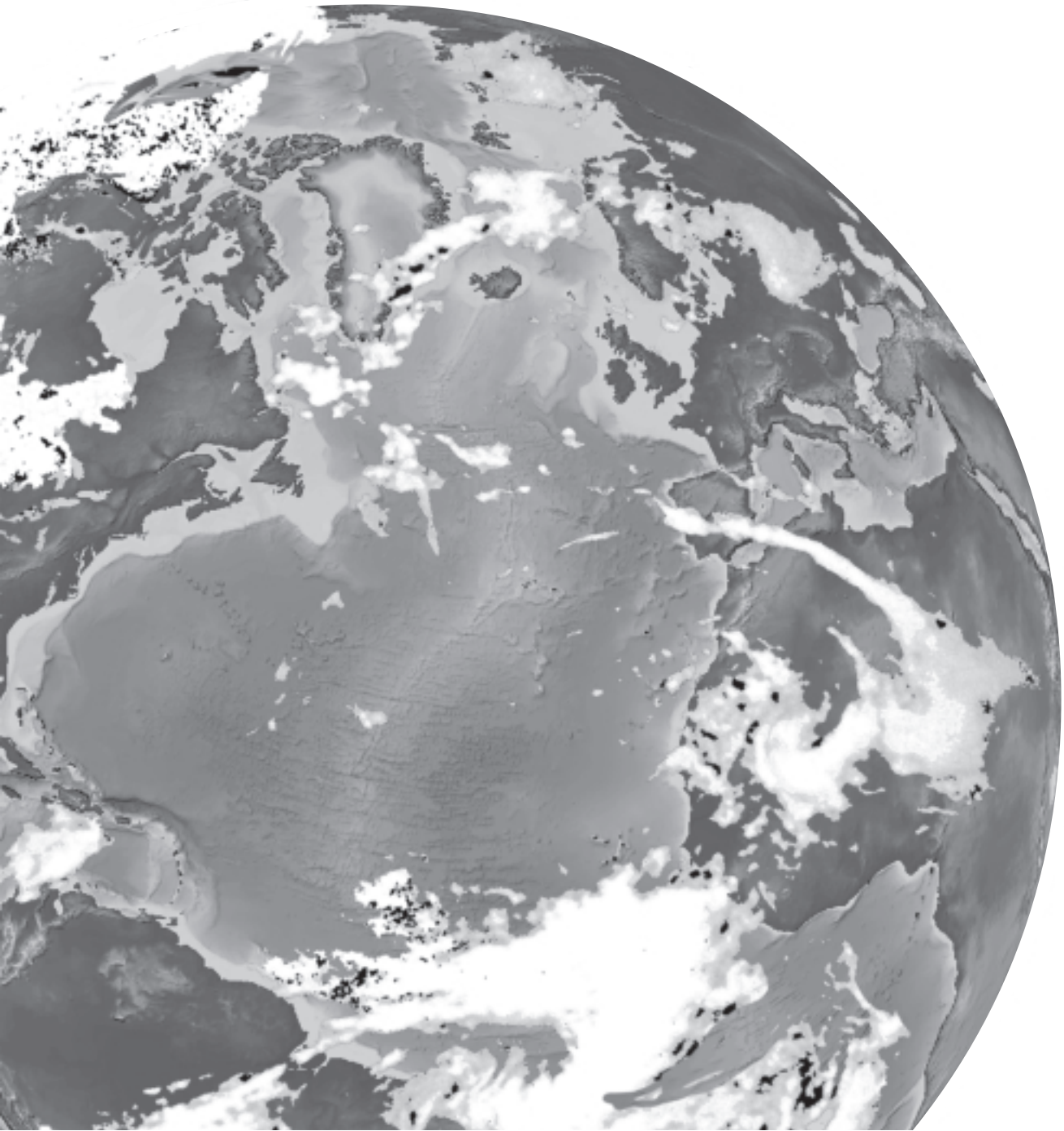
Biological Terrorism, Emerging Diseases, and National Security

PROJECT ON WORLD SECURITY
ROCKEFELLER BROTHERS FUND

Christopher F. Chyba



This is an interactive document.

Any text that appears in blue is a link to another part of the document, a World Wide Web site, or an email address.

You can also navigate this document with the Acrobat Bookmarks feature. Click on the "Bookmarks" button, or choose "Show Bookmarks" from the "File" menu. You can then click on the desired bookmark to jump to that section.

CHRISTOPHER F. CHYBA is affiliated faculty at the Center for International Security and Cooperation and Consulting Professor of Geological and Environmental Sciences at Stanford University. Dr. Chyba holds the Carl Sagan Chair for the Study of Life in the Universe at the SETI Institute in Mountain View, California.

ROCKEFELLER BROTHERS FUND, INC.
437 Madison Avenue
New York, New York 10022-7001
Telephone: 212.812.4200
Facsimile: 212.812.4299
E-mail: rock@rbf.org
World Wide Web: www.rbf.org

Design: H Plus Incorporated
Printing: Friendship Creative Printers
Printed on Recycled Paper

TABLE OF CONTENTS

SUMMARY

This report argues that public health surveillance for emerging diseases and preparedness for biological terrorism are strongly related. It first surveys possible scales of bioterrorist attacks and the extent to which these have proven or may prove difficult to distinguish from outbreaks of emerging diseases. Building on these examples, the report makes recommendations for how the United States could better prepare to meet the threat of biological terrorism. These recommendations range over domestic and international improvements in public health surveillance, the need for improved coordination within the U.S. government, and plausible verification measures for the Biological Weapons Convention.

Many potential biological agents have incubation delay times within infected individuals that are long when compared to contemporary national and international travel times. This endows these agents with special advantages as terrorist weapons compared to other potential means of mass destruction. The possibility of contagion (in the case of agents such as smallpox) is a further terror advantage. These aspects of biological agents emphasize the importance of *a strategy of public health surveillance* for incidents of bioterrorism—a strategy that is inapplicable to the case of chemical or nuclear attacks. For many plausible biological attacks, those at the "sharp end of the spear" Will be physicians in hospitals, clinics, and family practice, rather than quick-response teams.

Preparing for bioterrorism requires improving the sensitivity and "connectivity" of public health surveillance systems within the United States and overseas. Domestically, physicians and other health-care workers must be given the training needed to recognize or at least suspect unusual diseases. The ability to check these suspicions quickly at the state, regional, and national levels must be available. Within the U.S. government, coordination between public health, law enforcement, and intelligence agencies should be strengthened. Internationally, the United States should work with foreign governmental, multilateral, and non-governmental organizations to improve global surveillance for suspicious outbreaks. The right for international investigations of such outbreaks should be negotiated as a verification measure to the Biological Weapons Convention.

This report makes specific recommendations in each of these areas. An appropriate national security response to the threat of biological terrorism should build directly upon the improved public health surveillance needed to combat the environmental threat of emerging diseases. In this context, responsibility for national security extends throughout society, from primary care physicians and pathologists at local hospitals and clinics, to state and national health laboratories and officials, and to public health surveillance networks overseas. These responsibilities need to be matched with appropriate resources. Public health and national security merge in the realm of emerging diseases and biological terrorism.

EMERGING DISEASES AND NATIONAL SECURITY

Since the end of the Cold War, the foreign policy community has debated the role of environmental issues in national security. Just as the oil shocks of the 1970s demonstrated that traditional defense-oriented notions of security had to be broadened to include economic issues,[1] so some now argue that certain environmental issues should be included as well.[2,3] But not all environmental threats may be cogently and usefully framed as security issues. Such threats must be sufficiently understood scientifically for proposed solutions to be credible, and they also must be of enough potential consequence to justify the commitment of resources and the attention of senior policy makers. Few environmental threats have been perceived across the political spectrum as satisfying both these requirements, and few have achieved broad recognition as security issues.

Emerging infectious disease may provide the strongest example of an environmental challenge that poses a clear threat to national security. Emerging infections undermine the societies of the most disease-stricken countries, readily cross international borders, and consequently directly threaten the health of people throughout the world. The 1918-19 Spanish influenza pandemic killed twenty to twenty-five million people worldwide, including one-half million Americans.[4] The human immunodeficiency virus (HIV), which infects over 5 percent of the population of sub-Saharan Africa,[5] remains one of the ten leading causes of death in the United States.[6] Even definitions of national security restricted to defense and economics alone must acknowledge the relevance of epidemics of this magnitude and the importance of preventing future outbreaks. Moreover, there is the possibility that a major outbreak of disease could originate not from natural causes, or unintended consequences of human behavior, but rather as a result of deliberate biological attack.

Diseases that enter the human population from some natural reservoir are said to have "emerged." Diseases emerge for many, often poorly understood, reasons.[7,8,9] Mad cow disease most likely emerged when humans ate infected cattle products.[10] The horrific Ebola virus lives in an unidentified animal or insect host and only now and then jumps to humans, for reasons that remain largely unknown.[11] The fatal hantavirus outbreak in the American Southwest in 1993 was traced back to deer mice whose population had exploded due to local climate change: food sources had been unusually abundant that year because of record precipitation.[12] In other cases, such as that of tuberculosis in the United States, diseases once thought to be under control developed resistance to known antibiotics and experienced a resurgence.[13] Epidemic diphtheria returned to Eastern Europe as vaccination programs weakened, the pool of immunologically compromised individuals in major cities expanded, and infected travelers spread the disease.[14]

Even excluding HIV/AIDS (itself a recently emerged disease), the death rate from infectious diseases rose by 22 percent in the United States between 1980 and 1992.[9] It is anticipated that as more organisms develop resistance to over-prescribed antibiotics,[15,16,17] as the growing human population increases its inroads into tropical

forests,[18] as cities in the developing world become more crowded and sanitation ever more problematic,[13] and as greater numbers of people travel or flee across international borders,[9,13] more "new" diseases will appear or take hold in the human population.[4,7,8,9,13,19]

As was true with emerging disease, the threat of biological terrorism was present throughout the Cold War, but concern over this threat has since escalated. During the Cold War, the greatest biological threat faced by the United States was posed by the Soviet Union, and that threat seemed most likely to be manifested in the event of overt war rather than in acts of terrorism. Nations currently regarded as rogue states were less likely during the Cold War to have the freedom of action to launch terrorist attacks using weapons of mass destruction. With the collapse of the Soviet Union and the current overwhelming conventional military superiority of the United States, weapons of mass destruction might now be seen by these nations as equalizers, to be brandished or used in terrorism or unconventional warfare.[20,21]

Moreover, the human and technical resources needed for a biological weapons program are spreading throughout the world. While it may still be true that most developing countries lack the microbiological capacity needed to develop biological warfare agents,[22] eight or more developing nations have been implicated in developing an offensive biological warfare capability.[23] It has been alleged by a prominent Russian defector that Russian scientists have used genetic engineering to produce antibiotic-resistant strains of a number of disease organisms.[24] Some of this research has been published in the open literature, so it is available for application by nations developing their own biotechnology industries. Worse yet is the possibility that some Russian researchers may market their personal expertise to other nations.[25]

The world recently learned of the Aum Shinrikyo, a multinational terrorist group intent on the development and use of an array of weapons of mass destruction. Biological and chemical agents are now demonstrably within the technical expertise of such groups, and even primitive and inefficient versions of these weapons could have devastating economic or terror impacts. With the independent bombing attacks at the World Trade Center in New York in 1993 and the Federal Building in Oklahoma City in 1995, the release of sarin nerve agent in the Tokyo subway system in 1995 by the Aum Shinrikyo, and that group's attempts to attack Tokyo using anthrax and botulism,[26,27] large-scale terrorist attacks on civilian populations using weapons of mass destruction no longer seem in the realm of the fantastic. At their worst, the New York, Oklahoma City, and Tokyo attacks may represent the crossing of a grim threshold,[28] weakening long-standing taboos and increasing the likelihood of analogous attacks in the future.

BIOTERRORISM: A UNIQUE THREAT?

Biological weapons differ fundamentally from other weapons of mass destruction. Whereas nuclear and chemical weapons cause immediate casualties, biological agents require hours to days or even weeks of incubation before they cause fatalities. (Exposure to some biologically derived toxins, as opposed to living organisms which incubate inside the body, could exhibit timescales more similar to those of chemical weapons—but toxins are, in effect, biologically derived chemical weapons.) Barring a

terrorist announcement or fortuitous discovery, a biological attack will first become known hours or days after its execution, when its victims begin to appear at doctors' offices and hospital emergency rooms. Sufficiently subtle biological terrorist attacks might go unrecognized, or remain undetected, for long periods of time. Terrorism involving the dispersal of radiological materials could, in this respect, share some similarities with biological agents.

Desirable characteristics for biological agents for military use include minimal contagiousness (as with *Bacillus anthracis*, the sporulating bacterium that causes anthrax) to ensure that the disease cannot produce an uncontrolled epidemic that could boomerang and infect the attacker's forces or population.[23] For a terrorist attack, however, contagiousness (communicability) might well be viewed as an asset. Contagious agents may spread the disease far beyond the initially exposed population. For example, the two- to three-day incubation period for plague (*Yersinia pestis*) is long enough to allow victims of an attack to travel by air between virtually any city in the world and any city in the United States before falling seriously ill — especially so if the organisms were released in the departure gates area of a major international airport.

The smallpox virus has an incubation time of seven to seventeen days. The discontinuation of routine vaccination, the contagiousness of the disease (including secondary transmission from infected individuals who might themselves never manifest the disease), and the unknown extent of possible clandestine stockpiles[29] make smallpox seem an especially attractive agent of bioterrorism. It has been reported that North Korea may retain smallpox cultures for use as a biological weapon.[30]

Consider the outcome of one infected individual visiting New York City. In 1947 an American businessman arrived from Mexico with fever, headache, and rash, and then spent several hours sightseeing. His illness turned out to be smallpox, and he died nine days later after having infected twelve others, of whom two died. Public health officials viewed the potential for transmission to be so serious (despite the fact that Americans at that time were routinely vaccinated against smallpox) that over six million people in New York City were vaccinated within a month.[31] In contrast to 1947, Americans have not been routinely vaccinated against smallpox since 1980.[32] The federal Centers for Disease Control and Prevention (CDC) currently maintains over twelve million doses of vaccine in storage.[33]

In a more recent case, in 1972 a pilgrim returned to Yugoslavia from Iraq infected with smallpox. To contain the resulting outbreak, over ten thousand people were quarantined, and twenty million were vaccinated in less than two weeks.[34]

The incubation delay endows biological agents with advantages as terrorist weapons that nuclear or chemical weapons lack. The possibility of contagion (in the case of some agents such as smallpox), and resulting fear, is a further terror advantage. These aspects of biological agents emphasize the importance of *a strategy of public health surveillance* for incidents of bioterrorism — a strategy that is inapplicable to the cases of chemical or nuclear attacks. The threats posed by biological weapons must be thought about and addressed in a very different way.

Barring a terrorist announcement or an interruption of an attack while underway, traditional "first responders" (fire, police, paramedics) or quick-response teams with specialized equipment and training will not be among those initially recognizing and responding to a biological attack. As described below, biological terrorist attacks conducted by followers of Baghwan Shree Rajneesh[35] in 1984 and attempted by members of the Aum Shinrikyo[26,27] in the early 1990s were accompanied by no announcements and remained unrecognized while in progress. As these examples illustrate, recognition and response to a successful biological attack, domestically or abroad, will most likely depend upon the sensitivity and connectivity of the existing public health system.

Sensitivity refers to how likely it is that a given presentation of a disease will be recognized by a physician or other health-care worker as being out of the ordinary. *Connectivity* refers to how quickly and accurately information about a case gets passed "vertically" from the clinical level up to state, national, or international authorities, and "horizontally" within these levels.

Within the United States, surveillance for infectious diseases is a largely passive process.[13] Each state has its own requirements for the reporting of specific diseases by physicians, hospitals, and other health care providers. Local or state health departments are supposed to be notified by physicians or laboratories if a patient is diagnosed with a disease defined as reportable by that state. At the national level, the CDC collaborates with the Council of State and Territorial Epidemiologists in maintaining a list of national notifiable diseases. Individual states' requirements for notifiable diseases typically parallel this list. Through the National Notifiable Diseases Surveillance System (NNDSS), states voluntarily report weekly to the CDC on the incidence of some fifty diseases. These diseases include several of potential interest to bioterrorists, such as anthrax, botulism, brucellosis, and plague. Reporting is mandatory for a small number of diseases requiring quarantine, such as suspected smallpox, infectious tuberculosis, and viral hemorrhagic fevers. Outbreaks of diseases not on the national notifiable diseases list may remain undetected until an outbreak is well under way. The CDC analyzes the data it receives and reports on it in its *Morbidity and Mortality Weekly Report*.

A second type of national disease surveillance by the CDC involves the use of "sentinel" hospitals.[19] In this case, no attempt is made to gather comprehensive national data. Rather, the National Nosocomial Infection Surveillance (NNIS) system gathers data voluntarily provided by 163 (as of 1993) hospitals. (Nosocomial infections are infections acquired while a patient is hospitalized.) Incidence of infections in the participating hospitals may be used to estimate the national incidence of nosocomial infections. In addition to the NNDSS and the NNIS system, the CDC also engages in pilot projects with certain states, in key U.S. cities, or with individual "sentinel" physicians, to gather data on the incidence and characteristics of other diseases or disease outbreaks.[13]

A survey of the possible scales of terrorist attacks and the extent to which these have proven or may prove difficult to distinguish from outbreaks of infectious diseases, will make it clear that improving surveillance for biological terrorism must build directly upon existing public health surveillance systems. As discussed below, this requirement has specific implications for the steps that should be taken to prepare for bioterrorism.

POSSIBLE SCALES OF TERRORIST ATTACKS

An examination of biological terrorism episodes illustrates the range of threats for which we must prepare. The most dramatic biological threat is a major terrorist attack against an urban center, using an efficient mechanism for the dispersal of the biological agent. In 1993, the Office of Technology Assessment (OTA) estimated that 100 kg of aerosolized (converted to respirable particles in the 1 to 5 micron size range) *Bacillus anthracis* spores dispensed by an airplane upwind of a major city could kill hundreds of thousands to millions of people.[36] A different scenario estimates that the number of deaths resulting from an anthrax aerosol dispersed from a boat sailing upwind from New York City could be over 400,000 people.[37] While no such major biological attack has yet succeeded, this decade has seen the release of sarin nerve agent in the Tokyo metro system in 1995 by the Aum Shinrikyo religious cult (killing eleven people, with over 5,000 injured, of whom some 700 required hospitalization). Moreover, the Aum repeatedly—at least nine times—attempted biological attacks on Tokyo city as well as nearby U.S. naval installations.[27] While the failure of the Aum's attacks suggests that acquiring and successfully weaponizing an effective biological agent remains challenging, large-scale attacks on civilian urban populations nevertheless are clearly no longer in the realm of the fantastic.

A large-scale attack against an urban center using biological agents would be the manifestation of biological terrorism having the most in common with a chemical or nuclear attack. Even for a massive urban biological attack, however, public health surveillance could be critical to minimizing deaths and casualties, as well as economic costs. A recent study[38] examined expected deaths and economic impact for scenarios involving three different biological agents *(Bacillus anthracis, Brucella melitensis,* and *Francisella tularensis)* released as aerosols in a terrorist attack on a major city. The timescales required for effective intervention vary according to the agent. First, consider the anthrax case as an example. The study found that intervention (taken to be 90 percent effective administration of antibiotics and vaccinations) within one day after the attack could keep deaths to below 10,000, as opposed to over 30,000 if intervention occurred five or more days later, and could save $15 billion to $20 billion. At the other extreme in incubation timescales, for the case of brucellosis, intervention within the first two weeks after the attack would reduce deaths to about 100 compared with over 500 if intervention did not take place until after two months. Effective intervention would only be possible if family physicians and emergency room personnel recognized as early as possible during an outbreak that an anomalous situation existed, and if these concerns were effectively passed to state and national health authorities for rapid diagnosis and response.

These same public health capabilities are those necessary to detect more subtle attacks as well. One can envision terrorists introducing a disease into the United States in such a way that no easily recognizable outbreak occurs, or so that no outbreak is noticed until the disease is well under way. Such a masked attack, followed by a credible terrorist announcement, could have an impact far out of proportion to the deaths that actually resulted.

It has sometimes been asserted that there is an outstanding puzzle (perhaps of a psychological nature) to be solved regarding why terrorists have so far been deterred from biological attacks.[39,40] In light of the attempts by the Aum Shinrikyo to attack Tokyo with biological weapons,[26,27] this supposed puzzle now seems moot. Indeed,

biological terrorist attacks have been conducted or attempted at many scales. The following examples illustrate this point and demonstrate the range of incidents over which surveillance must be effective.

Individuals. In 1995 two members of the Minnesota Patriots Council were convicted of planning to use the biological toxin ricin to assassinate Internal Revenue Service agents and a deputy U.S. marshall. In that same year, a member of the white supremacist organization Aryan Nation was arrested for ordering three vials of freeze-dried bubonic plague from American Type Culture Collection, a biological supply house in Rockville, Maryland.[28]

Assassination Campaigns. Testimony in June 1998 before South Africa's Truth and Reconciliation Commission revealed that the apartheid-era South African government developed chocolates and cigarettes infected with anthrax, beer bottles containing botulism, sugar laced with *Salmonella*, and bottles of cholera culture. These products were used both for the attempted assassination of specific political opponents and, perhaps, to cause outbreaks in African National Congress training camps.[41]

Workplaces. In 1996, twelve laboratory workers at a large medical center in Texas developed acute diarrheal illness after eating doughnuts left in their break room that had been intentionally contaminated with the bacterium *Shigella dysenteriae*.[42]

Local Communities. In September 1984, members of an Oregon commune headed by the Bhagwan Shree Rajneesh used *Salmonella* to contaminate restaurant salad bars and coffee creamers in The Dalles, the county seat of Wasco County, Oregon. Although there were no fatalities, some 750 people became ill, with 45 requiring hospitalization. The outbreak strain of *Salmonella typhimurium* was shown in 1985 to be the same as a culture of *S typhimurium* found by an Oregon Public Health Laboratory official in a clinical laboratory operated by the commune. Two commune members were indicted in 1986 and later pleaded guilty to conspiring to tamper with consumer products by poisoning food. The commune members had been testing a plan to incapacitate voters in preparation for an upcoming election, intending to influence the outcome by making citizens of The Dalles sick on election day. Public health authorities had initially rejected the possibility of intentional contamination in this case, in part because they assumed that terrorists would issue a public statement in order to create widespread fear, rather than engage in a covert attack.[35]

Cities — Water Supplies. In 1972, members of a U.S. fascist group called the Order of the Rising Sun were arrested in possession of 30 to 40 kg of typhoid bacteria with which they planned to contaminate water supplies in Chicago, St. Louis, and other midwestern U.S. cities.[23] It is unlikely such an attack could have been successful, due to chlorination.[39]

Cities — Aerosol Release. In the early 1990s, the Aum Shinrikyo released anthrax bacteria at least twice from a building in eastern Tokyo. [26] Similarly, they sprayed anthrax in aerosol form from a truck driven around Tokyo, and they released botulism in a similar manner. None of these attacks appears to have resulted in any casualties, and it appears that the Aum both failed to breed the most virulent strains and did not master aerosolization.[27]

Attacks on U.S. Military Bases. The Aum Shinrikyo reportedly also sprayed anthrax from a truck driven past the U.S. naval installation at Yokohama, then by the headquarters of the U.S. Navy's Seventh Fleet at Yokosuka. Again, neither of these attacks appears to have resulted in any casualties.[27]

Accidental Releases from Biological Warfare Facilities in the Soviet Union and the United States. In 1979, an unusual anthrax epidemic occurred in the Soviet city of Sverdlovsk in the former U.S.S.R. Soviet officials attributed the outbreak to consumption of contaminated meat, whereas U.S. agencies suspected it to be due to the accidental release of spores from a military facility located in the city. In 1992 Russian President Boris Yeltsin, who in 1979 had been the chief Communist Party official of the Sverdlovsk region, stated that "the KGB admitted that our military developments were the cause." Subsequent analysis of epidemiological data confirmed that the pathogen had been airborne, and allowed the location and date of escape to be identified.[43]

The latter example suggests that international surveillance for biological terrorism may encounter examples of accidental as well as intentional release. This possibility is supported by the history of the U.S. biological weapons program. In the U.S., an offensive biological weapons program was begun in 1942 with research and development facilities at Camp (later Fort) Detrick, Maryland, testing sites in Mississippi and Utah, and a production facility in Terre Haute, Indiana. This production facility lacked adequate engineering safety measures, and tests of the fermentation and storage processes using nonpathogenic bacteria demonstrated contamination of the plant and its environs.[44]

Inspections of biological facilities in Iraq by the United Nations Special Commission (UNSCOM) indicate that the Baghdad government cut corners on safety and biocontainment,[28] viewing production workers as expendable. Some governments may be especially likely to infect their own citizens during weapons development and production. These examples suggest that unintentional releases of biological agents may be typical events in a developing biological weapons program. International surveillance capable of investigating accidental releases (requiring access to sites and epidemiological data) is therefore important.

RESERVOIRS OF AMBIGUITY

Analysis of clinical samples and/or epidemiological data may allow a distinction to be made between naturally occurring illness and intentional attack; modern DNA sequencing techniques should enhance this capability.[23] From the public health standpoint, whether an outbreak is natural or artificial may be of little significance, though the political or legal ramifications of that distinction could be large.

The inextricable relationship between surveillance for biological terrorism and surveillance for naturally occurring diseases becomes clear through the consideration of further examples illustrating the potential difficulty in disentangling natural outbreaks from certain biological attacks.

Legionnaire's Disease. In 1976, 221 people suddenly contracted pneumonia at an American Legion convention in Philadelphia, leading to thirty-four deaths. The bacterium *Legionella pneumophila* had multiplied in the water tower for the hotel's

evaporative cooling system, exposing many guests to an infective dose of the organism.[45] It was later shown that sporadic illnesses in 1947 and an outbreak in 1957 had in fact been due to "Legionnaire's Disease" but had not been identified at those times.[46] In both the case of Legionnaire's Disease and in the outbreak of Hantavirus pulmonary syndrome in the southwestern U.S. in 1993 (fatal to 50 percent of those infected), there was initial concern that the illnesses might be due to criminal or terrorist attacks.[47]

Plague in Surat. The 1995 outbreak of pneumonic plague in Surat, India, was depicted by a cover story in the Indian national newsweekly *The Week* as being due to biological warfare experiments conducted by the United States.[48] While scientific refutations are unlikely to be entertained by the most extreme of those making such accusations, this incident, along with the previously cited domestic U.S. examples, serves to emphasize the importance of determining that certain outbreaks are *not* the results of terrorism.

Intentional Introduction of Diseases Using Natural Vectors. During the Second World War, the Japanese attacked at least eleven Chinese cities with biological agents, contaminating food and water supplies with *Bacillus anthracis, Vibrio cholerae, Shigella, Salmonella,* and *Yersinia pestis*. Plague was developed as a weapon by allowing fleas to feed on plague-infested rats; as many as 15 million fleas were then harvested and released from airplanes per attack over Chinese cities.[44] More recently, in 1969 the medical attaché to the French Department of Overseas Territories was quoted as saying that in Brazil, infectious organisms "were deliberately brought into Indian territories by landowners and speculators utilizing a mestizo previously infected," leading rapidly to the deaths of many Indians, who lacked immunity. Between 1957 and 1963, the attaché said, outsiders intentionally introduced smallpox, influenza, tuberculosis, and measles to the tribes of the Mato Grosso region. In 1964 and 1965, tuberculosis was allegedly intentionally introduced into the northern section of the Amazon Basin.[49]

Aum Shinrikyo and Ebola. In 1992, Shoko Asahara, the head of the Aum Shinrikyo, and some forty followers traveled to Zaire, evidently with the intention of obtaining samples of the Ebola virus to culture and use in biological attacks.[27,40]

Foodborne Outbreaks. Diseases borne by domestic and foreign foods kill 9,000 Americans each year, and sicken millions.[50] Almost none of these cases is tracked back to its cause. Dr. Michael Osterholm, Minnesota's chief epidemiologist, comments that, "If you get an outbreak of 500 people in a state, but no more than a few in any one household, you'll never pick it up."[51] The Food and Drug Administration currently samples less than one percent of the shipments of 30 billion tons of food imported annually into the United States. Twelve states have no system for reporting foodborne disease, largely because of budget restrictions.[51,52] It is evident that infectious organisms could be intentionally introduced into the United States with little likelihood of detection prior to the food being eaten. Domestic surveillance for food-borne illnesses is essential not only for tracking natural outbreaks, but for detecting possible intentional poisonings.

Unexplained Deaths Due to Possible Infectious Causes. The CDC is establishing an emerging infections program (EIP) network to conduct special population-based surveillance projects. Four EIP sites, in California, Connecticut, Minnesota, and

Oregon (covering a population of 7.7 million) are conducting surveys of unexplained deaths and critical illnesses due to possibly infectious causes. The study considers only individuals between the ages of one and forty-nine who are hospitalized with a critical illness due to a possibly infectious cause, with no etiology (disease organism responsible) identified on initial testing. The results of this study are startling. In 1992, 744 unexplained deaths due to possible infectious causes (UDPIC) were identified among previously healthy people in the four sites; these deaths accounted for 14 percent of all 5,304 deaths among persons one to forty-nine years of age in hospitals and emergency rooms.[46] From 1995 to 1997, laboratory specimens and clinical and epidemiological data were collected for UDPIC cases in the four regions and examined by CDC. Yet 77 percent of these cases remained undiagnosed. Some of these may represent fatal infections by altogether new pathogens.[53]

There is evidently a substantial background level of undiagnosed infectious disease in the United States that could be capable of masking sufficiently subtle and dispersed terrorism. From the point of view of improving surveillance for biological terrorism, it is important to recognize that we cannot *currently* recognize what is causing the deaths of many Americans from infectious diseases. Improving surveillance for bioterrorism must begin with the capability to diagnose what is already taking place. Effective surveillance for biological terrorism requires improved surveillance for infectious disease.

PREPARING FOR BIOLOGICAL TERRORISM

Preparing for biological terrorism has more in common with confronting emerging diseases than with preparing for chemical or nuclear attacks. Biological terrorism will bypass the quick-response teams that would be critical to coping with attacks using chemical or radioactive materials. Unless a biological attack is announced, or discovered while still underway, it would not become clear that something was wrong until victims began to show up in doctors' offices and hospital emergency rooms. The disease agents likely to be used as terrorist weapons may incubate for hours, days, or even weeks before their victims feel any symptoms. More than likely, the earliest symptoms will mimic those of a bad cold or flu.[29,54] Sufficiently subtle or distributed terrorist attacks may, at least initially, be indistinguishable from naturally occurring infections or outbreaks. This emphasizes the importance of training physicians and other health care workers to determine rapidly, on the basis of the earliest cases, that an unusual infection is involved. Such training is currently still largely missing.

Because of the incubation delays, no nation can protect itself by simply screening travelers at its borders. Nor can a country such as the United States hope to inspect more than a small fraction of the food it imports daily.[50,51] As agricultural markets become increasingly global, the potential vulnerability of nations to food-borne natural or intentional disease will continue to increase.

Protection against both emerging diseases and biological terrorism must instead rely on disease surveillance. The synergy between the responses needed to meet these two threats is a powerful one and the United States and global organizations should take full advantage of it. Improving public health surveillance for biological terrorism must have both strong domestic and international components. It also requires better coordination between public health, law enforcement, and intelligence agencies.

How do we measure success in these endeavors? The success of a strategy of prevention is invevitably difficult to prove unambiguously. The more successful a prevention strategy proves to be, the more a metric for success will need to measure surveillance capabilities rather than response. The absence of an undesired, perhaps catastrophic, outcome can never be proven to be due to any particular level of preparedness. Given the importance of prevention, policymakers must become comfortable with this less direct metric of capabilities. Yet it is, after all, a familiar one in the national security realm—as familiar as the Cold War strategy of deterrence.

DOMESTIC MEASURES

Because incubation delay periods for many diseases are longer than international flight travel times, we cannot hope to stop all diseases at the borders of the United States. Nevertheless, screening and quarantine efforts at ports of entry and inspection of food imports provide an important component of public health surveillance. In 1995, the Committee on International Science, Engineering, and Technology

(CISET) of the Clinton Administration's National Science and Technology Council (NSTC) called for the strengthening of screening and quarantine efforts at ports of entry into the United States.[9] With respect to food safety, the Administration issued the *National Food Safety Initiative*,[50] which includes improved coverage for imported foods (as well as for domestic produce, seafood, and livestock). Recognizing the importance of acting abroad to ensure domestic protection, the Initiative calls for the Food Safety and Inspection Service (FSIS, within the U.S. Department of Agriculture) to provide technical assistance to countries whose products are implicated in food-borne illnesses. These initiatives should improve surveillance for both natural and artificial outbreaks.

Further improving domestic surveillance requires improving sensitivity and connectivity along the chain from physicians to national health authorities. We will consider each link in that chain in turn. First note, however, that it may be unrealistic to expect domestic public health agencies to find substantial resources to improve surveillance for biological terrorism within their existing budgets. For example, the formal mission of the CDC is "To promote health and quality of life by preventing and controlling disease, injury, and disability"[55]; its mandate is to provide the greatest good for public health. It is inevitably difficult to draw resources from programs that are protecting the lives of Americans from day-to-day life-threatening illnesses and redirect them to surveillance for future attacks that may or may not ever take place. Expanding public health surveillance explicitly to include surveillance for biological terrorism will require new resources.

An announced biological attack, or one discovered while under way, will require first responders who are appropriately trained. Other biological attacks must first be recognized by pathologists, physicians, and other health-care personnel in family practices, clinics, and hospitals. It is important, therefore, that these medical professionals have some knowledge of the clinical presentations of likely biological terror agents. There is a broad parallel with actions recommended in the Clinton Administration's CISET report[9] for addressing emerging diseases. That document called for expanded formal training and outreach for health-care providers. The National Institutes of Health (NIH) and CDC have responded by writing to medical and microbiology associations and other professional organizations urging them to focus training and certification programs on emerging diseases, and continue to sponsor meetings on related training needs. Similar actions on the part of NIH and CDC to raise physicians' awareness of biological agents should be undertaken. A first step is the article "Clinical recognition and management of patients exposed to biological warfare agents"[29] in the August 6, 1997, issue of the *Journal of the American Medical Association.* However, the best way to ensure that busy physicians improve their expertise in this area is to require relevant knowledge in medical school curricula and certification examinations, and to offer appropriate training.

In FY97, Congress appropriated $52.6 million to the Department of Defense (DoD) to implement various domestic preparedness programs. These funds were used in a variety of ways, including the development of a Chemical-Biological Rapid Response Team (CBRRT) and to procure additional equipment for the U.S. Marine Corps Chemical Biological Incident Response Force (CBIRF). The DoD also began to train trainers in 120 U.S. cities to prepare for and respond to emergencies involving

weapons of mass destruction. By the end of 1997, twenty-seven cities had received visits.[56] The DoD expects to discontinue this training after FY99.

Lead agency responsibility for this training should therefore be transferred to the Public Health Service (PHS). The Federal budget currently devotes some $7 billion annually to unclassified terrorism-related programs.[57] It is critical that within this vast budget, sufficient and ongoing resources be found to train the local physicians and other first responders to any likely biological attack.

In June 1998, President Clinton requested an additional $294 million from Congress to deter and respond to terrorist incidents involving biological and chemical weapons.[58] This request included continued funding for local training programs. The first step in improving sensitivity for incidents of biological terrorism is for the federal government to make this a long-term, sustained commitment to training for the nation's physicians, pathologists, and other first responders.

Next, regional centers of excellence, building directly on the best state public health laboratories, should be established with the capability for rapid diagnoses of clinical samples from within their geographic areas. These regional centers must have the trained personnel and diagnostic tools necessary to accomplish this mission, and connections to both local and national institutions must be assured.

To improve the ability to identify rapidly and accurately the early stages of a possible bioterrorist attack, some six to ten regional sites around the United States should be designated for substantial improvement in both epidemiological and rapid diagnostic capabilities. This capability for high-volume rapid diagnostics differs from the traditional expertise of national reference laboratories. These new regional centers of excellence should build directly on the best of the state public health laboratories in order to minimize additional expense. The President's 1998 request to

Congress[58] also asks for an additional $43 million to improve the ability of public health centers to recognize and share information on outbreaks of suspicious diseases.[59] This important request, which if implemented would improve both sensitivity and connectivity, should be fully funded.

At present, too little attention is being given to developing rapid diagnostics appropriate to this sort of laboratory setting. For example, state or regional laboratories will need diagnostics for biological agents that are capable of thousands of sequential assays. Such diagnostics would not have to be hand-held, and would not necessarily need to employ cutting-edge technologies. But they would need to be robust and reliable.

Similar equipment may also be useful for the Army and Naval Research Facilities overseas; at times of major outbreaks of infectious diseases, these regional reference labs may be swamped by samples requiring examination. (The Department of Defense operates infectious disease laboratories in six countries overseas. These labs conduct epidemiologic investigations, diagnose diseases, and recommend control measures. They conduct research on diseases of mutual interest to both the host country and the United States.)[9] Whereas high-volume diagnostics might remain unstressed for long periods in the United States, at reference laboratories overseas they would more likely be challenged by use in real outbreaks; this could provide a

valuable opportunity to refine these tools under real conditions. The relevant federal agencies should ensure that at least one agency is working to meet needs for robust, rapid, high-volume laboratory diagnostics.

A related requirement, also with resource implications, is to maintain a cadre of individuals in the United States with expertise in the diseases likely to be employed by terrorists. For example, at present CDC has the only laboratory in the world that serves as a reference laboratory for plague. There is only one full-time employee at that laboratory with experience and training in plague epidemiology and treatment.

The agencies that would be called upon to perform these tasks in the event of outbreaks of biological warfare agents should complete an inventory of critical personnel needs. It is unlikely that agencies will contribute additional positions to individuals with expertise in diseases rarely encountered in the United States. (In 1996, five cases of plague were reported in the United States, of which two were fatal; both decedents died before plague was diagnosed.)[60] Yet individuals with training appropriate to most biological warfare agents are important for responding to outbreaks abroad, since most biological agents are also naturally occurring diseases in one or another region overseas. Funding and positions should be provided for sufficient individuals to maintain national expertise in those diseases likely to be used for biological terrorism.

INTERNATIONAL NETWORKS

Surveillance for disease outbreaks overseas must also be improved. The surest way to alleviate human suffering, as well as to prevent disease from reaching America's shores, is to detect and stop outbreaks quickly while they are still abroad. The capacities that are needed — trained health care workers and epidemiologists, regional laboratories with reliable diagnostic equipment, good communications, and the ability to send in teams of experts — will help spot both emerging diseases, as well as any outbreaks resulting from the use, testing, or accidental release of biological agents.

The first step should be to improve the existing international network for the detection of infectious diseases. There are currently too many geographic holes in the international disease surveillance system. The World Health Organization (WHO), the obvious choice for a multilateral solution, has in the recent past been viewed with skepticism by many experts, due in part to its limited resources. "By the time WHO realized there was an AIDS epidemic it already existed on four continents. That's WHO preparedness and emergency response for you," commented D.A. Henderson, the physician who led WHO's smallpox eradication effort.[61]

But there is cause for growing optimism. In 1995, the World Health Assembly, the legislative body of the WHO, adopted a resolution calling on WHO to lead, strengthen and coordinate international efforts to respond to emerging infectious diseases. As a result, the Division of Emerging and other Communicable Diseases Surveillance and Control (EMC) was established, with a mission to strengthen national and international capacity in the surveillance and control of communicable diseases.[10]

The WHO/EMC publishes in both print and electronic formats the bilingual English/French *Weekly Epidemiological Record* and the electronic *Disease Outbreak News*. It is also compiling a searchable database of the WHO/EMC collaborating centers worldwide and, jointly with the World Bank and the Joint UN Programme on HIV/AIDS (UNAIDS), connecting the collaborating centers electronically.[10] Simultaneously, the Program to Monitor Emerging Diseases (ProMED), an international non-governmental group of infectious disease experts, has established an electronic reporting system open to unconfirmed reports of disease outbreaks.[62] This system parallels the more strongly filtered WHO *Rumour Outbreak List*.

These steps are reminders of how "connectivity" increasingly means access to electronic mail and the World Wide Web, and the extent to which international health security is enhanced when all nations, including developing nations, gain access to these networks. This is an area where U.S. agencies such as the U.S. Agency for International Development (USAID) may be especially well placed to provide technical assistance and support, working together with international agencies and host governments.

There are two broad categories into which improvements in international surveillance for bioterrorism may be divided. The first is ongoing "background" surveillance with the intention of recognizing outbreaks as they occur, while the second involves a directed response to a specific outbreak that has been detected. These latter cases remain in the category of surveillance as long as the "response" includes an investigation whose goal is to identify the nature, extent, and origin of a disease outbreak. By this definition, the CDC team[9] dispatched to the Ebola outbreak in Kikwit, Zaire, in 1995 was involved in surveillance (in addition to its critical missions of providing medical care and containing the outbreak).

Investigations of recognized outbreaks (especially those deemed suspicious) and the ability to identify the responsible organism or strain are critical, but these capabilities are dependent upon a surveillance system operating in the background that is able to detect outbreaks as they occur. While egregious attacks or accidents in biological warfare programs may be difficult to miss, the ability to verify the Biological and Toxin Weapons Convention (BWC) and to deter would-be violators is enhanced by having as sensitive a public health surveillance network as possible, one that will detect outbreaks that are subtle or identify less-than-subtle outbreaks in their earliest stages. Moreover, such a network provides the best opportunity to stop an outbreak before it reaches the United States.

The surest route to such a capability is to improve the international surveillance system for emerging diseases. In 1996, Vice President Gore announced the Clinton Administration's new policy for responding to emerging infectious diseases. Under that policy, President Clinton directed that the U.S. government would "work with other nations and international organizations to establish a global infectious disease surveillance and response system, based on regional hubs and linked by modern communications technologies."[63]

Such new regional networks should be integrated with the five independent monitoring and alert systems of the WHO/EMC. Information from these systems are made freely available on the World Wide Web and in other fora. One of these

systems comprises the WHO Collaborating Centers, a network of over two hundred laboratories and institutions around the world. Collaborating Centers carry out specific activities on behalf of WHO and provide information on disease distribution, while providing laboratory diagnoses and training in the host nation. Host governments agree to allow the Centers to report directly to WHO, without first going through the government. However, there are large regions of the world where these Centers are absent or rare, including Eastern Europe and much of Saharan and sub-Saharan Africa, Central America, and Southeast Asia. The new regional networks would help fill these gaps.

The CDC has thoroughly examined how to support the development of international regional networks of closely linked epidemiology and laboratory programs to promote disease surveillance. These plans were outlined in the 1994 CDC document, *Addressing Emerging Infectious Disease Threats: A Prevention Strategy for the United States*.[19] In 1993, ProMED had endorsed a system similar to that proposed by the CDC.[64] Ten medical centers, strategically located in the developing world, would serve as global health sentinels. The centers would be built directly upon the most capable existing facilities, in order to minimize expense, but would need to be given priority for international assistance.[65] The initial costs for such a network could be modest, perhaps $10 to $20 million per year.[66] This would represent a small fraction of the $7 billion in unclassified terrorism-related programs the U.S. government currently spends.[57] If the United States wishes to improve global surveillance for either emerging infectious diseases or incidents of biological terrorism, taking the lead in developing an international surveillance network is perhaps the most important commitment it could make.

A proposal for substantially augmenting the global monitoring system[65] might also provide a useful tool in the BWC negotiations. Under Article X of the BWC, States that are Parties to the Convention "in a position to do so shall also cooperate in contributing individually or together with other States or international organizations to the further development and application of scientific discoveries in the field of bacteriology (biology) for prevention of disease, or for other peaceful purposes." Augmentation of global surveillance for infectious diseases could be presented as cooperation under Article X.

One element of the global monitoring system being strengthened by the Division of Emerging and other Communicable Diseases Surveillance and Control (EMC) provides a model for public health reporting that sidesteps explicit references to biological agents. The International Health Regulations (IHR) are the only international public health legislation that requires mandatory reporting of infectious diseases (cholera, plague, and yellow fever). To transform the IHR into a global alert system, WHO is revising them to broaden their scope to include many diseases for which they currently make no provision. The approach is to require notification of five specific clinical syndromes (respiratory, neurological, antimicrobial resistance, diarrhoeal, and hemorrhagic). Reports of syndromes will be followed by reporting of specific diseases once the diagnosis is known, but action can commence even before a laboratory diagnosis is made.

From the point of view of those concerned with incidents of biological terrorism, these five syndromes will capture outbreaks due to biological warfare agents as well as

natural causes. This in turn could provide an appropriate way for regional networks to *de facto* participate in surveillance relevant to biological agents without having to do so explicitly.

THE BIOLOGICAL AND TOXIN WEAPONS CONVENTION

A verification regime for the BWC is hampered by the easy availability and dual-use nature of the microbiological technology needed to culture disease organisms.[23,67] In this light, investigations of unusual or suspicious outbreaks of disease may be the best option for improving verification.[68,69,70] The United States should continue to work for the right of the global community under the BWC to investigate suspicious outbreaks wherever they occur. Would-be developers of biological weapons should fear that if an accidental release occurs, the world may discover the resulting outbreak and pinpoint its origin. These same investigations may lead to the identification of unusual but natural outbreaks as well.

The Ad Hoc Group of Governmental Experts (also known as Verification Experts or VEREX) created by the Third Review Conference for the BWC in 1991 explored twenty-one different possible verification measures for the BWC, including surveillance of publications and legislation, scheduled declarations of activities, remote and on-site inspections, and others. The VEREX concluded that no combination of measures could be found that would uncover violations with a high degree of confidence.[70,71] A consideration of the demands placed by attempted verification of the BWC makes it clear why the task is so difficult. For example, sales estimates of fermenters in the range appropriate for illicit pilot-plant production of biological agents numbered 3,600 in 1984 alone; such plants could be attached to most major universities or biological firms.[67] Because of such practical considerations, BWC negotiators have narrowed the likely categories of declarable facilities to biosafety level 4 laboratories, those facilities producing vaccines or biopesticides, and military and biodefense programs. Otherwise, the number of sites requiring verification is just too large.

Moreover, U.S. companies have concerns regarding the protection of industrial secrets which might be compromised by inspections under a BWC regime. In any case, the experience of the United Nations Special Commission (UNSCOM) in Iraq makes it clear that even comprehensive mandatory declarations and intrusive challenge inspections of a range of biocapable facilities is insufficient to guarantee compliance: Iraq developed and maintained a biological weapons capability while under the direct scrutiny of UN inspectors.[70]

Investigations of unusual or suspicious outbreaks of disease may therefore be the best option for improving verification of the BWC. President Clinton endorsed such a measure in his speech to the UN General Assembly in September 1996.[68] In light of the history of accidental releases in biological weapons programs, a right of investigation could provide a deterrent to such programs, and a possibility of detecting violations. The Defense Special Weapons Agency[69] has conducted a disease outbreak exercise that corroborates the utility of on-site epidemiological investigations in making determinations of the nature of unusual disease outbreaks, and it has outlined preliminary criteria for recognizing possible biological weapons events.

Mechanisms for the initiation of formal on-site epidemiological investigations of suspicious disease outbreaks are under discussion in ongoing negotiations for a protocol to the BWC,[70] and the United States should place high priority on these negotiations. Because it is important that health agencies be able to operate overseas in a transparent manner, directed investigations into suspicious outbreaks are probably best left to teams specifically organized under the BWC.

A different kind of deterrent stems from some of the same molecular biological technologies that could facilitate the engineering of improved biological agents. Genetic fingerprinting (or more broadly, biological signatures tracking: the ability to identify, distinguish, and establish relationships between particular strains of organisms through biochemical or molecular biological analyses of those strains, for example via the development of a library of DNA sequences corresponding to different strains of viruses and bacteria) would help assure would-be attackers that even a secret biological release might nevertheless be tracked to its source. Greater transparency, to include the exchange of strains of organisms held in the national laboratories of individual nations, could facilitate this goal.[72]

A DNA-sequence database for different strains of organisms, especially for those associated with weapons programs, is very important for investigating either domestic or international outbreaks. Biological signatures tracking and attribution could be a powerful tool for identifying when an outbreak is artificial and who its perpetrator might be. Biological signatures tracking and attribution research and development should receive high priority for continued and additional funding.

IMPROVED COORDINATION WITHIN THE U.S. GOVERNMENT

Coordination between public health and civilian emergency response agencies is improving. Under the National Food Safety Initiative,[50] the four federal agencies charged with responding to outbreaks of food-borne and water-borne illnesses (the Food and Drug Administration [FDA], CDC within Health and Human Services [HHS], the Food Safety and Inspection Service [FSIS] within the U.S. Department of Agriculture [USDA], and the Environmental Protection Agency [EPA]) are establishing the Food-borne Outbreak Response Coordinating Group (FORCG) to develop standardized procedures for the rapid exchange of data and information associated with food-borne illness outbreaks. The HHS, USDA, and EPA will designate the Assistant Secretary of Health, the Under Secretary for Food Safety, and the Assistant Administrator for Water, respectively, as their outbreak coordinators.

However, public health surveillance, both domestic and international, could also be improved through better coordination among public health and law enforcement[73] and intelligence agencies. Coordination is inhibited because of the conflicting demands created by the transparency required for public health agencies to operate freely in the United States or abroad, and the requirements of law enforcement or intelligence gathering. Consider, for example, an institution such as a hospital or university that experiences a disease outbreak. Personnel and administrators may talk freely to scientists pursuing a public health mission, but may be much less forthcoming if those investigators are perceived as surrogates for law enforcement agencies which could pursue possible prosecutions. Internationally, the situation is

even more delicate. After the 1995 plague outbreak in Surat, for example, the Indian newsweekly *The Week* explicitly accused the United States of being responsible for the outbreak and identified by name four members of the CDC who had arrived in India to study it. The CDC's desire to send epidemiologists was described as suspicious.[48] U.S. agencies conducting epidemiological or other public health activities, be they civilian or military, will be understandably reluctant to risk compromising their ability to detect and respond to diseases overseas by appearing to have ties with intelligence gathering or covert activities.

Nevertheless, the threat of biological terrorism, and potential early ambiguities between natural outbreaks and intentional or accidental releases of biological agents, demand that closer ties between law enforcement, intelligence, and public health be established. For example, public health surveillance could likely benefit from domestic and international intelligence that there was a probable biological threat and consequent concern over the potential use of a particular biological agent. Conversely, law enforcement and intelligence could benefit from being regularly informed on what outbreaks are being seen in public health surveillance (domestic and overseas) and how these events are being resolved.

Federal law enforcement has considerable experience working with local actors (such as local police departments) and success at maintaining the confidentiality of appropriate information passed on in these relationships. The appropriate levels and individuals in the public health surveillance system to receive analogous information need to be determined. Maintenance of confidentiality could be inconsistent with a very broad notification. For this sort of exchange of information to be secure and effective, pre-planning is a requirement.

A ROLE FOR SCIENTISTS AND SCIENTIFIC SOCIETIES

Scientists have in the past alerted the public and decision-makers to dilemmas posed by their research, for example in the 1970s during the recombinant DNA controversy.[74] Zilinskas[75] has suggested that, given the difficulties in verifying the BWC,[67] individual scientists and scientific societies must cultivate an ethic in which the illicit development of biological weapons will be discouraged and perhaps revealed to outsiders. He recommends that scientists in nations suspected of sponsoring biological weapons research be especially encouraged to attend scientific meetings and provided with electronic communications access to their international colleagues. Similarly, science students from these nations should be invited to international fora where scientific ethics are discussed. National and international scientific societies such as the American Society for Microbiology and the International Council of Scientific Unions are natural sponsors for such activities. Moreover, scientific and technical workers who once worked in biological weapons programs, for example in the former Soviet Union,[25] should be provided with challenging work in their home nations so as to deter them from marketing their biological weapons skills abroad. International programs established by the European Union, Japan, the United States, and private individuals, such as the International Science and Technology Center, should be supported with these objectives in mind.

CONCLUSION: NATIONAL SECURITY AND PUBLIC HEALTH

Terrorist attacks using biological weapons have been carried out or attempted at virtually every scale, from individual assassinations to indiscriminate attacks. While apocalyptic urban attacks have not succeeded, they have been attempted by at least one terrorist group. Prudent national security policy requires the United States to prepare itself for such attacks.

Because diseases have long incubation times when compared to modern national and international travel times, preparing for biological terrorism is necessarily different from preparing for attacks using other weapons of mass destruction. Preparing for bioterrorism requires improving the sensitivity and "connectivity" of public health surveillance systems within the United States and overseas. Domestically, physicians and other health care workers must be given the training needed to recognize or at least suspect unusual diseases, and the ability to check these suspicions quickly at the state or regional level must be available. Internationally, the United States should work with foreign governmental, multilateral, and non-governmental organizations to improve global surveillance for suspicious outbreaks. These same systems will also help protect American citizens, and people throughout the world, from emerging diseases.

The incubation delay periods of many diseases as well as the growing amount of food imported into the United States demonstrate the insufficiency of protecting the security of U.S. citizens through monitoring for human-borne illnesses at ports of entry or inspection of food imports. Both forms of monitoring are important and should be improved, but some diseases will inevitably elude this screening. There is no alternative to a defense in depth, with improved surveillance at all levels, from the local to the international. The United States has a strong stake in determining the nature and origin of outbreaks overseas. Threatening outbreaks are best recognized and stopped while still abroad.

An important component of such international detection and response will continue to be the dispatching of epidemiological and medical teams overseas. However, international surveillance must primarily rely upon multilateral cooperation, in the form of both sentinel laboratories and formal and informal electronic and voice networks. It is therefore directly in the interest of the United States to strengthen these.

Preparations for a biological attack via improved public health surveillance, both domestic and international, will simultaneously protect U.S. citizens against emerging infections and other naturally occurring outbreaks. Even if a major biological terrorist attack never occurs, the investment in public health will, on a daily basis, work to improve the health of all Americans.

It is sobering that many of these conclusions are reiterations of lessons learned decades ago. In 1950, soon after the onset of the Korean War, it was recognized that a

biological terrorist attack within the United States was possible, and that little could be done to stop such an attack. However, the disease could be contained and quickly treated if early detection were achieved. To this end, the CDC's Epidemic Intelligence Service (EIS) was formed; medical officers were trained in field epidemiology and assigned to the CDC, state health departments, and universities.[76] In the absence of a terrorist attack, members of the EIS could maintain their expertise and improve American public health by analyzing natural disease outbreaks. These baseline assessments would in any case be important for the recognition of possible attacks, as they would be needed to determine whether an outbreak exceeded normal background levels—and was therefore potentially suspicious.

An appropriate national security response to the threat of biological terrorism is interwoven with the response that is needed to combat the environmental threat of emerging diseases: improved public health surveillance. In this context, responsibility for national security extends throughout society, from primary care physicians at local hospitals and clinics, to state and national health laboratories and officials, and to public health surveillance networks overseas. These responsibilities need to be matched with appropriate resources. Public health and national security merge in the realm of emerging diseases and biological terrorism.

REFERENCES

1. Jordan, A.A., W.I. Taylor, and L.J. Korb. 1993. *American National Security: Policy and Process.* Baltimore: The Johns Hopkins University Press.

2. Mathews, J.T. 1989. "Redefining security." *Foreign Affairs* 68(2): pp. 162-77.

3. Homer-Dixon, T.F. 1992. "On the threshold: Environmental changes as causes of acute conflict." *International Security* 16(2).

4. Lederberg, J. 1997. "Infectious disease as an evolutionary paradigm." *Emerging Infectious Diseases* 3: pp.417-23.

5. Altman, L.K. 1997. "U.N. reports 3 million new H.I.V. cases worldwide for '96." *The New York Times,* 28 November: p. A6.

6. National Center for Health Statistics. 1997. Cited in *The World Almanac and Book of Facts 1997.* Mahwah, NJ: World Almanac Books, p. 964.

7. Krause, R.M. 1992. "The origin of plagues: Old and New." *Science* 257: pp. 1073-78.

8. Morse, S.S. 1995. "Factors in the emergence of infectious diseases." *Emerging Infectious Diseases* 1: pp. 7-15.

9. Committee on International Science, Engineering, and Technology, National Science and Technology Council. 1995. *Infectious Disease—A Global Health Threat.* Washington, DC.

10. World Health Organization. 1996. *EMC Annual Report.* World Health Organization.

11. Peters, C.J., et al. 1993. "Filoviruses." In *Emerging Viruses,* ed. S.S. Morse. Oxford: Oxford University Press, pp. 159-75.

12. Sternberg, S. 1994. "Tracking a mysterious killer virus in the Southwest." *Washington Post Health,* 14 June: p. 10.

13. Institute of Medicine. 1992. *Emerging Infections: Microbial Threats to Health in the United States.* Washington, DC: National Academy of Sciences.

14. Maurice, J. 1995. "Russian chaos breeds diphtheria outbreak." *Science* 267: pp. 1416-17.

15. Cohen, M.L. 1992. "Epidemiology of drug resistance: Implications for a post-antimicrobial era." *Science* 257: pp. 1050-55.

16. Neu, H.C. 1992. "The crisis in antibiotic resistance." *Science* 257: pp. 1064-73.

17. Altman, L.K. 1998. "Experts see need to control antibiotics and Hospital infections." *The New York Times,* 12 March: p. A12.

18. Gibbons, A. 1993. "Where are 'new' diseases born?" *Science* 261: pp. 680-81.

19. Centers for Disease Control and Prevention. 1994. *Addressing Emerging Infectious Disease Threats: A Prevention Strategy for the United States.* Atlanta, GA: U.S. Department of Heath and Human Services, Public Health Service.

20. Betts, R. 1998. "The new threat of mass destruction." *Foreign Affairs* 77(1): pp. 26-41.

21. Freedman, L. 1998. "International security: Changing targets." *Foreign Policy* 110: pp. 48-64.

22. Zilinskas, R. 1990. "Terrorism and biological weapons: Inevitable alliance?" *Perspectives in biology and medicine* 34: pp. 44-72.

23. Office of Technology Assessment. 1993. *Technologies Underlying Weapons of Mass Destruction.* OTA-BP-ISC-115. December. Washington, DC: U.S. Government Printing Office.

24. Weiner, T. 1998. "Soviet defector warns of biological weapons." *The New York Times,* 25 February: p. A1.

25. Alibek, K. 1998. "Russia's deadly expertise." *The New York Times,* 27 March: p. A19.

26. U.S. Senate. 1995. Permanent Subcommittee on Investigations, Committee on Governmental Affairs. "Staff Statement: Hearings on Global Proliferation of Weapons of Mass Destruction: A Case Study on Aum Shinrikyo." October 31. Cited in Tucker, 1996.

27. Broad, W.J., S. WuDunn, and J. Miller. 1998. "How Japan germ terror alerted world." *The New York Times,* 26 May: p. A1.

28. Tucker, J.B. 1996. "Chemical/biological terrorism: Coping with a new threat." *Politics and the Life Sciences* 15(2): pp. 167-83.

29. Franz, D.R., et al. 1997. "Clinical recognition and management of patients exposed to biological warfare agents." *Journal of the American Medical Association* 278: pp. 399-411.

30. Fialka, J.J. 1993. "CIA says North Korea appears active in biological, nuclear arms." *The Wall Street Journal,* 25 February: p. 16.

31. Rosebury, T. 1949. *Peace or Pestilence: Biological Warfare and How to Avoid It.* New York: McGraw-Hill Book Co.

32. Kadlec, R.P. 1995. "Twenty-first century germ warfare." *In Battlefield of the Future,* ed. B.R. Schneider and L.E. Grinter. Air University, Maxwell Air Force Base, pp. 227-50.

33. McClain, D.J. 1997. "Smallpox." In *Textbook of Military Medicine.* Office of the Surgeon General, Department of the Army, chap. 27, pp. 539-59.

34. Altman, L.K. 1998. "Protection urged for possible smallpox attack." *The New York Times,* 11 March: p. A16.

35. Török, T.J., et al. 1997. "A large community outbreak of salmonellosis caused by intentional contamination of restaurant salad bars." *Journal of the American Medical Association* 278: pp. 389-95.

36. Office of Technology Assessment. 1993. *Proliferation of Weapons of Mass Destruction: Assessing the Risks.* OTA-ISC-559. August. Washington, DC: U.S. Government Printing Office.

37. Kupperman, R.H., and D.M. Smith. 1993. "Coping with biological terrorism." In *Biological Weapons: Weapons of the Future?* ed. B. Roberts. Washington, DC: Center for Strategic and International Studies.

38. Kaufmann, A.F., et al. 1997. "The economic impact of a bioterrorist attack: Are prevention and postattack intervention programs justifiable?" *Emerging Infectious Diseases* 3: pp. 83-94.

39. Purver, R. 1995. *Chemical and biological terrorism: The threat according to the open literature.* Canadian Security Intelligence Service.

40. Cole, L.A. 1996. "The specter of biological weapons." *Scientific American,* December.

41. Daley, S. 1998. "In support of apartheid: Poison whisky and sterilization." *The New York Times,* 11 June: p. A3.

42. Kolavic, S.A., et al. 1997. "An outbreak of *Shigella dysenteriae* type 2 among laboratory workers due to intentional food contamination." *Journal of the American Medical Association* 278: pp. 396-98.

43. Meselson, M., et al. 1994. "The Sverdlovsk anthrax outbreak of 1979." *Science* 266: pp. 1202-08.

44. Christopher, G.W., et al. 1997. "Biological warfare: A historical perspective." *Journal of the American Medical Association* 278: pp. 412-17.

45. Zilinskas, R. 1992. "Confronting biological threats to international security: A biological hazards early warning program." *Annals New York Acad. Sci.* 666: pp. 146-76.

46. Perkins, B.A. 1996. "Unexplained deaths due to possibly infectious causes in the United States: Defining the problem and designing surveillance and laboratory approaches." *Emerging Infectious Diseases* 2: pp. 47-53.

47. Wheelis, M. 1998. *Investigation of suspicious outbreaks of disease: Implications for biological arms control.* Forthcoming.

48. Prasannan, R. 1995. "Military microbe." *The Week,* 23 July: pp. 30-37.

49. Davis, S.H. 1977. *Victims of the Miracle: Development and the Indians of Brazil.* Cambridge: Cambridge Univ. Press.

50. National Food Safety Initiative. 1997. *Food Safety from Farm to Table: A National Food Safety Initiative.* Report to the President, May.

51. Gerth, J., and T. Weiner. 1997. "Imports swamp U.S. food-safety efforts." *The New York Times,* 29 September: p. A1.

52. Berkelman, R.L., et al. 1994. "Infectious disease surveillance: A crumbling foundation." *Science* 264: pp. 368-70.

53. Flood, J., et al. 1997. "Surveillance of unexplained illnesses and deaths of possible infectious causes." Paper presented to Infectious Disease Society of America, San Francisco.

54. Sidell, F.R., E. T. Takafuji, and D. R. Franz, eds. 1997. *Medical Aspects of Chemical and Biological Warfare.* Washington, DC: Office of the Surgeon General.

55. Centers for Disease Control and Prevention. 1997. http://www.cdc.gov/aboutcdc.htm#mission.

56. Cohen, W. 1997. Letter to the Honorable Strom Thurmond, Chair, Committee on Armed Services, 15 December.

57. General Accounting Office. 1997. *Combating terrorism: Spending on governmentwide programs requires better management and coordination.* GAO/NSIAD-98-39.

58. Office of the Press Secretary, The White House. 1998. *President requests additional funding for protection against biological and chemical terrorism.* 8 June.

59. Miller, J. 1998. "Clinton seeks additional $300 million to fight bioterrorism." *The New York Times,* 9 June: p. A16.

60. "Fatal human plague—Arizona and Colorado, 1996." 1997. *Morbidity and Mortality Weekly Report* 46: pp. 617-20.

61. Quoted in Garrett, L. 1994. *The Coming Plague: Newly Emerging Diseases in a World Out of Balance.* New York: Farrar, Straus and Giroux.

62. "Fast-tracking epidemic information." 1996. *The Lancet* 348: p. 1599.

63. Office of the Vice President. 1996. "Vice President announces policy on infectious diseases." Press release. The White House, 12 June.

64. Morse, S.S., et al. 1996. "ProMED global monitoring of emerging diseases: design for demonstration program." *Health Policy* 38: pp. 135-53.

65. Rosenberg, B.H., and J. Woodall. 1997. "Sentinel centres for global health security." *The Lancet* 349.

66. Morse, S.S. 1997. "Controlling emerging infectious diseases." http://www.fas.org/promed/papers/morse.htm

67. Zilinskas, R. 1986. "Verification of the biological weapons convention." In *Biological and Toxin Weapons Today,* ed. E. Geissler. SIPRI. Oxford University Press.

68. Office of the President. 1996. "Speech to the UN General Assembly. Press release. 24 September. Washington, DC.

69. Defense Special Weapons Agency. 1996. *Unusual Disease Outbreak Exercise Final Report.* McLean, VA.

70. Kadlec, R.P., et al. 1997. "Biological weapons control: Prospects and implications for the future." *Journal of the American Medical Association* 278: pp. 351-56.

71. Defense Nuclear Agency. 1994. *Global Proliferation: Dynamics, Acquisition Strategies, and Responses.* Vol. IV - *Biological Weapons Proliferation.* DNA-TR-93-129-V4.

72. Wheelis, M.L. 1992. "Strengthening biological weapons control through global epidemiological surveillance." *Politics and the Life Sciences* 11: pp. 179-89.

73. Tucker, J.B. 1997. "National health and medical services response to incidents of chemical and biological terrorism." *Journal of the American Medical Association* 278: pp. 362-68.

74. Chyba, C. 1980. "The recombinant DNA debate and the precedent of Leo Szilard." In *Science and Ethical Responsibility,* ed. S.A. Lakoff. Reading, MA: Addison-Wesley, pp. 251-64.

75. Zilinskas, R. 1998. "Bioethics and biological weapons." *Science* 279: p. 635.

76. Henderson, D.A. 1993. "Surveillance systems and intergovernmental cooperation." In *Emerging Viruses,* ed. S.S. Morse. Oxford: Oxford University Press, pp. 283-89.