SURVEILLANCE AND DETECTION: A PUBLIC HEALTH RESPONSE TO BIOTERRORISM

by

Barbara F. Bullock

The Counterproliferation Papers
Future Warfare Series No. 12
USAF Counterproliferation Center

Air University
Maxwell Air Force Base, Alabama

Surveillance And Detection:
A Public Health Response To Bioterrorism

Barbara F. Bullock

February 2002

The Counterproliferation Papers Series was established by the USAF Counterproliferation Center to provide information and analysis to assist the understanding of the U.S. national security policy-makers and USAF officers to help them better prepare to counter the threat from weapons of mass destruction. Copies of No. 12 and previous papers in this series are available from the USAF Counterproliferation Center, 325 Chennault Circle, Maxwell AFB AL 36112-6427. The fax number is (334) 953-7530; phone (334) 953-7538.

Counterproliferation Paper No. 12

USAF Counterproliferation Center

Air University

Maxwell Air Force Base, Alabama 36112-6427

The internet address for the USAF Counterproliferation Center is:

http://www.au.af.mil/au/awc/awcgate/awc-cps.htm

Contents

Disclaimer

The views expressed in this publication are those of the author and do not reflect the official policy or position of the U.S. Government, Department of Defense, or the USAF Counterproliferation Center.

The Author

Barbara Franklin Bullock is an acquisition program manager at the Standard Systems Group, Maxwell AFB-Gunter Annex, Alabama. A June 2001 graduate of the Air Command and Staff College, she entered federal service in July 1974 as a computer programmer, after earning a Bachelor of Science degree in mathematics from Alabama A&M University. Her career encompasses over 27 years of experience facilitating the acquisition, development, testing, deployment and sustainment of Air Force base-level automated systems. She holds acquisition professional development program Level II ratings in program management and communications-computers. In her current assignment as the Deputy Program Manager for the Case Execution Management Information System (CEMIS), she works to develop a replacement management information system for the ordering and shipping of U.S. defense articles and services to foreign countries.

Acknowledgments

I entered this elective course absent a wealth of knowledge about the subject matter. I end it appreciably more informed. For this, I thank Dr. Costanzo and other knowledgeable members of the seminar who contributed greatly to this evolution. Additionally, I thank the Air University Library staff for their assistance in locating needed material for my research and Ms. Pamela Hollabaugh for her assistance with the research template.

List of Tables

Surveillance and Detection: A Public Health Response to Bioterrorism

Barbara F. Bullock

I. Introduction

Perhaps the most frightening apparition of our times is the possibility that a biological agent (bacterium, virus, or toxin) will be used to attack our unprotected civilian population and inflict mass casualties. Until the Fall of 2001, anthrax attacks delivered through the mail to various U.S. senators, to the Governor of New York, and to various media offices, the previously expected use of a weapon of mass destruction against the United States has been a nuclear device that explodes or a chemical cloud that is set adrift. However, today, of all the weapons of mass destruction (nuclear, chemical, and biological), the biological weapons are the most feared by many defense experts but these are the ones that our country is least prepared to deal with.[1] Like the concept of a "nuclear winter," the potential destructiveness of a biological attack can come in many forms and is presently very hard to detect and control, and its results could be catastrophic. The unleashing of biological agents against an unprotected civilian population also, in some cases, constitutes the ultimate medical disaster with the capability to completely overwhelm the present health care system. Patients might go to health facilities in unprecedented numbers and demands for intensive care could well exceed available medical resources. Discerning the threat of bioweapons and appropriate responses to them are critical if we are to prevent the devastating effects of bioterrorism.

In the last century not a single American is known to have died as a result of bioterrorism.[2] Yet, even before the anthrax attacks of late 2001, in previous years, the threat of bioterrorism used against our civilian population had attracted the attention and the resources of U.S. leaders through congressional hearings, government warnings, funding, research studies, and commentaries.[3] For example, during the first "National

Symposium on Medical and Public Health Response to Bioterrorism" held in 1999, Donna Shalala, former Secretary of Health and Human Services, identified four challenges that our government cannot meet alone in combating this emerging threat: 1) awareness, 2) preparedness, 3) public health and medical communities taking the lead in this fight, and 4) cooperation between all levels of government and the medical community.[4]

Awareness, our first challenge, centers on recognizing that an act of bioterrorism in the United States has already happened. In late 2001, someone mailed anthrax-laced envelopes to various U.S. Senators, the Governor of New York, media leaders, and others in the wake of the September 11th terrorist events sponsored by Osama bin Laden's Al Qaeda organization. Because of America's unrivaled military preparedness, potential enemies (rogue states, international terrorists, and national terrorists) are more likely to resort to asymmetrical biological attacks rather than conventional military confrontations. Jonathan B. Tucker, noted expert at the Monterey Institute of International Studies, states that "a biological arsenal might serve as the basis of an 'asymmetric strategy' in which, instead of confronting a superior conventional military power head-on, the weaker state employs biological weapons to inflict high casualties, spread terror, and undermine the enemy's will to fight."[5]

Biological weapons share seven characteristics that make them ideal weapons for rogue nations and terrorists: 1) ease and low cost of production; 2) ease of dissemination as aerosols; 3) efficient exposure of great numbers of people through inhalation; 4) delayed effect; 5) high potency; 6) high subsequent mortality and morbidity; and, 7) their ability to wreak psychological havoc.[6]

Biological attacks could create mass casualties if properly manufactured, if appropriate delivery systems are provided, and if meteorological conditions are right. For example, Secretary of Defense William Cohen has stated that a bioterrorism attack of 100 kilograms of anthrax, properly dispersed, would have the impact of two to six times the fatality consequence of a single megaton nuclear bomb.[7] Initially, discussions about the implications of bioterrorism were largely restricted to the Department of Defense, Department of State, Federal Bureau of

Investigation (FBI), and the intelligence communities. Only recently have the civilian medical and public health communities begun to engage the practical challenges posed by this threat. Professional societies have begun to incorporate discussions of bioterrorism in national meetings and in 1998, the World Health Organization established an expert group to review and revise its 1970 landmark document, "Health Aspects of Chemical and Biological Weapons."[8]

Once aware of the threat, preparing a credible national medical response to any such attack is the second challenge. In May 1998, President Clinton signed Presidential Decision Directive 62 to define the Administration's policies on preparedness against weapons of mass destruction and other unconventional threats, and to designate the first National Coordinator to bring together various federal programs on unconventional threats.[9] The Department of Health and Human Services spent 158 million dollars and 230 million dollars in fiscal years 1999 and 2000, respectively, to fund its ongoing "Anti-Bioterrorism Initiative," devised to significantly raise our level of preparedness to include public health surveillance, epidemiological capacity, medical response, building a stockpile of pharmaceuticals, and research and development.[10] Public health surveillance, the ongoing systematic collection, analysis, interpretation, and dissemination of health data, plays a major role in our preparedness by enabling epidemiologists to use the collected data to detect biological outbreaks and characterize disease transmission patterns by time, place, and person.

With a bioterrorism attack, the public health and medical communities are our frontline response. They are the ones who must first detect that the incident has actually occurred, identify the biological agent, decontaminate the area (if needed), determine the likelihood of secondary transmission, identify the exposed population, and provide preventive measures and treatments.[11] First responders are emergency department physicians and nurses, infectious disease physicians, infection control practitioners, epidemiologists, laboratory experts, public health officials, and hospital administrators. Rapid detection, accurate diagnosis, and speedy treatment by the first responders can save many lives. Hence, our

third challenge is to ensure that first responders are capable of performing this mission.

Successfully combating biological warfare requires unprecedented cooperation between the federal government, state and local agencies, and the medical community, and is our fourth challenge. The federal government [Health and Human Services (HHS), the Federal Bureau of Investigation (FBI), Federal Emergency Management Agency (FEMA), and others] plays a key leadership role by supporting state and local planning efforts with funding, expertise, and training, and developing an infrastructure for detecting biological attacks and delivering mass medical care. Hence, medical response plans for managing the consequences of bioterrorism must be well integrated and coordinated with other emergency response systems.

Of the four challenges cited by Secretary Shalala, ensuring that first responders are capable of performing this mission (the third challenge) is the most critical because the efficiency of the first responders determines the casualty count. Our medical response to a biological attack is vested in the local public health systems being able to detect that a biological attack has occurred, identify the biological agent, provide an accurate diagnosis, and effectively treat an uncommon disease. Because we do not have extensive experience with a biological attack, our public health systems would be challenged to undertake emergency management of bioterrorism. Special measures would be needed for patient care and hospitalization, obtaining laboratory confirmation regarding the identity of the biological agent, providing vaccine or antibiotics to a large population, and identifying and possibly quarantining patients. Rapid and accurate surveillance detection and epidemiologic investigation by the first responders would be a key factor in minimizing suffering and loss of life. The limitations of our public health departments in conducting disease detection and surveillance and epidemiologic investigations have caused many public health experts to raise concerns about the adequacy of the country's infectious diseases surveillance network and its ability to function in the midst of a biological attack.[12]

II. Local Disease Surveillance and Detection by Physicians

The current system of medical response to a bioterrorism attack in the United States emphasizes the critical role of the first responders, the local emergency care systems, in the initial period of a biological attack. Knowing that a biological attack has occurred (detection) is the first challenge faced by first responders, since biological agents lend themselves to clandestine dissemination in the air, food or water supply.[13] The release would most likely be unannounced by the attacker and would most certainly be undetected. For example, an airborne or aerosol release would produce a cloud that would be invisible, odorless, and tasteless. Depending on the biological agent used, no one would know until days or weeks later that anyone had been infected. This knowledge would come long after a considerable amount of damage had been done. It is highly probable that most victims of an unannounced biological attack will delay seeking medical care because most of the biological agents used in such attacks will manifest flu-like symptoms in the early stages of infection.[14] Because of this delayed reaction, even the possibility of a bioterrorist attack causes trepidation in the medical community. It is not surprising that first responders from 22 cities who attended federal bioterrorism preparedness planning, training and equipment programs provided an average self-assessment rating of 4.1 out of a possible 10 points for their municipality's medical bioterrorism response capability.[15] These poor ratings are indicative of just how far emergency officials in these cities receiving federal aid to combat bioterrorism believe they have to go before they could truly handle a major infectious disease outbreak.

Regardless of the trepidation of the first responders, eventually, patients would begin appearing in emergency rooms and physician offices with possibly flu-like symptoms and physicians would return most of them home without having ordered any diagnostic testing.[16] A tide of patients would return to their care facilities and only then would physicians begin extracting cultures such as throat swabs, urine, stool, and blood samples. The severely ill would be admitted to intensive care units and medical wards. Due to the harried pace of the medical personnel, it is doubtful that

anyone would notice that the influx of patients currently being treated in multiple emergency facilities, came from the same geographic area.[17] The patients would be treated by another set of physicians who are even less likely than their emergency department colleagues to recognize the symptoms that manifest from exposure to biological attacks, since few physicians have seen a case of anthrax, smallpox, or the plague.[18]

A physician in Pennsylvania's Allegheny County tested how alert his on-duty colleagues were to the signs of smallpox, a disease that has not been seen in the United States for decades.[19] Of 17 physicians quizzed, only one of the two infectious disease specialists correctly connected the symptoms to smallpox. In another example, a Maryland emergency room physician who had completed the domestic preparedness training program, estimated that numerous people would have to be coughing up black blood, others on ventilators, and dozens dead before he and his colleagues would connect the symptoms to anthrax.[20] A 1998 survey of 76 physicians (53 percent reported that their emergency medicine residency programs included formal training in biological warfare agents) heightens the concern that most physicians would miss the clinical signs of a bioterrorist attack. Of those surveyed, over 70 percent rated their ability to detect the clinical signs of bioterrorism as very poor or less than adequate.[21] Because bioterrorism is seen as a low probability event, active participation by critical private sector players may be minimal. This is evidenced by the "Train the Trainers" sessions on bioterrorism held in Baltimore in 1999 where only five emergency room physicians and no hospital representatives attended.[22] If clinicians seeing a host of cases with similar symptoms considered factors such as the normal patterns of a disease, or a disease not endemic to a particular geography worthy of further investigation, they would get a head start on discerning a terrorist attack from a natural occurring disease; see Table 1.[23]

Despite the emphasis on emergency room physicians as the early response team, the medical community may not identify the reason people are falling ill until days or even weeks later, after hospitalization and when laboratory results are available.[24] By this time, many lives would have been lost. A 1972 outbreak of smallpox in Yugoslavia clearly illustrates

this point.[25] The last smallpox outbreak in Yugoslavia had occurred in 1927 but Yugoslavia continued population-wide vaccinations to protect against imported cases. A pilgrim returning home from Mecca became ill with an undiagnosed febrile disease and was hospitalized. He received visitors from a number of different localities; eleven of the visitors became ill within two weeks with high fever and rash. The patients were unaware of each other's illness and their physicians, few of whom had ever seen a case of smallpox, failed to make a correct diagnosis. The first cases were correctly diagnosed two days after one of the visitors died and four weeks after the first patient became ill. By then, 150 persons were already infected. Nine weeks after the first patient became ill, 175 persons had contracted smallpox and 35 had died. The high casualty numbers were averted due to mass vaccination clinics held throughout the country.

III. Local Laboratory Surveillance and Capacity

The next impediment to detection that hinders a rapid response by the first responders occurs in the laboratory. When a clinical specimen reaches the laboratory, diagnosis may be hindered for several reasons.[26] First, microbes that grow rapaciously in the lungs or intestines can be difficult to grow in a petri dish. Second, microbiologists have an even harder time growing cultures when samples are not taken with precision and properly prepared and stored. Prior to being received in the laboratory, cultures are handled by clinicians and delivery service personnel who may not be trained in the appropriate procedures for taking, preparing and storing cultures. It is not difficult to imagine this happening among harried medical personnel working with a large influx of patients. Before the late 2001 terrorist anthrax attacks against U.S Senators, the Governor of New York, and selected mass media leaders, it is likely that if microbiologists were to receive an unexpected result like anthrax, they previously might have been likely to consider it a fluke caused by mishandling and disregard the result. Hopefully, that is no longer the case. Third, microbiologists routinely run a series of time-consuming tests for ordinary diseases before they start testing for exotic ones. Fourth, if a disease is presented to them that they have only seen in textbooks, technicians are likely to restart the test, often requesting that a new culture be drawn from the patient. At some point, the cultures that are difficult to identify go into the stack of unknowns to be scrutinized by a pathologist, who may request additional diagnostic assays such as those shown in Table 2.[27] Fifth, some microbiologists may be unfamiliar with how to plate and test for biological warfare agents; for example, a special medium has to be used to test for anthrax.[28] Sixth, until September 11, 2001, and its aftermath, the vast majority of hospital, public health, and private laboratory technicians were not attuned to the possibility of a bioterrorist attack because they have not been targeted for awareness or other technical training.[29] That may be changing but there is still a long way to go to train this group sufficiently to handle the level of threat we may face. A difficult, unknown culture still may be referred up the laboratory chain,

with the hospital or private laboratory sending the culture to the local public health laboratory, which could pass the culture on to its state counterpart, which may pass it on to the CDC or the U.S. Army Medical Research Institute of Infectious Diseases.[30] With delays for re-tests, several weeks may pass before laboratories unravel the mystery. Delays in determining the scope and magnitude of a biological attack may result in illness and deaths that may have been avoided if a rapid response, based on accurate and timely surveillance data, were made.[31]

IV. Problems with Current Epidemiologic Investigation

A major mission of public health departments is prompt identification and suppression of infectious diseases. Our national concept of operations for an early bioterrorism response relies heavily on local, state, and federal health organizations being able to detect a biological attack through surveillance by first responders and their reporting of a possibly uncommon disease. Surveillance systems for collecting, analyzing, and interpreting reports of such cases and trained staffs to monitor for disease outbreak are the foundation of public health epidemiology.[32] They are also the core of the problems with our current epidemiologic investigation capabilities.

Surveillance systems that rely on voluntary disease reporting from health care providers are called passive surveillance systems and are notorious for their poor sensitivity, lack of timeliness, and minimal coverage.[33] Because the passive system is inexpensive to implement, it comprises the majority of surveillance systems in place at local, state, and federal levels. Generally, the quality of information in passive surveillance systems is greatly limited, making them not well suited to the needs of bioterrorism surveillance. The CDC oversees a large number of passive disease surveillance systems. They are based on collaboration with state and local health departments, which in turn depend on physician-initiated reports of specific diseases or information from state health laboratories; the National Notifiable Disease Surveillance System is probably the best known. CDC and state epidemiologists compile and periodically review a national list of fifty diseases; this list currently includes anthrax, smallpox, plague, hemorrhagic fevers, and botulism. By state laws, clinicians, hospitals, and laboratories are required to report cases involving any of these fifty diseases.[34] Although many states have legal penalties against a health provider that does not report, the penalties are seldom imposed. Hence, the reliability of passive surveillance systems is often low because physicians or hospitals often fail to make the initial report or do not do so in a timely manner. Because little if any federal

funding is provided to support surveillance, local and state health departments have no incentives to actively support it.

Active surveillance, which requires a staff to actively search for and identify new cases, provides more timely and accurate information than the passive systems but must have sufficient numbers of adequately trained epidemiologists to collect, compile, analyze, and interpret the data to determine the source of the biological agent; an example of an active system is the Sentinel Surveillance Networks.[35] Detecting and characterizing an outbreak caused by a covert release of a biological agent can be difficult, but it may also be startlingly obvious. A reported case of anthrax in an area of the country where anthrax is never reported or in an individual with no obvious risk factors for the disease would raise the suspicions of the public health epidemiologist. Although intentional infection would not necessarily be the first explanation investigated, a process of elimination or additional case reports would eventually lead to a serious consideration of this possibility. The time it takes to reach this point can determine if we have a small casualty count or mass casualties. In the case of a biological attack, lost time may quickly translate into lost lives. Therefore, it is a critical infrastructure resource and expertise problem of national importance that we have a sufficient number of adequately trained epidemiologists at both the local and state levels. The CDC trains a cadre of Epidemic Intelligence Service (EIS) officers, who are available to assist state and local epidemiological response. Surprisingly, the EIS was created during the Korean war in response to fears about biological weapons and the perception that state and local public health resources were inadequate to deal with disease outbreaks.[36] Now, nearly fifty years later, facing a threat from these same biological weapons, our country finds itself understaffed and underprepared.

Former Minnesota State epidemiologist Dr. Michael Osterholm surveyed the policies and scientific capabilities of all fifty state health departments. He discovered that the tremendous variations in disease reporting reflected enormous discrepancies in the policies and capabilities of the health departments.[37] In the United States, all disease surveillance begins at the local level, and then is transmitted to the state level and

finally to the CDC. Because the United States has a very mobile population, a weak link in the local to federal chain severely compromises the entire system, and could lead to unnecessary deaths when dealing with a biological attack.

In a General Accounting Office (GAO) report on state surveillance systems, which also found that disease surveillance is not comprehensive in all states, many state laboratory directors and epidemiologists blamed inadequate staffing, information-sharing problems, and the CDC as culprits in hindering their ability to generate and use laboratory data to conduct infectious diseases surveillance.[38] First, the state laboratory directors and epidemiologists asserted that the number of laboratory staff to perform tests and the number of epidemiology staff who can analyze data, translate surveillance information into disease prevention and control activities are insufficient. The number of epidemiologists who are prepared for fieldwork is limited because the public health sector competes poorly with academia and industry for new epidemiology graduates.[39] Second, they reported that participants in the surveillance network (especially at the local level) often lack basic computer systems needed to allow them to rapidly share information. Third, they cited a requirement for training to ensure that their staffs have the skills to take advantage of the technological advances in laboratory methods and information-sharing systems. These three assertions reinforced a prior Dr. Osterholm study which discovered that nearly two decades of government belt tightening, coupled with decreased local and state revenues, had limited the ability of public health departments to hire the quantity of trained personnel needed, and to purchase new equipment and training.[40] Advances in information technology, in large part, have not reached local and some state health agencies. The capacity of state and local health departments to communicate electronically with each other is limited, with fewer than fifty percent of local health departments having any capacity for Internet connectivity. Fourth, they expressed concerns about CDC's many separate data reporting systems rather than an integration of its many systems. This results in duplication of effort and further drains limited resources. Fifth, they wanted CDC to help the states

build systems that link them with local and private surveillance partners. Large medical practices and managed care facilities often have patient medical records in electronic form that may identify a case of a potential biological terrorism-related illness. Sixth, the states wanted CDC to provide more hands-on training experience. They placed high value on CDC's testing and consulting services, but they also stated that CDC needed to improve its on-site expertise. Last, state officials pointed out that obtaining assistance with problems that cut across programmatic boundaries could be improved if CDC's departments communicated better with one another. The many separate departments often failed to share information within CDC.

V. Efforts to Enhance Surveillance and Detection

Detection and identification of biological agents, either in the environment or in victims' bodies, is currently a piecemeal operation that, in the absence of other information, is as much art as science.[41] Local health officials and emergency planners, state public health officials, and the CDC are striving to find more expedient ways to detect and respond to a biological attack.

At the local level, several syndrome surveillance concepts are being implemented to achieve early detection of suspicious disease outbreaks by auditing fluctuations in the number of patients admitted to hospitals; the numbers are derived from the activity levels of the emergency management systems (EMS).[42] In some cities like Boston, Cleveland, and Denver, doctor supervision of the EMS personnel provides valuable information about community health problems, enabling the doctors to identify a disease outbreak early. Some cities are operating websites to monitor the number of incoming patients, the diversion status of hospitals, and the number of incoming patients with similar symptoms. Additionally, they are requiring the EMS crews and hospital emergency departments to inform the attending emergency doctor or charge nurse when they see a rapid or developing rise in patients with similar symptoms.

State public health departments are also becoming more diligent about active surveillance. A few states have instituted a statewide system to recognize an elevation in hospital admissions by requiring a designated area hospital to notify the state public health department if two or more of the hospitals in the network are experiencing an increase in same-symptom cases.[43] State health officials then determine if something out of the ordinary is taking place and, if so, send a high priority facsimile to hospitals and EMS services throughout the state.

Some states are also employing the syndrome surveillance approach in a rather unique manner: rather than waiting for laboratory identification of a culture, data about disease types and rates are collated from various sources, allowing the geographic and temporal evolution of a disease in a given area to be mapped.[44] This information can assist public health

officials in differentiating between disease patterns, in determining if the disease is contagious, and in deducing whether the disease outbreak was natural. This surveillance approach uses sources such as over-the-counter medication sales, private practice physicians, and primary care clinics to detect a covert bioterrorist attack. In New Mexico, the state health department and some hospitals are testing a syndrome-based surveillance system designed to differentiate normal cycles of disease from a possible bioterrorist attack by documenting patient admissions for five different causes (flu-like illness, mental status change with fever, fever and skin rash, hepatitis/acute jaundice, and diarrhea with fever). The data is transmitted in real-time and tabulated in a central database, which is used to provide the doctor information on whether the patient being treated is an isolated case or part of a more widespread pattern of illness. Additionally, this system will help the state health care authorities to manage a budding health care crisis by increasing shipment of medicines and controlling access into and out of an affected area.

In 1994, the CDC identified three complementary programs to help rebuild the U.S. public health infrastructure for surveillance and response to infectious diseases that will prove useful in a bioterrorism incident: the Epidemiology and Laboratory Capacity (ELC) program, the Emerging Infections Programs (EIP), and provider-based sentinel networks.[45] The goal of the ELC program is to help large health departments develop the core capacity to meet the infectious disease threats of the future by providing technical tools, training, and financial resources. ELC activities include developing innovative systems for early detection and investigation of disease outbreaks, and ensuring electronic reporting of surveillance data. Between September 1995 and September 1998, CDC entered into ELC agreements with 30 states and localities and plans to involve all 50 states by 2002. The goal of the EIP is to conduct population-based surveillance and research to address new problems in infectious diseases and public health, and to enhance laboratory and epidemiologic capacity. The EIP also evaluates certain disease syndromes of unknown origin. The CDC 1994 plan established provider-based sentinel networks to study conditions that are not covered by health

department surveillance and that are likely to be seen by specific kinds of health providers. Since 1997, three networks have been established. The first is the Emergency Department Sentinel Network for Emerging Infections (EMERGEncy ID NET). This is a network of academically affiliated emergency medicine centers that operate emergency departments at 11 hospitals in large cities and monitors syndromes such as bloody diarrhea, illnesses that follow exposure to animals, illness in immigrants and travelers, and first-time seizures not associated with head trauma. The second is the Infectious Diseases Society of America Emerging Infections Network (IDSA EIN) which is a network of over 500 infectious disease practitioners whose purpose is to enhance communications and health education among its members, to collaborate on research projects, and to provide assistance in casefinding during outbreak investigations. The third is the Sentinel Network of Travel Medicine Clinics (GeoSentinel) which is composed of 22 travel medicine clinics located in the United States and other countries that monitor temporal and geographic trends of infectious diseases among travelers, immigrants, and refugees.

With the cooperation of health care personnel in Atlanta, Seattle, Philadelphia, and Los Angeles, the CDC has also begun to test its own variation of an active syndrome surveillance system. During the Centennial Olympic Games held in Atlanta in the summer of 1996, the CDC worked with 40 federal, state, and local agencies to develop an operational concept for response to a chemical or biological terrorism incident.[46] Subsequent tests occurred in Seattle during the World Trade Center Convention in December 1999, in Philadelphia during the Republican National Convention in July 2000, and in Los Angeles during the Democratic National Convention in August 2000.[47] In Philadelphia, the template included surveillance at first aid stations, hospital census data (number of admissions in the emergency department, ICU, regular admissions, and the number of deaths), and sentinel emergency department surveillance data.[48] These data were used to track patients with the following disease syndromes: 1) respiratory tract infection with fever; 2) diarrhea/gastroenteritis; 3) rash and fever; 4) sepsis and/or acute shock; 5) meningitis/encephalitis; 6) botulism-like syndrome; and 7)

unexplained death with history of fever. Syndrome surveillance promises to be a powerful disease detection tool.

An important laboratory development is the ability to sequence different parts of microbial genomes.[49] By identifying distinct features of different genes, it is possible to identify not only microbes of interest but specific strains, and thus more precisely track infectious disease outbreaks. This fingerprinting technique is useful as a sentinel indicator that a new strain has entered a community, and in distinguishing natural occurrences from intentional releases by identifying microbial or viral strains that are foreign to the normal community or by matching new outbreak pathogens with pathogen strains from suspected terrorist groups. An example of a sentinel system utilizing fingerprinting technology is the PulseNet system, a national network of state health laboratories initiated in 1998. These systems allow seemingly disparate infectious disease outbreaks, a likely objective in a bioterrorist attack, to be potentially linked. Through their computerized databases, these systems can possibly mitigate attacks of bioterrorism and minimize their aftermaths by allowing outbreaks to be more rapidly recognized and investigated and information more rapidly shared[50].

VI. Recommendations

Efforts to improve disease surveillance and continue research and development of better diagnostic capabilities, therapeutic agents, and effective response plans capable of mitigating the effects of a biological attack remain paramount.[51] Although authorities are to be commended for the improvements already initiated by them, much work is still needed. Hence, the following recommendations for improvements in local, state, and CDC surveillance and epidemiology infrastructure are provided.

Training

Availability of Training

Training is cheaper if it is available locally; therefore, federal grants should be sent directly to the cities to avoid siphoning funds by state governments.[52] Additionally, CDC and other such national organizations should develop or sponsor internet-based training, videos, and other information exchange technology aimed at the education of local and state health departments. Because training would be conducted locally, scarce funding previously allocated to training could be used in other areas.

Institutionalization

If preparedness, our ability to survey, detect, and identify biological agents, is to take hold nationally on the frontlines and be sustained, then it belongs in the local and state training academies and in the nursing and medical schools.[53] Responsibility for institutionalizing training belongs to the federal government, with the CDC as the agency responsible for its implementation. The CDC should be tasked to develop a standardized syllabus to be used in all local and state training and medical facilities.

Certification/Re-certification

First responders should be tested at least annually on their knowledge of biological agents and their surveillance and detection skills, and should receive annual refresher training in epidemiologic improvements.[54]

Standards

Standards are the backbone of accountability and should be established nationally for surveillance and detection of biological agents so they do not differ from state to state.[55]

Public Awareness

Because a bioterrorism attack would likely be directed towards the civilian population, public awareness of the threat must occur. If nothing else positive flows from the anthrax attacks in CONUS that occurred after the Al Qaeda attacks of September 11th, at least the public, media, and Congress are all aware of the potential for future bioterrorist attacks and, perhaps, how they could have been much more serious. In much the same way as the public prepared for a nuclear holocaust during the Cold War era, today's citizens must be better educated on this biological threat. Public service announcements using television and radio are good beginnings. All levels of government and large corporations should institute an annual training awareness program on how to react and deal with this threat. The time devoted to this could pay huge dividends in the event of an actual attack by avoiding unnecessary panic and casualties.

Epidemiology and Laboratory Capacity

Regional Laboratory Network

The establishment of a network of regional laboratories capable of rapid diagnostic testing is essential to mitigate the number of fatalities caused by inadequate laboratory capabilities. Because biological warfare is a low-occurring event, many of our laboratories may not be capable of

performing the required assays, and even the "experts" (to include some at the CDC) may miss the identification.[56] This forwarding of cultures will more than likely be of limited benefit to the initial victims but will facilitate rapid diagnosis of delayed or secondarily infected patients.

Symptom-based Diagnostic Aids

An interactive diagnostic decision-making system to assist clinicians in considering a biological exposure (and possibly provide an early warning) would be of great value.[57] This type of system would necessitate a complex, multiple search mechanism that includes early signs and symptoms of atypical disorders caused by biological agents. An integrated system that utilizes natural disease rates, clinical probabilities based upon signs and symptoms, and laboratory findings could further enhance an early warning system.

Communication

Electronic Communication

Advances in information technology must be used to enhance the capacity of local and state health departments to communicate electronically with one another. Few public health epidemiologists have sophisticated knowledge about biological warfare, but through information technology, many could have access to some of the best minds in this field. The Federation of American Scientists established the system, Program for Monitoring Emerging Diseases (ProMED) (approximately 100,000 scientists participate in it), to provide communication among sentinel stations around the world capable of reporting unusual disease outbreaks, including those resulting from a biological attack.[58] ProMED could serve to improve the response capabilities of public health departments by electronically bringing together experienced scientists to discuss the situation.[59]

Laboratory Reporting System

A national electronic laboratory reporting system would assist immensely in getting important laboratory information quickly to the epidemiologists, enabling the country to improve its public health response to a biological attack.[60] A national reporting system could provide epidemiologists with nearly real-time notification of a suspected biological agent. The linchpin in our ability to respond is early detection.

Funding

Political Coalitions

Government programs for responding to bioterrorism should be designed to be multi-purpose rather than highly specialized, so that they are considered worthwhile regardless of how the threat is assessed.[61] The measures needed to impede the threat of bioterrorism are similar to those needed to control and prevent emerging infections. Improving capabilities and capacities to respond to one issue will almost certainly benefit the other. For example, developing rapid diagnostic techniques that would make it possible to quickly detect bioterrorist attacks involving anthrax or the plague would have considerable usefulness in the routine clinical diagnosis of pneumonia.[62] Policies that provide social benefit as well as reduce the country's vulnerability to bioterrorism make it easier to build political coalitions that support funding responses to bioterrorism.

VII. Conclusion

Biological terrorism, aimed at our unprotected civilian population, is more likely than ever before and far more threatening than nuclear or chemical attacks. Our population is vulnerable and the terrorists are motivated and capable. Because of the accessibility to knowledge about the manufacturing of biological agents and the inexpensive cost of doing so, preventing bioterrorism is nearly impossible. Since biological agents lend themselves to clandestine dissemination, detecting their release will almost always be delayed with the first evidence of such use being in our medical emergency departments, clinics, and physician offices. Thus, the medical community will constitute our frontline of defense. The rapidity with which the medical community reaches a proper diagnosis will determine the speed with which preventive and therapeutic measures can be applied. It will be the difference between a small casualty count and mass casualties. However, few of our physicians have ever seen a case of, or would recall the characteristics of, anthrax, smallpox, plague, hemorrhagic fever, or botulism, the most likely candidates to be used in a biological attack. Few diagnostic laboratories are prepared to promptly confirm promptly such diagnoses.

Our medical community must be prepared to detect, to diagnose, and to characterize epidemiologically outbreaks of disease resulting from the intentional release of a biological weapon. We need at all levels of government (local, state and national) a greater capacity for surveillance and detection, an improved network of laboratories, better diagnostic instruments, and a more adequate cadre of trained epidemiologists, clinicians, and researchers. The federal government, specifically the CDC, would be prudent to refine syndrome surveillance and evaluate its effectiveness for recognizing unusual disease patterns in order to direct more intensive laboratory analysis, epidemiological investigation, and medical intervention as early as possible in a disease outbreak.

The medical community plays an integral role in detecting biological warfare because they participate in the network of disease surveillance and reporting that may be the first indication of a biological attack. From a

public health perspective, timely surveillance, clinician awareness of syndromes potentially from bioterrorism, epidemiologic investigation capacity, laboratory diagnostic capacity, continued research and development of improved diagnostic capabilities, and the ability to rapidly communicate critical information remain paramount. Recognition of the need for preparedness at all levels of government provides an opportunity to strengthen the public health system and its linkages with current and new partners.[63] As former President Bill Clinton said in his address at the National Academy of Sciences in January 1998, "These cutting edge efforts will address not only the threat of weapons of mass destruction, but also the equally serious danger of emerging infectious diseases. So we will benefit even if we are successful in avoiding these attacks."[64]

Table 1

Epidemiologic Clues To A Possible Bioterrorist Attack

- Distribution of cases that is inconsistent with normal disease patterns (geographically and/or temporally), with greater than anticipated numbers of patients, especially in a distinct population.
- More severe illness than is typical for a given pathogen, as well as unusual routes of exposure (e.g., inhalation anthrax as opposed to cutaneous or gastrointestinal cases).
- Disease that is not endemic to a given geographic area, unusual for the time of year, or impossible to transmit naturally, since the disease carrier (e.g., mosquito, rodent) is not present in the area.
- Simultaneous upswings of different diseases.
- Disease outbreak affecting both animal and human populations.
- Unusual strain of a disease or atypical antibiotic resistance patterns.
- Higher rates of disease among those who were located in certain areas at a certain point in time (e.g., inside a building where agent was released, outside if the attack was outdoors).
- Intelligence data that a country or terrorist group possessed a certain biological warfare agent or agents.
- Claims by a terrorist group to have released a biological agent.
- Direct evidence (e.g., environment samples, delivery system) that an agent was released.

Source: Julie A. Pavlin, "Epidemiology of Bioterrorism," in *Emerging Infectious Diseases 5, no. 4* (July/August 1999); 529.

Table 2

Diagnostic Samples, Assays, And Isolation Precautions For Biological Warfare Agents

Agent	Diagnostic Sample	Diagnostic Assay	Patient Isolation Precautions
Anthrax	• Blood (Level 2)	• Gram stain • Antigen – ELISA* Serology: ELISA	• Standard precautions
Smallpox	• Pharyngeal swab • Scab material (Level 4)	• ELISA • Polymerase chain reaction • Virus isolation	• Airborne precautions
Plague	• Blood • Sputum • Lymph node • Aspirate (Level 2/3)	• Gram or Wright-Giemsa Stain • Antigen – ELISA • Culture Serology • ELISA Immunofluorescence assay	• Pneumonic: droplet • Precautions until patient treated for 3 days
Viral Hemorrhagic Fevers	• Serum • Blood (Level 3 for Rift Valley, Yellow and Korean hemorrhagic fevers; Level 4 for others)	• Virus isolation • Antigen – ELISA • Reverse transcriptase polymerase chain reaction • Serology: antibody ELISA	• Contact precautions • Consider additional precautions if massive hemorrhage
Botulinum	• Nasal swab (Level 2)	• Antigen – ELISA • Mouse neutral	• Standard precautions

*ELISA: enzyme-linked immunosorbent assay

Source: David R. Franz et al., "Clinical Recognition and Management of Patients Exposed to Biological Warfare Agent," *Journal of the American Medical Association 278, no. 5* (6 Aug 1997): 400-1.

Notes

1. Donald A. Henderson, "The Looming Threat of Bioterrorism," *Science* 283 (26 February 1999): 1279-82.

2. Jonathan B. Tucker and Amy Sands, "An Unlikely Threat," *Bulletin of the Atomic Scientists* 55, no. 4 (July/August 1999): 46-8.

3. Jeffrey D. Simon, Ph.D., "Biological Terrorism – Preparing to Meet the Threat," *Journal of American Medication Association* 278, no.5 (6 August 1997): 428-30.

4. Donna E. Shalala, Secretary of Health and Human Services, "How Prepared Are We?" *Emerging Infectious Diseases* 5, no. 4 (July/August 1999): 492-3.

5. Jonathan B. Tucker, "The Biological Weapons Threat," *Current History* (April 1997): 170.

6. Ibid., 171-2.

7. William S. Cohen, "Defending Against Biological Warfare," *Public Broadcasting System: Frontline* 1998, n.p.; on-line, Internet, 9 February 2001, available from http://www.pbs.com/frontline.htm.

8. Henderson, "The Looming Threat of Bioterrorism."

9. "Response to Terrorism," *United States Information Agency*, 15 March 1999, n.p.; on-line, Internet, 9 February 2001, available from http//usinfo.state.gov/topical/pol/terror/99031501.htm.

10. "White House Fact Sheet: President Clinton Unveils New Efforts to Combat Terrorism in an Address to the International Association of Firefighters," *United States Information Agency*, 15 March 1999, n.p.; on-line, Internet, 9 February 2001, available from http://usinfo.state.gov/topical/pol/terror/99031501.htm.

11. Shalala, "Bioterrorism: How Prepared Are We?"

12. Henderson, "The Looming Threat of Bioterrorism."

13. David W. Siegrist, "The Threat of Biological Attack: Why Concern Now?", *Emerging Infectious Diseases* 5, no. 4 (July/August 1999), n.p.; on-line, Internet, 9 February 2001, available from http://www.cdc.gov/ncidod/EID/vol5no4/siegrist.htm.

14. Melissa Hendricks, "Rx Against Terror," Johns Hopkins Magazine (February 1999), n.p.; on-line, Internet, 9 February 2001, available from http://www.johnshopkins.com.

15. Amy E. Smithson, "Ataxia: The Chemical and Biological Terrorism Threat and the US Response," 319, on-line, Internet, 9 February 2001, available from http://www.stimson.org/cwc/ataxia.htm.

16. John G. Bartlett, "Applying Lessons Learned from Anthrax Case History to Other Scenarios," *Emerging Infectious Diseases* 5, no. 4 (July/August 1999): 561-3.

17. Ibid.

18. Henderson, "Bioterrorism as a Public Health Threat," *Emerging Infectious Diseases* 4, no. 3 (July/September 1998), n.p.; on-line, Internet, 9 February 2001, available from http://www.cdc.gov/ncidod/EID/vol5no4/hendrsn.htm.

19. Jonathan D. Silver, "Local Doctors Fail Their Test on Diagnosing Germ Terrorism," *Pittsburgh Post-Gazette*, 13 February 2000.

20. Bartlett, "Applying Lessons Learned from Anthrax Case History to Other Scenarios."

21. Smithson, "Ataxia," 252.

22. Bartlett, "Applying Lessons Learned from Anthrax Case History to Other Scenarios."

23. Julie A. Pavlin, "Epidemiology of Bioterrorism," *Emerging Infectious Diseases* 5, no. 4 (July/August 1999): 529.

24. Bartlett, "Applying Lessons Learned from Anthrax Case History to Other Scenarios."

25. Henderson, "Bioterrorism as a Public Health Threat."

26. Laurie Garrett, *The Coming Plague: Newly Emerging Diseases in a World Out of Balance* (New York: Farrar, Straus and Giroux, 1994), 174-91.

27. David R. Franz et al, "Clinical Recognition and Management of Patients Exposed to Biological Warfare Agent," *Journal of the American Medical Association* 278, no. 5 (6 August 1997): 400-1.

28. Bartlett, "Applying Lessons Learned from Anthrax Case History to Other Scenarios."

29. Henderson, "The Looming Threat of Bioterrorism."

30. Smithson, "Ataxia," 251.

31. Henderson, The Looming Threat of Bioterrorism."

32. "Chemical and Biological Terrorism: Research and Development to Improve Civilian Medical Response," Committee on Research and Development Needs for Improving Civilian Medical Response to Chemical and Biological Terrorism Incidents, *National Research Council*, n.p.; on-line, Internet, 9 February 2001, available from http://www.nap.edu/readingroom/books/terrorism.html.

33. "Emerging Infectious Diseases: Concerns on Needed Laboratory Capacity Could Strengthen Surveillance," *General Accounting Office*, GAO-HEHS-99-26, 5 February 1999, n.p.; on-line, Internet, 9 February 2001, available from frevebgate.access.gpo.gov/cgi-bin/multidb.cgi.

34. "Chemical and Biological Terrorism: Research and Development to Improve Civilian Medical Response," *National Research Council*.

35. Ibid.

36. Ibid.

37. Garrett, *The Coming Plague*, 605.

38. "Emerging Infectious Diseases: Concerns on Needed Laboratory Capacity Could Strengthen Surveillance," *General Accounting Office*, GAO-HEHS-99-26.

39. Hendricks, "Rx Against Terror."

40. Garrett, *The Coming Plague*, 605-6.

41. "Chemical and Biological Terrorism: Research and Development to Improve Civilian Medical Response," *National Research Council*.

42. Smithson, "Ataxia," 254-8.

43. Ibid.

44.Ibid.

45. "Preventing Emerging Infectious Diseases: A Strategy for the 21st Century," *Centers for Disease Control and Prevention*, 28 September 1999, n.p.; on-line Internet, 9 February 2001, available from http://www.cdc.gov/ncidod/emergplan/9obj11.htm.

46. Jonathan B. Tucker, "National Health and Medical Services Response to Incidents of Chemical and Biological Terrorism," *Journal of the American Medical Association* 278, no. 5 (6 August 1997): 362-8.

47. Smithson, "Ataxia," 254-8.

48. Ibid.

49. "Chemical and Biological Terrorism: Research and Development to Improve Civilian Medical Response," *National Research Council*.

50. Ibid.

51. James M. Hughes, "The Emerging Threat of Bioterrorism," *Emerging Infectious Diseases* 5, no.4 (July/August 1999), n.p., on-line, Internet, 9 February 2001, available from http://www.cdc.gov/ncidod/EID/vol5no4/hughes.htm.

52. Smithson, "Ataxia," 300.

53. Ibid.

54. Ibid., 301.

55. Ibid., 302.

56. "Chemical and Biological Terrorism: Research and Development to Improve Civilian Medical Response," *National Research Council*.

57. Ibid.

58. Garrett, *The Coming Plague*, 602.

59. "Chemical and Biological Terrorism: Research and Development to Improve Civilian Medical Response," *National Research Council.*

60. Ibid.

61. Tucker, "National Health and Medical Services Responses to Incidents of Chemical and Biological Terrorism."

62. Joseph E. McDade, "Addressing the Potential Threat of Bioterrorism--Value Added to an Improved Public Health Infrastructure," *Emerging Infectious Dise*ases 5, no.4 (July/August 1999), n.p., on-line, Internet, 9 February 2001, available from http://www.cdc.gov/ncidod/EID/vol5no4/mcdade.htm.

63. Hughes, "The Emerging Threat of Bioterrorism."

64. William J. Clinton, "Keeping America Secure for the 21st Century," National Academy of Sciences, Washington, D.C., 2 January 1998.

USAF Counterproliferation Center

The USAF Counterproliferation Center was established in 1999 to provide education and research to the present and future leaders of the USAF, to assist them in their activities to counter the threats posed by adversaries equipped with weapons of mass destruction

Barry R. Schneider, Director
USAF Counterproliferation Center
325 Chennault Circle
Maxwell AFB AL 36112-6427

Email: Barry.Schneider@maxwell.af.mil

Jo Ann Eddy, Associate Editor
The Counterproliferation Papers

Email: JoAnn.Eddy@maxwell.af.mil

(334) 953-7538 (DSN 493-7538)