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Public Health Preparedness: The Best Defense against Biological Weapons

Within the past two years, two major exercises have tested the U.S. government's preparedness for, and capacity to respond to, a large-scale, covert biological weapons attack. TOPOFF, led by the Federal Emergency Management Agency (FEMA) and the Department of Justice in May 2000, and Dark Winter, directed by CSIS in May 2001, found that the United States was ill prepared to detect and respond effectively to a bioterrorist attack in a way that would prevent the attack from escalating into a major security crisis. These exercises demonstrated the devastating impact a bioterrorist attack can have when initiated against a poorly prepared government: hundreds of thousands dead or sick, widespread panic, a resultant breakdown of civil society, and the suppression of individual rights in order to control the spread of disease.

TOPOFF and Dark Winter revealed how a biological weapons attack is unlike an attack utilizing conventional weapons or even another type of weapon of mass destruction. Although the Department of Defense and typical first-responders (local fire and police departments) ably handle the defense against, management of, and deterrence of most weapons, these actors are not sufficient for detection and control of a biological attack. Maintaining homeland security against a biological attack requires a strong civil defense rooted in the capabilities of a new player in the realm of national security: the public health system.

The public health system is a federal, state, and local infrastructure responsible for monitoring health status, diagnosing and investigating health problems, linking people to health services, enforcing health laws

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and regulations, assuring a competent health workforce, communicating with the public, disseminating information, and conducting scientific research.[1] This system plays a vital role in an effective defense against biological weapons. A strong public health system can quickly identify the presence of a biological attack, contain the number of patients, help restore calm to society, and ensure the health of the population. Understanding the role of public health will allow policymakers to structure a comprehensive weapons defense, allocate funds appropriately, and set up collaborative efforts.

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Preparedness and Response to Biological Weapons

Preparedness for biological weapons use necessitates the expertise of many federal, state, and local governmental agencies that can engage in the two phases of security: before and after an attack. Biological security involves the military, law enforcement, State Department, intelligence community, and first-responders, as well as agencies such as the Departments of Agriculture and Justice and the U.S. Customs Service. Public health is just one layer in a comprehensive biological defense, but it is a crucial component—particularly after an attack.

Preattack

Preattack prevention strategies consist of defensive measures, offensive measures, and political maneuvers designed to make vulnerable populations less susceptible to attack.[2] A major component of preattack defensive measures is increased security in areas that are likely venues for an attack, such as the heating, ventilation, and air conditioning (HVAC) systems in potential target buildings, water storage areas, and food processing plants. Other defensive measures include monitoring or restricting the sale of equipment necessary to make biological weapons, as well as registering and approving those trained to do certain types of microbiology or biochemical engineering.

Offensive measures to prevent attack rely primarily on the ability of the military and intelligence communities to disable terrorists or nations physically from using biological weapons. This effort requires exceptional intelligence on what groups or nations have weapons, where those weapons are kept, and the purpose for which they are intended. After intelligence is gar-

nered and interpreted, either political maneuvering would dissuade nations or groups from deploying the weapons, or preemptive strikes may attempt to wipe out arsenals.

Postattack

Because of the difficulties inherent in biological weapons detection (both of their production sites and initial releases), the bulk of preparedness involves postattack scenarios, which require clear and coordinated response plans to ensure that an attack affects the smallest number of people possible. An effective postattack strategy has many aspects, the first being early detection of a biological weapons attack. Detection may be preinfection and postinfection. Detecting a biological attack before infection utilizes sophisticated sensors that monitor air, ground, water, and food for unusual biological agents. Detection after infection uses a complex surveillance system in which trained physicians identify infections by biological agents, laboratories efficiently culture an agent and provide microbiologic confirmation, and epidemiologists determine the time and place an agent was dispersed and the population that was exposed.

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Postattack strategies require enforcing public order to facilitate population mobilization for treatment, vaccination, and distribution of prophylactic antibiotics; to subdue public fears; and to enact quarantine procedures if necessary. These requirements necessitate the existence of public health and emergency management laws designed for these situations before an event occurs. Law enforcement officers must also be able to mount a quick response to collect evidence and track down the attack's perpetrator(s).

Aside from rapid detection of the attack, the most important part of a postattack response arguably is the provision of medical services to limit the extent of any illness or death among the population. Adequate preparation requires the availability of a stockpile of drugs and vaccines, as well as the implementation of a predetermined plan to distribute them to affected persons. Additionally, physicians in every corner of the country must be trained to recognize and treat diseases that result from the release of the biological weapon, and hospitals should be equipped to handle large numbers of infectious patients.

The public health system's role in overall biological defense is predominantly in the postattack stage, specifically, postinfection. The primary re-

sponsibility for the public health community is to detect disease in the population, treat those infected, and contain the epidemic.

Public Health Preparedness Today

If a terrorist group or hostile nation releases a biological weapon on the U.S. public, the first sign of an attack is likely to be the seemingly innocent event of a small number of people going to their private doctors' offices or the emergency room at their local hospitals, complaining of flu-like symptoms. Patients may arrive at various hospitals throughout a geographic region, reducing the likelihood that one hospital may raise suspicions that a cluster of disease is within the community. Once such a cluster has been identified, determining if the disease results from a natural epidemic or if a biological attack has taken place will most likely be initially impossible.

To determine exactly what is wrong with the patients, blood samples will be sent to local laboratories and then possibly to state or federal laboratories, depending on the initial suspicions of the physicians treating the patients or the inability of a local lab to identify an agent. This process can continue for a day or a month, depending on the capacity of the local labs (the size, personnel, and equipment available), the awareness of disease possibilities, and the agent itself.

Once officials have detected and diagnosed the disease, they must determine the number of people affected, treat the infected populations, and make efforts to contain the spread of disease. This process may be as simple as getting antibiotics to a finite number of infected people if the biological agent is not communicable (cannot be spread from person to person) or as complicated as tracking down possible contacts of patients, initiating vaccination campaigns, and enacting quarantine procedures for infectious patients. In order for the public health system to operate effectively during a biological weapons attack on the United States, it must include a strong infectious-disease surveillance system, vaccine development and pharmaceutical stockpiles, scientific research, communications networks, laboratory capacity, hospital readiness, and professional training.

Infectious Disease Surveillance

The longer it takes to identify the presence of an outbreak, the more people will become sick or die, at a greater cost to society. According to one study, if officials identify an anthrax attack on a population of 100,000 and distribute proper doses of antibiotics to the exposed population within 24 hours, approximately 5,000 people will die and the cost to society both in health

care expenditures and economic loss will be $128 million. On the other hand, if officials do not identify the attack for six days and only then give doses of antibiotic prophylaxes to the exposed population, approximately six and a half times as many people will die (33,000) at a cost almost 205 times higher ($26.3 billion).[3]

This example demonstrates the importance of early detection of an event, be it an epidemic of a naturally occurring disease, such as the occasional outbreak of meningitis on a college campus, or a biological attack, such as the anthrax letters of last fall. To identify such an event quickly, a multifaceted surveillance system is needed. Well before an attack occurs, public health departments around the country from the local to the state level must establish and enforce reporting mechanisms of diagnoses from hospitals and private physicians, findings from laboratories, and sales of prescription drugs as well as over-the-counter medication from pharmacies. Complete, real-time reporting from all of these areas, in addition to accurate historical trends to use for comparison, would enable public health departments to identify out-of-the-ordinary occurrences, as well as piece together an initial picture of the location and timing of events in a given region. Information from this system should be monitored at the federal level in order to analyze both regional and national trends.

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Accurate reporting in this surveillance system will depend on trained physicians, competent local laboratories, and functional communication systems, as well as vigilance on the part of participants in the surveillance system, to ensure that information is continuously updated, either automatically or through personnel dedicated to this task. A comprehensive surveillance system relies on passive (having disease information reported to a central location) and active (searching for information on disease occurrences) surveillance and requires personnel to monitor the situation 24 hours a day. A national infectious disease surveillance system is only as strong as its weakest link. Thus, in order for the system to be effective, every region of the country must be connected and actively participate.

Today, a hodgepodge of surveillance systems operates around the country, with the nearly 3,000 local health departments, 50 state health departments, and several large municipalities all using different variations. The Centers for Disease Control and Prevention (CDC) maintains more than 100 surveillance systems, most of which operate independently of each

other. Recognizing the need to manage information from local and state surveillance better, the CDC created the National Electronic Disease Surveillance System (NEDSS), which is designed to integrate a variety of disease databases.[4] Although NEDSS is a start, by no means has it accomplished the task of integrating all the surveillance systems operating nationwide. A comprehensive system must be available to all and capable of reporting to the local, state, and federal level. This system must also be impervious to attack, from both outside and within the public health community. The Office of Homeland Defense, with the guidance and expertise of the CDC and health informatics professionals, is an appropriate choice to coordinate an integrated nationwide surveillance system.

Vaccine Development

Vaccination against known bioterrorist agents, specifically anthrax and smallpox, are part of a preattack defense and a postattack containment. Although engaging in large-scale vaccination programs of the civilian population prior to an attack is neither practical nor safe, vaccine availability if a large-scale attack did occur is important, particularly for smallpox. Because the smallpox vaccine is dangerous to people with compromised immune systems (e.g., people with HIV/AIDS, on chemotherapy, or with autoimmune diseases), a large-scale vaccination program is only practical if a viable threat exists that outweighs the danger posed by the vaccine itself. If a smallpox outbreak did occur, however, engaging in a regional vaccination program to contain the spread of the disease would be essential.

The United States once kept a stockpile of smallpox vaccine, but much of that vaccine has deteriorated, leaving only 15.4 million original doses. Packaging and distribution problems could further reduce the number of available doses, although a recent study suggests that the existing 15 million doses can be expanded through dilution to at least 75 million and possibly 150 million.[5] The federal government recently approved contracts for the production of enough smallpox vaccine to serve the entire domestic population, with delivery promised in a year, and a pharmaceutical company will donate to the government 85 million vaccine doses recently discovered in storage. Whether any of these stockpiled vaccines will be made available to foreign nations in the event that smallpox is released overseas, however, is unclear.

More research is needed to improve the currently available vaccines, as well as to develop and manufacture vaccines for other diseases categorized by the CDC as bioterrorist threats. Tests also must continue to determine if the available vaccines protect against more potent variants of diseases, such as the drug-resistant anthrax bioengineered by the Soviet biowarfare program.[6]

In order to avoid chaos during an event, development and dissemination prior to an attack of vaccine priority and distribution plans is essential. These plans should incorporate the best methods for controlling the spread of disease, saving the most lives, and ensuring the utility of responders. The CDC has developed vaccination plans for smallpox containment, but plans do not currently exist for vaccination for other known biological weapons, nor have the details of distribution techniques and prioritization among nonpatients been established in all regions. The public health community should work with organizations such as the National Guard as well as local law enforcement and even local business to arrange plans to distribute vaccinations to large numbers of people. Authorities could use the same plans to distribute drugs and other medical supplies.

No nationwide communication system connects all public health community members.

Pharmaceutical stockpile

The CDC has taken the lead in creating the National Pharmaceutical Stockpile Program, which maintains a national repository of drugs and medical material to be delivered to the site of a biological attack. Mandated by Congress in January 1999, this stockpile can provide quantities of drugs and medical supplies that might otherwise be difficult to obtain rapidly in the event of an emergency. Originally funded with $52 million a year, this program can presently deliver packets of drugs and medical equipment, along with a small team to assist with distribution, to any U.S. site within 12 hours.[7]

The program has developed remarkably well with such limited funds, but further resources are needed to enhance the program's ability to respond to a greater variety of situations. With additional funds, more drugs can be stocked in a larger variety of locations around the country, reducing the time between request and delivery of the stockpile as well as increasing the number of people that could be treated. Local authorities could also receive more intensive training in distribution strategies, and leaders could dispatch larger teams of experts in the case of an emergency.

Research

Support of scientific research is a significant component of bioterrorism defense because it enables the understanding of naturally occurring and bioengineered agents as well as the development of methods to minimize

their effects in humans. Research into the genetic makeup of microbes is essential to understand how antibiotic resistance develops. This type of research provides the foundation for the development of new antimicrobials that will be the next line of defense should the current antimicrobials' effectiveness fail against biological agents.

In the wake of September 11 and the anthrax letters, the National Institutes of Health (NIH) established a bioterrorism research program focusing primarily on biological agents identified by the CDC as critical threats. The NIH research plan has four main components: (1) the design and testing of new diagnostic methods, particularly methods to identify microbes rapidly; (2) the development and evaluation of new treatments, such as drugs that will treat a wide range of agents; (3) the development and evaluation of new vaccines usable in the general population: and (4) a focus on basic research, genomics, and creation of an infrastructure capable of supporting research into critical threat agents.[8] This research will be conducted at NIH facilities, as well as at universities and research institutions nationwide.

It is not enough to have a cadre of experts at the CDC ready to be called when needed.

The NIH will face several challenges to its bioterrorism research agenda. The NIH must ensure that researchers are coordinating their efforts with other governmental agencies and research institutions involved in similar work; ensure that research dollars are allocated quickly, facilitating work and progress in a timely fashion; and find enough qualified scientists and researchers, who do not pose any security threat, to become involved. Finding appropriate researchers, many of whom officials will have to entice from other research projects, without significantly harming the research efforts of other important areas of public health will be problematic.

Communication

Until the mid-1990s, some local health departments around the country did not have touch-tone telephones, let alone computers with Internet or e-mail service. The CDC allocated $40 million in grants to local and state health departments to upgrade their communication capacity as part of the Health Alert Network (HAN). By 2001, however, only 37 state health agencies and 3 metropolitan health departments had received HAN funding, and some local health departments around the country still lack high-speed Internet connections. A strong communications system is necessary to ensure that all public health officials in every area of the country are able to give information to,

and receive it from, state and federal officials quickly regarding suspicious outbreaks, unusual presentations of patients, or increases in the expected number of patients with general flu-like symptoms. All health departments need the capacity to exchange information rapidly and securely.

Like the infectious disease surveillance system, the health communications infrastructure around the country is not uniform, and the communications tools and systems in place among different health departments vary greatly. The CDC created a new communications program in late 2000 called Epidemic Information Exchange (Epi-X), which allows for secure nationwide communication of urgent messages, information tracking, epidemic reviews, and emergency communication through telephones and pagers.[9] Epi-X, however, has not yet been implemented nationwide, and many health departments are not even aware of the system's existence. Thus, no nationwide communication system connects all members of the public health community. As with the nationwide surveillance system issue, the Office of Homeland Defense might be the best organization for ensuring the completeness and security of a health communication system.

Laboratories

An epidemic becomes more difficult to contain as the time for diagnosing a patient or patients grows. Because obtaining laboratory confirmation is a vital step to a definitive diagnosis, any effective system must make the laboratory process as efficient and reliable as possible. The Association of Public Health Laboratories (APHL) has been working to update public health laboratories and improve communications between labs and health departments, but the identification of some biologic agents can still take weeks. Only four labs in the country are capable of handling extremely contagious and dangerous agents (Biohazard Level 4), including the CDC in Atlanta and the U.S. Army Medical Research Institute of Infectious Disease (USAMRIID) in Fort Detrick, Maryland.

During the past few years, officials have initiated several programs to enhance laboratory capacity and communication. The Laboratory Response Network (LRN) was established to respond to bioterrorism. It can accept samples and diagnose biological weapon agents, but additional equipment, personnel, facilities, and security are still needed. In addition to the LRN, the CDC is funding a new program—the National Laboratory System (NLS). The purpose of this system is to facilitate communication between the public health laboratories and the more than 170,000 labs found in doctors' offices, hospitals, and private corporations. Like the LRN, it needs substantial support in order to be implemented nationwide.[10]

HOSPITALS

Currently, U.S. hospitals are operating at close to full capacity, and barely enough hospital beds and nurses are available to respond to the annual flu epidemic. Most metropolitan areas have a limited number of ventilators and beds in rooms especially designed to isolate infectious patients. The entire Washington, D.C., area has fewer than 100 of these isolation beds, all of which would be quickly filled in the event of a biological weapons attack of smallpox or some type of hemorrhagic fever, such as the Ebola virus.

The U.S. public health system may now receive enough resources to protect the public.

All major hospital centers in the country should develop plans to handle a bioterrorist event. In the event of a large-scale bioterrorist attack, hospitals must first decide where to situate patients physically and then assess whether enough personnel are available to work in an emergency, as well as whether the hospital is equipped to quarantine patients if necessary. Hospitals might need to hire additional nurses and purchase equipment for use in an emergency. Because these expenditures may be inconsistent with individual hospitals' profit maximization policies, compensating hospitals from the bioterrorism preparedness funds may be necessary.

TRAINING

When Hantavirus Pulmonary Syndrome (Sin Nombre Virus) appeared in 1993, local physicians were the first people to realize the occurrence of suspicious deaths and to call for state and federal assistance to determine the cause of the outbreak. The first hint of a problem related to the anthrax letters of the fall of 2001 came from an astute physician and lab worker in Florida, who thought to have the first case tested for the rare disease. If the public health community in the United States had not initiated bioterrorism awareness campaigns prior to that period, many more people might have died waiting for treatment while authorities tried to determine the cause of the initial case's disease.

In almost all emerging infectious disease outbreaks, the local medical and public health personnel are the first professionals to identify the existence of a problem, and only then are federally trained experts involved. Having a cadre of experts at the CDC ready to be called when needed, however, is not enough. Physicians, nurses, epidemiologists, emergency medical personnel, and lab workers nationwide must also be trained to recognize the existence of a problem, even if only to know when to call federal experts.

Not enough epidemiologists and public health officials are trained to investigate every suspected outbreak at the local, state, or federal level. Funding should be given to schools of public health and to fellowship programs to ensure that a cadre of highly trained professionals are available. Officials should also allocate portions of local and state budgets to the hiring of infectious disease epidemiologists. Federal programs should also expand so that more people will be trained in advanced outbreak investigation. Currently, the CDC places Epidemic Intelligence Service members (highly trained professionals) in state health departments around the country. On average, however, only one person is placed in each state, and at least 12 states have no representative. Fortunately, officials have slated this program to receive a significant increase in funding, which they will hopefully use to place at least one person in every state and large metropolitan region, with preferably a small team of professionals in each state to coordinate disease investigations and communication with federal authorities.

In addition to training more epidemiologists, existing medical personnel must learn about the role they might play in a biological attack. Most U.S. physicians and first-responders today have never seen a case of smallpox or many of the other diseases listed as critical threats; an infection would thus challenge them to present a diagnosis of the disease without laboratory confirmation. Because rapid diagnosis and treatment is an essential component of bioterrorism response, physicians should become familiar with likely bioterrorist attack agents. Although some physicians initially resisted attending training sessions, they are becoming more willing participants as they perceive the threat of a bioterrorist attack and recognize the role they might play. In addition to the voluntary training of attending physicians, an organized, mandatory program should educate medical students, selected residents, and paramedics on the signs, symptoms, and treatment of agents identified by the CDC as possible biological weapons. Officials should also reinforce for these professionals the protocols for reporting diseases and the required actions in the event of a bioterrorist attack.

> Such a large influx of funds, however, carries its own set of problems.

How to Appropriate the Increased Funds

The public health system has suffered years of financial neglect, leaving it disabled in its ability to manage outbreaks of infectious diseases effectively without quickly becoming overwhelmed. In 1992, 12 states had no one on

the payrolls responsible for monitoring food-borne and waterborne diseases (the two easiest pathways for terrorists to release a biological weapon).[11] A 1999 Harvard University study determined that public health leaders felt they were only performing one-third of the functions essential to protecting the health of the U.S. public, primarily because of insufficient resources.[12]

In 1999 the Congress appropriated $121 million to the CDC to improve the national disease surveillance system. For fiscal year 2000, $277.6 million was set aside for the Department of Health and Human Services (which includes NIH and CDC) to improve the disease surveillance system, engage in research, stockpile drugs, and create vaccines.[13] Bioterrorism funding for 2002 was raised to $1.4 billion, and the president's budget for 2003 proposes a 319 percent increase, to $5.9 billion.

For the first time in its history, the U.S. public health system is positioned to receive enough resources that, if spent appropriately, could improve the public health infrastructure to the point where the system could fulfill its mission to protect the public's health. Such a large influx of funds, however, carries its own set of problems. Leaders should spend this money to improve local, state, and federal infrastructure, while ensuring that systems are coordinated at all levels.

In January 2002, states began receiving allotments of $5 million in base awards, with supplements depending on the size of the population living in the state. Each of the states will likely use the funds to enhance their own public health systems, but the states will not decidedly commit to a single coordinated system that, in fact, does not yet exist. The public health system should use this opportunity to create a unified system that will enhance surveillance, communication, and training around the country. The rest of the government should take advantage of this situation to coordinate communication systems and share expertise in security, informatics, and response.

Beyond improvements in the U.S. public health system, public health infrastructure around the world could be improved. The release of a biological agent in one part of the world will not be limited in its spread to national borders unless a nation's public health infrastructure is capable of containing the disease. Thus, from a security and a public health point of view, our nation's best interest lies in enhancing the surveillance and response capacity of public health systems around the world—particularly in areas with a possibly increased threat of biological attack.

A strong additional argument for funding the public health system for bioterrorism preparedness is the beneficial side effects of antibioterrorism programs. In the 1950s, officials allocated the CDC funds to establish an Epidemic Intelligence Service (EIS), designed to create a cadre of professionals who could serve as "an early-warning system against biological war-

fare and man-made epidemics."[14] EIS has existed for 50 years and has played a key role in combating epidemics all over the world, including eradicating smallpox, controlling Ebola outbreaks, discovering how AIDS is transmitted, and studying U.S. public health problems. The EIS program has also trained many medical and public health leaders in the United States, including the most recent director of the CDC, deans of prominent schools of public health, and practicing physicians around the world.

Improving the nation's ability to detect a biological attack quickly will also enhance its ability to identify the occurrence of a natural disease outbreak. For example, outbreaks of *E.Coli* 0157:H7 have occurred in North America in association with undercooked fast-food hamburgers, apple juice, cider, and a variety of other sources. If someone becomes stricken, he or she has a 5–10 percent chance of developing complications that can lead to kidney failure and even death, especially in young children. A strong infectious-disease surveillance system can rapidly identify the existence of an *E.Coli* 0157:H7 outbreak, locate the source of the problem, take steps to stop the spread of the disease, and initiate treatment, thus potentially saving the lives of infected children while keeping other children from becoming sick.

The Unique Bioweapons Challenge

The threat of a biological weapons attack on the United States is more real than at any time in the nation's history. The goals and actions of terrorists and hostile states have changed in a way that makes biological weapons use conceivable, while technological advances have made biological agents weaponization more feasible than in decades and centuries past.

Rapid detection and consequence management of a biological attack will be the primary responsibility of the public health system. As it stands today, a biological weapons attack would quickly overwhelm the public health system. In order for this system to be effective in its detection and response roles, officials should focus more attention toward strengthening the public health infrastructure in general and the infectious disease surveillance system in particular.

Notes

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