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Public Health Preparedness for Chemical, Biological, Radiological, and Nuclear Weapons

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The U.S. public health and health-care delivery systems are important components of our nation's preparedness against terrorism and other public health threats (Trust for America's Health 2006). The September 11, 2001, terrorist attacks and the anthrax attacks later that year renewed government, public health, and medical personnel's awareness of chemical, biological, and, to a lesser extent, radiological and nuclear threats. It also underscored the importance of ensuring the nation's overall preparedness and ability to respond to terrorism and other public health emergencies. Toward this end, the federal government has invested more than $5 billion (Nelson et al. 2007) in public health preparedness at the state and local levels since 2001. With an investment of this magnitude questions naturally arise as to what return has been received. Is the nation prepared to effectively respond to the next public health emergency? This is a challenging question to answer for a number of reasons. First and foremost, there is no clear, consensus definition of what public health preparedness is and thus no specific goal against which to gauge progress. In addition, because the investment is relatively recent, there is very little literature evaluating the effectiveness of these federally funded programs. The effect of preparedness activities on the public health system more generally also complicates the question. Some states have leveraged preparedness resources to improve day-to-day public health activities (Staiti, Katz, and Hoadley 2003). However, others have cut state budgets in response to the federal increases, thereby shifting funding away from more traditional public health activities like tuberculosis prevention and control. Finally, the federal contribution to state and local public health preparedness has declined more than 20 percent over the past several years, raising concerns that much of the post-2001 progress will not be sustained (NACCHO 2007).

This chapter presents a broad overview of the nation's public health response system, recent efforts to improve preparedness, and options for moving forward. Section 11.1 reviews federal efforts to define WMD threats and priorities. Section 11.2 looks at the current national response framework for a coordinated response in four

functional areas. Section 11.3 looks at the issues in implementing this framework at the state and local levels, with a focus on coordination issues. Section 11.4 assesses the current state of public health preparedness. Finally, section 11.5 presents some brief conclusions.

11.1 Characterizing and Prioritizing WMD Threats

From a planning perspective, there is considerable overlap between public health emergency preparedness for natural disasters and for WMD. While WMD do require some unique preparation and response activities, they also share many public health functions with natural threats like pandemic influenza or hurricanes. Public health agencies are increasingly adopting an all-hazards planning approach that is flexible enough to accommodate different types of emergencies. That is, they have focused resources on improving preparedness to conduct activities or purchase equipment (e.g., interoperable communications) that can be used for both WMD response and other public health emergencies like pandemic influenza or hurricanes.

Public health planning is also complicated by uncertainty about the type and scale of the anticipated attack: "Future terrorist attacks could vary in many different ways, such as the agents or weapons employed, the size of an attack, the kind of release, the location (rural area or a city), and whether it occurs inside a building or outdoors" (Davis et al. 2003). Perhaps the most important dimension is advance warning. Advance warning is common for many natural disasters (e.g., hurricanes, West Nile virus) and would also be realistic for some WMD based on contagious agents (e.g., smallpox). In such cases, public health officials will often have time to put surveillance systems and other public health measures in place as the disease spreads over time.[1] The situation is different for other forms of WMD like noncontagious biological, chemical, and radiological agents. In these cases, attacks may only be detected after victims have been exposed. This makes advance preparation key to ensuring U.S. preparedness.

Understanding the similarities and differences between different threats is the first step in informed planning and prioritizing scarce resources. The Centers for Disease Control and Prevention (CDC) has prepared an important framework for understanding terrorist-related public health threats. In the case of bioterrorism, the CDC categorizes agents along four separate dimensions: (1) the anticipated number of illnesses and deaths; (2) the ability to reach large populations based on the difficulty of mass producing and distributing the agent, the agent's stability, and the potential for person-to-person transmission; (3) public perception and the potential for fear and civil disruption; and (4) special public health preparedness needs like stockpile requirements, enhanced surveillance, or diagnostic tools for responding to an at-

tack. These dimensions have, in turn, been used to assess priorities. For example, Category A agents like anthrax, botulism, tularemia, smallpox, plague, and viral hemorrhagic fevers (e.g., Ebola) rank high across all four dimensions (Khan 2003; CDC n.d.(d)). Category B bioterrorism agents rank comparatively lower across the four dimensions but still require substantial preparedness investments. Examples include brucellosis, food-safety threats, and ricin toxin. Finally, Category C bioterrorism agents do not currently present a high bioterrorism risk. These include emerging pathogens that could be engineered for mass dissemination like Hanta and Nipah viruses (CDC n.d (a)).

The CDC similarly lists various chemical weapons categories, including biotoxins, blister agents/vesicants, blood agents, caustics (acids), choking/lung/pulmonary agents, incapacitating agents, long-acting anticoagulants, metals, nerve agents, organic solvents, riot control agents/tear gas, toxic alcohols, and vomiting agents (CDC n.d.(e)). Unlike the CDC's lists of biological agents, however, the list of chemical agents is not prioritized. The CDC similarly lists various radioactive isotopes that might be used to make weapons and provides information for the public and professionals on how to cope with them (CDC n.d (c)). The CDC stops short of prioritizing these threats or assessing their importance relative to chemical or biological agents.

11.2 National Response Framework

The National Response Plan (NRP) outlines a "single, comprehensive approach to domestic incident management to prevent, prepare for, respond to, and recover from terrorist attacks, major disasters, and other emergencies" (DHS 2006). The NRP takes a functional approach by grouping the required planning, support, resources, program implementation, and emergency service capabilities into Emergency Support Functions (ESFs). One basic tenet of the NRP is that incidents should be handled at the lowest jurisdictional level possible. This means that all responses are local in the first instance and that the federal government's role is to supplement state and local resources if and when they are overwhelmed and at the request of state governors. DHS can also declare an "Incident of National Significance" (INS) in consultation with the White House and other agencies whenever "[there is] an actual or potential high-impact event that requires robust coordination of the federal response in order to save lives and minimize damage, and [to] provide the basis for long-term community and economic recovery" (DHS 2006).

Once a potential or actual INS is declared, federal medical assistance to state and local levels is coordinated under ESF-8. This assistance is subdivided into four functional areas: (1) assessment of public health and medical needs (including behavioral

health), (2) public health surveillance, (3) medical-care personnel, and (4) medical equipment and supplies. These areas, in turn, embrace a wide range of specific activities including, but not limited to, increasing medical-care surge capacity, implementing a quarantine, deploying medical countermeasures and medical supplies from the Strategic National Stockpile (SNS), evacuating hospital patients, and identifying victims and providing mortuary services. Other activities (e.g., planning, coordination within and across agencies, and communication) cut across these core functional areas and support them. We discuss each functional area separately in what follows.

11.2.1 Functional Area 1: Assessment of Public Health/Medical Needs

Federal response depends on assessing the event's impact and identifying state and local needs. Institutionally, the federal government starts this process by deploying an Emergency Response Team, Advance Element (ERT-A). Team members usually include a Federal Emergency Management Agency (FEMA) representative, a state representative, and various specialists. Depending on the emergency, these can include hazardous materials (hazmat), medical, mass-care, and/or infrastructure experts. Within this team, the medical specialist has the primary responsibility for assessing medical infrastructure (hospitals, clinics, and pharmacies), environmental health, sanitation, special needs populations, emergency medical services, and patient evacuation needs and capabilities. In general, the ERT-A works closely with state and local authorities to facilitate their requests for assistance.

While the ERT-A focuses on damage to infrastructure, state and local public health authorities are responsible for assessing health needs. This information is used to help identify, prioritize, and target relief efforts where the need is greatest. However, the work can still take several days and new technologies are currently being developed to collect these data faster. For example, a North Carolina team of state and local public health officials has developed a powerful new rapid needs assessment system that takes advantage of handheld computers, geographic information system (GIS) mapping software, and Global Positioning System (GPS) technologies. When Hurricane Charley hit North Carolina in 2004, the team was able to collect 210 surveys from 30 block groups, analyze the data, and prepare a complete report overnight (NACCHO 2007).

The demand for hospital care will surge following any large-scale disaster. This makes it critical for public health authorities to be able to identify available hospital beds and staff at the local level. Information technology systems for monitoring available beds would allow public health and medical-care providers to better manage the influx of patients and demand for medical supplies. Denver Health's Hospital Available Beds for Emergencies and Disasters (HAvBed) system provides a

typical example of this technology. It combines data from existing systems (e.g., databases that support hospital divert status) to provide real-time information about availability (Philips and Knebel 2007).

Once resource needs are identified, local authorities can decide whether they need state assistance and states can request help from the federal government. If a state anticipates that its resources may be exceeded in an emergency, a governor can request assistance from the federal government and/or other states through mutual aid and assistance agreements (DHS 2008). In many circumstances, this process works well. However, Hurricane Katrina provides an example of how the scope of a disaster can become so large—and damage or destroy so many local resources (e.g., infrastructure)—that the public health system has great difficulty assessing medical needs in a timely way.[2] In situations where states may be overwhelmed due to the catastrophic nature of a disaster or public health emergency, the federal government may want to be proactive in reaching out to states and helping them to develop a formal assistance request.

11.2.2 Functional Area 2: Public Health Surveillance

Public health surveillance has been described as the "ongoing, systematic collection, analysis, and interpretation of health-related data essential to the planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of these data to those responsible for prevention and control" (Thacker and Berkelman 1988). Surveillance is a primary function of public health in both in its day-to-day and emergency response roles.

Surveillance would play a critical role in determining that a biological attack has occurred, identifying the agent, evaluating the likelihood of transmission, and identifying exposed populations (Bullock 2002). Because biological agents can be released in an aerosol form, it could take days or even weeks to detect an attack. Given that time is of the essence in treating these illnesses and mitigating transmission, improved surveillance systems could potentially save many lives.

Traditional public health surveillance consists of both passive and active systems. *Passive surveillance systems* depend on physicians and hospitals to identify and voluntarily report cases. The National Notifiable Disease Surveillance System (NNDSS) is an example of such a system and is built around a state-developed list of notifiable diseases.[3] Physicians who diagnose these diseases must report the information to state authorities, who, in turn, are required to compile the information and share it with the CDC. However, in many cases, the reporting process is still paper-based. This means that it can take a long time for information to pass from the local level to the state and/or the CDC. In addition, reporting obligations are seldom enforced so that underreporting is thought to be a problem. It is estimated that

passive surveillance systems only capture 5 to 60 percent (Campos-Outcault, England, and Porter 1991; Marier 1977) of reportable-disease cases. This delays response actions and results in some cases that could have been prevented (CDC 1992).

These concerns limit the usefulness of passive systems like NNDSS for detecting biological attacks quickly. That said, initiatives are currently underway to improve these systems. Several steps focus on improving identification and diagnosis by physicians and labs. For example, the CDC is taking steps to educate physicians by publishing detailed case definitions for likely biological agents and posting webcasts, slide presentations, and other physician training materials on its website (CDC n.d.(d)). The CDC is also taking steps to enhance laboratory capacity for identifying agents and confirming physician diagnoses. The *Laboratory Response Network* (LRN) is a nationwide network of local, state, and federal public health, food testing, veterinary diagnostic, and environmental testing laboratories that provides the laboratory infrastructure for responding to biological and chemical terrorism and/or other public health emergencies (CDC 2007b). The CDC also supports training and new equipment to build member laboratories' capacity and speed.[4]

In addition, the CDC is working to make reporting more timely. Its *National Electronic Disease Surveillance System* (NEDSS) uses information technology to transfer surveillance data securely over the Internet. However, the system has yet to be implemented in all states. The CDC is also working to improve the capacity of public health departments to receive and analyze disease reports. The CDC (2003a) recommends that public health departments maintain a single, well-publicized phone number for receiving urgent case reports around the clock and that a trained public health official respond to all calls within thirty minutes. However, a recent study of nineteen local health departments found that just half (53 percent) had the recommended single phone number and that the mean response time was fifty-five minutes (Dausey, Lurie, and Diamond 2005).[5]

Unlike passive systems, *active surveillance systems* require public health personnel to (a) actively pursue information about new cases from physicians, hospitals, and laboratories, and (b) follow up known cases. They also require a cadre of trained epidemiologists to compile and analyze these data. In recent years, the focus has been on developing new methods like *syndromic surveillance*, which aims to speed detection by analyzing symptoms data before physicians have arrived at a diagnosis. Data sources are usually electronic and come from emergency rooms, physicians' offices, over-the-counter pharmaceutical sales, and absenteeism reports. These sources are analyzed at frequent intervals and used to identify disease clusters for aggressive, targeted investigations (CDC 2004d; Stoto, Schonlau, and Mariano 2004).

The federal government has made a substantial investment in syndromic surveillance at the national, state, and local levels. At the national level, its *BioSense program* generates near-real-time surveillance data from Veterans Administration and Defense Department health-care facilities, private and public hospitals, state and regional surveillance systems, and national laboratories (CDC 2007a). The data are then analyzed using sophisticated statistical methods. Access to these results is provided over a secure web page limited to the CDC, state and local public health authorities, and participating health-care organizations (CDC 2004d; Loonsk 2004). Because syndromic surveillance methods are still relatively new, they have yet to be fully evaluated. However, there is growing skepticism about the value of syndromic surveillance for detecting biological attacks. One survey found that the effectiveness of syndromic surveillance is limited by the inherent trade-offs between sensitivity, timeliness, and false positives (Stoto, Schonlau, and Mariano 2004). New York City's health department, which implemented syndromic surveillance in the early 1990s, similarly found that many signals turned out to be nothing and that investigating them wasted valuable resources (McKenna 2007).

Other forms of surveillance rely on *environmental monitoring systems* to detect biological or chemical attacks. DHS's *BioWatch program* uses pathogen detectors to collect airborne particles onto filters. These filters are periodically retrieved and analyzed in laboratories. Some have questioned whether the BioWatch program is a reasonable and effective response to bioterrorism. The primary concern is that the system is best suited to detecting large-scale releases (Shea and Lister 2003). The Central Intelligence Agency (2003) has suggested that this threat may be less important than small-scale attacks that the system might not detect.

There are a wide range of surveillance systems in place at the national, state, and local levels (Stoto 2003). One problem with this patchwork of systems is that it can be difficult to synthesize information from multiple sources to get a clear picture of what is happening, both within a state and at the national level. Improvements in information technology and efforts to make reporting formats more consistent have helped, but critical gaps remain.

11.2.3 Functional Area 3: Medical Personnel

Since 2001, the federal government has invested in improving the public health and health-care workforce's ability to respond to terrorism. Major initiatives include funding academic Centers for Public Health Preparedness, cooperative agreements with states to enhance preparedness, and efforts to develop and build systems to coordinate medical volunteers. One major stumbling block has been the absence of a clear definition of what a "prepared workforce" is. Moreover, it is not clear who is included in the public health workforce. In current usage, the term includes "all

those responsible for providing the essential services of public health regardless of the organization in which they work'' (HHS 1994). This definition is very broad and includes many occupations and nongovernment workers. These include dentists, physicians, nurses, social workers, educators, biostatisticians, and epidemiologists. For example, a nurse in a private hospital that works to prevent nosocomial infections (i.e., diseases that originate in a hospital) would be included. By this measure, there are probably half a million public health workers in the United States, although the vast majority (86 percent) are employed by public health agencies at the federal, state, and local levels (HHS 2000).

While public health's presence in emergency or disaster response is not new, there has been a renewed emphasis on the need for better integration of emergency preparedness and public health since September 11. The emergency preparedness mission has changed the mix of personnel and skills that public health agencies need. This includes a new emphasis on hiring people with emergency management or military backgrounds with expertise in incident management. Integrating these new hires with more traditional public health staff has created predictable tensions. The new hires worry that public health's traditional emphasis on careful analysis could impede action in an emergency. For their part, traditional public health staff worry about the ''militarization'' of public health, arguing that the traditional focus on providing care for the public and understanding community needs remains valuable and could be overlooked.

Federal, state, and local authorities have also developed significant training programs to help ensure that the public health workforce is prepared to respond to a large-scale emergency. That said, it is still too soon to say how effective these programs have been. One widely discussed idea has been to develop emergency preparedness core competencies for public health departments. These competencies would, in turn, provide a yardstick for evaluating the effectiveness of training. In the meantime, the CDC has developed multiple initiatives to deliver training. First, the CDC's Centers for Public Health Preparedness program funds colleges and universities to develop, deliver, and evaluate preparedness education programs for public health workers, health-care providers, students, and others (CDC n.d.(d)). Topics include the use of incident command systems, personal protective equipment, worker safety, and various tabletop exercises. Although a number of centers have been funded and various program activities undertaken, no systematic evaluation of this overall model has yet been conducted. Second, the CDC has joined forces with the National Association of County and City Health Officials (NACCHO) to fund eight Advanced Practice Centers (APCs). The program's goal is to identify and develop demonstration programs and practices that can be shared with other health departments.[6] Third, the CDC disseminates emergency preparedness training resources directly through its website.[7] Training materials are provided for different

scenarios (e.g., bioterrorism, chemical, and radiation emergencies), including such topics as treating mass casualties, administering mass prophylaxis, and decontamination procedures. The program is addressed to a wide range of audiences including first responders, physicians and hospitals, and public health personnel. However, its effectiveness as a vehicle for distributing training materials has yet to be systematically evaluated.

Absenteeism is also expected to be a problem. Surveys indicate that one-fourth to one-third of the health-care workforce may not show up for work during a biological, chemical, or radiological attack because of fears for their personal and/or their family's safety. The problem is particularly acute for attacks involving contagious pathogens (Qureshi et al. 2005). Various strategies have been implemented to encourage workers to respond in an emergency. First, at least one state has used its CDC grant money to provide standby pay of $200 per month for public health nurses who obtain training and commit to participate in an emergency. Second, some communities have promised to give families of public health and medical personnel higher priority for drugs and vaccines if an attack occurs. Third, many jurisdictions have tried to enhance workers' personal safety by purchasing training and personal protective equipment.

Finally, the day-to-day public health and medical workforce is not large enough to treat mass casualties. As such, supplemental personnel would be needed to carry out an effective medical response. These personnel will be more effective if several issues are addressed ahead of time. For instance, medical personnel coming from other states are generally not licensed to provide medical care at the attack site. Allowing these personnel to treat victims could create legal liability for volunteers and the organizations that host them. Efforts are currently underway to promote agreements in which states would recognize each other's medical licenses in the event of a large-scale disaster. Even then, however, there would still be no quick way to verify out-of-state credentials and skill levels. This could force volunteers to sit idle until their credentials were verified. This was a problem in the response to Hurricane Katrina. Although many health-care professionals volunteered, public health authorities lacked systems to coordinate volunteers and match their skills to identified needs. The absence of an agreed-on method for verifying health-care workers' credentials and skills was particularly problematic (Ringel et al. 2007). Congress has since moved to fill this gap by instructing the Health Resources and Services Administration (HRSA) to create an Emergency System for Advance Registration of Health Professions Volunteers (ESAR-VHP). The goal of the program is to assist states in developing standardized preregistration systems for medical volunteers (HRSA n.d.). Despite progress, the system has yet to be fully implemented.

Still other federal, state, and local program levels are designed to facilitate relief across state lines if mass casualties occur. For example, the federally coordinated

National Disaster Medical System (NDMS) is designed to route medical personnel, supplies, and equipment to affected areas. The heart of the system consists of rapid response Disaster Medical Assistance Teams (DMATs) that deploy with enough supplies to maintain operations for seventy-two hours.[8] Once activated, DMAT members become federal employees; this automatically means that their licenses and certifications are recognized by all states and protects them from malpractice claims (HHS 2007). However, the DMAT system encountered some problems during the response to Hurricane Katrina. In Houston, for example, available personnel were overwhelmed by the volume of evacuees (approximately 68,000) who arrived at the triage center in a short period of time. One interviewee reported that DMAT teams were requested but were never sent or did not arrive in time (Ringel et al. 2007).

The Emergency Mutual Assistance Compact (EMAC) provides another mechanism that states can use to request medical assistance following major disasters. It provides formal structures for requesting and receiving aid and speeds the process by resolving many key issues—for example, liability and reimbursement for equipment and personnel—in advance (EMAC n.d.). HHS's Medical Reserve Corps (MRC) similarly helps communities recruit, train, and credential medical volunteers to meet surge demand in an emergency. Volunteers include physicians, nurses, pharmacists, and various nonmedical personnel who provide administrative and logistical support skills. The MRC currently includes more than 120,000 volunteers and is organized into 689 units (MRC n.d.).

11.2.4 Functional Area 4: Medical Equipment and Supplies

An effective response depends on medical equipment, supplies, and pharmaceuticals. The CDC-administered Strategic National Stockpile (SNS) is the country's primary mechanism for distributing medical equipment, supplies, and pharmaceuticals in an emergency. SNS can deliver "Push Packages" to any state within twelve hours. Because the Push Packages are designed to arrive when needs are still being assessed, they contain a broad range of medical assets that might be needed. Thereafter, more targeted pharmaceuticals and/or supplies can be deployed from SNS's vendor-managed inventories (i.e., caches stored in the vendors' warehouses) within twenty-four to thirty-six hours (CDC n.d.(e)).[9] On arrival, state and local officials would immediately take control of SNS materials and assume responsibility for distributing them.

Many states and local governments also maintain their own medical materiel caches. These stockpiles are paid for from a variety of sources, including the CDC, DHS, HRSA, and state and local tax dollars. The caches provide a hedge in case SNS is overwhelmed by a nationwide event (e.g., pandemic influenza) and can also be used to fill the twelve-hour gap before Push Packages arrive. However, the exis-

tence of multiple stockpiles raises coordination issues in terms of which populations are covered and which materials are stockpiled. This problem is further aggravated by differences in how stockpile programs (and grant authorities) define geographic coverage, likely threats, and deployment time frames (ASTHO 2005). Better planning and coordination are needed to eliminate the resulting duplication and gaps between stockpiles.

11.3 Implementing the National Response Plan at the State and Local Levels

ESF-8 is limited to specifying how federal agencies would support the response to an Incident of National Significance, facilitating coordination, and providing guidance for the development of detailed supplemental plans and procedures at the federal, state, and local levels. It does not, however, impose a specific state and local response strategy (DHS 2006). Because public health is a state function under the Constitution, there is substantial variation in how states organize their public health systems. This means there is no "one-size-fits-all" model for how a public health and medical-care emergency response should be carried out. CDC guidance to states explicitly recognizes this fact, noting that states differ in many ways (e.g., size, public health system organization, risks) and "addresses important areas of preparedness and response that can be tailored to the needs of the individual jurisdiction" (CDC 2001). This section briefly introduces the key players who would be involved in a response, recent efforts to coordinate their planning and response activities, and how they would conduct risk communication to the public before, during, and after an event.[10] Finally, we turn to coordination problems that tend to impede key players' planning and preparedness activities.

11.3.1 Key Players

Many players are involved at the state and local levels in implementing the National Response Plan's four functional areas. These include state and local public health departments, hospitals and health-care providers, hospital associations, pharmacies, law enforcement, fire departments, National Guard, emergency management agencies, emergency medical services, Red Cross, and mental health and social service providers. Of these, public health departments, hospitals, and health-care providers tend to be the key players in implementing the health and medical response at the local level.

Public Health Departments State public health systems vary along several dimensions. Some states have a freestanding agency; others house public health within a larger department of health and human services. In some states, the system is centralized, with a state agency exercising direct control over local health departments

staffed by state employees. Elsewhere, the system is more decentralized and local health departments exercise greater control over public health policy and service delivery (Wasserman et al. 2006). Finally, there are states that fall in between these two extremes. Public health departments also differ in the services they provide. Some health departments provide direct medical care through public hospitals and clinics; others limit themselves to ensuring that health-care services are available and facilitating connections between providers and patients. Given these differences, response strategies will clearly differ from community to community. Some public health departments have the personnel to provide emergency medical-care services, whereas others must rely on hospitals and other private health-care workers to provide services. While variation in how the public health system is structured in different states is not inherently bad—indeed, it provides useful room for experiment—it does complicate the process of delineating public health departments' roles in responding to an emergency.

Emergency response is most effective when all organizations understand their roles and responsibilities. During Hurricane Katrina, roles and responsibilities were often unclear. For example, some special needs shelters were inadequately staffed because it was not clear which agency was responsible for providing medical personnel (Ringel et al. 2007). Response organizations can avoid these problems by discussing the allocation of tasks as an explicit part of the planning process. Coordination is often complicated, however, by the wide range of organizations involved: "The U.S. 'public health system' is not a single entity, but rather a loosely affiliated network of more than 3,000 federal, state, and local public health agencies, often working closely with private sector voluntary and professional health associations" (Trust for America's Health 2006).

Hospitals and Health-Care Providers According to the American Hospital Association's 2005 annual hospital survey, there are 5,756 registered hospitals in the United States including 4,936 community hospitals (American Hospital Association n.d.). Other health-care providers include clinicians, insurance plans, group purchasers of health-care services, and independent physicians and networks. These can be public, private/for-profit, or private/not-for-profit organizations. Not surprisingly, communication, collaboration, and planning among these various entities are limited (IOM 2003).

11.3.2 Planning Prior to an Event

Prior to September 11, many state and local public health departments lacked plans for responding to terrorist events.[11] The Public Health Security and Bioterrorism Preparedness and Response Act of 2002 was designed to close this gap by authoriz-

ing additional funds for federal bioterrorism preparedness programs and grants to states. The CDC and HRSA are responsible for distributing these grants to the states (and ultimately localities) through cooperative agreements. CDC cooperative agreements focus on state and local preparedness planning (including SNS stockpile deployment), surveillance, epidemiology, and laboratory resources; information technology (including the Health Alert Network (HAN)); threat communication; and education and workforce training (Trust for America's Health 2006). Funds are apportioned between state and local jurisdictions based on "consensus, approval or concurrence between state and local public health officials for the proposed use of these funds" (CDC 2004b).

The CDC and HRSA cooperative agreements also establish goals and benchmarks for measuring public health preparedness, although meeting the specified critical benchmarks does not necessarily demonstrate adequate preparation. Since 2005, critical benchmarks for public health agencies included developing "scalable plans" for local, statewide, and regional responses to bioterrorism, catastrophic infectious disease, and other public health emergencies; maintaining a 24/7 system for activating emergency responses; conducting exercises to test all plans on an annual basis; reviewing and assessing changes needed to comply with the National Incident Management System (NIMS); conducting vulnerability assessments; updating and refining state, city, and regional response plans to correct deficiencies uncovered during exercises or actual events; and expanding communication capabilities (CDC 2004a).

The HRSA cooperative agreements were similarly intended to support hospital preparedness (Trust for America's Health 2006). Priority areas included administration, surge capacity, emergency medical services, links to public health departments, education and training, and preparedness exercises. The HRSA funds were distributed according to a population-based formula that required states to distribute at least 80 percent of all funds to hospitals, emergency medical systems, and other health-care entities (Trust for America's Health 2006). The CDC and HRSA also created a set of crosscutting benchmarks to encourage their grantees to cooperate with one another (Trust for America's Health 2006). These included requiring recipients to specify how public health departments and the hospital/health-care system would be integrated into NIMS-compliant incident management systems, as well as training staff to respond in a coordinated, nonoverlapping manner.

Other entities have also developed planning requirements. For example, the Joint Commission on the Accreditation of Healthcare Organizations (JCAHO) now requires health-care organizations to prepare emergency plans that address mitigation, preparedness, response, and recovery; perform hazard vulnerability assessments; conduct drills for a wide range of contingencies; and develop procedures that address emergency care, evacuation, and decontamination. While JCAHO

(2005) requires members to adopt an "all-hazards" command structure, no specific system (e.g., ICS) is required. JCAHO (2005) has also developed a planning guide for the many small rural and suburban communities that have found themselves struggling to meet post–September 11 mandates. The guide provides strategies and planning tools that health-care providers, public health leaders, elected or appointed officials, and others can use to establish an effective community-based management planning process.

Finally, JCAHO (2006) has published a report detailing the health-care community's responsibility for planning, building, and setting up "surge hospitals" as temporary stopgap facilities in an emergency. Drawing on Hurricane Katrina, the report describes what surge hospitals are, what planning is needed to support them, how they can be set up, and who should take responsibility for them. Local, state, and federal authorities can use this information to prepare detailed plans. JCAHO is also drafting a set of minimum standards to govern safety and care standards in these settings.

11.3.3 Incident Management

A large-scale bioterrorism attack would involve multiple federal, state, local, and tribal governments, private-sector companies, and nongovernmental organizations (e.g., the American Red Cross), each of which has its own characteristic disciplines, command structures, communication systems, and emergency management protocols. Response organizations have long recognized the need for a unified, nationwide emergency management system that could coordinate these disparate elements.

By the mid-1980s, fire, police, paramedics, and other first responders had developed a common Incident Command System (ICS). However, most hospitals and public health agencies used their own incident command and management systems, and many personnel had less training on ICS than their emergency-responder counterparts. In 1987, the Hospital Council of Northern California moved to bridge this gap by creating an ICS-like Hospital Emergency Incident Command System (HEICS). HEICS defines a common management structure, responsibilities, reporting channels, and standard nomenclature to help hospitals communicate with other emergency responders. Although adoption remains voluntary, HEICS has been widely adopted across the western United States (San Mateo County Health Services 1998).

September 11 accelerated efforts to improve coordination between hospitals, health agencies, first responders, and other response organizations. In 2003, the White House directed the Secretary of Homeland Security to develop a National Incident Management System (NIMS) (U.S. Government 2003a). NIMS provides a nationwide template and unified approach for incident management, standardized

command and management structures, and a framework for cooperation in preparedness, mutual aid, and resource management (FEMA n.d.). In 2005, experience with Hurricane Katrina and fears of pandemic influenza brought renewed attention to the gap between hospitals and other first responders. The National Bioterrorism Hospital Preparedness Program (NBHPP) explicitly requires participating hospitals and health-care systems to adopt NIMS and train health personnel in ICS (HHS 2005c).

11.3.4 Risk Communications with the Public

Public behavior is a key part of preparedness. Preemergency risk communication seeks to educate employers and the general public about a threat and how to mitigate losses and take protective actions (Davis et al. 2003). Here, the goal is to change people's behavior. Successful public health campaigns (e.g., seat belts, smoking, disaster preparedness) raise awareness, offer straightforward guidance, and are periodically reinforced over time (NRC 1989). They also recognize that people differ in the amount of information they want, the degree to which they feel they can exercise control over exposure and/or remediation, and their tolerance for risk. This means that multiple messages must be devised to reach and persuade different populations and groups.

Emergency risk communication, on the other hand, provides warnings and guidance immediately before and during a specific emergency. This needs to be an interactive process. Successful communication should not only satisfy the public that they have been adequately informed within the limits of available knowledge, but also improve officials' available information (NRC 1989). Because risk communication is tightly linked to risk management, improved risk communication often means modifying previous risk analyses to reflect the public's concerns.

Although much energy has been devoted to developing and disseminating risk messages, much less research has been done to gain a systematic understanding of how and why risk communication succeeds. Common problems include (1) establishing credibility, (2) creating understandable and informative messages, (3) preparing messages in an emergency, (4) capturing the intended audience's attention, and (5) providing sufficient information to draw satisfactory conclusions (NRC 1989). Poorly crafted, inadequately prepared, or conflicting messages can quickly erode trust that authorities need in order to provide leadership. Finally, communications must use language and concepts that their target audience readily understands. Failed risk communication can make it hard for the public to prioritize and/or decide what to do in an emergency (NRC 1989).

The 2001 anthrax attacks revealed important weaknesses in how public health messages about bioterrorism and other public health emergencies are communicated

to the public. Stein et al. (2004) interviewed federal employees who had potentially been exposed to anthrax to find out why they did/did not follow the government's advice to take prophylactic antibiotics. Employees who decided against prophylaxis usually followed the advice of private physicians, whereas those who complied had usually consulted multiple sources. The study highlighted the need for better integration between the public and private health-care systems and the importance of equipping private physicians for their role in helping their patients decide what to do during a crisis.

A second study of postal workers (and Capitol Hill staff) exposed to the 2001 anthrax attacks found that some minorities felt that they had been excluded from communication and planning. The finding confirmed the importance of developing individualized messages for different segments of the population (Blanchard et al. 2005). Since then, there have been several successful examples of targeted communication campaigns during more recent outbreaks. For example, during the SARS outbreak in 2003, the New York City health department worked with universities and high-tech companies to reach their Asian employees and others who traveled frequently to Asia (Stoto et al. 2005). In California, a mosquito control district similarly developed special pamphlets, posters, and other communication materials in multiple languages to communicate the risk of West Nile virus (Stoto et al. 2005). That said, many jurisdictions are still poorly equipped to communicate in multiple languages and lack established relationships with key community leaders and groups. This is particularly true for ethnic-minority and low-income communities, who may have a more guarded attitude toward government, including public health agencies. For instance, Stoto et al. (2005) found that language and cultural barriers continued to hamper the California Public Health Department's efforts to communicate with Asian Americans during the SARS outbreak. Finally, many health departments have found themselves overwhelmed by the sheer number of calls that they receive during outbreaks. This can divert capacity that would otherwise be used to communicate with "hard-to-reach" populations, including ethnic minorities, migrant workers, and homeless people.

Post-anthrax experiences with disease outbreaks and other nonterrorist emergencies have also uncovered examples of inadequate communication plans and poor coordination when local and state health departments, hospitals, and local officials communicate to the public. For example, Stoto et al. (2005) found that New York City health department officials had trouble communicating what they felt was a clear scientific case for using pesticides to control the West Nile virus. Despite their best efforts, public concerns over increased pesticide risk continued to rise over time. State and local health officials also had trouble speaking with one voice, reaching out to minority and affected communities, and addressing the worried well. While

Louisiana officials found that local media tended to embrace their message, national coverage was more sensational (Stoto et al. 2005). Similarly, Colorado health officials noted that state and local press releases often reported different numbers of West Nile cases, largely because some organizations reported "cases under investigation" instead of "confirmed cases." This encouraged the media to distrust both sources of information.[12] At least some of these difficulties may have been caused by the media's failure to understand the public health system and the science behind contagious outbreaks. HHS has since developed a reference guide that reporters can read to educate themselves about terrorism and/or public health emergencies (HHS 2005b).

11.3.5 Coordination

Local public health departments must be able to work seamlessly with each other and with a variety of other actors, including hospitals and/or hospital councils; medical providers; the CDC and other federal agencies; emergency medical services, fire, law enforcement, and other first responders; emergency management; and interagency disaster planning groups and task forces.[13] Furthermore, these organizations must work together on many different issues. Some of the most important ones are illustrated in figure 11.1.

Coordination is further complicated by the fact that—unlike law enforcement, fire, and other emergency responders—public health agencies seldom have com-

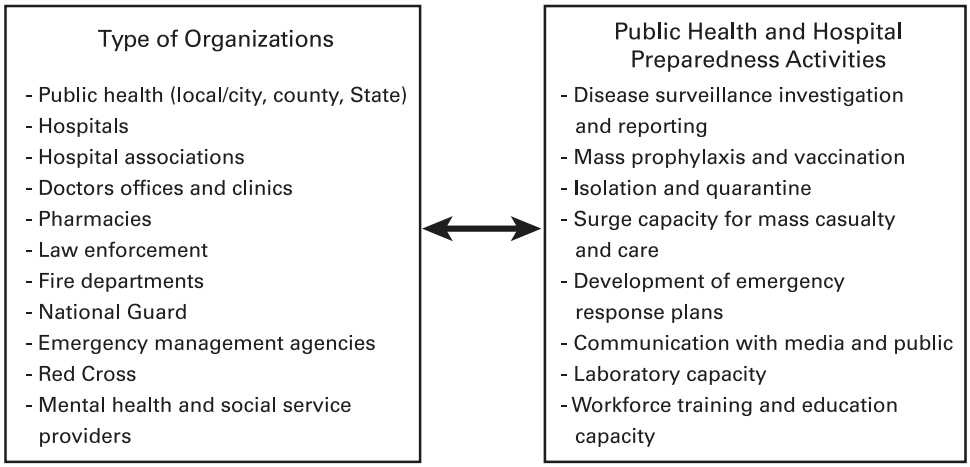

Figure 11.1
Typical preparedness activities and organizations involved

mand and control authority over the resources they need. Instead, they must rely on a host of other individuals and organizations like health-care providers, emergency responders, and other public health agencies (e.g., in bordering jurisdictions and other levels of government) to mount an effective response (Stoto et al. 2005).

Previous studies have found that public health authorities and hospitals face especially high coordination barriers. These include differences in funding; differences in organizational mission, culture, and priorities; overlapping roles that can lead to turf battles; incompatible information management systems; and differences in leaders' commitment to success (GAO 1992; Edwards and Stern 1998; Martinson 1999; Lasker et al. 1997). Differences in mission and culture run especially deep for collaborations between public and private entities like health departments and for-profit hospitals. For example, while many for-profit hospitals include community service in their missions, hospital CEOs differ widely in how they see their role in public health preparedness and the extent to which they encourage personnel to participate in preparedness (Davis et al. 2006a) "Because of its history, structure, and particularly the highly competitive market in health services that has evolved since the collapse of health-care reform efforts in the early 1990s, the health-care delivery system often does not interact effectively with other components of the public health system" (IOM 2002).

There are also deep disconnects between public health and medicine. Focus-group interviews have shown that public health professionals see medicine as an arm of public health, whereas medical professionals view public health as a subspecialty of medicine (Lasker et al. 1997). Focus-group participants were also unable to articulate or agree on a precise definition of their relationship and few could describe how the activities of the other discipline are relevant to what they did. This may be because members of the two fields have had little or no experience working with each other's discipline (Davis et al. 2006a). The situation is aggravated by the ongoing restructuring of health-care, including the replacement of individual practitioners with corporations, the changing role of government, and the severe fiscal constraints imposed by managed care, government downsizing, and privatization.

Although federal bioterrorism funding is specifically aimed at encouraging collaboration, health departments and hospitals still do not fully understand each other's roles or the benefits of coordination (Davis et al. 2006a). Preparedness exercises continue to show that public health departments are often unaware of hospitals' response plans. Conversely, hospitals often fail to include local health departments in their exercises. The fact that states and localities manage CDC and HRSA cooperative-agreement funds differently only adds to the problem.

Public health agencies, general hospitals, and emergency responders also differ in the priority they place on preparing for different types of WMD (Davis et al.

2006a). This reflects differences in organizational mission. A 2003 survey found that local health departments tend to focus on biological events; hospitals, EMS agencies, and local emergency management offices tend to prepare for chemical events (albeit with biological events a close second); and law enforcement and fire departments tend to focus on conventional explosives and then chemical incidents. To the extent that these perceptions translate into different investment patterns, coordination becomes even more complicated.

Law enforcement and other first responders would have multiple responsibilities in a public health emergency. These could include enforcing quarantines, managing crowds, or participating in joint investigations with public health departments (Davis et al. 2006b). Many observers have criticized the lack of integration between the public health and medical communities (Hamburg 2001). In a 2003 survey, Davis et al. (2006b) found that only a quarter of all law enforcement agencies and a third of all fire departments reported having participated in joint preparedness activities with local health departments since September 11. On the other hand, a significant number of local health departments reported working with law enforcement and fire departments during the same period. This inconsistency suggests a disconnect between how emergency responders and public health assess progress in integrating their preparedness activities and that improvements are still needed. Davis et al. (2006a) have also conducted a series of case studies to examine integration between public health agencies and hospitals. Because JCAHO has emphasized disaster preparedness for many years, hospitals tend to have a longer history of establishing preparedness and coordination relationships with first responders. By contrast, first responders have seldom seen public health departments as important partners, much less leaders, until recently (Davis et al. 2006a).

11.4 Taking Stock

So far, we have treated preparedness as a series of individual problems and reviewed the various programs that have been launched to address them. What we would really like, however, is a global assessment of the nation's ability to respond to a WMD attack. This section briefly reviews the overall state of the public health system and the prospects for improving it. We then review the sometimes controversial attempts to assess preparedness as a whole.

11.4.1 Public Health Infrastructure

The U.S. public health system had deteriorated significantly in the years before September 11 (IOM 2003). Deficiencies included outdated and vulnerable technologies, a poorly prepared workforce, antiquated laboratories, lack of real-time surveillance

and epidemiological systems, ineffective and fragmented communication networks, incomplete emergency preparedness and response capabilities, and a lack of essential public health services in some communities (IOM 2002). According to the Public Health Foundation, fixing these public health deficiencies would cost more than $10 billion (Trust for America's Health 2006).

The heart of the problem is funding. Today, approximately 70 percent of America's public health spending comes from state and local sources, and the federal government supplies the rest (Trust for America's Health 2006). Given the financial situation in many states, progress almost certainly depends on significant federal investment. In 2000, Congress passed the Public Health Threats and Emergencies Act (Public Law 106-505) to address the nation's decaying public health infrastructure. The act included grants to state and local governments that emphasized building capacity to identify, detect, monitor, and respond to public health threats including bioterrorism. This focus on providing resources for preparedness planning, exercises, and equipment has sharpened since September 11. We have already seen how the Public Health Security and Bioterrorism Preparedness and Response Act (Public Law 107-188) channeled CDC- and HRSA-administered grants to state and local health departments, hospitals, and other health-care agencies. In all, the federal government has allocated more than $5 billion[14] to improve U.S. preparedness for bioterrorism since September 11 (Nelson et al. 2007).

There is little doubt that these resources have improved federal, state, and local preparedness. At the same time, the response to Hurricane Katrina shows that much remains to be done. Moreover—and despite statutory "nonsupplantation" provisions—some states have made offsetting cuts in their support for local public health programs. In these cases, the net effect has been to promote bioterrorism preparedness at the expense of traditional public health functions like tuberculosis prevention (Katz, Staiti, and McKenzie 2006). State and local health departments have also expressed concern about the stability of federal bioterrorism funding. CDC and HRSA spending declined by roughly 3 percent ($40 million) between 2003 and 2005 (Katz, Staiti, and McKenzie 2006).[15]

Bioterrorism funding since September 11 has helped many local health departments hire staff and fund specific training and planning activities. This has made it possible for many health departments to become more involved in preparedness. However, there is still room for improvement. In a series of case studies, Davis et al. (2006a) found that a number of participants believed there should be more flexibility in how cooperative-agreement money is spent, who can receive it, and when funds can be spent on coordination with private partners. Respondents also complained that federal and state delays in processing proposals often led to situations in which local health departments only received grants late in the fiscal year. This

led to some projects being rushed and money being spent less effectively than it otherwise would have been (Davis et al. 2006a).

11.4.2 Assessing Public Health Preparedness

Given these large investment, how prepared is the United States? On average, there has clearly been progress. A 2003 nationwide survey found that many general acute-care hospitals took significant steps after September 11 to update mutual-aid agreements and response plans for chemical, biological, and radiological attacks. Furthermore, roughly 70 percent of hospitals and 42 percent of local public health departments had conducted risk assessments. On the other hand, this progress has been uneven. In general, local public health departments that see their jurisdictions as likely terrorist targets have been much more willing to update their WMD response plans and invest in preparedness than other jurisdictions. Hospitals that perceive a high terrorism threat have been similarly more likely to buy detection and decontamination equipment (Davis et al. 2006b). A recent assessment of states' public health preparedness for disasters and public health emergencies reflects these mixed results:

- Although all states have a basic plan to respond to bioterrorism, planning for chemical and radiological threats has lagged behind.
- Plans tend to be limited to the public health sector, are not well coordinated with emergency responders, and seldom include the private sector and surrounding communities.
- Plans are not consistently tested and exercised and there are few procedures for incorporating lessons learned.
- Despite dramatic improvements in laboratory capabilities, shortages of reagents remain.
- While a number of states have joined the CDC's National Electronic Disease Surveillance System, public health information technology is still outdated.
- Median state spending for public health is only $31 per person per year, and an additional $2.6 billion would be needed to equalize spending across the states.
- Only fifteen states and two cities have received the highest preparedness rating for distributing and administering SNS medications.
- Although Congress appropriated $5 billion for pandemic influenza preparedness, the U.S. vaccine industry remains fragile, with only limited incentives to pursue R&D for new vaccines.
- Shortages of doctors, nurses, facilities, beds, medical supplies, and equipment mean that the United States has very limited surge capacity.
- Government risk communication strategies are outdated and do not sufficiently include the public in planning (Trust for America's Health 2006).

This assessment is admittedly controversial and more precise statements are hard to come by. Standardized measurements of organizational and community readiness would help. Since September 11, the CDC and HRSA have repeatedly worked to establish preparedness metrics. Despite some incremental improvements, however, existing measurements still depend on unverified/self-reported information, focus on process versus outcomes, and suffer from other problems (Trust for America's Health 2006). Other federal, state, and nongovernmental attempts to create objective performance metrics have been similarly controversial. Observers argue that they usually include "ambiguous and uncertain preparedness goals, a lack of agreement about what the measures should aim at and how they should be interpreted, and a weak system of accountability for producing results" (Nelson et al. 2006).

Ultimately, progress is impossible without some basic consensus on what constitutes a well-prepared community. RAND recently convened a panel of experts who proposed a list of sixteen elements grouped into three categories: (1) a preplanned and coordinated rapid-response capability; (2) an expert and fully staffed workforce; and (3) accountability and quality improvement (Nelson et al. 2007).[16] This list—or something like it—represents an essential first step in developing the metrics needed to judge preparedness and identify areas that need improvement.

11.5 Conclusion

However important, public health preparedness is just one aspect of the United States' overall preparedness effort. Although we have focused on public health departments and hospitals, many aspects of public health preparedness (e.g., SNS distribution, quarantine plans) need support from law enforcement, emergency medical services, and other actors outside the public health system. This wider group will bring their own funding sources, missions, organizational characteristics, and priorities to the planning table. It is not enough for health organizations to coordinate with one another. They must also build relationships outside the health-care field.

Federal investments since September 11 have increased the country's ability to respond to public health emergencies. For example, the influx of bioterrorism funding for expanded laboratory, surveillance, planning, and communication capabilities has served to improve public health preparedness generally. However, the absence of standardized metrics makes it hard to know where we stand and what remains to be done. More consistent public health emergency preparedness concepts and doctrines are clearly needed. Accountability also requires a much clearer definition of federal, state, and local actors' respective responsibilities (Lurie, Wasserman, and Nelson 2006).

Despite substantial investments in public health infrastructure development and preparedness, it is not clear how much preparedness has actually improved. There is anecdotal evidence that some localities and states cut traditional public health funding as federal funding became available. In addition, many local public health departments have commented on the resulting shift in emphasis away from traditional public health functions and toward bioterrorism. The key issue that localities and states currently face is how to sustain these investments in public health preparedness as federal funding is reduced.

Finally, recent progress remains tentative without a long-term strategy for sustaining the system. Money is scarce, and federal, state, and local governments continue to quarrel over who should pay for public health. This disagreement is particularly debilitating for challenges (e.g., rebuilding the public health workforce) that cannot be addressed within a year or two. The increasing importance of individual practitioners and private sector health-care providers has, if anything, made the problem more complicated. Progress will depend on communities' willingness to bring all the relevant stakeholders together to prepare and plan for a wide range of potential public health threats.

Notes

1. Many natural disease outbreaks (e.g., West Nile virus) similarly evolve over periods of months or years (Stoto et al. 2005).

2. Indeed, public health staff were themselves among the storm's displaced victims.

3. Because the list is compiled at the state level, a few diseases are notifiable in some states but not others. The Council of State and Territorial Epidemiologists (CSTE) offers a recommended list, but its suggestions are not binding.

4. For more information on the LRN, see http://www.bt.cdc.gov/lrn/.

5. Response times also showed substantial variation, ranging from 0.5 to 2,470 minutes.

6. The programs are archived at http://www.naccho.org/topics/emergency/APC.cfm and http://www.naccho.org/toolbox/program.cfm?id=9.

7. http://www.bt.cdc.gov/training/#new. Additional training programs are archived and available through the NACCHO website: http://www.naccho.org/topics/emergency/APC.cfm. The APC Toolbox (http://www.naccho.org/toolbox/program.cfm?id=9) also contains useful resources, including exercises, drills, protocols, and planning guidance developed by APCs.

8. DMATs consists of professional and paraprofessional medical personnel brought together to serve as rapid-response teams that can be deployed to disaster sites. For additional information on the NDMS, see http://www.oep-ndms.dhhs.gov/index.html.

9. For additional information about the Strategic National Stockpile see http://www.bt.cdc.gov/stockpile/.

10. Planning, coordination, and risk communication with the public support the core functional areas described above.

11. A nationwide survey conducted just prior to the September 11 terrorist attacks found that only about one-third of local public health departments and hospitals had plans in place for responding to a moderate-sized biological attack. Shortly after September 11, the corresponding figures for moderately sized chemical attacks were 27 percent for local health departments and slightly over 50 percent for hospitals (Davis and Blanchard 2002).

12. The media has also been frustrated by public health department confidentiality regulations that limit its ability to interview victims.

13. The private sector also plays a role in public health planning. Possible tasks include educating employees, using company communication networks to provide information to employees, customers, and tenants; distributing vaccines; surveillance reporting; and providing supply chain and logistics expertise to move government personnel and supplies to the scene of the emergency.

14. In addition to the CDC's Public Health Preparedness and Response for Bioterrorism and HRSA's Bioterrorism Hospital Preparedness cooperative agreements, this estimate includes a variety of federal bioterrorism programs.

15. The drop has also been geographically uneven, with the CDC's Cities Readiness Initiative redirecting resources to cities thought to be high-risk terrorism targets (Katz, Staiti, and McKenzie 2006).

16. The panel defined public health preparedness as "the capability of the public health and health-care systems, communities, and individuals, to prevent, protect against, quickly respond to, and recover from health emergencies, particularly those whose scale, timing, or unpredictability threatens to overwhelm routine capabilities. Preparedness involves a coordinated and continuous process of planning and implementation that relies on measuring performance and taking corrective action" (Nelson et al. 2007).