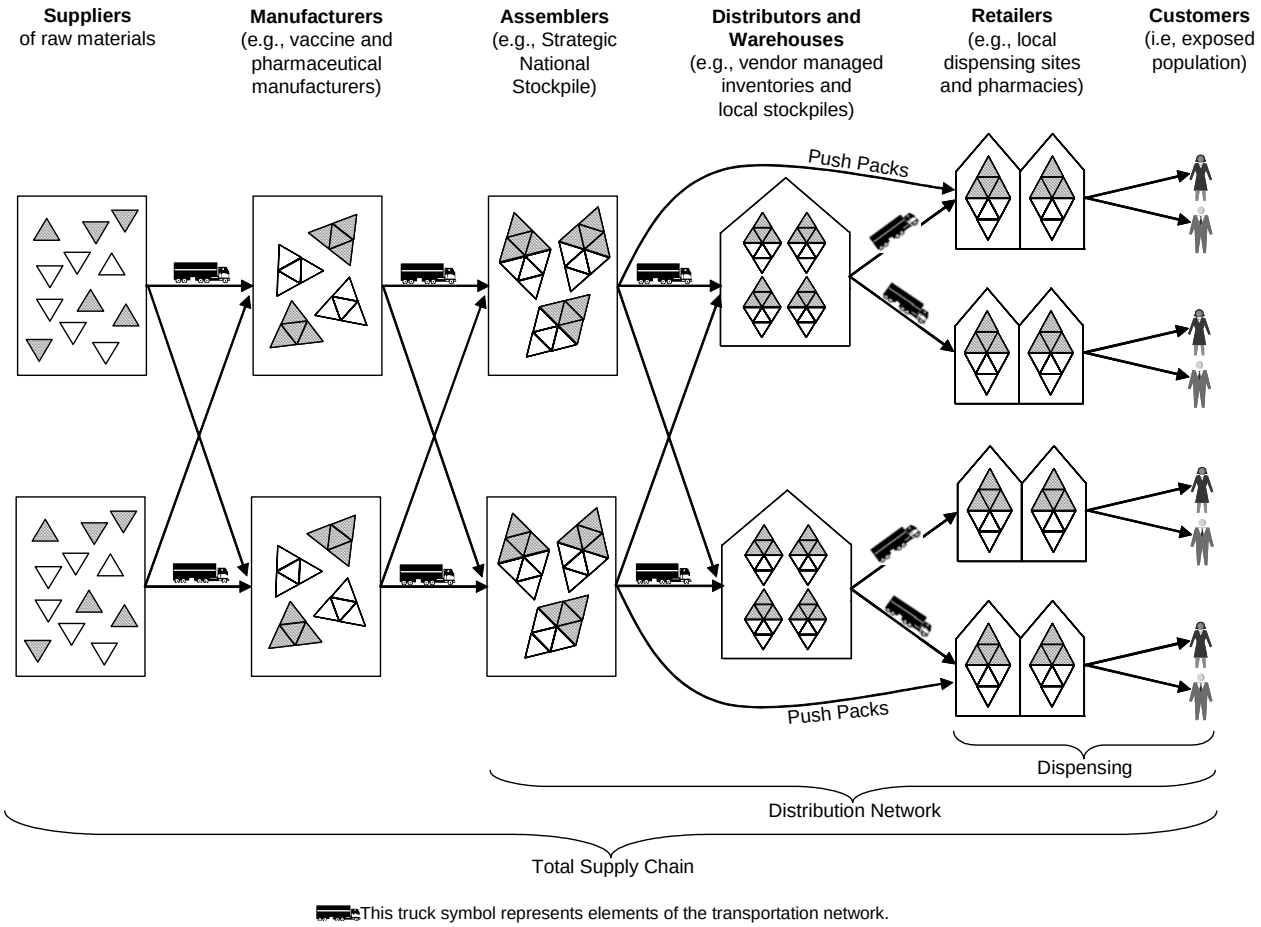
supply an exposed population? Which customers and products will be served from each facility or antibiotic/vaccine stockpile? How much inventory should be held in each facility? *Functional* issues involve determining how various tasks will be carried out (e.g., transportation carrier selection, fleet management, warehousing, and inventory management).[49] *Implementation* issues involve creating the information systems to support the supply chain, and installing and maintaining facilities, equipment, and personnel.

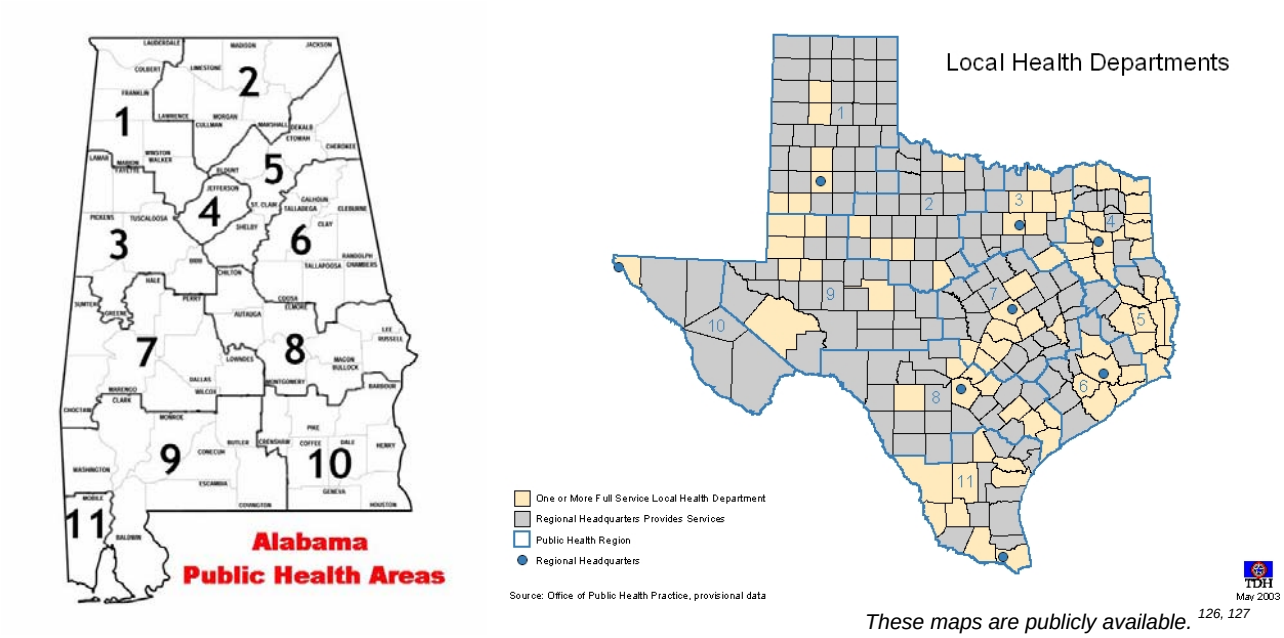
Figure 1. The Bioterrorism Response Supply Chain



The literature is inconsistent in its use of the terms *dispensing* and *distribution*. In general, dispensing refers to the end of the supply chain when medical supplies are given to patients—it is the terminal component of the distribution network.

From each supply chain case study, we abstracted information about the supply chain innovation described, and the outcomes of interest. We now describe the five specific concepts from evaluations of supply chains that are relevant to the bioterrorism response supply chain about which we abstracted information from each included article: **network design**, **inventory management**, **postponement and modularization**, **supply chain coordination and management of incentives**, and **management of information**. (We present details of the data abstracted from the supply chain case studies in Chapter 3 under the section "Synthesis of Evidence About Regionalization of Supply Chains".)

Figure 2. Regionalization of Public Health Departments in Texas and Alabama



These maps are publicly available. [126, 127]

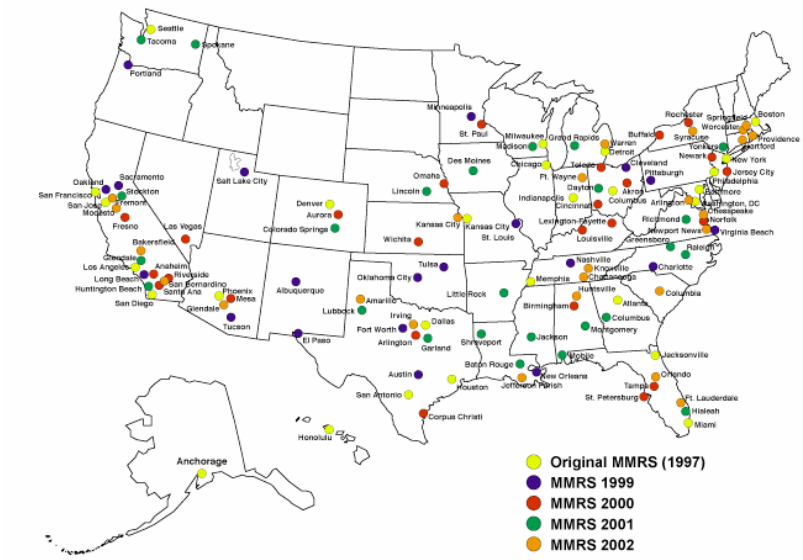
Public Health Legislation Affecting Bioterrorism Planning and Responses. A comprehensive review of the heterogeneous municipal, state, and federal legislation that directly affects the decision making responsibilities of public health officials, clinicians, and emergency management officials during a bioterrorism event is outside the scope of this Report. Moreover, many relevant laws are currently under revision following the recent national attention to the tradeoffs between personal privacy, civil liberties, and national security. For reviews of the salient legal issues, we refer interested readers elsewhere.[89, 90]

In our brief review of the laws affecting key public health and clinical decisionmakers, we found two issues that may affect regionalization during a bioterrorism response. First, for some highly controversial policies such as quarantine, the legal authority to implement the policy may be inadequate for its practical implementation and enforcement.[*91, 92] For example, in many states the legal authority to institute a quarantine lies with the local health officer (and if local and/or state laws are inadequate for implementation of necessary quarantine or isolation, local

[*]In his article on the legal issues raised by the 1999 West Nile Virus outbreak, attorney Wilfredo Lopez of the New York City Department of Public Health wrote: "In modern society, public health initiatives, no matter how justified and necessary, are likely to be scrutinized and challenged, both in the media and in the courts. The proliferation of federal, state, and local agencies since the 1960s, and the laws and regulations that go along with them, means that there is much more jurisdictional overlap among governmental entities than ever before. Perhaps the most fundamental lesson of the W[est] N[ile] V[irus] experience is the reaffirmation of the fact that today's public health practitioner cannot implement public health policy and interventions without sound legal advice that is cognizant of not only the nuances of traditional public health law but also of the law that governs kindred agencies. In effect, public health law is broader and more complicated than in the past."[91]

and non-Metropolitan Medical Response System cities, other federal programs (such as National Disaster Medical System, Medical Reserve Corps, Public Health Service's Commissioned Corps Readiness Force, the National Guard's weapons of mass destruction Civil Support Teams), and other regional response providers.*

Figure 3. The Metropolitan Medical Response System



This map is publicly available.[133]

The Department of Homeland Security

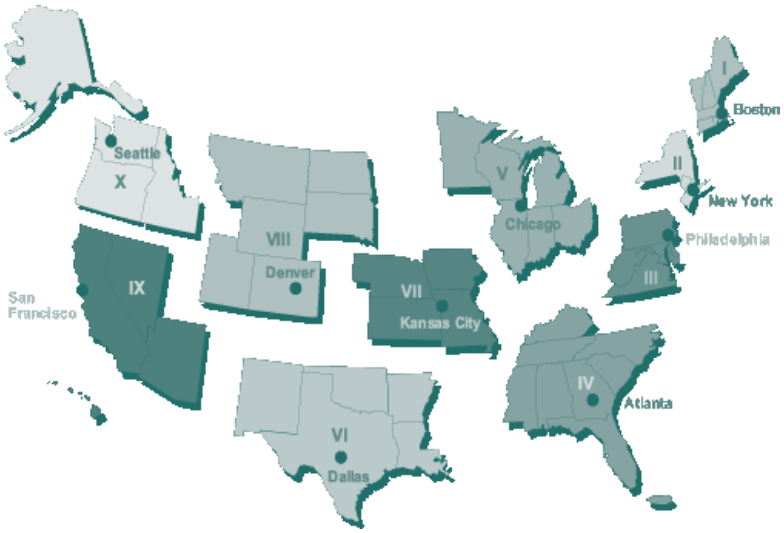
Background. The Department of Homeland Security was established by Congress under the Department of Homeland Security Act of 2002,[134] to integrate and coordinate the leadership, assets, personnel, and functions of the numerous federal agencies involved in all aspects of homeland security, including bioterrorism preparedness and response.[113-116] The establishment of Department of Homeland Security required an enormous reorganization of the federal government, including the transfer of several programs in their entirety (e.g., U.S. Coast Guard, FEMA, U.S. Secret Service, and Metropolitan Medical Response System) and the selective transfer of key defense programs from other departments (e.g., from HHS the Office of Emergency Preparedness and the Strategic National Stockpile).[134] Ongoing efforts by these agencies (such as the use of surveillance technologies to monitor cargoes coming into the United States for weapons of mass destruction) represent promising initiatives in preventions efforts against bioterrorism. The Department of Homeland Security is organized into four main directorates: Border and Transportation Security, Emergency Preparedness and Response, Science and Technology, and Information Analysis and Infrastructure Protection. The role of the

*Some cities in FEMA region IX, such as San Jose, California, serve as a model for coordination between the Metropolitan Medical Response System and other regional responders known as the Metropolitan Medical Task Force.

Emergency Preparedness and Response directorate is to "oversee domestic disaster preparedness training and coordinate government disaster response."[135] This directorate coordinates efforts of FEMA, the Strategic National Stockpile, National Disaster Medical System, the Nuclear Incident Response Team (DOE), and the Domestic Emergency Support Teams (DOJ).

FEMA, the agency responsible for coordinating federal responses to disasters, created the Federal Response Plan,* which identifies the essential emergency response functions of the 27 participating federal departments and agencies, and the American Red Cross.[117] The 12 essential emergency response functions include communications, medical services, and search and rescue.[117] FEMA does not have its own response materials or equipment but does have emergency response professionals who advise and coordinate the requesters and providers of disaster relief. FEMA has coordinated successful regional relief efforts to hurricanes, earthquakes, tornadoes and volcanic eruptions; specific responses are described in the section on "Synthesis of Evidence About Regionalization of Emergency Trauma Care". FEMA has four main responsibilities for disaster preparedness: preparedness, response, recovery, and mitigation.[117] Since the September 11th attack, FEMA has been designated as the lead agency for incident management.[118]

Figure 4. Regions as Definined by FEMA, HHS, HRSA, and Others

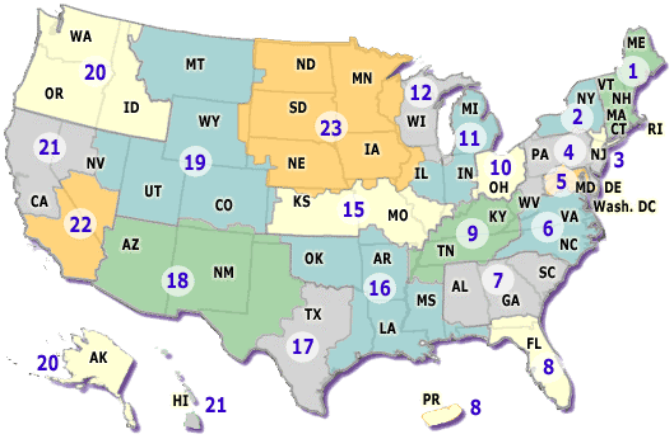


This map is publicly available. [119]

Regionalization of the Department of Homeland Security. At the time of writing this Report, the organization of Department of Homeland Security is underway. Once this reorganization is completed, it is expected that Department of Homeland Security will have a significant role to play in a regionalized response to bioterrorism. Currently, Department of

*The Federal Response Plan will soon be replaced by the National Response Plan which will utilize the National Incident Management System.

Figure 5. The 23 VA Veterans Integrated Service Networks



This map is publicly available [136]

Bioterrorism Preparedness Programs Sponsored by the Department of Defense

The DoD has sponsored several programs that translate its military expertise in preparedness and response to bioterrorism for civilian use. We direct interested readers to a recent evaluation by the U.S. General Office of Accounting of federally sponsored information technologies that could be used during a bioterrorism response (including several sponsored at least in part by the DoD).[120] This section briefly describes two military programs that would likely play a key role during a regionalized civilian response.

National Guard. During a bioterrorism event or other disaster, governors can mobilize the Army and Air National Guards of their state. Often these guardsmen and women provide security, medical treatment, debris clearing, transportation, shelter construction, and other services.[146-148] Under mutual aid agreements (described in greater detail in the "Synthesis of Evidence About Regionalization of Emergency Trauma Care" section), governors can also direct the use of their state National Guard units in a neighboring state. If the magnitude of the disaster has exceeded the capacity of local responders and state's National Guard, the governor can request federal assistance from the President of the United States.[146] Depending on the type of support required, FEMA, as coordinator of all federal assistance through the Federal Response Plan, may send active U.S. military forces to provide disaster relief.

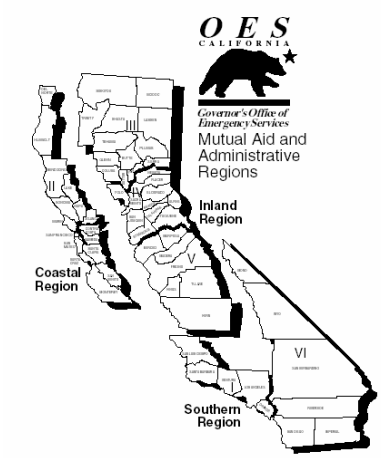
Emergency response decisionmakers (such as the head of each state's National Guard and governor) differ with respect to the role that they envision for the National Guard during a bioterrorism response. For example, the DoD has developed National Guard Weapons of Mass Destruction Civil Support Teams* to "assist local and state authorities in assessing the situation surrounding a weapons of mass destruction emergency; advise these authorities regarding appropriate actions; and facilitate requests for assistance to expedite the arrival of additional state

*National Guard Weapons of Mass Destruction Civil Support teams were formerly known as Rapid Assessment and Initial Detection (RAID) teams.

disaster becomes too large for a single area to manage alone or if a disaster encompasses multiple regions.

Having started as a statewide agreement among California fire and law enforcement agencies in the 1950s (Figure 6), statewide mutual aid systems now exist in many U.S. states.[438] Under mutual aid, local jurisdictions who expect to exhaust their own resources call on neighboring jurisdictions for assistance, according to mutually agreed upon rules for deployment and reimbursement. If the resources of a mutual aid region are expected to be overwhelmed, the region may also request state assistance. Several states have developed information systems that link members of the mutual aid regions. For example, California's Response Information Management System (RIMS) is a secure Web-based system (with access limited by user type) designed to coordinate and manage the State's response to disasters and emergencies.[502*]

Figure 6. Office of Emergency Services Mutual Aid and Administrative Regions



Map publicly available. [450]

Whereas mutual aid agreements are typically within states, neighboring states have developed regional agreements for disaster management (particularly important for states like Tennessee with multiple neighboring states). In 1992, the 19 members of the Southern Governors' Association, responding to the massive destruction caused by Hurricane Andrew in Florida and Louisiana, developed the Emergency Management Assistance Compact.[447, 448] The design of the Emergency Management Assistance Compact was complicated by the heterogeneity in participating states' constitutional and statutory laws. Party states independently resolved legal questions associated with the compact such as "whether a governor, absent specific statutory authorization, had the power to grant good faith immunity to relief workers from another state or to spend money out of state on interstate assistance."[447] The Emergency Management Assistance Compact has been highly effective, and since being

[*] An example of a mutual aid disaster response that could have been facilitated by more robust information management occurred following the 1989 Loma Prieta earthquake in the San Francisco Bay Area. Three counties (Marin, San Mateo, and Santa Clara) sent ambulances to San Francisco County in response to a mutual aid request, increasing San Francisco's ambulance capacity by 300%. However, radio frequencies used by these three ambulance organizations were not compatible, so dispatch centers were unable to track all units under their control. The result was that some ambulances idled, awaiting instructions, while others struggled to respond to multiple calls simultaneously.[478]

implement it).[461, 462] The system continues to be developed, and may benefit from providing more specific alerts to localities rather than issuing a warning for the nation as a whole (thus avoiding unnecessary spending by localities unaffected by the perceived threat), and from providing responders with more information about appropriate measures to take in response to a given threat.[458]

Figure 7. Homeland Security Advisory System

Figure publicly available.[464]

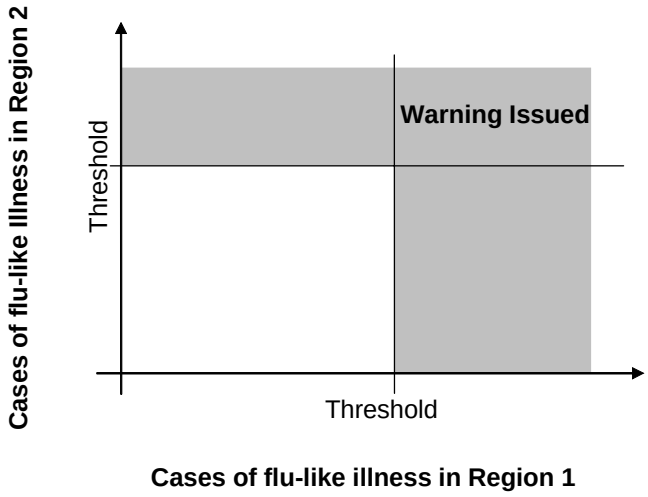
During an emergency, the public can also receive information via disaster-specific media channels. After the 1994 Northridge earthquake, victims were kept updated by an extensive FEMA media effort that included "reports, memos, summaries and updates."[463] Six days after the earthquake, FEMA established the Recovery Channel, which was shown by local television stations and in disaster response centers such as shelters and disaster relief application centers. The following week, FEMA began publishing the Recovery Times, a newsletter with specific information for victims, updating them about the status of the recovery and providing information about where and how to apply for assistance.[463]

Volume-Outcome Associations. The included articles support the concept that increased disaster response experience is associated with better response outcomes.[486] After the 1989 Loma Prieta earthquake, residents of one community who had responded to many disasters, including mudslides and wildfires, contributed significantly to a high-quality response.[486] The ongoing risk of natural disasters increased the experience of local responders and compelled the community to plan and participate in disaster training exercises.[486]

Conversely, lack of experience has negatively impacted disaster responses. For example, during the 1990 Texas floods, one community's Red Cross chapter had only a single paid employee who was relatively new to the job and had no experience planning for or responding to disasters.[486] As a result, the quality of the local response was inadequate, prompting deployment

Figure 8 illustrates the detection thresholds for two regions. The number of cases of flu-like illness for Region 1 is plotted on the *x*-axis and the number of cases for Region 2 is plotted on the *y*-axis. For each of the two regions we illustrate the threshold above which a warning will be issued indicating an unexpected peak in cases of flu-like illness. The entire shaded area in Figure 8 represents the numbers of case reports from the regions that would cause a warning to be issued.

Figure 8. Thresholds for Detection of Outbreaks in Two Regions



When data from two regions are pooled, the warning thresholds may need to be modified to prevent an increase in the probability of false positives. This situation is illustrated in Figure 9. A simple way to pool data is to calculate the sum of cases in both regions. Figure 9 shows a diagonal line that represents a threshold for the pooled data. The space between the diagonal line and the individual thresholds (indicated by an asterisk) represents case reports in the two regions for which a warning would not be issued if data from the two regions were analyzed individually (unpooled) but a warning would be issued it the data were pooled (using the sum). If the thresholds for the two regions are not adjusted, then the use of pooled data will increase not only the probability of detecting an outbreak associated with bioterrorism but also the probability of a false positive. The overall probability of a false positive can be held constant by increasing the values of the individual thresholds. In Figure 9, the thresholds for Regions 1 and 2 have been increased so that the probability of exceeding either threshold decreases by an amount that offsets the increase in probability associated with using pooled data.