Chapter 4. Discussion

We must first succeed alone, that we may enjoy our success together.
—Henry David Thoreau[626]

Given the complexity and cost of training, staffing, equipping, and mobilizing an adequate bioterrorism response infrastructure, no single community can be expected to develop and maintain the necessary capacity for a large-scale bioterrorism response. Instead, regionalization may benefit some bioterrorism preparedness and response capabilities. Our extensive search of four literatures relevant to bioterrorism responses (medical, emergency management, supply chain and government documents) found that the response infrastructure for a bioterrorism event includes numerous agencies with regionalized organizational structures. However, most of these structures have been developed independently and efforts to coordinate them are underway but not yet widespread. Specifically, the Department of Homeland Security, which has oversight and coordination responsibilities for many of the agencies that would contribute to a regionalized bioterrorism response is currently reorganizing its regional structure.

Our literature review provides six key results about regionalization of services for bioterrorism preparedness and response. First, there have been very few evaluations of whether regionalization has benefited a particular response organization or task. Evaluations of regionalization were essentially limited to those of trauma care systems, which demonstrated significant improvements in both clinical and process outcomes after regionalization. These improvements were largely attributed to concentrating specialized trauma services in pre-designated hospitals. Efforts to develop a regionalized infrastructure for bioterrorism responses will likely benefit from careful evaluations of the numerous tasks involved in a bioterrorism response and the alternative strategies for providing the necessary resources to perform these tasks.

Second, regionalization has benefited disaster responses. Our review of the responses to natural disasters such as hurricanes, earthquakes, and wildfires and manmade disasters such as the destruction of the Alfred P. Murrah Federal Building in Oklahoma City and the terrorist attacks of September 11, 2001 emphasize that during large-scale disasters, local response capacity can be quickly overwhelmed. The key method of organizing regionalized disaster responses is mutual aid agreements. These agreements provide the necessary surge capacity when health services, firefighting, law enforcement and other essential services are overwhelmed in local jurisdictions. The Emergency Management Assistance Compact has been adopted by all states and U.S. territories except for Hawaii and California (which has longstanding mutual aid agreements in place). The elements of successful mutual aid agreements include pre-event ratification of legislation by all signatories to resolve issues of compensation, liability, and insurance and uniform information systems to track needs and resources. Efforts are ongoing to expand existing mutual aid agreements for bioterrorism responses. Specifically, bioterrorism responses are likely to benefit from mutual aid agreements that are uniform across the United States, that include agreements with neighboring regions of Mexico and Canada, and that provide surge capacity for public health services.

Third, regionalization efforts have successfully expanded surge capacity for laboratory services. Our review of the literature describing the response to SARS and the 2001 anthrax

attacks highlighted the ability of the regionalized networks of public health and research laboratories to rapidly expand surge capacity for pathogen identification and testing of clinical and environmental samples. During the anthrax attacks, the Laboratory Response Network successfully provided laboratory surge capacity. Whether this Network would be able to respond as well to a larger bioterrorism event remains untested.

Fourth, information technologies facilitate accurate determination of response needs and available resources, effective application of the chain of command, communication among responders and with the public, and surveillance. Our review of evaluations of supply chains emphasized the importance of accurate information for coordination of all elements of the supply chain. Additionally, they demonstrated that investments in information technologies often resulted in net cost savings for the supply chain while improving customer service. Conversely, the disaster response literature provided examples of how inadequate information infrastructures led to delays in responses. Regionalization of bioterrorism preparedness and response efforts will likely benefit from careful consideration of the information technologies that can facilitate sharing of information by different response organizations and by responders at local and regional levels.

Fifth, local personnel are the first to respond and typically comprise a considerable proportion of the work force during an emergency response. The disaster literature emphasizes that local responders are often at great risk of personal injury during a response. Our literature review emphasizes three considerations for preparedness planning efforts to enhance the capacity of local responders. First, because local responders will always be the first on a scene during an emergency, bioterrorism responses may benefit from first responder training that emphasizes personal safety, triage, diagnosis, and outbreak management tasks. Second, because local responders with training in bioterrorism preparedness may participate in more than one response organization, careful accounting of response personnel may avoid the problems associated with double counting of responders. Third, particularly during responses to emerging infectious diseases or communicable bioterrorism events, strategies to protect first responders and their families may be essential to maintaining an adequate work force.

Finally, few included articles specifically articulated lessons learned from their bioterrorism-related preparedness or response experiences. Our review of government documents, particularly responses of military personnel, found that organizational commitment is a key factor in implementing a ‘lessons learned’ approach to ensuring that knowledge gained from both good and bad experiences is maintained in institutional memory. Plans to regionalize services for a response to a large-scale bioterrorism event could benefit from the experiences of responses to small bioterrorism events and relevant naturally occurring outbreaks if the lessons learned from these experiences were documented and used to improve planning efforts. Given the complexity of a bioterrorism response, the iterative application of lessons learned from one experience to the next requires commitment from all relevant response organizations to institutionalize a ‘lessons learned’ approach.

Our review of the supply chain literature yielded two results. First, recognizing that several key components of a response to large-scale bioterrorism are essentially supply chain management issues (e.g., purchasing, inventorying, and distributing relevant supplies), we used six criteria commonly applied to evaluations of traditional supply chains to evaluate the literature about the bioterrorism response supply chain. These evaluations include network design, inventory management, postponement and modularization, supply chain coordination and management of incentives, and management of information. They supplement the evaluation

criteria derived from other relevant literatures and serve as a framework that can be applied to future evaluations of bioterrorism preparedness and response systems. Second, there is scant evidence about the incentives of bioterrorism response personnel and organizations. The complexity of a large-scale bioterrorism event suggests that coordination of such a response may benefit from a careful pre-event evaluation and from attempts to align the incentives of relevant response organizations.

We found no evidence about regionalization of two essential components of bioterrorism preparedness and response: surveillance and the timely delivery of medical supplies for prophylaxis and treatment. To address these significant gaps in the literature, we created two simulation models. The preliminary results of our surveillance model suggest that whereas large outbreaks can be relatively easy to detect using either unpooled or pooled (i.e., regionalized) data analysis methods; small outbreaks can be difficult to detect by both methods. Additionally, we found that pooling strategies may improve detection capabilities but the circumstances under which pooling strategies are consistently more effective or cost effective than using unpooled data, remain poorly characterized.

Our inventory management simulation model yielded three interesting results. First, we found that the mortality associated with anthrax bioterrorism may be highly sensitive to the demand for prophylactic antibiotics. This is a critical finding given that for many types of bioterrorism responses, it will be difficult to determine whether an individual has been exposed to the biothreat agent. Second, for a large-scale bioterrorism event, strategies that deliver multiple Push Packs until the regional Vendor Managed Inventory has been delivered may reduce mortality. We plan future analyses to evaluate other inventory-dependent strategies for delivering and dispensing antibiotics (e.g., dispensing short courses of antibiotics if the on-hand inventory is low or the demand is high). Finally, whereas our literature search found several references to local organizations purchasing and maintaining local inventories of pharmaceuticals and supplies for a bioterrorism response, our simulation model found that increasing the availability of local inventories may be cost effective only if the annual probability of attack is high.

Our conclusions are limited by quality of available evidence in two ways. First, very few of the included articles were evaluations of regionalization of bioterrorism-related services; rather, most were descriptions of responses to outbreaks or disasters. The design and implementation of rigorous evaluations of regionalization of bioterrorism-related services may be technically difficult. However, bioterrorism preparedness planning efforts would likely benefit from detailed evaluations of various strategies to regionalize each of the heterogeneous tasks required of a bioterrorism response. Second, we found little evidence regarding regionalization of bioterrorism preparedness for special populations such as children, pregnant women, the elderly, and the disabled. Recent Census data indicates that nearly 130 million people in the United States can be considered a member of one or more “special populations.” Without information about bioterrorism response services for them, policy makers are limited in their ability to specifically plan for the needs of these vulnerable populations during a bioterrorism response.

We conclude that regionalization is likely to benefit elements of a bioterrorism response including the provision of surge capacity in essential response services such as triage, the provision of medical care, distribution and dispensing of prophylactic therapies, outbreak investigation, security management, and emergency management. Additionally, regionalization is likely to be a cost effective strategy for developing teams of trained response personnel and maintaining inventories of response equipment. There are numerous response organizations with

regionalized infrastructures that will serve key functions during a large-scale bioterrorism response. Coordination of these organizations may benefit from implementation of information management strategies and pre-event agreements that specify response roles, remuneration, and chain of command.

Future Research

As we noted, despite the large number of studies and articles we reviewed, we found very few evaluations of systems relevant to bioterrorism preparedness, and even fewer evaluations of the regionalization of a system relevant to bioterrorism preparedness. Future research is needed to fill this gap in the literature. Specifically, evaluations are needed for a better understanding of the costs and benefits of regionalization of surveillance, inventory management and distribution systems, and information management.

Because of the challenges of performing comprehensive evaluations of bioterrorism-relevant responses, modeling may be an effective means of supplementing this evaluative evidence. Specifically, future modeling efforts might investigate the costs and benefits of various strategies for regionalizing or pooling surveillance data (e.g., determining how pooling of surveillance data changes the surveillance system's sensitivity, specificity, and timeliness). Additionally, simulation models may evaluate the costs and benefits of strategies of inventory management and distribution for a communicable bioterrorism outbreak such as smallpox. Such a model would likely require the evaluation of dispensing strategies like door-to-door, postal-type distribution to avoid contact between the exposed and infectious populations at dispensing sites.