Bioterrorism Preparedness in Public Health: Knowledge Needs for Robust Transformations

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The typical response of organizations dealing with external uncertainty is to develop strategies to adapt to the situation and focus on regaining a stable state. A crucial element of responding successfully to external uncertainties is to identify changes in knowledge needs within core organizational processes. This paper discusses the changing knowledge needs of public health organizations as they deal with the uncertainties unleashed by the challenge of bioterrorism preparedness.

Keywords: Knowledge Management, Change Management, Learning

The process of organizational change is often initiated in response to changes in the firm's external environment. There is consensus among organizational theorists and practitioners alike that change is now more recurrent, complex, and has greater levels of uncertainty than in the past (Sutcliff & Vogus, 2003). In response to these changes, most organizations tend to take calculated, coherent steps to adapt to the uncertainty and regain equilibrium (Chakravarthy, 1982). A critical aspect of responding to external uncertainties is to identify changes in knowledge needs within core organizational processes, acquire new knowledge, and reorganize existing knowledge to meet the unique requirements created by the change process. Public health organizations across the country are good examples of entities that have had to respond to enormous uncertainties and continuing volatility in their environments. This paper examines the significant reorientation forced on public health organizations since 2001 and the new knowledge needs that have emerged as they develop capabilities for bioterrorism preparedness.

Theoretical Framework

How well an organization responds to and emerges from situations characterized by uncertainty is based on both the environmental conditions and the organization's capabilities. It is now being argued that complexities in the external environment are becoming so intense, that the potential for sudden, crisis-level uncertainties to hit organizations has increased significantly (Sutcliff & Vogus, 2003). A significant body of literature has examined how organizations adapt to environmental uncertainties and changes (e.g., Chakravarthy, 1982; Jennings & Seaman, 1994; Tripsas & Gavetti, 2000). Adaptation is defined as the ability of the organization to survive the changes in its environment and there are three commonly accepted states of adaptation: unstable, stable and neutral (Chakravarthy, 1982). In an unstable state, the organization attempts to buffer itself from the changes in the environment; a stance of passivity in the face of external uncertainties. A more reactive strategy is found in stable state organizations. Responding to a changing environment, these organizations mobilize their resources to realign their strategies for adaptation. In the final category, the neutral state, organizations have proactively anticipated and prepared for environmental changes and hence are adequately equipped not only to ride out the flux but in some cases actually contribute towards changing the environment. While these three states of adaptation are considered viable means of coping with external uncertainties, Lengnick-Hall and Beck (2005) argued that this framework and others in adaptation research are limited to conditions where environmental changes transition from a state of uncertainty to a new equilibrium. They introduced the concept of *robust transformation*, defined as "a deliberately transient, episodic response to a new, yet fluid, environmental condition (p.742)." Robust transformations allow organizations to respond to complex changes in their environments with the assumption that external conditions will not reach a state of new equilibrium. According to Lengnick-Hall and Beck, robust transformations are characterized by four assumptions: (1) the organization focuses on the condition that forced the change, (2) there is emphasis on creating new solutions and responses, (3) organizational strategy and resources are focused on responding to the uncertainly and enhancing future viability, and (4) slack resources are used to develop flexibility and expanded response capabilities.

An example of an event that created significant uncertainties for organizations in one domain was the anthrax attacks of 2001. These intentional attacks of bioterrorism created a jolt for public health organizations across the country. The anthrax events not only exposed the inadequacies of the public health system, but also called into

question the core objectives of public health entities and their fundamental premises of how to achieve these objectives. The events of 2001 pushed many public health organizations into states of transformation, forcing them to respond rapidly to an environment made uncertain by the threat of bioterrorism. Lengnick-Hall and Beck (2005) suggested that robust transformations are relevant to situations that are either very temporary or undergoing continuous change. It can be argued that public health organizations are operating in an environment subject to continuous change. While the dramatic impact of the anthrax attacks and its repercussions on public health have somewhat reduced in intensity, continuing changes in the external environment materialize from a variety of factors: variations in funding; evolving standards for information exchange and reporting within and between agencies; intense scrutiny of public health operations from both local and federal levels; geo-political events that focus attention on public health practices; and the ever present threat of biological or other types of terrorism. In addition, public health organizations have to address the relentless challenges of dealing with cyclical outbreaks of well-known diseases (e.g. Influenza, West Nile Virus), the sudden outbreaks of smaller, unexpected diseases, and more significantly, the looming threat of less known diseases such as the Avian Flu.

Reorienting an organization in such a fluid environment requires comprehensive strategic decisions. Implementing these strategies require changes to the everyday operations and routines of the organization: changes that often require new knowledge to be acquired, disseminated and deployed by individuals engaged in these processes. When an organization is forced to respond to dynamic external factors, the knowledge needs of core work processes and practices often undergo a transformation. There is a resulting impact on individuals and work groups—what they know, how they apply their knowledge to everyday work practices, how they learn, and how they process and store new knowledge in the context of their work. However, the relationship between organizational change and the impact of changing knowledge needs within the organization has been inadequately examined and understood. With the failure rate of organizational change initiatives being as high as seventy per cent (Beer & Nohria, 2000), the impact of external changes to individual and organizational knowledge needs be adequately identified and addressed.

Since the early 1990's, knowledge has been acknowledged as the most valuable asset to organizations (Davenport & Prusak, 1998) and a resource that is critical to organizational success (Leonard-Barton, 1995; Nonaka & Takeuchi, 1995). According to the Knowledge-Based View (KBV) of the firm, knowledge-based resources that are socially complex and inimitable are the major determinants of sustained competitive advantage and corporate performance (Kogut & Zander, 1992; Spender, 1998). Knowledge in organizations is both held by individuals (Brown & Woodland, 1999) and embedded in everyday operations, routines and norms (Lam, 2000). It is therefore to be expected that any strategic reorientation of the organization would impact individuals and the work processes they engage in; requiring the acquisition of new knowledge and the reorientation of existing knowledge. Despite its importance, understanding and articulating the changing knowledge needs of an organization as it responds to external uncertainties is challenging. Tacit knowledge that is often personal, and the 'know-how' that is embedded in routines and social practices, defy attempts at articulation and measurement (Brown & Duguid, 2001). Even when knowledge is explicit, it may not be readily accessible and reframing knowledge needs in the context of specific change situations and strategies might continue to remain a challenge for actors in the organization. One approach to addressing the difficulties of studying changing knowledge needs when an organization is in flux is to first understand the context in which the change is taking place followed by a close examination of the critical processes that are impacted by the change. Therefore, in this paper, the context of bioterrorism preparedness in public health is presented first followed by a more comprehensive look at the core bioterrorism surveillance and response processes and the resulting changes in knowledge needs that are required for a robust transformation.

The Need for Robust Transformations in Public Health

Public health organizations are at the forefront of the response to a bioterrorism event. Not only are they critical to identifying the biological agent and containing its spread, but are also entrusted with responding to the long term health concerns of the community resulting from such an event. Responding to the spread of a toxic biological agent requires expeditious and accurate decision making, the absence of which could have potentially catastrophic consequences to the local community. Additionally, the intentionality of a bioterrorism attack adds increasing levels of complexity to the surveillance function, thrusting public health personnel into new roles of investigating and identifying the perpetrators of the event. Since 2001, public health organizations are operating in a constantly evolving external environment, having to deal with uncertainties and challenges that were relatively non-existent prior to this period. Responding appropriately to these challenges—achieving bioterrorism preparedness—thus represents a significant reorientation of the mission and fundamental premises of operation for public health organizations.

The core function of public health organizations is epidemiological surveillance. Epidemiology is the scientific discipline of studying the incidence, dispersion, and containment of disease in a population and the factors affecting the progression and natural history of diseases (Beaglehole & Kjellström, 1993). Traditionally, public health organizations, through their surveillance mechanisms, were set up to identify and control the spread of naturally occurring diseases. In typical cases, information about the potential outbreak of a disease would be reported by agents within the community such as physicians, school nurses, nursing home attendants, and concerned individuals. Epidemiologists would then investigate the situation and implement a response strategy based on the specific disease. Public health organizations also engage in analyzing historical data to identify patterns of disease development to build strategies of response to contain the spread of known agents. However, the resources available to public health organizations to engage in these functions proved to be inadequate for bioterrorism preparedness. Epidemiological surveillance for bioterrorism preparedness thrust individuals into roles for which they had neither an adequate knowledge base nor sufficient experience. Planning for bioterrorism preparedness disrupted the everyday operations of surveillance staff, stretched the resources and capacities of individuals and organizations. Furthermore, it forced public health organizations to consider radical transformation in order to be effective in the future.

If organizations are to deal effectively with radically changed circumstances, they not only need to reexamine themselves in light of the new external realities but also launch responses to this change that move away from traditional routines and practices (Lengnick-Hall & Beck, 2005). Suitable responses to radical uncertainties would be creative, often counterintuitive, and would be tailor-made to the specifics of the emerging situation (Meyer, 1982). Epidemiologists and others involved in surveillance would need to acquire new knowledge and redirect their experience and expertise into developing new processes and protocols that would deploy in the event of an attack. Most importantly, public health personnel would have to reorient themselves to the new mission of their organizations and redefine their own roles, skill sets and expertise in order to achieve a robust transformation. These issues facing public health organizations can be framed through the lenses of many different fields. However, the key challenges of acquiring know-what and know-how (learning), deploying this knowledge within the organization (performance management) and building interfaces between individuals, groups and organizational systems and managing change by addressing culture and leadership issues (organization development) are consistent with the goals and practices of the Human Resource Development area.

Changing Knowledge Needs for Bioterrorism Preparedness

The following section examines in detail the new knowledge requirements for public health surveillance and how the field of HRD can potentially contribute to bioterrorism preparedness.

Knowledge of biological agents and their impact: Knowledge in organizations, both individual and collective, has been divided into two broad categories: explicit and tacit (Nonaka & Takeuchi, 1995; von Hippel; 1998). For those involved in public health surveillance capacities, core functional knowledge (tacit and explicit) includes that of diseases, how to detect and contain outbreaks, and how to analyze captured data to identify patterns in disease outbreaks and develop strategies to combat these diseases. Various aspects of this knowledge base exist as both know-what and know-how. Know-what refers to information based, task related knowledge that is often easily codified and stored within the organization (Lowendahl, Revang, & Fosstenlokken, 2001). Know-what for epidemiologists constitutes knowledge of various diseases and their impact in the event of an outbreak. In the context of bioterrorism preparedness, the process of converting surveillance data to public health intelligence involves a demanding process of new knowledge acquisition for all the individuals involved. Surveillance personnel now have to be familiar with a variety of biological agents, be able to recognize how these agents can be dispersed within a community, and the remedies that need to be initiated for each type of agent. Surveillance personnel also need to be able to distinguish a real attack from a hoax, i.e. be able to identify a real biological agent from harmless materials that may be similar in nature. An additional challenge for bioterrorism preparedness is that new information about biological agents and how these agents can be weaponized is being released quite regularly. According to Lengnick-Hall and Beck (2005), robust transformations are characterized by a focus on the conditions that created changes in the environment and the ability to develop flexible yet robust strategies to address these changes. Therefore, among the changing knowledge needs for public health surveillance is the ability to acquire know-what specific to biological agents that can be weaponized and their impact to the community in the event of an attack.

Expanding know-how to deal with large-scale emergencies. Along with know-what related to bioterrorism events, it is also critical that epidemiologists—who would be the first responders from public health—acquire the required know-how about preparing for and managing a large public health emergency. Von Hippel defined know-how as "the accumulated practical skill or expertise that allows one to do something smoothly and efficiently"

(1988, p. 629). While experienced epidemiologists have the expertise to deal with disease outbreaks, very few disease outbreaks become large-scale emergencies and posses the characteristics of a bioterrorism event. For bioterrorism preparedness, epidemiologists need know-how regarding: (a) critical decision making in a large-scale emergency, (b) investigating and containing the outbreak (c) dealing with uncertainty and inadequate information, and (d) addressing the public's concerns. Asymmetries of information and the volatility of the situation in a terrorism event demand decision-makers who can respond rapidly to detect and contain the spread of the agent. In such situations where poor decisions could lead to mass injuries and casualties, the quality of decision-makers and the knowledge they bring with them can make a considerable difference to both the short and long term outcomes of an attack. A critical knowledge need of public health organizations is to develop adequate levels of know-how and maintain a core pool of expertise in emergency response and management.

Information, as it is used for any type of surveillance is defined by two characteristics: knowledge specificity and time specificity (Choudhury & Sampler, 1997). When its knowledge specificity is high, information can be acquired and used only by those individuals who have the specific knowledge base to make that information useful to the decision making process. High time specificity refers to information that loses its value if it is not acquired and used relatively soon after it originates. Both knowledge and time specificity are particularly relevant in the context of a bioterrorism event (Burton & Ipe, in press). Information with high knowledge specificity demands individuals with well-established expertise and skills in emergency management who can then respond appropriately to the information that reaches them. The availability of a large pool of tacit knowledge through employees with broad organizational and functional experience is likely to make a significant difference in response time and efficiency in a bioterrorism event. High time specificity results in the need for "just-in-time" knowledge requiring sophisticated information technology systems and networks to acquire, disseminate and use information in a timely manner. As a result, acquiring the know-how to deal with such an event means not only developing a pool of individuals with the necessary knowledge base and skills to interpret and react to new information but also investing in systems and structures that facilitate the flow of critical information and enhance decision making capacities within the organization during the emergency.

Training plays an imperative role in addressing gaps in organizational know-what and know-how. In order to address their changing knowledge needs, public health organizations have to develop a comprehensive training strategy that aligns with the bioterrorism preparedness goals of the organization. Such a strategy should include investing in learning opportunities such as structured on-the-job training, providing adequate resources for self-directed learners and creating a culture that facilitates continual learning. However, for training to be effective, the cycle of developing content, delivering it effectively, measuring results and retraining where necessary, has to be understood and executed successfully. Since the expertise and focus of surveillance specialists is the containment and prevention of public health outbreaks, in many cases, these professionals often lack the proficiency necessary to develop and design appropriate training and learning systems for their organizations. This presents an opportunity for HRD professionals and researchers whose education and experience can and should be brought to bear in assisting public health organizations prepare for and address their training and learning requirements.

Redirecting expertise within the organization. Organizations receive information from a variety of internal and external sources everyday that need to be interpreted adequately before it can be appropriately utilized to meet the needs of the entity (Daft & Weik, 1984). Analyzing, interpreting and utilizing information is the process of sensemaking—the means by which collective meaning is created over a period of time by groups as well as the organization as a whole (Dougherty et. al., 2000). Dealing with the fluid environment of bioterrorism preparedness requires constant reinterpretation of existing knowledge, routines and practices in the light of new information from the external environment. Significant changes to public health surveillance processes have to be orchestrated at strategic intervals and incremental adjustments to these changes have to be conducted quite constantly to keep up with the changes in the external environment. Achieving a robust transformation thus mandates individuals and groups in public health surveillance to redirect their knowledge and expertise to restructure and streamline existing routines, policies and practices.

Knowledge in organizations is characterized by embededness—it exists in routines that arise from the relationships between individuals, technologies, formal procedures and emerging processes (Badaracco, 1991; Zander & Kogut, 1995). According to Lengnick-Hall and Beck (2005), routines that absorb complexity are vital to robust transformations. Complexity absorption refers to an organization's ability to have enough capabilities and the flexibility required to deal effectively with emerging contingencies (Boisot & Child, 1999). For public health organizations, the routines that were sufficient to support traditional surveillance practices are inadequate when it comes to bioterrorism preparedness. New process and protocols to guide information creation, exchange and deployment both within the organization and with key external entities have to be designed, tested and maintained. This reorientation towards preparedness requires individuals and groups to reframe their existing knowledge and

capabilities to tackle unique features of bioterrorism preparedness. Redirecting knowledge internally would also mean that existing routines are examined critically for relevance and potential effectiveness in unconventional health emergencies such as an attack of bioterrorism. These processes of redirecting knowledge internally may appear superfluous to surveillance professionals whose focus is on the everyday threats to public health within a community. In order to institutionalize these practices, it is imperative that public health organizations build these processes into their performance management systems. The vast body of research that supports theories and practices related to performance management should be utilized to design adequate evaluation and reward mechanisms that support not just bioterrorism preparedness but also the long-term goals of these organizations.

Cultivating and maintaining the information supply chain. Traditionally, epidemiologists in public health organizations had informal and formal relationships with hospitals, laboratories, schools and child care centers within the community that allowed information exchange related to disease outbreaks. However bioterrorism preparedness requires public health organizations to be well connected with several other external agencies to assist in the detection and containment of biological agents. These agencies include police and fire departments who tend to be first responders during emergencies, agencies involved in investigations such as the FBI, and entities within the community such as retail and commercial centers. In the event of an attack, all or most of these agencies have to share information fairly constantly, securely, and in a timely manner to contain the release and spread of the agent. The need for secure channels that support information exchange creates an information supply chain, tying together a variety of entities that may otherwise be engaged in fairly diverse activities. It should be noted that the information supply chain being discussed here does not include communication between public health organizations and the general public, which constitutes a separate area called health communication, independently supported by a strong body of literature.

Research in the area of traditional supply chains has identified problems between entities across the supply chain that include information inadequacies and asymmetries, lack of timely information, and incompatibilities between information sharing systems (Christopher & Juttner, 2000; Lee, et al. 1997). These problems translate in nearly exact terms to the information supply chain required for bioterrorism preparedness. In addition to the issues related to the accuracy and adequacy of information, the challenge for public health organizations is to first establish relationships with key individuals in all the relevant entities in the information supply chain and then develop protocols for information exchange in an emergency. According to Laszlo (1996), organizations can gain critical knowledge through information networks that exist both within and between organizations. Strong networks between key individuals in the information supply chain create reliable information channels crucial to decision making in an emergency. Developing, strengthening, and maintaining this information supply chain thus becomes a critical knowledge need for bioterrorism preparedness. To do this, epidemiologists need to be aware of key resources both within public health organizations and in critical external entities. This knowledge of self and other resources tied to ones ability to function effectively is defined as transactive knowledge (Wegner, 1986).

Another knowledge challenge in developing the information supply chain is that of differing absorptive capacities across the chain. Szulanski (2000) defined absorptive capacity as the lack of shared context between senders and receivers of information rooted in incompatibility in language and cultural conventions. Each of the entities in the public health information supply chain operates using its own knowledge bases, characterized by unique procedures, practices, and norms of communication. Integrating these differences so that the information supply chain is effective in an emergency requires key individuals in each agency to contribute to building shared vocabularies, norms, systems and protocols. It requires all key individuals to pool their experience and skills to creating new knowledge around communication and decision-making during emergencies, realigning existing emergency plans for bioterrorism preparedness and creating new plans to address gaps in current plans.

Institutionalizing knowledge and maturing organizational memory. Information stored within organizations that is used to make everyday decisions is called organizational memory (Walsh & Ungson, 1991). According to Walsh and Ungson, memory resides in individuals, culture, transformation, structures and the ecology of the organization. Organizational memory contains experiences and information critical to the organization that is absolutely essential to future activities and decision making. However, in most organizations, core knowledge is located within select numbers of experienced professionals; much of this is tacit knowledge based on problem-solving and experience over the years. As a result, the knowledge pool created by well-trained and expert professionals serves as the basis for everyday operations and the foundation for future learning. Skilled professionals are also strategic assets of the organization, creating capabilities and resources that are specialized, hard to imitate and find (Amit & Shoemaker, 1993).While public health organizations have had a long history of dealing with disease outbreaks, bioterrorism preparedness, being a relatively new phenomenon, does not have deep institutionalized knowledge associated with it. A critical knowledge need is to institutionalize knowledge relating to bioterrorism preparedness so that the

organization does not find itself operating in a reactive mode from one event to another. Unlike other disease outbreaks that occur frequently, there have been just a few biological events in the nation over the last five years.

Despite the lack of opportunities to build organizational memory, knowledge related to biological agents and emergencies have to be institutionalized within public health organizations through adequate training of surveillance personnel, the retention of experts over extended periods of time, technology-based systems that capture and store critical information, and organizational structures and routines that are created and maintained for bioterrorism preparedness. The challenge for public health organizations is to develop cultures and strategies that support a reorientation of thinking both within the organization and in those organizations within the public health information supply chain. When an organization's structure, strategies, culture and processes are not aligned, performance is compromised (French & Bell, 1999). Managing the change towards a robust transformation requires vision and the commitment to investing in individuals and organizational systems that can deliver in a constantly changing environment.

Challenges to Achieving Robust Transformation

There is realization in the public health arena that achieving capabilities for bioterrorism preparedness will not only be relevant in the event of a terrorist attack but also prepare the organization to deal with any type of large-scale emergency. The transformation that public health organizations have to undergo, while initiated by the anthrax attacks of 2001, are now seen as a necessary growth phase in response to the systemic changes and constant uncertainties in the external environment. Nonetheless, the new knowledge needs imposed by bioterrorism preparedness generates considerable challenges for public health organizations:

- How to contend with the learning needs of individuals, groups and the organization as a whole while continuing to deal with everyday public health situations?
- How can existing resources be redirected to create and sustain systems and processes that lead to the acquisition of new know-what, know-how and institutionalized knowledge over a period of time?
- How to acquire capabilities for bioterrorism preparedness and ensure long-term viability while operating in an environment that is rife with uncertainties?

Robust transformations require creative solutions to meet the immediate changes in the external environment and robust strategies and processes that allow the entity to be viable in the long term (Lengnick-Hall &Beck, 2005). In order to respond rapidly and appropriately to the uncertainties in the environment, public health organizations find themselves on a steep learning curve, trying to acquire new levels of know-what and know-how. While knowledge resides in different forms and places within organizations, it is only people who can learn, and so individuals become the primary repository of both explicit and tacit knowledge (Lado & Wilson, 1994). However, for public health organizations, the ability to hire and maintain a highly qualified workforce over an extended period of time continues to be a challenge. The lack of an adequate cadre of individuals with the right kind of know-how leaves public health decision making vulnerable to errors and inefficiencies in the event of a biological attack and significantly impairs the organization's ability to achieve robust transformation. Shortages of employees exist across the spectrum of public health, but more significantly so with epidemiologists who are critical to bioterrorism surveillance and response (CSG, 2004). Furthermore, public health organizations are also unable to retain epidemiologists over a long period of time, the primary reasons being non-competitive salaries and a shortage of professionals (GAO, 2003). The lack of sufficient numbers of qualified personnel for everyday operations is also a significant roadblock to meeting training goals and diverting slack resources to work on developing emergency capabilities. Apart from addressing issues of adequate resources, challenges to meeting the new knowledge needs lie in technological and social barriers to knowledge sharing within public health organizations and between external entities that are critical to bioterrorism preparedness. While the search for solutions to assist public health organizations achieve a robust transformation is not limited exclusively to the HRD domain, the tools, practices and expertise from the field of HRD can and should be brought to bear to help public health organizations acquire and institutionalize the systems and practices that are required in this new knowledge environment. The push towards bioterrorism preparedness in the context of today's constantly evolving environment creates opportunities for HRD professionals and researchers to partner with public health organizations to build bridges between theory and practice and allow knowledge and change management initiatives to be informed by the vast body of theory and research that exists in this area. While the knowledge needs described in this paper represent a conceptual framework for addressing changes in public health organizations, there is great need for further research in this area to examine the role of an organization's structures, systems and human resources in the context of emergency preparedness, whether it is bioterrorism or any other type of emergency.

Conclusion

The knowledge needs of public health organizations for robust transformation span a broad spectrum from individualized personal knowledge on one end to codified, externally stored information on the other end. Knowledge needs identified in this paper also include knowledge that resides in organizational processes and the interfaces between individuals and organizational systems and structures. Each of these knowledge areas merits deeper examination and evaluation. The objective of this paper, however, is to identify and broadly examine the new knowledge requirements needed for public health organizations as they respond to a constantly changing external environment. Despite the many challenges that public health organizations face during the change process, this paper suggests that identifying and acting upon key knowledge needs is critical to ensuring that these organizations achieve robust transformations.

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