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If the Worst Happens: Five Strategies for Developing and Leveraging Information Technology-Enabled Disaster Response in Healthcare

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If the Worst Happens: Five Strategies for Developing and Leveraging Information Technology-Enabled Disaster Response in Healthcare

***Abstract*—Natural disasters, such as hurricanes, tornadoes, cyclones, earthquakes, volcanic eruptions, wildfires, and floods, can have a profound impact on healthcare by limiting healthcare providers' ability to effectively provide patient care in the affected areas and respond to myriad healthcare needs of the affected population. The situation can potentially be exacerbated if healthcare providers do not have effective mechanisms in place for disaster response. The response to hurricane Katrina, a category 3 hurricane that made landfall in August 2005 and affected several states in southwestern U.S., was a vivid example of how the lack of effective planning and responsiveness can affect healthcare services. In this article, based on an extensive case study, which included a careful assessment of information from various sources, of the Veterans Health Administration's (VHA) response to hurricane Katrina, we present five strategies for developing and leveraging information technology (IT) capabilities to effectively respond during natural disasters: (1) an integrated IT architecture; (2) a universal data repository; (3) web-based disaster coordination; (4) an IT-enabled disaster support system; and (5) standardized and integrated IT-enabled disaster response processes. We discuss how these strategies can effectively help healthcare providers manage continuity and offer quality of care during the time of natural disasters.**

***Index Terms*—disaster response, IT strategy, IT architecture, natural disaster, universal data repository**

I. Introduction

SINCE the dawn of human civilization, natural disasters, such as hurricanes, tornadoes, cyclones, earthquakes, volcanic eruptions, wildfires, and floods, have interrupted the course of civilization and in many cases put the very survival of human civilization in jeopardy. Even in recent years, deadly natural disasters, such as hurricane Katrina in the U.S. in 2005, earthquake and tsunami in Japan in 2011, cyclone Nargis in Myanmar in 2004, tsunami in Indian Ocean in 2004, have caused unbearable pain and sufferings to the local populations. While developing countries typically face major challenges with respect to responding to natural disasters because of the lack of resources, recent disasters in developed countries, such as the U.S. and Japan, have brought to light the fact that even developed nations find it challenging to respond to natural disasters [1], [2]. One of the major challenges is related to the difficulty in maintaining the quality of healthcare delivery in the aftermath of major natural disasters [1], [2]. For example, in the aftermath of Katrina in the U.S., the federal government, lawmakers, and healthcare agencies started to rethink and reevaluate the options and strategies to minimize the impact of such disasters on healthcare [1].

Although the lives of affected people in the region and elsewhere slowly return to normalcy, the imminent threat of such disasters in the future and questions about the effectiveness of different agencies, particularly healthcare providers, in handling such disasters is still being widely debated in the popular media. For instance, scientists have been predicting that a major earthquake will hit the San Francisco area in the next 4 to 5 years and federal authorities have openly acknowledged that the current mechanisms in place to manage the impacts of such large-scale disasters on healthcare are far from adequate. According to the Federal Response Plan, the federal operational procedure to be used for disasters and emergencies and protecting the lives and safety of the victims are the utmost priorities of disaster response (see http://www.dhs.gov for more details). Effective management of disaster responses will have substantial implications not only for the social and economic future of the affected area, but also for the long-term public health and spreading of diseases and epidemics.

Information technologies (ITs) have transformed our society in many ways [3], [4], [5]. Important economic sectors, such as healthcare, education, manufacturing, finance and banking, transportation, energy, telecommunications, retailing and military, are increasingly dependent on IT capabilities to achieve successful outcomes. While the important role of IT in the healthcare sector is generally recognized (e.g., [6]), it has been a focus of much discussion and debate, particularly after hurricane Katrina. The federal government, healthcare agencies, IT vendors, humanitarian organizations such as Red Cross [7], and even companies such as Wal-Mart have realized the importance of IT during disasters and have pledged increased investments in IT capabilities that will help respond to emergencies in more effective and efficient ways. The critical role of IT in the aftermath of disaster, terrorism, and war has also been underscored by scholars in the field of health informatics [8], [9], [10]. Consistent with their suggestions, we believe that leveraging IT capabilities during natural disasters can help healthcare providers and other related agencies substantially reduce the loss of lives and property, coordinate responses, report damages, track personnel movement, and deploy necessary resources immediately.

Based on a case study of the Veterans Health Administration's (VHA) IT-enabled disaster response during hurricane Katrina, we present five strategies to develop and leverage IT-enabled disaster response capabilities to effectively respond to the crisis created by a natural disaster. The VHA's effort during hurricane Katrina has shown that an effective IT

infrastructure can help reduce the loss of lives during natural disasters [11]. We have closely examined different events and organizational actions at the VHA during and after hurricane Katrina and use the lessons learned from the VHA to develop the strategies described in this paper. In the sections that follow, we first present the case of the VHA's IT-enabled disaster response. We then explicate the five strategies for developing and leveraging IT-enabled disaster response. We conclude with a discussion of how these strategies can help healthcare providers offer high quality patient care during the time of natural disasters.

II. Case Study: Veterans Health Administration (VHA)

We conducted an in-depth case study of the VHA's response to Katrina. We gathered data/information from multiple sources, including semi-structured interviews, documents provided by the organizations and the key informants, and other publicly available information (e.g., press releases, academic and trade press articles). We thoroughly analyzed the data to identify concepts and various activities related to the VHA's disaster response and management. We verified these concepts and activities with our key informants in order to ensure the accuracy of our interpretations and analysis.

A. Background

At the time of hurricane Katrina, the VHA operated one of the largest healthcare networks in the world with an annual budget of over $26 billion, 158 medical centers distributed in 21 regions across the country, 877 outpatient clinics, 137 nursing homes, 43 domiciliaries, 73 home care programs, 207 readjustment counseling centers, and various other facilities. It had 193,000 employees who served more than 5 million patients nationwide annually. The number of patients increased more than 100 percent between 1995 and 2005.[1]

The VHA's healthcare system was once known as one of the worst in the U.S. The entire system had deteriorated so badly by the early 1990s that Congress even considered disbanding it. However, in the late 1990s and early 2000s, the VHA had undergone a dramatic transformation and started to be considered one of the best healthcare providers in the nation and a leader in almost any healthcare performance metric. IT infrastructure and capabilities played a central role in the transformation process [12]. The VHA was touted to have the nation's best healthcare IT infrastructure and capabilities by several media outlets, such as the Washington Post and Wall Street Journal [13]. Business Week reported that the VHA has the most advanced electronic health record system and the most comprehensive healthcare IT architecture in the U.S. [14]. In 2006, the VHA received the prestigious *Innovations in American Government Award* presented by the Ash Institute for Democratic Governance and Innovation at Harvard University's John F. Kennedy School of Government for its IT systems.

B. The VHA's Response to Hurricane Katrina

It is important to note that the Department of Veterans Affairs (VA), the federal agency that support Veterans and manage the VHA, is responsible for assisting other federal agencies and the general public during emergencies according to an 1982 Act (i.e., The 1982 VA/Department of Defense Health Resources Sharing and Emergency Operation Act). Per this Act, the VA must respond to the range of emergencies and disasters through participation in the mitigation, preparedness, response, and recovery stages of emergency management. The VHA indeed has an Office of Emergency Management (OEM) that is responsible for assisting the agency to respond and manage emergencies and natural disaster through managing four phases of the emergency management cycle: preparedness, response, recovery, and mitigation/prevention. Because of such focus and history related to emergency responses at the VHA (see [15] for a recent review of the VA's emergency management), it was not surprising that the VHA responded effectively to Katrina.

The VHA Medical Center in New Orleans (VANW) served 39,310 patients, an average of more than 1,700 patients daily in July 2005. On August 29, 2005, within a few hours after hurricane Katrina made landfall, the VANW initiated rescue and evacuation of its patients. Like other healthcare providers in the affected region, the VANW lost power and communication with other VHA facilities were broken. By September 2, 2005, all 192 VHA inpatients and 367 staff and family members were evacuated and relocated to other VHA medical centers. While the IT systems at the VANW were shut down after August 29, 2005, all data current to that time were physically re-hosted from back-up tapes and integrated into the IT systems at Houston on September 2, 2005. By September 16, 2005, all VANW patient data were available nationwide through the Houston IT systems [11].

Patient records, including prescription and pharmacy data, were accessed at over 200 sites of care in 48 states and 2,300 displaced veterans with chronic medical conditions or in critical state were provided uninterrupted care within 3 weeks of hurricane Katrina landfall [11]. By the end of September 2005, 38,000 of the 39,310 patients served by the VANW were accounted for and their locations known. In contrast, the other non-veteran evacuees of New Orleans who needed medical attention were unable to get proper care that resulted in several deaths. Due to a lack of information about these evacuees, many hospitals around the country were forced to provide medical care without proper medical records that, in fact, resulted in aggravating the conditions of many patients. In the following section, we describe the five strategies that emerge from our close study of the VHA's activities that can help healthcare providers develop and leverage IT infrastructure and capabilities to effectively respond during natural disasters.

[1]The VHA is currently the largest integrated health care system in the U.S. consisting of 150 medical centers, nearly 1,400 community-based outpatient clinics, community living centers, vet centers and domiciliaries (http://www.va.gov/health/aboutVHA.asp). These healthcare facilities along with more than 53,000 independent licensed healthcare practitioners provide comprehensive care to more than 8.3 million veterans each year.

III. Strategies For IT-Enabled Disaster Response

In this section, we present five strategies for developing and implementing IT-enabled disaster response based on the VHA's response to hurricane Katrina. In identifying and elaborating these strategies, we examined the various activities that the VHA performed during and in the aftermath of hurricane Katrina. We also identified the impact of these activities on continuity and quality of care provided by the VHA.

A. Develop an Integrated IT Architecture

One of the key challenges that healthcare organizations face is to integrate heterogeneous IT systems developed by different vendors for different purposes and located in different geographic locations. Such integration is critical for facilitating accurate and reliable access to patient records. A 2005 report by the Commission of Systemic Interoperability, appointed by the President and the leaders of the Senate, note the lack of integrated and interoperable healthcare IT systems in the U.S. [16]. The report stated that only 17 percent of the U.S. physicians have access to integrated and interoperable electronic health records systems [16]. Surveys conducted by the Healthcare Information and Management Systems Society (HIMSS) indicated that only about 20 percent of the hospitals have integrated and interoperable health information systems [17, 18]. Lack of interoperability among IT systems was clearly identified as a major concern in the post-Katrina response efforts and several studies after hurricane Katrina have illustrated that that a majority of healthcare providers lack comprehensive and interoperable IT systems [19, 20]. In fact, the federal response document that was created in the aftermath of Katrina clearly noted the importance of interoperability and integration in the context of healthcare technology and communications [1].

To facilitate integration, there needs to be a common architectural platform that can provide seamless integration, standardization, and interoperability across the various IT systems. Through an integrated IT architecture, different IT systems will be able to communicate with each other using the same data format and communications standards.

Although there has been a recent explosion of a plethora of vendors and products into the healthcare IT market, a majority of these IT systems are too function-specific and often isolated from other systems both in connectivity and compatibility resulting in a chaotic and disorganized flow of information [21]. Each of these systems have independently improved patient record-keeping and safety. Yet, the lack of standardization and integration among the systems have made it difficult to adversely reduce errors, particularly during the time of a disaster. During natural disaster, it is important that data about the patients displaced is accessed by the nearest point-of-care to provide immediate medical care. However, even if the patients' data are available, it cannot be accessed by the point-of-care IT system, if the data format is not compatible with the system or if the point-of-care system cannot communicate with the system that originally stores the patients' data.

This was particularly evident during hurricane Katrina, as many hospitals had to provide medical care without the information about the patients. In order to overcome this, an interoperable IT architecture must be developed to ensure that clinical records are available virtually anywhere in the country and accessible through any healthcare IT system.

The VHA's experience during Katrina illustrates the benefits of having an integrated IT architecture that supports various healthcare processes through integration, standardization, and communication. Even though the VHA had/has many independent, geographically-dispersed IT systems that support patient records, drug records, care delivery, clinical management, care management, prescription management, billing management, and several other activities, these systems are based on the same architectural platform, known as VistA (Veterans Health Information Systems and Technology Architecture). One of the key architectural features of VistA is the Health Level 7 (HL7), an American National Standards Institute (ANSI) standard messaging protocol, that specifies the set of transactions and encoding rules for electronic data exchange between healthcare IT systems. This protocol enables all the VistA-based IT systems to exchange healthcare information with one another using the same data exchange standards. The Department of Veterans Affairs (VA) is currently implementing an integrated enterprise architecture—One VA Enterprise Architecture—that would integrate all the VA IT systems and provide seamless access to clinical and administrative data to key stakeholders—i.e., customers (e.g., patients and their family members), employees, top management, and suppliers. Figure 1 presents the logical model for the VA's enterprise architecture.

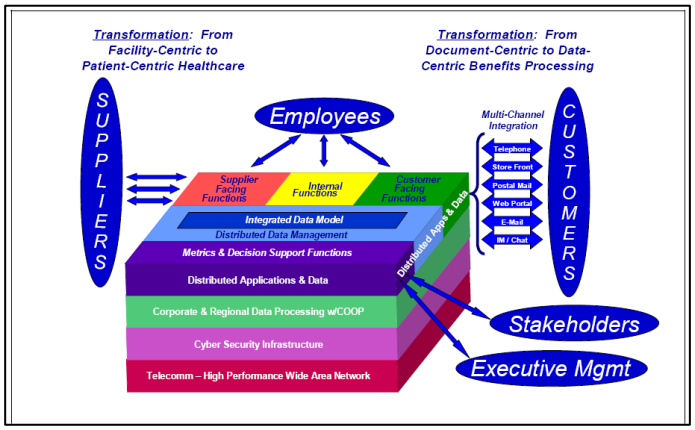

Fig. 1 Logical Model for the VA Enterprise Architecture.
Source: One-VA Enterprise Architecture Implementation Plan: FY 2003, Department of Veterans Affairs (http://www.oit.va.gov/)

B. Develop a Universal Data Repository

An integrated IT architecture, as described in strategy 1, can be more effective if healthcare providers can develop a universal data repository (UDR) to support the IT architecture. A UDR is important for two key reasons. First, as patients seek medical care at several locations, especially in times of natural disasters that lead to geographical displacement, it is not always possible to access the systems from other providers instantaneously. A UDR, however, stores data that are

constantly updated and a particular healthcare provider can access the repository to look at patients' information. Second, a UDR will have all the data about a patient that are extracted from the original source such that each time the patient's data need to be accessed, the clinician can connect to the repository instead of connecting to the source systems, thus reducing the burden placed on the original system.

We recommend three interrelated components of a UDR: (1) patient record repository; (2) drug record repository; and (3) clinical knowledge repository. During the time of a disaster, displaced individuals often evacuate from the disaster area without their medical records. Information regarding the patients, drugs, and medical conditions—e.g., chronic medical conditions, drugs and dosage, and acute medical emergencies due to the disaster—needs to be accessed in a timely and accurate manner. A patient record repository will have this information about the patients so that all necessary preventive and precautionary measures can be assessed at the point-of-care before providing medical care during natural disasters.

A drug record repository will have information regarding all the known prescription drugs, such as dosage, adverse reactions, side effects and usage directions, that can be matched with the patients' information so that effective medication can be prescribed to the patients. During the time of a disaster, clinicians and emergency medical workers treating displaced patients can use the drug repository to understand the patients' medical history and ascertain their immediate medical needs. Similarly, the drug repository could be used identify drug dosage and quantity, interactions and allergies, and be used by pharmacists to reproduce the patients' medication and prescription records. A clinical knowledge repository will have information about the specific illness, diseases, epidemics, conditions, procedures, drug-specific information, recommended drugs for specific medical conditions, nutrition and dietary guidelines, pharmacies to help in clinical decision making at the point-of-care. During the time of disasters, the lack of clean water and sanitation could possibly cause diseases and spread epidemics, such as typhoid and cholera. Similarly, an epidemic, such as bird flu and SARS, could affect a large area in a fairly short period of time. In both cases, a clinical knowledge repository would be able to ascertain the conditions of the epidemics and diseases, quarantine procedures, and medication required to cure the patients as well as manage and control the spreading of the epidemics and diseases.

In the VHA, the Health Data Repository (HDR) serves as an operational clinical repository—a collection of clinical information from VHA and non-VHA sources—to be used by clinicians and other personnel to facilitate longitudinal, patient-centric care. Data in the HDR are organized in a format supporting the delivery of care regardless of the physical location of a patient's clinical information. The HDR also provides additional benefits, such as providing information to support research and population analyses, facilitating patient access to data and sharing information across the VHA, and improving data quality and data security. Prior research has indeed suggested that one of the cornerstones of the VHA's disaster response was the use of patient tracking [15]. In fact, the patient tracking system in the VHA, the Computerized Patient Record System (CPRS), was credited with its success to help the VHA provide patient care to thousands of displaced Veterans.

Figure 2 presents a logical model of the VHA's HDR initiative. The figure shows that data from the HDR can be accessed by VHA medical centers across the country using various IT systems (e.g., web clients and VistA applications) and by external entities (e.g., Department of Defense—DoD).

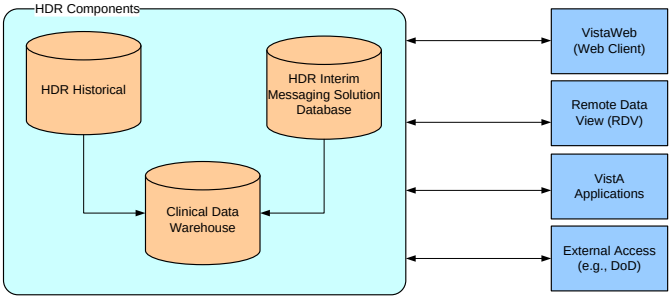

Fig. 2 The VHA's Health Data Repository (HDR) Initiatives.

C. Develop Web-based Communication and Coordination

Advances in Internet-based healthcare solutions have rendered many opportunities for not only delivering quality healthcare through the web, but also increasing access to health information. Web-based access to medical information has been making greater inroads into the healthcare landscape than ever before. However, as mentioned earlier, a lack of a common IT architecture for integrating and connecting healthcare IT systems has been slowing the progress toward online healthcare access. A web-based healthcare solution can provide robust and timely retrieval of patient data during disasters [10]. Our third suggested strategy is to develop web-based disaster coordination systems that include the management and delivery of patients and clinical records to all the institutions involved in disaster relief.

The VHA has implemented VistAWeb, a web-based remote data access system to access patients' records anywhere and anytime during a disaster. Network Health Exchange (NHE) is another system based on the VistA that provides clinicians quick and easy access to patients' information from any VHA medical facility where a patient has received care. NHE can access information concerning clinic visits, diagnoses, prescriptions, laboratory tests, radiology exams, and hospital admissions. It enables clinicians to request medical or pharmacy records for a patient from a single site or several sites. NHE uses predefined formats, thus requiring less input by the user and resulting in simpler, faster access to patient data. NHE also provides access to clinical information from other VHA medical centers, DoD sites, and the FDA through Remote Data Views (RDV). Patients' records pertinent to their allergic reactions, other signs and symptoms are currently being shared across the different systems and organizations. The VHA used VistaWeb extensively in the aftermath of Katrina to provide patient records to clinicians all over the country. Figure 3 shows a logical model of how VistaWeb access data from data sources

to provide accurate and timely data to the VHA facilities across the country.

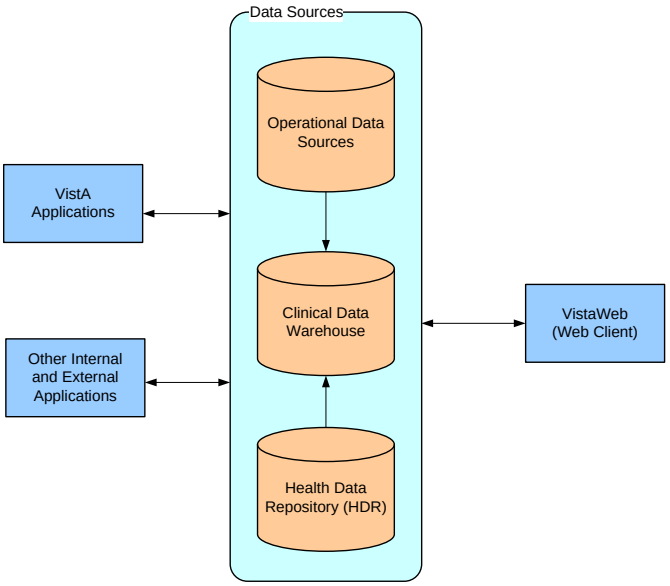

Fig. 3 The VHA's VistaWeb Logical Architecture.

D. *Develop IT-enabled Disaster Support Management System*

After the Katrina disaster, when scores of displaced evacuees lost their lives due to lack of timely and proper medical care, the federal government accelerated plans for disseminating patients, drugs and other clinical information for all the agencies and institutions involved in disaster management. Our fourth strategy suggests the need to develop an IT-enabled disaster support management that can serve to disseminate important information before, during, and after disasters so that effective medical care can be provided to displaced victims. An interoperable network of clinical knowledge is necessary to accelerate the process of integrating national and regional databases of important information to support and deliver the current knowledge to all involved in disaster planning, management, and relief at the point-of-care. Such a system can be extremely important in both planning for disasters and aftermath of disasters.

An IT-enabled disaster support system can immensely reduce the risk to public health from dangers, such as communicable diseases, epidemics, bloodborne pathogens, hazardous or unsafe conditions and other medical catastrophes, due to the impact of the disasters by providing essential information to different stakeholders (e.g., physicians, relief workers, humanitarian agencies) at the right time. Such a system can be incorporated with the disaster management and response processes such that individuals who are part of these processes can have access to this system to make better decisions. During the time of a disaster, it is absolutely necessary to alert policymakers, relief workers, hospitals, clinicians and patients immediately of any health hazards related to the disaster that has occurred. These systems should also be integrated with other IT systems from healthcare providers, public health agencies, relief agencies, research organizations, and the DoD systems on medical emergencies and threats, thereby giving disaster management personnel the information they need to react early. The IT systems at the VHA that are based on the VistA are integrated to provide such disaster management capabilities. Table 1 provides examples of disaster management decision support initiatives undertaken at the VHA to help dissemination information for better disaster preparedness.

TABLE 1
THE VHA DISASTER MANAGEMENT DECISION SUPPORT INITIATIVES

Clinical	Administrative
• Uncover patterns in infection control • Spreading of epidemics and diseases due to the impact of disasters • Historical data regarding outbreaks of diseases during earlier disasters • Enable public health/bio surveillance, and analysis of infectious disease outbreaks • Detect patterns of nosocomial infections (device-oriented; e.g., bloodstream infections, urinary tract infections) and antimicrobial resistance—using lab data • Implement predictive disease management: diabetes, cardiovascular disease, and asthma • Detect patterns of adverse drug events • Employees' and clinicians' exposure to bloodborne pathogens from needle sticks and sharps • Determine risk factors to a pre disposition to a disease; or predict occurrence of a disease; or behavior risk factor trends by age group and gender • Uncover patterns in patients admission for medical care • Identify potential targets for care and case management • Implement personalized medicine—integration of clinical genomic data • Availability of clinical resources such as drugs, medications, needle sticks, sharps, surgical devices, and emergency room resources • First-aid at the disaster areas and en-route to evacuation centers • Availability of pharmacies and pharmacies. • Predicting demand for chronic illness care, mental health, counseling, psychological services, child and women care • 24/7 resources to monitor health status indicators –e.g., vitals such as weight, blood glucose, blood pressure	• Identifying natural and man-made disaster prone areas • Disaster coordination • Forecast demand and resource requirements • Mobilization and Supply of relief materials • Tracking of materials and resources • Identifying places and sources of unrest (e.g., looting, killing) • Evacuation center occupancy management • Updating patient and clinical records • Detect claims fraud • Disaster relief utilization profiling • Projected traffic out of disaster areas and pockets of high-traffic clusters • Coordination of mobile medical centers and pharmacies during evacuation phase • Tracking and managing disaster coordination personnel • Evaluation of safety measures at all medical and evacuation centers. • Coordination of IT systems support teams • Recruitment of personnel and volunteers in disaster relief • Availability of clinicians, nurses, and other healthcare professionals • Coordination of emergency 911, ambulatory care, fire and rescue services, and relief organizations • Tracking discharge notes, progress summary notes, all transcribed notes, lab notes, surgical notes, radiology notes, e-mail, call center triage calls, and complaints • Training personnel for disaster management

E. Standardize and Integrate IT-enabled Disaster Response Processes

Effective disaster response requires coordinated and synchronized efforts by many different individuals and

functional units within a healthcare provider. These efforts constitute disaster response processes executed by healthcare providers during the time of disaster. In the aftermath of hurricane Katrina, it was evident that many healthcare providers in the affected region did not have effective disaster management processes enabled by IT [1], [11].

Our fifth strategy deals with standardization and integration of disaster response processes using IT capabilities and architecture (see strategy 1; [12]). We suggest that it is important for healthcare providers to develop a current understanding of existing disaster response processes and identify potential areas for improvement. In the absence of formal disaster response processes, healthcare providers need to develop these processes and integrate them with existing clinical and administrative business processes using IT capabilities, such as a centralized data management system. However, development and integration of disaster response process will not be sufficient for effective service delivery during natural disasters. Healthcare providers need to standardize the disaster response process in order to reduce variation, uncertainty, and ambiguity during process execution. The standardization requires clear guidelines for the orchestration of sequential activities performed within a process. Healthcare providers can leverage the capabilities of IT in the process of standardizing disaster response processes [22]. A standardized process requires accurate and timely information and clear guidelines on the flow of events. IT can provide required information and guide through the flow of events by giving notification and maintaining audit trail of events. Thus, when integrated with IT infrastructure and capabilities, the standardized and integrated disaster response processes can ensure continued healthcare services during the time of natural disaster.

The VHA's response during hurricane Katrina illustrates the importance of process standardization and integration with IT infrastructure and capabilities. The VHA's IT-enabled standard clinical processes and practices helped the seamless coordination of various service components, such as personnel tracking, doctors and staff tracking, patient tracking, pharmacies' medication stocking, access and management of patient, drug, clinical knowledge records, ambulatory care management, resource allocation, and tracking outbreaks of epidemics. While the city of New Orleans had difficulty tracking and coordinating emergency personnel, such as the police officers, FEMA officers, local administration personnel, hospital administration personnel, among others, for weeks, the VHA hospital could efficiently track and coordinate its staff to provide medical care at the highest level possible. Standardizing disaster response processes will ensure less variability, greater efficiency, and fewer errors during natural disasters. Every individual, functional unit, and external agency will know the procedures and processes to follow when providing critical medical care during such disasters.

IV. Concluding Remarks

The strategies suggested here are not a panacea to resolve the disaster response problems faced by healthcare providers. The events and failures following hurricane Katrina indicate that there is no easy fix to these problems [1]. There is a need for long-term planning, coordination, strategic investments, and involvement of many different agencies to develop a sustainable mechanism for responding to natural disasters. The implementation of new IT and IT-enabled processes requires such coordination from stakeholders who have competing objectives, particularly in healthcare organizations [23]. The strategies proposed in this article can help healthcare providers understand and appreciate the role of IT in disaster response processes and encourage them to develop effective IT infrastructure and capabilities to combat deadly service interruptions during natural disasters.

Although we focus on the role of IT in disaster response situations, we believe that the strategies suggested here can help improve the overall availability, continuity, and quality of healthcare in the U.S. and the world. For example, an integrated IT architecture can help improve the quality of healthcare services by providing seamless access to patient data, reducing errors in various clinical and business processes, and making clinical and business processes more efficient and less costly for healthcare providers. For example, a hospital can access records (i.e., medical history, procedures performed, laboratory results) of a patient who was not treated in that hospital before and make this information available to clinicians. This will help clinicians make informed decisions and order only those procedures that have not previously performed on a particular patient. In the same way, other strategies, such as universal data repository, web-based patient record access and standardization of processes, can also improve the quality of healthcare services in general.

IT-supported healthcare has become an important and critical issue in the management and delivery of healthcare products and services. However, as we have detailed in this article, the one area where the IT systems have not been fully utilized is in disaster response. Large-scale natural disasters have wreaked havoc in the past few years and the current IT systems lack the necessary infrastructure to deal with such disasters, particularly the healthcare challenges posed by the disasters. Based on a case study of the VHA's response during hurricane Katrina, we suggested five strategies for developing and leveraging IT-enabled disaster response for healthcare. We believe the strategies proposed in this article can be of value to the federal government, healthcare providers, emergency management agencies, physicians, and patients for better management of healthcare during emergency response situations.[*]

[*]The opinions and conclusions herein are the sole responsibility of the authors and do not in any way reflect the opinions of the VHA.

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