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BY SRINIVASAN VENKATRAMAN, HILLOL BALA,  
VISWANATH VENKATESH, AND JACK BATES

# Six Strategies for Electronic Medical Records Systems

THE INSTITUTE OF MEDICINE (IOM)<sup>a</sup> in 1999<sup>5</sup> shocked the nation by reporting that as much as 98,000 people die in hospitals every year due to medical errors. These errors are also said to cost hospitals as much as \$29 billion every year. Of the many reasons identified for the medical errors, one critical reason is the decentralized and fragmented nature of information related to patients, drugs, procedures, and clinical processes. IOM further reported that about three out of four errors could have been eliminated by better information systems to make drug and patient information readily available when needed. Over the past nine years, after the IOM report was published, the government and health care providers have recognized that an efficient information technology (IT) backbone is essential for safe and high-quality care<sup>11</sup> and cost savings.<sup>4</sup>

Recently, Electronic Medical Record (EMR) systems have emerged as a solution to providing timely and accurate information to support various health care needs. In 2005, President Bush created the Office of the National Coordinator for Health Information Technology (ONC) and proposed the creation of a comprehensive EMR of every American within the next decade. The Department of Health and Human Services<sup>10</sup> reported that hospitals spent about \$20 billion on IT in 2003 out of which about a third was spent on EMR systems. Thus, strategies to help the successful deployment of EMR are of great significance to the health care and IT industries.

The health care sector, despite its importance, is still behind most other industries such as retail, manufacturing, and financial services to leverage IT for operational and strategic purposes. Effective development and successful implementation of IT systems are critical in health care as these systems have direct implications for patient safety, mortality, and better quality of life. Here, we discuss several potential drawbacks of current EMR systems and offer six key strategies for development and improvement based on a case study of one of the largest health care providers in the nation—the Veterans Health Administration (VHA).

## Electronic Medical Records (EMR) Systems

EMR systems are automated clinical systems that generally include data related to medical history, patient demographics, clinicians' notes, drug information, electronic prescription, and diagnostic test orders.<sup>10</sup> There are many different types of EMR systems and the cost of implementing an EMR system depends on the functionality of the system and nature of health care services provided. Leapfrog Group, a national coalition of large health care providers, indicated

<sup>a</sup> The Institute of Medicine, established in 1970 under the charter of the National Academy of Sciences, provides advice related to health care to the nation's policymakers, healthcare providers, and the public.

that a 200-bed hospital can expect to spend up to \$7 million to implement an EMR system. It is estimated that the adoption of EMR systems could save hospitals \$142 to \$371 billion a year due to increased efficiency and reduced errors, while increasing social and other benefits.<sup>4</sup> In fact, EMR-based prevention and management of chronic diseases alone could produce \$80 to \$160 billion of savings a year. Further, due to EMR systems, the average annual national health care spending can be reduced by as much as \$813 billion<sup>4</sup> a year that in turn can lower health care costs for consumers. Some of the nation's largest hospitals have already initiated multi-million dollar investments in EMR systems. For example, the California-based Kaiser Permanente has spent about \$1.5 billion for EMR systems in 2005.<sup>3</sup>

Despite the known benefits of EMR systems, the current configuration of EMR systems do not even come remotely close to what can be considered optimal. While there are hundreds of vendors currently serving the EMR systems market, there is limited data standardization across these systems. Further, these systems are so fine-tuned and built for a specific function that integration with other systems (for example, computerized patient order entry systems [CPOE], automated drug dispensing systems [ADDS], and accounting/billing systems) becomes a nightmare. For every patient visit, prescription, medical, and billing orders have to be entered separately into each of these systems, thus duplicating records and increasing the chances of errors. While each of these systems have independently improved patient record-keeping and safety, the lack of standardization and integration among the systems have made it difficult to reduce medical errors.<sup>4</sup> Further, in some cases, different EMR systems are being used in different care functions within the same hospital. For example, a patient's records related to his or her urology-related problems are stored and managed separately from his or her cardiology-related problems. The use of an EMR system for a particular function eliminates the possibility of using the same system for a different function due to the lack of integration and data standardization, thus making health care services inefficient and costly.

### EMR Systems at the Veteran Health Administration (VHA)

The VHA's IT systems are considered today to be one of the best in the nation.<sup>1, 2, 6, 7, 9</sup> Some experts believe that the VHA has become an industry leader in safety and quality because of its high quality IT systems.<sup>9</sup> Specifically, IOM, in its report on health care IT,<sup>6</sup> indicated that the VHA's integrated suite of health care IT including its framework for using performance metrics to improve quality is one of the best in the nation. This is the same VHA, that, in the not too distant past, was considered dangerous, mistake-prone, and highly inefficient to the point where its very existence was questioned by lawmakers.<sup>9</sup> While there have been several reasons for the VHA's turnaround, one of the key reasons was their development and use of IT-based health care systems and processes. The VHA's IT systems are used for clinical care management, electronic prescription management, comprehensive patient and drug information management, complex decision support, and knowledge management.

The VHA renamed its operational applications known as the Decentralized Hospital Computer Program (DHCP) to the Veterans Health Information Systems and Technology Architecture (Vista) after reengineering the old system architecture in 1996.<sup>2</sup> There are 128 independent Vista systems across the VHA medical centers that store information pertaining to clinical, operational, administrative, and financial processes specific to a particular location. The Computerized Patient Record Systems (CPRS), a point-of-care system used by the physicians for data-entry and access, is integrated and interfaced through local Vista systems. As the veterans seek medical care at several VHA locations across the country, the VHA recently developed VistaWeb, a Web-based remote data view that provides integrated access to medical records. The VHA has also implemented several regional data warehouses that regularly update subsets of clinical and operational data extracted from the individual Vista systems at each of the VHA medical centers in the region. In 2005, the VHA began implementing a corporate data warehouse (CDW) that will serve as a centralized data repository of key clinical, administrative, and financial data for

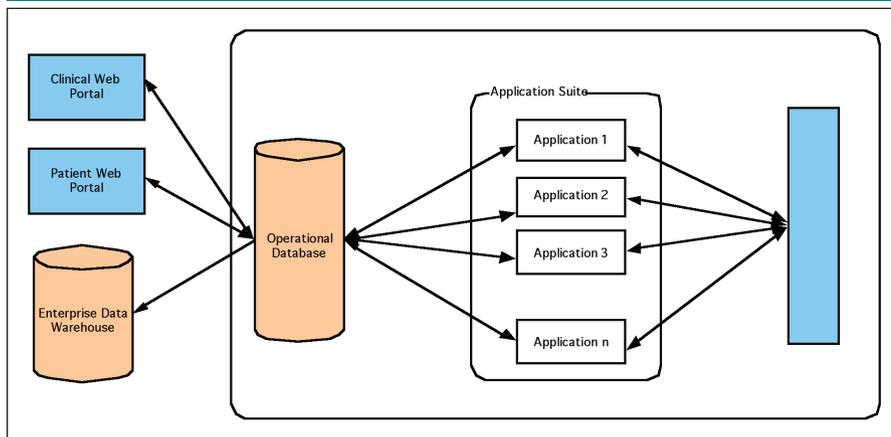
management and analytical research use. Overall, the IT systems of the VHA had far-reaching impact on the quality and efficiency of services provided to over 5 million veterans annually. The VHA recently received the prestigious *Innovations in American Government Award* presented by the Ash Institute for Democratic Governance and Innovation at Harvard University's John F. Kennedy School of Government for Vista.

**Six Strategies for Effective EMR Systems.** Based on our in-depth case study of the VHA's IT systems and architecture, we develop six strategies to help existing EMR systems and aid the development of new EMR systems. We expect that the implementation of these strategies will help health care providers develop and implement better IT systems and infrastructure to provide high quality services to their patients.

#### 1. Develop an integrated IT architecture to support EMR systems.

Several researchers have pointed out that, to substantially improve the benefits and reduce errors, all the systems (for example, CPOE) must be an integrated component of a more comprehensive health care information system.<sup>4</sup> The VHA proves that hospitals can get better results and efficient care through an integrated and organized health care IT system.<sup>1</sup> In Figure 1, we present the integrated IT framework that is used by the VHA. The core component of the framework is an application suite consisting of different operational applications integrated through a common operational database and an application interface. The common operational database and application interface is crucial because this will ensure standard data and interfaces for clinicians and other users. Also, this will reduce data redundancy and improve operational efficiency. Depending on the importance of different functional and operational areas, a health care provider may decide which applications to develop. The VHA has developed applications grouped into four categories: infrastructure, administrative, financial, and clinical applications.<sup>2</sup> There are more than 30 domestic and international health care organizations that have adopted one or more of these applications. The VHA has also developed two types of Web portals: one for the clinicians and the

**Figure 1. Healthcare IT Framework**



other for the patients. More information about these Web-based patient care services is provided later.

**2. Use clinical data exchange standards in EMR systems.**

The lack of efficient data exchange standards is a major barrier to the development of effective EMR systems. Patients' information should be portable to seamlessly transfer the information from one point of care to another. The limitation in the current EMR systems of using independent and separate files for one patient in multiple clinical settings is binding and significantly compromises the quality of care provided. While conversion of data to EMR is necessary, it is not sufficient to solve the portability problem. As EMR systems are often procured from different vendors, these systems may not be compatible with one another.

Unless EMR systems can communicate with other clinical IT systems, patient and drug information may not flow seamlessly from one clinical setting to the next and remain as independent and incompatible islands of data. Without an efficient system to accommodate clinicians' ability to exchange information with others, whether it is within the same hospital or across the country, medical information may not be readily available at the point of care, particularly during disasters and emergency response situations. In order to effectively overcome this problem, an interoperable system based on common standards and architecture must be developed. The ultimate goal of implementing clinical data exchange standards is to develop a comprehensive patient record that is available electronically virtually anywhere in the country

and accessible through any system. The ONC is developing a National Health Information Network (NHIN) to facilitate interoperability among several health care providers at both the regional and the national level.

**3. Align EMR systems with clinical and administrative processes.**

Having state-of-the-art EMR systems may not improve patient care, if the systems are not aligned with clinical and operational processes. Clinical processes refer to the interdependent and collaborative activities that are performed to provide effective and efficient patient care. Administrative processes refer to interdependent and collaborative activities related to operational and financial matters pertinent to patient care and organizational management. There are many examples of IT failure in health care organizations because of the lack of alignment between clinical practices and system features.<sup>8</sup> Another important issue is the organizational mandate for using the IT applications. For example, the VHA mandated the use of CPRS in 1999 and now almost all the VHA clinicians use CPRS.<sup>2</sup> The VHA developed several innovative applications that also help align clinical processes with technology. For example, VistA Imaging is an online multimedia application that integrates traditional medical chart information with a variety of medical images such as X-rays, pathology slides, cardiology motion views, wound photos, and pictures acquired through endoscopy, surgery, and eye exams, and scanned images of handwritten documents, diagrams, and outside medical reports. VistA Imaging serves as a bridge between technology and clinical

processes. The VHA also developed a Bar Code Medication Administration (BCMA) system to reduce inpatient medication errors by electronically validating and documenting medications and associated instructions for patients. It ensures that the patients receive the correct medication in the correct dose at the correct time and visually alerts staff when the proper parameters are not met. Thus, a successful alignment of clinical processes and IT is crucial for the success of EMR systems.

**4. Develop Web-based interface for EMR systems.**

Advances in Internet and Internet-based technologies have provided numerous opportunities not only for increased access to health information but also for delivering quality health care through the Web. Web-based delivery is gaining momentum among health care providers, but the efforts for an efficient online health care system are hampered by the lack of a common framework for integrating different health care providers' systems and the lack of security and privacy guidelines pertaining to patients' information. During hurricane Katrina, most hospitals in the affected areas had problems accessing patients' health care information. A Web-based solution provides robust and timely retrieval of patient data from any location. Our fourth strategy is to develop EMR systems that include the management and delivery of Web-based health care.

Due to the difficulties in accessing patient records, particularly during an emergency, the VHA developed VistAWeb, an Intranet Web application to remotely access patient information from VistA, Health Data Repository (HDR) databases, and the Department of Defense's (DoD) Clinical Health Data Repository database. VistAWeb provides a Web-based access called Remote Data Views (RDV) to the CPRS through the common VistA architecture. VistAWeb uses an n-tier architecture with distinct presentation, business process, and data tiers. While VistAWeb provides clinicians with remote access to patients' record anywhere anytime, they are not the only individuals who need greater access to patient information. Patients and their family members may also need to access EMRs and other clinical information. In 2002, more than 100

million Americans scouted the Web for a variety of health care needs.<sup>12</sup> Innovations in technology are emerging to give patients electronic access to their health record and the ability to gather specific information tailored to their illnesses, chronic conditions, and health characteristics. Individuals can maintain and manage their health information (and that of others for whom they are authorized) in a private, secure, and confidential environment. The VHA is currently in the process of implementing MyHealthVet, a personal health record management system, to effectively synthesize an abundance of health information and tailor it to patients' specific needs. As a part of MyHealthVet, the VHA has developed a secured online system called the Personal Health Journal that veterans can use to manage their health information and make well-informed health care decisions. The system provides veterans with an opportunity to play a more active role in their health care by giving them relevant information so they can make better decisions and also help reduce the cost of health care delivery.

#### **5. Develop enterprise data warehouse (EDW) and business intelligence systems and integrate with EMR systems.**

The VHA developed an EDW infrastructure to capture and process important health care data. The EDW architecture enables data from different operational systems including VistA to be loaded on to the warehouse through ETL (extraction, transformation, and loading) processes. Data marts are developed for different subject areas, such as outpatient encounters and pharmacy. Clinicians and other users can access the data through a common business intelligence and data analytic interface. The common interface powered by business intelligence and analytic tools present the vast amount of patient data accumulated over a long period of time in an aggregate fashion to understand long-term patterns, trajectories, and effectiveness of a certain procedure or medication. This improves patient care in two ways: clinicians can make better decisions; and the data from EDW can be used in medical research.

The VHA's plan to develop an EDW infrastructure created significant enterprise synergies, economies of scale, and enabled the following:

- ▶ National data marts such as Lab, Pharmacy, Trauma, Radiology, Primary Care, Clinical, Population Health, Disease Management, Oncology, Administrative (workload, cost, demographic, utilization), Access Management, and Quality Management;
- ▶ Successful regional data warehouses by supplying standardized and cleansed data, and by sharing best practices and knowledge;
- ▶ Data/text mining, discovery, and exploration for research and clinical purposes;
- ▶ Enhanced national level registries,<sup>b</sup> such as Diabetes, Hep C, SCI, PTSD, Mental Health, and Cancer, to support national efforts and achieve better interoperability with partners, such as the Department of Defense (DOD) and the FDA;
- ▶ Surveillance registries to support national health strategies and population health; and
- ▶ Feedback to other operational systems—seamlessly integrating analytic information into operational decision making.

#### **6. Provide decision support capability through EMR systems.**

One of the major health care initiatives of the federal government is to accelerate the diffusion and dissemination of clinical research data for policymakers, sponsors, researchers, the Food and Drug Administration (FDA), and the medical community at large. Research findings and the medical discoveries must be converted into useful products and services for physicians, patients, and health care providers. Clinical decision support systems (DSS) are vital components to enable this and can also substantially reduce the time of submission of higher-quality research data to the FDA for clinical trials. Eventually, an interoperable network of EMR systems is necessary to accelerate the process of transforming research into practice by integrating into national and regional databases of clinical DSS and thereby delivering up-

<sup>b</sup>Disease Registry is an organized system for the collection, storage, retrieval, analysis, and dissemination of information on individual persons who have either a particular disease, a condition (for example, a risk factor) that predisposes the person to the occurrence of a health-related event, or prior exposure to substances (or circumstances) known or suspected to cause adverse health effects. Examples include Hep C and Spinal Cord Injury (SCI) registries.

to-date knowledge to clinicians at the point of care. Our last strategy in developing and improving EMR systems is to integrate clinical DSS components into EMR systems.

Clinical DSS can help reduce the risk to public health from dangers, such as communicable diseases, hazardous or unsafe foods, and terrorism and other catastrophes, by disseminating critical information at the right time. In emergencies, it is absolutely necessary to alert both clinicians and consumers quickly. DSS can be updated and integrated with systems from hospitals, physician practices, public health agencies and other incoming data sources on medical threats, thereby giving policymakers and public health professionals all the relevant information they need to react early.

Another potentially important area for the use of clinical DSS is in the management and control of performance measures for effective and efficient health care delivery. Performance and quality control measures can be aimed at both clinical settings (e.g., hospitals, nursing homes, home visits) and health conditions (e.g., heart problems, pneumonia). Use of clinical DSS will streamline and standardize monitoring data that will allow information on quality to be more completely aggregated and analyzed, providing a comprehensive picture of quality both at the point of care and for research purposes. Developing EMR systems with clinical DSS components will facilitate electronic tracking of quality indicators and help minimize errors by health care professionals by allowing them to focus on treating patients rather than integrating the records themselves for decision-making.

#### **Conclusion**

Health care is one of the most important areas that can greatly benefit from the implementation and use of IT systems. As we discussed earlier, IT systems such as VistA—the core of the VHA's EMR systems—was one of the key reasons for the dramatic transformation of the VHA from one of the worst health care providers to one of the best in the U.S.<sup>9</sup>

Despite the enormous benefits of implementing EMR systems, the adoption of EMR systems by health care providers is still limited. There are several

key reasons for such a low adoption— e.g., high cost of implementation, lack of support from important stakeholders (i.e., clinicians, administrators), lack of existing IT infrastructure. In many cases, while the EMR system is in place, it does not provide the expected benefits because of the absence of important architectural and strategic aspects noted in our six strategies. The strategies presented here will help health care providers improve the quality of patient care through the effective development, deployment, and use of EMR systems. ■

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**Srinivasan Venkatraman** (svenkatr@coastal.edu) is an assistant professor of information systems at the Wall College of Business Administration, Coastal Carolina University, Conway, SC.

**Hillol Bala** (hbala@indiana.edu) is an assistant professor of information systems at the Kelley School of Business, Indiana University, Bloomington, IN.

**Viswanath Venkatesh** (vvenkatesh@vvenkatesh.us) is a professor and first holder of George and Boyce Billingsley Chair in Information Systems at the Sam M. Walton College of Business, University of Arkansas, Fayetteville, AR.

**Jack Bates** (jack.bates@med.va.gov) is with the Department of Veterans Affairs and is the Program Manager for the Veterans Health Administration (VHA) Corporate Data Warehouse.

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