

## LEVERAGING HEALTH INFORMATION TECHNOLOGY TO IMPROVE PATIENT SAFETY

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### ABSTRACT

**Objectives:** This article addresses the use of clinical information systems to improve patient safety within United States healthcare organizations. Additionally, it addresses the organizational strategic planning for information systems designed for the reduction of errors, improved clinical decision-making and real time access to patient information. The literature suggests that clinical information systems are necessary to improve the quality of care and foster an environment which maximizes patient safety.

**Methods:** Data on the status of U.S. Hospital patient safety information systems was drawn from the 2005 HIMSS Analytics™ database. The database surveyed over 4,000 hospitals in the United States and provided extensive data on the hardware, software and information technology infrastructure within healthcare organizations.

**Results:** Our research clearly documents the use of clinical information systems to improve patient safety in U.S. hospitals. Systems of particular interest include: Automated Dispensing Machine, Bar Coding, Electronic Medication Administration Record (EMAR), Computerized Patient Record (CPR), Computerized Data Repository (CDR), Point of Care Applications, Robotics and Wireless technology. From a strategic planning perspective, our research found growing interest in the following applications as documented by planned growth: Bar Coding for Medications (135%), Bar Coding for Nurses (186%), Bar Coding for Patients (150%), Computerized Physician Order Entry (68%), Electronic Medication Administration Record (21%), and Wireless Technology (18%).

**Conclusions:** The increasing investment in patient safety related information systems will enhance the clinical care process and improve the quality of healthcare. These Systems when linked with other clinical information systems will significantly reduce medical errors.

## INTRODUCTION

The Institute of Medicine (IOM) Quality of Health Care in America Committee was formed in June 1988 with a mandate to examine patient safety in healthcare systems and make recommendations to improve patient safety. The committee found an alarming number of medical errors and adverse events which could have been prevented. According to Kohn et al. (1999), the IOM's report, *To Err Is Human: Building a Safer Health System*, supported a growing national concern about patient injuries in United States hospitals. This report documented the need to address patient safety in healthcare organizations (HCO) in an effort to reduce escalating cost and improve the quality of care. IOM's second report, *Crossing the Quality Chasm* created mandates to improve healthcare performance in the following six areas: Safety, Effectiveness, Patient-Centeredness, Timeliness, Efficiency, and Equity (Berwick, 2002). The third IOM report released in 2003, *Patient Safety: Achieving a New Standard for Care* continued to expound on the message of patient safety in HCOs. This report found that quality and safety cannot be separated and must be linked together to ensure optimal patient care outcomes. Additionally, the use of clinical data is required for leaders to understand how adverse events occur and how to prevent them from reoccurring (Tang, 2003).

More recently, Davis et al. (2007) found the United States healthcare system to be the most costly in the world. Also, as part of their research they found the U.S. healthcare system under performed Australia, Canada, Germany, New Zealand and the United Kingdom on quality, access, efficiency, equity and healthy lives. In particular they found that U.S. healthcare had low quality scores on the management of chronic care as well as safe, coordinated and patient centered care. Leonard and Frankel (2006) proposed that healthcare system design should

include standard procedures for clinical care. This is supported by the human factors theory which suggests that clinicians make mistakes at a predictable rate and that medical errors are predictable. As a result, systematic processes for clinical care should be established. Ruchlin et al. (2004) believe an organization's culture should support patient safety by recognizing individual efforts and providing patient safety technology. This is accomplished by the development of policies and procedures as well as acquisition of health information systems. More recently, Roberts and Perryman (2007) believed creating a culture for quality and patient safety requires the support of clinical and administrative leaders. This is accomplished through shared decision making, mutual respect, effective listening and communication across the clinical team. Consistent with this focus, our research will examine how the use of health information technology (HIT) applications can improve patient safety.

The healthcare literature suggests medical errors and adverse events are a result of the complex healthcare system as well as an inefficient work process. This supports the premise that healthcare professionals providing care may not be directly responsible for some medical errors. Therefore, the healthcare industry must implement solutions to improve patient safety, reduce costs, and eliminate the needless loss of lives due to medical errors.

Johnson, Brennan, Newhouse (2002) found the annual cost in lost income, disability, and unnecessary healthcare expenditures due to preventable adverse events was between \$17 and \$29 billion. As a result, healthcare systems are under pressure to make decisions on how healthcare is delivered in order to ensure the efficient use of healthcare resources. Kalisch and Aebersold (2006) discuss high reliability organizations (HRO) and believe these organizations have a culture that supports a high degree of

safety. These HRO's have embedded into their culture practices which ensure safety. Beckmerhagen, Berg, Karapetrovie, and Wilborn (2003) point out that safety is paramount in the nuclear and aviation industries and propose similar high performance work processes be implemented in the healthcare industry. Organizations such as the Joint Commission on Accreditation of Healthcare Organizations, the Centers for Medicare and Medicaid Services, the Institute for Healthcare Improvement, the Institute for Safe Medical Practice, and the U.S. Food and Drug Administration have established mandates and recommendations to improve patient safety. As discussed by Klein (2005), Congress passed the Patient Safety and Quality Improvement Act which authorized the creation of patient safety organizations to collect, compile, and analyze information voluntarily reported from healthcare providers regarding medical errors. The law also mandates the creation of a national database of medical errors.

The Wired for Health Care Quality Act (S 1418) of 2005 approved disbursements of grants to encourage adoption of health information technology (HIT) and authorized \$125 million in 2006, \$155 million in 2007, and subsequent funding through 2010. This Act authorized the Agency for Healthcare Research and Quality (AHRQ) to establish a Center for Best Practices or a Center of Excellence which will provide assistance to healthcare organizations which implement HIT. It also established the National Coordinator of HIT as a senior advisor to the Secretary of Health and Human Services and to the President on all HIT programs (WHCQA, 2005) (ONCHIT, 2006).

As discussed in CDC (1999) The National Electronic Disease Surveillance System is a component of the Public Health Information Network and is an electronic system used to collect and monitor data for disease trends. The goal is to have a system that can transfer public health,

laboratory, and clinical data efficiently and securely over the Internet. Other national organizations involved in regulating patient safety include the National Center for Health Services Research and Technology, National Consumer Health Information, and the Health Promotion Act.

The IOM's report, *Patient Safety: Achieving a New Standard for Care* focused on the importance of healthcare data standards to support information exchange and the reporting and analysis of patient safety data. The report stressed healthcare organizations must use the information to change, eliminate, or improve those factors which are adversely affecting patient safety. According to Tang et al. (2003), this includes a commitment by all stakeholders to a culture of safety and improved information systems as well as the ability to access information from a standard network infrastructure.

Leonard and Frankel (2006) believe achieving and maintaining a culture of patient safety ultimately rests on individual hospitals and health systems. Therefore, many HCOs are creating a culture of patient safety and implementing HIT to support their efforts. However, due to the complex nature of the healthcare system there is no simple solution and it requires a commitment to continuous quality improvement. Leonard and Frankel (2006) reported 80 percent of medical errors are system derived and believe that reducing medical errors in the healthcare system requires information to support clinical providers as well as the support of senior leadership to create a culture of safety, collaboration and communication.

System change requires policies which support accountability for adverse events and the documentation of medical errors so that changes can be implemented. The involvement of physicians and healthcare leaders is essential to creating a culture of patient safety and requires communication and team building. Effective

communication strategies include multidisciplinary groups to focus on excellence as well as listening to patients and their families. The use of surveys to obtain feedback from patients, staff, and the community about their experiences and expectations is critical to patient safety.

As discussed in JCAHO (2006), the U.S. Pharmacopeia maintains a voluntary error-reporting program and found that 63% of medication errors were caused by poor communication. These errors frequently contributed to the death or significant injury of patients. Because of this data, The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) sent out a sentinel event alert to the 15,000 accredited healthcare organizations in January 2006. Their findings indicated 32% of these errors could have been avoided through better medication administration procedures (JCAHO, 2006). Additionally, they recommended the use of medication reconciliation which involves reviewing a patient's medications during transitional care. This transitional care includes patient movement between providers, geographic location, and the acuity level of care. JCAHO proposed eliminating medication errors by listing medications doses in highly visible places on the patient charts, notifying staff at the receiving HCO of the medication information and ensuring that patients have an accurate list of their medications upon discharge.

Bates (2007) believes healthcare providers have numerous opportunities to improve through the use of health information technology. These technologies include: computerized order entry, bar coding, and automated dispensing machines for pharmaceuticals. These technologies combined with a patient safety culture will allow HCOs to achieve the next level of safety.

According to Austin and Boxerman (2006), HIT is essential for organizations to lower costs, improve the quality of patient care and increase access to healthcare

services. A primary tool is the use of electronic health records which provide healthcare professionals with clinical decision support tools and will assist in avoiding medication errors. Malloch (2007) believes that applications within the electronic medical record such as computerized physician order entry, electronic medication administration record (EMAR) and clinical documentation will increase patient safety by reducing errors and improving the timeliness of care. Malloch believes the use of embedded clinical pathways and alerts within the electronic medical record will allow physicians to select the most appropriate treatment modality. Crawford (1996) proposed that HIT will be a key component to improving patient care outcomes by improved clinical decision making and managing more effectively across the continuum of care.

Personal digital assistants (PDAs) are handheld computers which are increasingly being used by healthcare professionals to access clinical information. They allow for immediate access to critical patient information including access from remote locations. The use of PDAs to support clinical applications is growing and has reduced medical errors. Bar-code scanners can be used with PDAs to scan the patient barcode bracelet and provide access to electronic medical records, medications, and patient history. Bar coding allows proper identification of the patient for the prescribed test or medication (Telecomworldwire 2005)

E-Prescribing applications allow physicians to write and generate e-prescriptions through wireless handheld devices directly to the pharmacy. These applications provide real time formulary information, drug interactions, a drug reference guide, and a patient's drug history (PR Newswire, 2005). In February 2005, a collaborative effort of twenty-seven HCOs in Maryland created an alliance to promote e-Prescribing. The goal was to use e-Prescribing

to improve patient safety by decreasing errors due to illegible handwriting and incorrect prescription dosage. Communication between physicians and pharmacies was also enhanced with e-Prescribing (Wireless News, 2005).

According to May (2005), the use of electronic medical records have transformed the delivery of healthcare and improved patient safety. Dr. David Brailer, the previous National Health Information Technology coordinator for the Department of Health and Human Services, reported the use of HIT was essential for improving patient safety. He reported a 20% reduction in medication errors due in part to computerized physician order entry (CPOE). A CPOE system makes prescription orders legible, identifies the correct medication and dose as well as signals alerts for potential medication interactions or allergic reactions. Additionally, CPOE data can be downloaded into a performance management system which analyzes clinical processes and business performance. The data can be measured against national benchmarks to identify where improvements could be made.

Croskerry and Sinclair (2001) proposed that blaming individuals for medical errors needs to be replaced by root-cause analysis. Root-cause analysis uses quantitative and qualitative methods to detect and classify medical errors as well as identifies systemic process weaknesses.

### *Methods*

Leveraging health information technology (HIT) to improve patient safety is essential to improving the quality and efficiency of US healthcare. To support these initiatives HIMSS Analytics™ (2005) has developed a comprehensive database relative to each organization's HIT status.

Data on the status of U.S. Hospital patient safety information systems was drawn from the 2005 HIMSS



Analytics™ database. The database surveyed over 4,000 health care organizations in the United States and provided extensive data on the hardware, software and information technology infrastructure within healthcare organizations.

## RESULTS

The HIMSS Analytics™ database found that in 2005 of 2,137 HCO's responding, there is a wide range of health information technology currently in use to improve patient safety. As shown in Table 1, in 2005 the following patient safety applications were in use: Automated Dispensing Machine (ADM), Bar Coding, Electronic Medication Administration Record (EMAR), Computerized Patient Record (CPR), Computerized Data Repository (CDR), Point of Care Applications, Robotics, Laboratory Information Systems and Wireless Technology.

An Automated Dispensing Machine (ADM) is a medication dispensing cabinet that automates the storing, dispensing and tracking of narcotics and other medications in inpatient care areas. The ADM provides secure storage for medications and eliminates the need for narcotic counts as well as keys. An ADM interfaces with hospital electronic billing systems to capture charges and with materials management systems to track inventory.

Table 2 provides information on strategic planning for U.S. hospitals to improve their level of HIT adoption in support of patient safety. In particular, our research shows the following applications had increasing rates of implementation: Automated Dispensing Machine (6.8%), Bar Coding for Medications (135%), Bar Coding for Nurses (186%), Bar Coding for Patients (150%), Computerized Physician Order Entry (68%), Electronic Medication Administration Record (21%), Point of Care (4.0%), Robotics (28%) and Wireless Technology (18%).

## DISCUSSION

Steers (2006) discussed the use of robotics in support of surgical procedures. He found that robotics can improve patient safety, reduce morbidity, reduce blood loss and improve the quality of life. However, his research did not document improved efficiency or greater return on investment due to increased expenditures for this technology. His research did provide a framework to assess, plan and initiate a robotics program within health care organizations. Dighe, Makar and Lewanprowski (2007) found that 70 percent of medical decisions are made using laboratory data. This documents the need for improved laboratory systems design to reduce medical errors and resolve errors that do occur. They found that laboratory information technology can play an important role in promoting patient safety by communicating tests results and aiding in the interpretation of data. This research was consistent with our results which found growing acquisition of robotics and laboratory IT systems in an effort to improve patient safety.

According to Elliott (2003), up to 30 percent of healthcare costs do not contribute significantly to improve patient outcomes. Additionally, the Commonwealth Fund (2006) believes inefficient and poor quality healthcare costs the U.S. between \$50 and \$100 billion annually. As a result, a high priority of healthcare system reform must be the management of care across the continuum of health services.

Davis et al. (2007) found opportunities for improving the efficiency of U.S. healthcare through the use of information technology and multidisciplinary teams. They believe the U.S. healthcare system should focus on quality patient care, improved patient safety, and decreased administrative costs. Additionally, healthcare leadership

must strategically plan for the use of HIT to improve clinical quality and patient safety.

Cronenwett et al. (2007) propose that health care professionals be educated to deliver patient-centered care through the use of an interdisciplinary team which incorporates evidence-based practice and informatics to develop the clinical care plan. The IOM has documented the need for a national effort to improve the U.S. healthcare system and politicians, medical professionals, and the public are in agreement with the importance of patient safety. The use of electronic medical records, development of clinical protocols and the reporting of adverse events are all part of the solution. Our research supports these initiatives and shows HCOs are increasingly investing in those health information technologies necessary to improve patient safety.

Brennan (2006) discussed costs associated with medical errors and suggested insurers and employers frequently shoulder the financial burden of adverse events. As a result, hospitals should face experience-related insurance premiums as an incentive to reduce malpractice costs. This would encourage hospitals to reduce malpractice costs by undertaking significant patient safety initiatives.

According to Rothfeder (2004), technology is critical to solving the nation's healthcare problems of skyrocketing costs and inconsistent clinical care. He sees pay-for-performance (P4P) programs as an incentive for hospitals and physicians to improve the quality of healthcare services. He believes the use of clinical information systems and evidence-based medicine will increase patient satisfaction and the quality of care. Additionally, Rothfelder (2004) believes electronic medical records will reduce dangerous medical mistakes and in the process cut 10 percent from the nation's \$1.6 trillion healthcare expenditure. Insurance companies support the

use of HIT to expedite the claims payment process and reduce the need for personnel. Unfortunately, this financial motivation perpetuates feelings of anger and distrust among healthcare providers and may adversely affect patient safety. Alternatively, P4P could be a positive motivation for hospitals and physicians to invest in HIT as a method to improve patient safety.

Reichard (2006) found the medical device industry support P4P measures for the use of HIT to improve quality of care. They also support Senate Bill (S 2022) that provides incentives for physicians to monitor patient status remotely through the use of health information technology.

#### Conclusion

Shorr (2007) believes the key to patient safety is a patient-centric approach to care. This requires the active involvement of healthcare leaders in creating a new paradigm for patient care processes. He believes that this will require high performance work processes which incorporate redundancies into clinical care in order to maximize patient safety. Similarly, Cronenwett et al. (2007) believe that patient safety can be improved by the coordination and integration of care, better communication through information technology and greater continuity of care. They also believe improved teamwork and collaboration as well as greater research into evidence-based medicine and the use of clinical practice guidelines leads to optimal health care. Finally, they believe continuous quality improvement through the measurement of variation in quality is necessary to improving the process of care. The measurement of variation is enhanced through the use of information technology and is essential for root-cause analysis and failure mode effects analysis. Our research has documented a growing investment in the technology necessary to complete this analysis as organizations strive to improve performance.

The IOM made initial recommendations for change in the U.S. healthcare system and federal regulations as well as professional standards have been implemented to prevent adverse events. Among these is the adoption of healthcare data standards to support information exchange and the tracking of patient safety. Tang et al. (2003) believe a comprehensive national health information infrastructure is needed to enhance patient safety programs. This infrastructure would include standards for data interchange, healthcare terminologies, knowledge representation, and a common format for reporting of medical errors.

On a positive note, our research shows that healthcare leaders are acquiring HIT to improve patient safety. Additionally, the literature indicates that HCOs are focusing on high performance work processes in order to reduce medical errors and improve patient safety. This is accomplished by implementing computer systems which create integrated patient databases to facilitate patient safety. Such a comprehensive approach is necessary to reduce medical errors, reduce costs, improve patient safety, and to regain public trust in the healthcare system.

Our research is consistent with Davis et al. (2007) who believe the U.S. must accelerate its adoption of health information technology and ensure these technologies are available to patients and providers. The electronic medical record combined with other clinical applications would allow for significant improvements in patient safety.

In summary, our research found that health information technology is increasingly being used to improve patient safety in the healthcare industry. This was supported by Nymark (2007) who found health information technology is effective in improving quality of care, reducing costs as well as enhancing patient safety. Additionally, it provides administrative and clinical data necessary to develop high performance work processes.

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Table 1: Patient Safety Information Systems Features

Patient Safety Information Systems Features
Automated Dispensing Machine (ADM)
Bar Coding for Medications
Bar Coding for Nurses
Bar Coding for Patients
Computerized Physician Order Entry (CPOE)
Electronic Medication Administration Record (EMAR)
Computerized Patient Record (CPR)
Computerized Data Repository (CDR)
Laboratory Information System
Clinical Documentation Software
Order Management Software
Physician Portal
Point of Care Software
EMR for Ambulatory Facilities
Patient Safety Expert Software
Clinical Documentation Management
Clinical Software for Ambulatory Care
Results Reporting System
Biometric Technology
Point of Care
Robotics
Wireless Technology

Source: 2005 HIMSS Analytics™

Table 2: Patient Safety Information Systems Planning

Variable	Healthcare Organizations Responding (N=2,137)		
	Current	Planned	Increase
Automated Dispensing Machine (ADM)	865	59	6.8%
Bar Coding for Medications	337	456	135%
Bar Coding for Nurses	139	259	186%
Bar Coding for Patients	189	284	150%
Computerized Physician Order Entry (CPOE)	774	529	68%
Electronic Medication Administration Record (EMAR)	605	130	21%
Point of Care	322	13	4.0%
Robotics	74	21	28%
Wireless Technology	797	151	18%

Source: 2005 HIMSS Analytics™

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