

Chasing High Performance: Best Business Practices for Using Health Information Technology to Advance Patient Safety

Jennifer S. Myers, MD; and Richard P. Shannon, MD

Despite increasing awareness of the risks to patients within the US healthcare system and the human and economic toll that medical errors exact, improvements in patient safety have been slow.^{1,2} While individual accountability for patient outcomes is essential for the delivery of high-quality medical care, the complexity of healthcare requires a highly reliable system built within a culture that recognizes errors and process defects as opportunities to learn and continuously improve. The Institute of Medicine report *To Err is Human* emphasized the important role of health information technology in preventing harm to patients.³ Through the automation of error-prone tasks and decision support systems designed to minimize reliance on human memory, health information technology has rapidly become an important tool to address problems faced by healthcare organizations and their patient safety programs.

In this essay, we describe the fundamental role of health information technology as a multifaceted and indispensable tool to achieve high reliability in healthcare. We illustrate how health information technology can contribute to the creation of high performance by discussing the operating characteristics of high-performing organizations and how they achieve superior outcomes. Finally, we caution readers that this technology has the potential to disappoint or even harm if poorly designed, implemented, or embedded within an institution that lacks a culture of safety. We write these opinions in our roles as healthcare leaders in an academic medical center that has a well-developed computer physician order entry system and a partially developed electronic medical record.

The Goal: American Healthcare as Best in Class

In his recent book entitled *Chasing the Rabbit*, Dr Steven Spear cogently outlines the characteristics of high-performing organizations that produce products that are “best in class.”⁴ A high-performing organization is an organization which embeds process improvement as a guiding principle and is committed to learning by understanding and solving real problems while developing problem-solving capabilities in all workers. Best-in-class products or solutions are those which are implemented reliably and affordably, and have sustainable outcomes. High-performing organizations achieve their results not through technological advances, but through the complete engagement of the wisdom, knowledge, and

skills of every worker. They predict results by implementing a change, measuring some component of the change process, and then compulsively comparing the

The emergence of information technology in healthcare holds the promise to transform the industry through the creation of highly reliable information exchange. These same technologies have a central role in the patient safety movement. Organizations that wish to deliver safe and high-quality healthcare will only be successful if they plan, develop, and use health information systems with the principles of high-performing organizations in mind. We discuss the current state of health information technology in the patient safety movement, how this technology can contribute to high organizational performance, and some caveats.

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Take-Away Points

Healthcare organizations can advance patient safety by using the principles of high-performing organizations when they design and implement health information technology tools. Key principles include:

- Engaging healthcare workers to design and provide feedback on health informatics tools.
- Promoting electronic error-reporting systems as a vehicle to identify errors and swarm and solve problems in real time.
- Leveraging technology such as computer screen savers and handheld electronics to present safety data to healthcare workers in the course of their daily work.
- Educating all healthcare workers in health information technology; developing and promoting a cadre of experts in the field to meet the growing needs of our healthcare industry.

actual outcome with the anticipated result. Any gap between what was anticipated and what actually occurred is the breeding ground for learning and information dissemination. Such organizations cope with complexity by focusing continuously on how to improve the work that they do.

The culture within high-performing organizations is built upon an organizational learning framework that facilitates and rewards problem-solving capabilities. According to Spear, these capabilities include capturing all existing knowledge, solving problems in real time to build new knowledge, rapid dissemination of knowledge, and building problem-solving and improvement skills in all workers. We will describe how health information technology impacts each of these capabilities below.

Specifying Work to Capture All Existing Knowledge

Problem-solving skills begin with an in-depth understanding of the nature of the current situation. Detailed observations of existing processes by individuals engaged in the work serve as the foundation for work redesign. Increasingly, information technology serves as the repository of existing knowledge in healthcare. In addition to serving as the central location for clinical documentation in many hospitals and health clinics, electronic medical records and computer physician order entry systems (CPOEs) are driving clinical decision making and healthcare delivery at the bedside. We have several examples from our institution to illustrate this concept. In an effort to improve anticoagulation safety and reduce medication dosing errors at our institution, our CPOE system now displays recent anticoagulant doses and lab values for physicians when a blood thinner is prescribed. Information on multi-drug-resistant organisms is captured and displayed prominently in our information systems so that patients who have had a prior resistant infection can be isolated immediately upon entering our emergency department. This reduces the risk of spreading these infections. A new information technology application within the CPOE allows

a common legible electronic format for nursing assessments at the bedside. This technology includes vital signs which can be trended so that significant variations are more easily apparent.

In each of these scenarios, reliance on human memory is decreased and the availability of relevant information at the point of care is increased, thereby allowing physicians to focus on the clinical decision at hand rather than being frustrated and distracted with the process of information gathering.

Conversely, we are challenged when all existing knowledge cannot be captured by information technology, and there are numerous examples of this challenge in healthcare. A prominent example is medication reconciliation. Medication reconciliation is a complex task that requires physicians to compare a patient's home medication list with their hospital medication list in an effort to identify discrepancies and prevent medication errors. In our medical center, as in many others, this is challenging because more than 1 information system is employed and medication lists from disparate systems are not merged into 1 list or visible on a single computer screen for side-by-side comparison. Pending laboratory tests at hospital discharge are another example of this challenge. Many healthcare systems lack the information technology to alert discharging and primary care physicians about important tests that are pending at discharge. Promising examples of health informatics solutions related to medication reconciliation and pending test results at discharge have been reported, yet much more work remains to be done in order to achieve high reliability at the intersection of patient safety and health information technology.^{5,6} These and other similar problems are ideal quality improvement targets for healthcare leaders. Conversations with the healthcare workers who use information technology at the point of patient care is a starting point for healthcare leaders who want to increase the usability of existing knowledge in their systems and learn where and how their informatics tools could be improved.

Swarm and Solve Problems to Build New Knowledge in Real Time to Avoid Information Atrophy

The primary approach to problem solving in high-performing organizations is to probe deeply into problems to find a rich new source of knowledge. A critical component of this approach is the examination of identified problems in real time. Information systems play an important role in this process by gathering data and transforming them into action.

Perhaps the most visible example of this in the patient safety movement is electronic error-reporting systems.⁷

Prior to electronic error-reporting systems, so-called “incident reports” often lay physically dormant for months in the offices of busy quality improvement directors or nurse managers. It could take weeks to circulate a report to the appropriate person responsible for action. This time delay put healthcare organizations and their patients at risk because the error or “new problem” was not known for a prolonged period, during which time similar incidents could occur.

Electronic error-reporting systems can be readily structured into domains such as *what* the problem was, *when* it occurred, *where* it occurred, *who* was involved, and ultimately after root cause analysis, *why* it occurred. This allows repetitive themes (eg, specific units, time of day, day of week, type of medication) to be identified and adds rich context to problem solving. For example, an electronic error-reporting system might identify nights as the most frequent time when a certain class of errors occurs. A specific illustrative example from our hospital’s electronic error-reporting system and review process is a problem of late-evening falls on our heart failure unit as patients arise to urinate. These falls were entered into the reporting system and traced to evening doses of diuretics, which prompted a change in the time of administration.

The ability to “swarm and solve” errors in real time, as described by Spear, was inconceivable for many healthcare leaders prior to the advent of electronic error-reporting systems. Now, armed with the technology that electronic error-reporting systems afford, healthcare leaders and organizations can avoid the inevitable information “atrophy,” speculation, and loss of employee trust that occurs with delayed investigations of errors and their precursor conditions. In our institution, electronic error reports are routed to and read by risk managers as well as the physician, nurse, and quality leader of the specific hospital unit or department where the event occurred. While risk managers perform the primary investigation for errors with harm, the local leadership leads the investigation of near-miss safety events and trends within their unit or area. Some problems are solved locally, while others that are more complex require collaboration with other leaders in a root cause analysis or related learning forum. This allows “swarm and solve” problem solving to begin locally before memories fade and information atrophies.

Share and Disseminate the New Knowledge Rapidly Throughout the Organization

Perhaps the most powerful application of health information technology related to patient safety is the ability to rapidly disseminate knowledge about error-prone conditions throughout an organization in order to learn, mitigate risk,

and improve outcomes. New knowledge about patient safety comes from innumerable sources such as voluntary error-reporting systems, root cause analyses, patient complaints and surveys, and the daily work of clinical staff.

Although e-mail has become the predominant mode of communication in most healthcare organizations, in our experience we have found that the volume of e-mails often leads to important safety information being overlooked or ignored. Additionally, e-mails are frequently read during non-clinical work time, yet the information contained within them would be more useful and effective if it were read in the normal work flow of clinical care. Thus, the development of novel communication methods that present information to physicians, nurses, and other healthcare workers in a “just in time” fashion must be explored.

Since new knowledge about individual patients is often gained through technology portals, it follows that more broad-based knowledge related to safety trends could be disseminated through the same portals. For example, the “idle” computer screen itself can be a portal, and the use of computer screen savers as an educational tool has been described.⁸ Since most healthcare workers already use personal digital assistants (PDAs), smartphones, or other similar handheld electronic devices to retrieve and organize factual medical information and personal information, it is conceivable that we will use these same devices to communicate safety information rapidly in the near future. Descriptions of healthcare interventions using PDAs have already been described.^{9,10} Information overload remains a concern with this mode of communication as well, and strategies to triage safety information and alerts based upon priority and risk scores will be necessary.

Moreover, information systems can be used to share quality improvement and error-reporting data in real time, thereby engaging all healthcare workers in the process and outcomes that they are creating. This requires building systems that can be used and understood by engaged workers and not shrouded in metrics that conceal the human elements of the work. A common taxonomy for patient safety work that includes a standardized vocabulary and definitions is helpful when building such a system. Restricting access to a few individuals or aggregated outcomes only limits information sharing, degrades trust, and creates barriers to healthcare worker engagement. The ability to create interactive and usable websites to display quality scorecards at the unit (micro) and hospital (macro) level should be available to all clinicians.

Lead by Developing These Skills in All Workers

Leaders in high-performing healthcare organizations not only must ensure that their staff have basic informatics skills, but also must identify, mentor, and develop clini-

cal leaders in the burgeoning field of health information technology.

In addition to the training provided during the implementation of new informatics tools, more formal education in the field of health information technology is being called for earlier in the training of healthcare professionals. For example, informatics is now included as a competency for quality and safety education in undergraduate and graduate nursing.¹¹ Similarly, the topic of educating physicians in this field is being discussed and should be included in curricula focusing on quality, safety, and healthcare systems.¹² By training all healthcare workers in the availability and use of informatics tools for patient safety, healthcare leaders can leverage these tools as they develop problem-solving capabilities within their workforce, empowering them to identify opportunities for informatics innovation in order to improve patient outcomes.

In parallel, healthcare organizations will need to identify and develop healthcare leaders with interest and skills in medical informatics in order to achieve excellent outcomes. Advanced training certificates, fellowships, and competencies in biomedical informatics exist and will likely expand to meet the growing needs of the healthcare industry.¹³ In addition, the field of human factors engineering, which evaluates the error-prone properties or “factors” of humans and considers them in the design and deployment of systems, is growing rapidly in order to increase the usability and safety of new and existing health information systems. Indeed, there is an increasing need for human factors engineers in robust biomedical informatics and patient safety programs.

Caveats

There is a tendency to believe that information technology itself will solve much of what is defective in our healthcare system. This is a dangerous posture, as a multitude of new errors have been introduced into healthcare as a result of technology.^{14,15} We assert that in order for information technology to enhance safety, the organization in which it is embedded must adhere to the fundamental principles of highly reliable organizations: preoccupation with failure, sensitivity to operations, reluctance to simplify, a commitment to resilience, and deference to expertise.¹⁶ Examples from other industries clearly indicate that a culture of continuous learning and preoccupation with failure trumps technological advantage. This is most evident in the automobile manufacturing industry, where Toyota’s inexorable rise to the top occurred despite similar technology being used by its American and Japanese competitors.

The impact of work flow design on health information technology is often overlooked, and its importance cannot be overemphasized. The implementation of each new informat-

ics or clinical decision support tool gives us the unique opportunity to re-examine how work is done in a detailed fashion and to redesign faulty, redundant, or antiquated processes. Despite this opportunity, many informatics tools continue to be implemented without attention to work flow and with insufficient input from clinical users. For example, in one study of bar code medication administration at 5 hospitals, nurses overrode bar code medication alerts for 4% of patients charted and 10% of medications charted.¹⁷ The end result of inattention to work flow and process design is automation of a bad process which leads to user frustration, non-adoption of the tools, workarounds, and perhaps most importantly, a loss of faith that information technology can improve daily work and patient safety outcomes.

Additionally, the amount of information available in health information systems can be overwhelming and lead to error. Poorly designed computer screen displays and thoughtless copy-and-paste documentation can lead to confusion from excess data as opposed to clarity from actionable information.¹⁸ Excessive computerized prompts in clinical decision support systems can create alert “fatigue” among healthcare workers which in turn undermines the safety benefits of more effective clinical decision support tools.¹⁹ In each of these scenarios, the power of health information systems paradoxically creates a double-edged sword that contributes to complexity rather than simplifies it.

Consistency in practice and its industrial synonym, standardization, are often viewed pejoratively in medicine. This is unfortunate because standardization of common practices is liberating and frees the mind to focus on the more complex cognitive task of clinical decision making. Just as no prerogative is usurped when all healthcare workers agree on how to place a central venous catheter, no prerogative is usurped when they are prompted to assess venous thromboembolism prophylaxis in a standardized way in their computer physician order entry system. Furthermore, the ability to measure the effects of improvement work on important quality and safety outcomes is lost when a process is not standardized. It should be emphasized, however, that standardization is not in and of itself the goal. Rather, standardization is necessary to achieve the unambiguous goal of better patient outcomes. Although many of the examples that we use in this commentary relate to the hospital setting, the principles of high-performing organizations and their applications to health information technology that we describe can be applied to any healthcare setting.

CONCLUSIONS

Health information technology is a tool, not a goal, for patient safety. As healthcare leaders continue on their journey

toward perfection, there will always be more complex systems and humans will continue to err.

In such an environment, safety will only be maintained through the actions of leaders who are committed to continuous learning about complex delivery systems and a culture of safety among healthcare workers who feel psychologically “safe” to halt a procedure, to ask a question, or to seek clarification about a task. Although health information technology is an essential tool for progress in patient safety, these technological advances will be mitigated in a culture that does not encourage and reward preoccupation with failure, error reporting, and a continuous quest to eliminate preventable harm.

Author Affiliations: From University of Pennsylvania School of Medicine (JSM, RPS), Philadelphia, PA.

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Address correspondence to: Jennifer S. Myers, MD, Associate Professor of Clinical Medicine, Patient Safety Officer, Dept Medicine, 3400 Spruce St, Penn Tower, Ste 2009, Philadelphia, PA 19104. E-mail: jennifer.myers@uphs.upenn.edu.

REFERENCES

1. Landrigan CP, Parry GJ, Bones CB, Hackberth AD, Goldmann DA, Sharek PJ. Temporal trends in rates of patient harm resulting from medical care. *N Engl J Med*. 2010;363(22):2124-2134.
2. Department of Health and Human Services; Office of Inspector General. *Adverse Events in Hospitals: National Incidence Among Medicare Beneficiaries*. <http://oig.hhs.gov/oei/reports/oei-06-09-00090.pdf>. Published November 2010. Accessed May 10, 2011.
3. Kohn L, Corrigan JM, Donaldson MS; Committee on Quality of Health Care in America. *To Err Is Human: Building a Safer Health System*. Institute of Medicine Report 2009. Washington, DC: National Academies Press; 1999.
4. Spear SJ. *Chasing the Rabbit: How Market Leaders Outdistance the Competition and How Great Companies Can Catch Up and Win*. New York, NY: McGraw-Hill; 2009.
5. Schnipper JL, Hamann C, Ndumele CD, et al. Effect of an electronic medication reconciliation application and process redesign on potential adverse drug events: a cluster-randomized trial. *Arch Intern Med*. 2009;169(8):771-780.
6. Dalal AK, Poon EG, Karson AS, Gandhi TK, Roy CL. Lessons learned from implementation of a computerized application for pending tests at hospital discharge. *J Hosp Med*. 2011;6(1):16-21.
7. Levitzion-Korach O, Alcalai H, Orav EJ, et al. Evaluation of the contributions of an electronic web-based reporting system: enabling action. *J Patient Saf*. 2009;5(1):9-15.
8. Anderson D, Dobson N, Lewandowski J. Using computer screen savers to enhance nurses learning in the intensive care environment. *Dimens Crit Care Nurs*. 2007;26(4):160-162.
9. Kho A, Henderson LE, Dressler DD, Kripalani S. Use of handheld computers in medical education: a systematic review. *J Gen Intern Med*. 2006;21(5):531-537.
10. Galt KA, Rule AM, Taylor W, et al. The impact of personal digital assistant devices on medication safety in primary care. In: Henriksen K, Battles JB, Marks ES, Lewin DI, eds. *Advances in Patient Safety: From Research to Implementation (Volume 3: Implementation Issues)*. Rockville, MD: Agency for Healthcare Research and Quality US; February 2005.
11. Quality and safety competencies. Quality and Safety Education for Nurses website. <http://www.qsen.org/competencies.php>. Accessed May 10, 2011.
12. Shortliffe EH. Biomedical informatics in the education of physicians. *JAMA*. 2010;304(11):1227-1228.
13. Gardner RM, Overhage JM, Steen EB, et al; AMIA Board of Directors. Core content for the subspecialty of clinical informatics. *J Am Med Inform Assoc*. 2009;16(2):153-157.
14. Koppel R, Metlay JP, Cohen A, et al. Role of computerized physician order entry systems in facilitating medication errors. *JAMA*. 2005;293(10):1197-1203.
15. Walsh KE, Adams WG, Bauchner H, et al. Medication errors related to computerized order entry for children. *Pediatrics*. 2006;118(5):1872-1879.
16. Leonard M, Frankel A. Focusing on high reliability. In: *Achieving Safe and Reliable Healthcare*. Chicago, IL: Health Administration Press; 2004.
17. Koppel R, Wetterneck T, Telles JL, Karsh BT. Workarounds to barcode medication administration systems: their occurrences, causes, and threats to patient safety. *J Am Med Inform Assoc*. 2008;15(4):408-423.
18. Siegler EL, Adelman R. Copy and paste: a remediable hazard of electronic health records. *Am J Med*. 2009;122(6):495-496.
19. Van der Sijs H, Aarts J, Culto A, Berg M. Overriding of drug safety alerts in computerized physician order entry. *J Am Med Inform Assoc*. 2006;13(2):138-147. ■