

# Leveraging Information Technology Towards Enhancing Patient Care and a Culture of Safety in the U.S.\*

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## Summary

**Objectives:** To heighten awareness about the critical issues currently affecting patient care and to propose solutions based on leveraging information technologies to enhance patient care and influence a culture of patient safety.

**Methods:** Presentation and discussion of the issues affecting health care today, such as medical and medication-related errors and analysis of their root causes; proliferation of medical knowledge and medical technologies; initiatives to improve patient safety; steps necessary to develop a culture of safety; introduction of relevant enabling technologies; and evidence of results.

**Results and Conclusion:** Medical errors affect not only mortality and morbidity, but they also create secondary costs leading to dissatisfaction by both provider and patient. Health care has been slow to acknowledge the benefits of enabling technologies to affect the quality of care. Evaluation of recent applications, such as the computerized patient record, physician order entry, and computerized alerting systems show tremendous potential to enhance patient care and influence the development of a culture focused on safety. They will also bring about changes in other areas, such as workflow and the creation of new partnerships among providers, patients, and payers.

## Keywords

Medical errors, patient safety, information technology, computerized patient record, physician order entry, clinical decision support, clinical outcomes, evidence-based medicine

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## 1. Introduction

Medical errors and issues of patient safety are hardly new phenomena. Even during the dawn of medicine, Hippocrates counseled new physicians, “to above all else do no harm.” In the U.S., efforts to improve the quality of health care can be seen in almost every decade of the last century. In the early 1900s, Dr. Ernest Codman failed in his efforts to get fellow surgeons to look at the outcomes of their cases. In the 1970s, there was an outcry that the military allowed an almost blind surgeon to continue to practice and even transferred him to the prestigious Walter Reed Hospital. More recently, two reports by the Institute of Medicine caught the attention of the media, the American public and the healthcare industry. *To Err Is Human* [1] highlights the need to reduce medical errors and improve patient safety, and *Crossing the Quality Chasm* [2] calls for a new health system to provide quality care for the 21st century [3].

## 2. Health Care Has a Problem

The Institute of Medicine (IOM) is not the only source indicating that the delivery of health care has significant shortcomings. A Rand Foundation report describes the U.S. healthcare system as “substandard” and

medical errors as “rife.” Only 60% of the chronically ill receive the care they need. Of the care given to the chronically ill, about 20% are “unnecessary and potentially harmful” [4]. According to a Kaiser study, 71% of consumers – who are increasingly involved in making their own healthcare decisions – are concerned or very concerned about patient safety [5]. Sixty-one percent fear being given the wrong medication and 56% fear complications in a medical procedure [6]. Furthermore, more than half of U.S. physicians believe their ability to deliver quality care has decreased in the past five years and 30% rate their hospitals as fair or poor at finding and addressing medical errors [7].

In a Robert Wood Johnson Foundation survey, *Pursuing Perfection*, four of five providers believe that “fundamental” changes are needed to ensure patient safety. Seventy-eight percent feel their organizations should take responsibility for developing solutions to the quality challenge. Fewer than 10% find the system close to error-free. The number of physicians (95%), nurses (89%) and administrators (82%) who report having witnessed a serious medical mistake is appalling [8].

And then there are the numbers. According to the IOM, medical errors account for an estimated 44,000 to 98,000 deaths per year in U.S. hospitals, making it the 8th leading cause of death in the United States [2]. Although some have questioned the validity of these numbers, the reality is that people are dying from medical errors. One study of 182 deaths of patients hospitalized for CVA (stroke), pneumonia, or heart attack found at least 14% and potentially as

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many as 27% of the deaths might have been prevented [9]. If morbidity and the outpatient environment are considered, the numbers may be far worse than the IOM suggests. A growing number of studies in peer-reviewed literature document the problem. Just over one-fifth of these studies define errors and adverse events, while 65% are related to medications. Only recently did a small number of studies begin to examine costs involved [1].

Looking just at medication-related errors, according to the Agency for Healthcare Research and Quality, adverse drug events cause 770,000 injuries and deaths a year [10]. Medication-related deaths in the U.S. increased 2.37-fold in hospitalized patients and 8.48-fold among outpatients between 1983 and 1993. This equated to one out of 854 inpatient deaths and one out of 131 outpatient deaths in 1993 [11]. Researchers found 5.5 adverse drug events per 100 outpatients coming for care. Of these, 38% were preventable. Even these numbers must be considered suspect, as there is general consensus that errors are underreported for a host of reasons. One study indicated that while 92% of hospital CEOs reported they were knowledgeable about the frequency of medication errors in their facility, only 8% said they had more than 20 per month, when probably all of them did [12]. In another recent prospective study of surgical units, almost 80% of errors identified by trained observers were not officially recognized or recorded [13].

### 3. The Challenge in Medicine Today: To Apply What We Know

It is not surprising that health care is experiencing difficulty. We are at a time of unprecedented discovery. "The science and technologies involved in health care – the knowledge, skills, care interventions, devices and drugs – have advanced more rapidly than our ability to deliver them safely, effectively and efficiently" [13]. For example, in 1998 the Federal Drug Administration approved 90 new drugs, 30 new molecular entities and 124 new uses for already

approved drugs [14]. New medical technologies are at an all time high and our medical knowledge is growing exponentially. In 1995, more than 10,000 articles were published on randomized clinical trials, our best source of data for evidence-based care, 100 times as many as in 1966 [15]. Except for rare and exceptional clinicians, it is just not possible to keep up-to-date on all the advances in medical knowledge.

## 4. The Nature of Medical Errors

Analysis of the nature and causes of medical errors has made it clear that they arise from a variety of causes and impact virtually all medical activities. Furthermore, they do not readily point to a common set of causes. More often than not, errors result from a combination of a series of latent errors built into the system. A recent prospective study could identify the individual who "might" be responsible in only 37.8% of the cases. In more than a third of the cases, it was "simply not possible to assign any responsibility." More than 60% of all errors were in the system. Even when an individual could be identified, the person was acting within the system [13]. This complex and pervasive nature of medical errors means they cannot be eliminated by efforts that are simplistic or narrowly focused.

## 5. Taking Action to Improve Patient Safety

The push to improve patient safety remains slow going, although definite efforts continue to arise. In the United States, the Joint Commission on Accreditation of Healthcare Organizations made its new patient safety standards effective on July 1, 2001. They call for internal reporting of medical errors, design of remedial steps to prevent future occurrences of these errors, prospective analysis and redesign of vulnerable patient care systems, and, finally, telling patients and their families when they have been hurt by a medical error [16].

The American Hospital Association offers its members educational materials to use in creating "a culture of safety." The Leapfrog Group is bringing the influence of private sector employers to bear upon the issue. The government has also taken steps [17]. In 2001, the U.S. Congress allocated \$50 million to establish the National Center for Quality Improvement and Patient Safety within the Agency for Healthcare Research and Quality (AHRQ). Through 2003, AHRQ expects to award up to \$25 million annually to establish centers for safety research and practice and to support research and education in key areas, including best practice guidelines [18].

Most states have also taken some initial steps to improve patient safety. California legislation requires hospitals to implement a formal plan for eliminating or substantially reducing medication-related errors by 2005 [19]. Other states have also passed laws related to medical errors. For example, 15 states have mandatory reporting from hospitals for adverse events. Five states and the District of Columbia have voluntary reporting.

## 6. Making Patient Safety Happen

To reach the goal of patient safety, each healthcare organization needs:

- Its own vision for patient safety that is clear, realistic, achievable and measurable.
- An understanding of what constitutes "best in class performance" outside its walls.
- A carefully selected and limited set of strategies and unambiguous measures.
- Organization-wide deployment and development of leadership across the organization to align its daily work with the vision.
- Governance at the senior leadership level to ensure that the strategies and initiatives are executed.

Each of these components is essential to developing a "culture of safety" and none

can succeed without leadership and commitment of the medical staff, nursing staff, and other leaders. Several steps can be taken to ensure that the process of improving patient safety is ultimately successful.

The *education* component brings all participants to a common level of understanding and recognition of the possibilities.

The *diagnostic* component allows a healthcare organization to gain an overview and clearly define the scope of patient problems within the organization.

*Process improvement* is critical to providing safer patient care and better outcomes. Applying what is known about “best practices” to clinical processes is the first step in continuous quality improvement. Healthcare organizations gain real value from access to an up-to-date, wide-reaching knowledge base of what actually works in other organizations similar to theirs.

*Evaluation* follows on an ongoing basis. Every process change and every new tool must be evaluated to determine whether it improves care. By gathering and analyzing its own data, and comparing those data to national benchmarks when appropriate, healthcare organizations can create their own evidence-based practices. In such an environment, evaluation and process improvement are concurrent and continuous.

## 7. Using Technology as Enabler

It is clear that achieving substantial (50% or greater) reductions in preventable medical errors is a difficult task. However, there is consensus that information technology can improve health care. In its report to the President, the President’s Information Technology Advisory Committee (PITAC) outlines the role the federal government must play in using IT to transform health care. In addition to calling for a national vision and information infrastructure, PITAC charges the federal government with coordinating its own cross-agency activities – which are numerous and far reaching in scope – and establishing pilot projects and enabling technology centers. PITAC concluded: “Information technology tools can provide the healthcare sector with unprece-

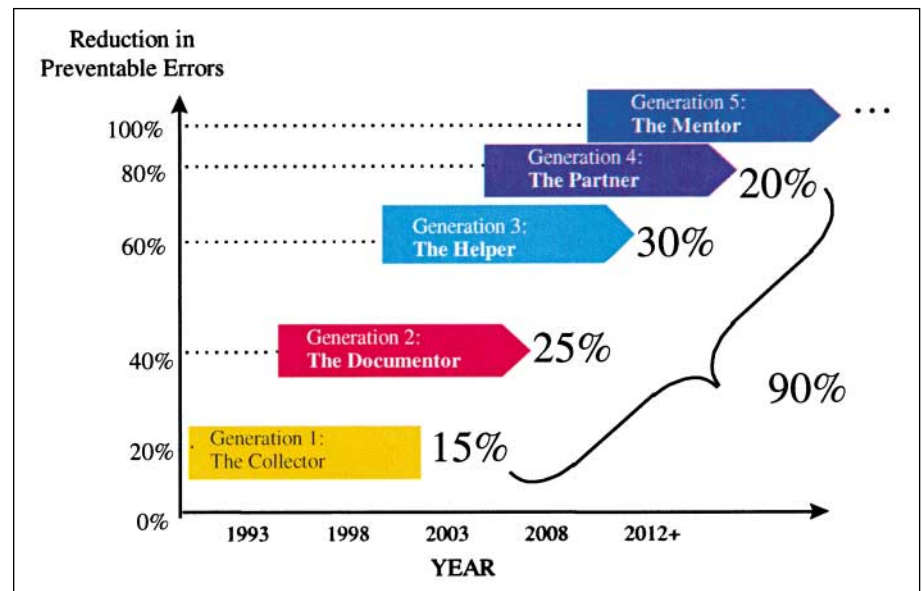


Fig. 1 Error impact of CPR generations; source: Gartner, Inc.

ded productivity and quality of care if there is a strategic vision and adequate research to ensure success” [20].

The IOM’s call for action reviews the medical literature, adds the insights of experts, and reiterates the need, first set forth in *The Computer-Based Patient Record*, to make use of information technology as an “enabler” in the service of patient care [2, 21, 22]. It is our position that to achieve the goal of significant error reduction, a computer-based patient record (CPR) is essential. The use of a CPR is mandatory because of the wide variety of medical errors that can occur and the broad set of tools and capabilities needed to enable a care delivery organization to detect, correct and compensate for errors across this diverse environment.

According to Gartner, Inc., CPR offerings can be defined by five separate generations of CPR systems based on the progressive capabilities they offer. First-generation CPRs are simple systems that provide a site-specific encounter solution to the need for access to clinical data. Second-generation CPRs are basic systems that allow clinicians to document care adequately. Third-generation CPRs include episodic as well as encounter coverage and must work in ambulatory and acute-care settings.

Fourth-generation CPRs are more complex, with integrated documentation, workflow and decision support, and must cover more than just the ambulatory and acute-care settings. Fifth-generation CPRs are complex, fully integrated systems crossing the continuum of care designed to be used by healthcare providers and healthcare consumers. Currently, vendors are predominately delivering Generation 2 products. Since different CPRs offer different sets of capabilities, it is reasonable to ask: “What degree of error reduction should one expect to be able to achieve with various generations of CPRs?”

Figure 1 gives a high-level answer to this question. Each of the five generations of CPRs is plotted on a graph. On the horizontal axis is the anticipated time when such a system will become available. On the vertical axis is the projected efficacy of that generation in reducing medical errors. Note that the vertical axis deals with preventable errors not total errors. The 1999 IOM report estimated that roughly 70% of medical errors are preventable. It is important to note that no CPR system, regardless of how sophisticated, can be expected to eliminate errors completely.

In order to estimate the error reduction potential of different CPR generations, the

types of errors reported in the IOM report were analyzed and combined with the minimal features required for each CPR generation.

## 8. Evidence to Support the Use of Technology

While the CPR is the best technology used for overall error reduction, there is evidence that components of the CPR can result in definite improvement in patient safety. Clinical information systems will be some of the most important developments in the next few years leading to error reduction [23]. In the U.S. the development of the national health information infrastructure will play a major role in supporting interoperability needed to bring the Electronic Health Record into wide use [24].

### 8.1 Physician Order Entry

A Computerized Physician Order Entry (CPOE) system can reduce the potential

for error in increasingly complex CPR environments by ensuring that orders are more legible, complete, and appropriate [25]. However, when CPOE is combined with clinical decision support to identify serious potential complications, including drug-drug interactions, potentially life threatening allergies and conditions that require different treatment options, only then the true benefit of a CPOE system can be realized [26, 27].

In addition to the information in Table 1, the following references provide us with demonstrated benefits derived from the use of enabling technologies towards a safer environment for our patients:

- 55% reduction in serious medication errors as a result of computerized physician order entry [25].
- Utilizing standardized care processes guided by computer reminders resulting in improved outcomes of care at a reduced cost [28, 29].
- There is also more and more evidence that these enabling technologies can indeed reduce patient stays in hospitals and reduce the cost [30, 31].

### 8.2 Computerized Alerting Systems

Alerting systems are a type of clinical decision support. By notifying physicians about likely adverse events at the time those events actually occur, online alerts can improve the timeliness of response [26]. The end results: fewer errors, improved quality of care, and better patient outcomes. The challenge has been to deliver the message in real time to the physician responsible for the patient so that he or she can take timely and appropriate action. Messages on computer terminals, e-mail, and flashing lights have all been tried and can be effective.

Evidence:

- E-mail alerts to physicians on markedly abnormal lab values in patients receiving drugs affecting kidney function resulted in medications being adjusted or discontinued 21.6 hours earlier than when no email was delivered [32].
- Paging clinicians about “panic” lab values decreased time to therapy by 11% and mean time to resolution of an abnormality by 29% [33].

**Table 1** Documented results at institutions using computerized physician order entry

Institution	Documented Results
Brigham and Women's Hospital, Boston, Massachusetts	<ul style="list-style-type: none"> <li>● 55% drop in serious medication errors</li> <li>● 83% reduction in error rates</li> </ul>
Ohio State University Medical Center, Columbus, Ohio	<ul style="list-style-type: none"> <li>● Average length of stay down by 2 days</li> <li>● Turnaround for pharmacy orders 2 hours faster</li> <li>● Pharmacy charges down \$910 per admission</li> </ul>
Montefiore Medical Center, New York, New York	<ul style="list-style-type: none"> <li>● Medication errors down 50%</li> <li>● Turnaround for pharmacy orders 2 hours faster</li> </ul>
Regenstrief Institute for Health Care, Indianapolis, Indiana	<ul style="list-style-type: none"> <li>● Average length of stay down 0.9 days</li> <li>● Average hospital charges down 13%</li> </ul>

Sources: On the Brigham: Bates DW, Miller EB, Cullen DC, et al. Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. *JAMA* 1998;280(15):1311-6. Bates DW, Miller EB, Cullen DJ, et al. Patient risk factors in hospitalized patients. *Arch Intern Med* 1999;159:2553-660. On Ohio State: California HealthCare Foundation. *A Primer on Physician Order Entry*. California: CHCF, 2000. On Montefiore: Beers J, Berger M. Medical errors: Sources and solutions. *HIMSS Proceedings 2001, Session 17, CD version*. On Regenstrief: Tierney WM, Miller MD. Physician inpatient order writing on microcomputer workstations: Effects on resource utilization. *JAMA* 1993; 269:379-83.

## 9. A New “Culture of Safety”

We need to develop a “culture of safety” requiring an entire change in behavior and attitude of the healthcare worker. A very valuable lesson was learned through the unfortunate death of a Boston Globe medical reporter, Betty Lehman, in 1994, which awakened a major set of government hearings in the U.S. Ms. Lehman was given a mega dose of a cancer drug, which resulted in her death, at the famous Dana Farber Cancer Institute in Boston, Massachusetts. This event, in addition to the publication of the IOM study entitled “To Err is Human: Building a Safer Health System” gave the healthcare industry a wake up call [1].

The IOM report challenged the healthcare system to reduce medical errors by 50% within the next 5 years. These are the recommendations:

- Creating a Center for Patient Safety;
- Mandating a reporting system for medical errors;

- Encouraging voluntary reporting;
- Providing greater legal protection for data collected for patient safety and quality improvement purposes;
- Promoting performance standards (people and organizations) that emphasize safety; and
- Emphasizing safe use of drugs through the Food and Drug Administration (FDA).

During the past year, major efforts have been initiated by the government to recommend standards and move towards the encouragement of a national Electronic Health Record [34]. Bar coding is seen as a major move in the right direction in error reduction [35-37] as is POE and medical vocabularies [2].

## 9.1 Medical Error Reporting Systems

Medical error reporting systems link hospital-based systems to larger data repositories, allowing individual hospitals to benchmark their performance against other provider organizations and to determine how much errors cost and affect patient outcomes [38].

## 10. Conclusion

The current situation regarding patient safety is unacceptable. In addition to the high mortality and morbidity associated with medical errors, there are numerous "secondary" costs. Clinical outcomes are poor because of complications and injuries associated with medical mistakes. This clearly leads to patient dissatisfaction and yields dissatisfaction on the part of caregivers who are unable to provide the quality of medical care they desire because of the limitations of inadequate healthcare automation systems.

Serious errors can also lead to malpractice suits with the concomitant risk of financial losses, as well as injury to the institution's reputation. The challenge of patient safety is twofold. More adverse events must be identified, including those

without dire consequences, and the number of preventable adverse events that result from such errors must be reduced.

Health care has been slow to see that the enabling technologies make the required changes healthcare organizations need as we have entered the new millennium. We will eventually reap the benefits from a major change in changing the current "culture" to a culture of safety. We will see a major process change as a result of the new enabling technologies. We will see new partnerships among the providers, the patients and the payers. Major changes are afoot in our society. The future is bright! We have just seen the dawn of the day. Information technology will play a definite role as an enabler. Healthcare providers must decide how it will be used most effectively and consistently to provide the best possible care for those in need.

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