

# Enabling technologies promise to revitalize the role of nursing in an era of patient safety

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## Abstract

The application of information technology (IT) in health care has the potential to transform the delivery of care, as well as the health care work environment, by streamlining processes, making procedures more accurate and efficient, and reducing the risk of human error. For nurses, a major aspect of this transformation is the refocusing of their work on direct patient care and away from being a conduit of information and communication among departments. Several of the technologies discussed, such as physician order entry and bar code technology, have existed for years as standalone systems. Many others are just being developed and are being integrated into complex clinical information systems (CISs) with clinical decision support at their core. While early evaluation of these systems shows positive outcome measurements, financial, technical, and organizational hurdles to widespread implementation still remain. One major issue is defining the role nurses, themselves, will play in the selection and implementation of these systems as they become more steeped in the knowledge of nursing informatics. Other challenges revolve around issues of job satisfaction and the attraction and retention of nursing staff in the midst of a serious nursing shortage. Despite these concerns, it is expected that, in the long run, the creation of an electronic work environment with systems that integrate all functions of the health care team will positively impact cost-effectiveness, productivity, and patient safety while helping to revitalize nursing practice.

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## 1. Introduction

According to studies conducted in the mid-1990s by Clarian Health Systems, nurses spend the majority of their time in activities other than the one they most value, direct patient care. From 1994 to 1996, researchers

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at Clarian conducted 1000 h of continuous videotaping on a medical surgical unit in 12 h segments. They discovered that, on average, direct patient contact occurred between 20 and 50 min per patient over a 12 h period, with the median being 20 min. Clarian's report shows that nurses spent the remaining time on other functions, primarily managing and coordinating the communication of patient information to other departments, physicians, or members of the health care team [1].

The scenario depicted in this study should not come as a surprise. While traditional tenets call for nurses to play a pivotal role in the direct care of patients, the inefficiencies of our current health care system are such that the nursing role has become increasingly peripheral to this objective. Not only have nurses' cognitive capabilities been put in jeopardy, but other elements in the health care work environment are also contributing to nurses' growing dissatisfaction with their jobs. There is also evidence that this issue is international in scope. According to a recent study of nurse satisfaction in five countries, nurses leave the profession when they perceive that system inefficiencies compromise the quality of care they are able to give [2]. Compounding the issue is the responsibility for patient safety, which has become a renewed priority for all members of the health care team. Yet despite this seemingly bleak outlook, the signs of change are positive as all players in the health care industry respond to the growing pressure to reduce medical errors, increase the quality of patient care, and improve the working environment. A major factor in these efforts is the deployment of information technologies (IT) that promise to streamline processes, make procedures more accurate and efficient, and drastically reduce the risk of human error.

## **2. Legislative and industry initiatives**

Legislative and industry efforts have been instrumental in providing the impetus for these technology initiatives. The most recent is the passage of Maryland's Senate Bill Number 46 (SB 46) in February, which requires a statewide commission to convene a summit to address issues affecting the nursing shortage, namely recruitment, education, and retention. The bill also requires the identification of technology-driven, point-of-care (POC) applications that maximize productivity and contribute to patient care and an improved work environment for nurses [3].

On the federal legislative front, the Medication Errors Reduction Act of 2001 (S824.IS), which was introduced by Senators Bob Graham (D, FL) and Olympia Snowe (R, Maine) and is currently in committee, calls for making available \$97.5 million in grants to hospitals and skilled nursing homes each year for the next 10 years. These funds would help offset the costs of implementing clinical care information systems designed to improve patient safety and to reduce adverse events resulting from medication errors [4].

Two Institute of Medicine (IOM) reports also have been instrumental in providing the impetus for these incentives. "To Err Is Human: Building a Safer Health System," which was released in 1999, thrust the issue of medical errors into the spotlight with unprecedented attention [5]. The second IOM report, "Crossing the Quality Chasm: A New Health System for the 21st Century," released in 2001, specifically addressed the need for industry to adopt IT and to fundamentally restructure itself in order to achieve a 21st century health care system that is evidence-based, patient-centered, and systems-oriented [6].

Further support was granted last year by the health care panel of PITAC, the Presi-

dent's Information Technology Advisory Committee, which concluded in its report that "Significant improvements [in health care] would be possible if modern clinical information systems were widely implemented and a sound national health information infrastructure were in place." The panel also put forth a series of challenges, including the need for a national vision and an infrastructure that supports a standardized approach to health records, billing, and the concept of a person-based medical record. At the organizational level, the panel called for a commitment for using IT strategically in health care in a way comparable to how it is being applied in other industries such as banking and manufacturing [7].

A significant industry initiative has been spearheaded by the Leapfrog Group, a major advocate of the use of IT in health care. This group, which is sponsored by The Business Roundtable, is comprised of 86 Fortune 500 businesses that purchase more than \$45 billion in health care benefits annually for more than 20 million Americans. The Leapfrog Group has identified certain requirements on which they will base purchasing decisions for health care, including the use by providers of technologies that incorporate computerized physician order entry, medication administration at POC, evidence-based hospital referral, ICU staffing by physicians trained in critical care medicine, and adherence to the guidelines of the Institute of Safe Medical Practices. In addition, Leapfrog member companies are creating incentives by providing higher payments to those health care organizations that use these technologies [8].

### 3. Technologies transform the delivery of care

Many of these technologies have existed as standalone systems for several years; others

are just being developed and are being integrated into highly complex clinical information systems (CISs). Among the most prevalent standalone systems are computerized provider order entry (CPOE), the computerized patient record (CPR), and bar code technology, which is used to verify patient identification, track and dispense medication, and gather blood specimen information.

Systems, such as CPOE, whereby a provider enters orders online directly to the pharmacy, are highly useful in helping reduce medication errors. They are particularly valuable to nurses since nurses are the ones who are usually required to transcribe handwritten orders. At least half of adverse drug reactions are attributed to errors during the prescription order entry process, and it is estimated that every time an order is transcribed, a 15% chance of error is introduced. CPOE eliminates these pitfalls by putting accountability in the hands of the provider issuing the prescription.

When integrated as part of a CIS, CPOEs have been shown to dramatically reduce medication errors and improve the delivery of health care. At Brigham and Women's Hospital in Boston, for example, an 88% drop in serious medication errors has been reported [9]. At the Ohio State University Medical Center in Columbus, pharmacy charges have been decreased to \$910 per admission, and turnaround time for pharmacy orders is 2 h faster [10].

These benefits notwithstanding, CPOE systems have had setbacks, with impediments related to cost and organizational issues. On the cost side, software alone can cost \$2–3 million plus \$2–3 for training for every dollar invested. Implementation itself can take up to 2 years, aggravated at times by physician reluctance or by a lag in technology in the pharmacy area [11]. Other organizational issues revolve around implementing the pro-

cess correctly, i.e. making sure that a provider does not write out a script by hand and then hands it over for entry to a nurse or clerk. Efficiency with CPOE can only be achieved if the standard and accepted practice is for the physician initiating the order to enter the prescriptions directly online with the stipulation that handing it off to another person to do is unacceptable. This often requires mandates at the organizational level such as at the National Institutes of Health where the self-entry of orders is the only way that orders can be handled.

It should be noted that hospitals that have been most successful in implementing CPOE have cited their ability to take away the barriers to the system that were making physicians feel uncomfortable using it. Other physicians advise that in order to get the most out of CPOE, it should not be implemented just for the sake of automating medication ordering, but it should be integrated with decision support, warnings, and best practice guidelines [12].

#### **4. The move to clinical integrated systems**

It is the concept of integrating these capabilities that forms the foundation for today's CISs. Integration leverages the power of technologies such as clinical decision support that allows for rules checking and "push" technology that "pushes" suggestions to all levels of clinicians. In addition to clinician order entry, components of these technologies include:

- interactive clinical data repository systems that support integration and sharing of data among applications;
- multidiscipline documentation, which allows for the integration of documentation from various departments;

- POC devices, which can be mobile, stationary, or handheld, and which provide user access to patient documentation and allow for the gathering of information from data repository, via the Internet, or from other sources.

These systems are highly valuable in preventing errors of omission and providing safeguards in medication administration. POC solutions, in particular, allow nurses to verify against the five "rights," i.e. the right patient, medication order, dose, route, and time. Most POC systems that are integrated with physician order entry and pharmacy systems also have interaction checking alerts, dose checking, and lab rules alerts. These latter alerts display to the nurse and assist in catching medication errors. CPOEs can also be integrated with an online physician desk reference (PDR) and perform automatic checks on drug interactions.

In these systems, the medication administration record (MAR) is automatically populated by provider order entry or modifications made in the pharmacy in real-time. Such integration between the provider's order, the MAR, and the pharmacy system eliminates the time needed to recopy the MAR, prevents the risk of information being out of sync with the pharmacy's MAR, and eliminates the risk of transcription errors.

As valuable as the benefits of the POC medication administration system are, however, a key element to its success is that each member of the team—physician, pharmacist, and nurse—works in real-time. Scenarios that emerge in root cause analysis of adverse drug errors—such as orders that do not make it to the pharmacy due to lost faxes or pneumatic tubes, order corrections, or modifications that are printed in pharmacy but are not seen until after the medication has been administered—literally disappear.

Another significant factor is the potential these systems have for removing a major obstacle to nursing productivity in acute care—getting timely responses from pharmacy on medication orders. Pharmacist shortages are acute in various parts of the US, and together with multiple-step work processes, delays are not uncommon. In many hospital organizations, the time delay between a medication order being placed and the nurse receiving the medication can range from 2 to 6 h. A study conducted by a large integrated delivery network (IDN) in the northeast identified pharmacy issues as the most common obstacle to productivity by the majority of nurses surveyed. In a follow-up 20 h observational study of a busy transplant unit, in only one instance were all the necessary drugs in place for a given patient [13].

## 5. Integration at work: Our Lady of the Lake

Although the deployment of integrated CISs is still in relatively early stages, organizations that have adopted them, such as Our Lady of the Lake Regional Medical Center (OLOL) in Baton Rouge, Louisiana, are beginning to realize payoffs in terms of productivity, patient safety, and nurse satisfaction. OLOL has been using informatics to drive the delivery of care since 1993 when it started out with a system that allowed nurses to enter documentation online and made 85% of the patient medical record accessible online. The system, however, did not offer enterprise-wide integration; so, areas such as laboratory, clinical documentation, order management and results reporting, and pharmacy could not interact and share patient data and best practices information. OLOL turned its sights to integrated solutions that would make available advanced capabilities to all clinicians such as a clinical data repository, rules

engines, and decision support tools. The goal was to drive out variances, standardize care, and use clinical protocols.

Substantial workflow redesign was needed in order to provide physicians with online access to patient charts, the ability to capture vital signs at point of care, I/O and weights, and medical order alerts. The objective of patient safety cut across all clinical tasks with a heavy emphasis on embedding rules and alerts in nursing documentation, lab tests, and pharmacy orders. The functionality of the initial system, which rolled out in late 1999, included wireless laptop devices that nurses could use for POC documentation, a clinical repository for access to the electronic medical record, and a pharmacy system with a reference database that would enable checking for drug–drug interactions and adverse drug event (ADE) rules.

The ADE package is a set of 20 rules that check a patient's age, weight, and gender against other captured patient data including lab values, medication orders, and radiography contrast media. The ADE rules set targets the most common causes of mortality and severe morbidity and is based on research completed at Banner Health Arizona, which was published in the *Journal of the American Medical Association* in 1998 [14]. Additional rules were built specifically to identify patients at risk for falls, pressure ulcers, and other medical errors, and to mitigate the chances of these patients sustaining harm due to error. When one of the rules set appears to be compromised, the system fires an alert from the clinical documentation that triggers care protocols with orders simultaneously deployed to multiple departments that may require a response, e.g. dietary control, central supply, nursing, or the physicians themselves.

Fig. 1 shows a summary of the 95 rules used across all clinical areas at OLOL over a 12-month period, including nine related to phar-

## LOL's Rules Hospital-Wide -- 1 Year

Summary of rule firings: November 11, 1999 – November 10, 2000

Domain	Rules	Firings	Mean
Blood Bank	28	1905	68
Chemistry	5	272	54
Clinical Services (Outreach)	3	14,387	4,796
Hematology	19	68,780	3,620
Microbiology	15	24,079	1,605
Nursing	8	10,841	1,355
Nutrition	2	7,543	3,772
Pharmacy	9	28,348	3,150
Physical Medicine	6	1,281	214
<b>TOTAL</b>	<b>95</b>	<b>157,436</b>	<b>1,657</b>

Fig. 1. A summary of the 95 rules used across all clinical areas at Our Lady of the Lake over a 12-month period. Nursing used a total of eight rules and experienced rules firing 10,841 times per year for an average of 30 rules triggered per day.

macy and eight to nursing. Fig. 2 details the nursing documentation categories within which rules were fired. Over the 12-month study period, LOL's falls rate decreased from 4.45 to 3.70 falls per 1000 in-patient days. Before the study, the risk of pressure

### LOL Use of Rules in Nursing Documentation

November 1999 to November 2000	
<b>8 Rules:</b>	
◆ Conley Scale for Falls <ul style="list-style-type: none"> <li>■ Scale used = 50,134</li> <li>■ Actions Triggered               <ul style="list-style-type: none"> <li>level 2 risk = 5,235</li> <li>level 3 risk = 7,413</li> </ul> </li> </ul>	◆ Admission Assessment <ul style="list-style-type: none"> <li>■ 2, 198 alerts fired</li> </ul>
◆ Braden Risk for Pressure Score <ul style="list-style-type: none"> <li>■ 5012 at risk detected</li> </ul>	◆ Deaf Patient alert to Social Service & Nursing = 182
◆ Pressure Ulcer alert to ET <ul style="list-style-type: none"> <li>■ 1,116 Pt detected at admission</li> </ul>	◆ Discharge Assessment Needs, Homeless = 186
	◆ Foreign Language alert to Social Service & Nursing = 177
	◆ Persistent Cough >3 wks alert to Infection Control = 1,970

Fig. 2. The nursing documentation categories within which rules were fired over the 12-month study period at Our Lady of the Lake. Risk for falls and pressure ulcers were the two most frequent areas for rules to trigger. Other important benefits to patient safety initiatives included better efficiency in discharge planning, improved delivery of services for deaf patients and non-English speaking patients, and most importantly, increases in patient satisfaction ratings.

sore prevalence during a hospital stay was estimated at about 9%, and with the rules-supported documentation, incidence within the group identified as at risk ( $n = 5012$ ) was reported as less than 1%. The impact of clinical decision support embedded in nursing documentation is evident in positive outcome measurements and in strong endorsement by nursing staff.

Positive results were also manifest both in terms of cost-effectiveness and productivity. Cost avoidance savings for pressure ulcers were estimated minimally to be about \$150,000, using the cost statistic of \$2000 added cost per pressure ulcer occurrence. LOL also found significant time savings in assessment documentation by nursing. Two years after initial implementation, the LOL team took advantage of a planned systems downtime to measure the time difference for documentation between manual and automated methods. The time studies were performed on the same unit and the same shift over 2 days. Significantly, nurses required 11.4 min more to complete their documentation manually than to do the same documentation using the system. Just as important, however, nurses complained that the loss of system reminders for work organization negatively impacted their productivity due to the need to do repeated checking on the paper chart [15].

Meanwhile, at LOL, the second phase for documentation rollout went live in late February 2002. It focuses on the use of "push" technology in its POC system to put all members of the care delivery team in real-time contact with the electronic medical record. Using a laptop or handheld device, the provider uses the system to keep in touch with the status of each patient and to determine what needs to be done for the patient at that time. Based on the provider's assessment of the patient, the system will "push" suggestions, warn of potential problems, and suggest

standards of care that represent best practices. When scheduled tasks start to become overdue, the system also sends out reminders; so, nothing is missed by omission.

For nurses, the greatest advantage is having accessibility to a system that provides them with alerts about new orders, new results, and new test procedures. If a new lab result comes in, they are immediately notified, and they can see at a glance if it is abnormal. This prevents duplication of orders as well as of scheduling procedures. The system also tells nurses if a patient is at risk for fall or skin breakdowns, and so they can deploy necessary interventions. It also prevents nurses from having to run back to the station to constantly refer to the patient's chart.

Nurses have responded very well to these systems claiming that it makes their jobs more efficient. Previously, bedside clinicians had to add up risk orders, add up numbers, and then remember to call a department and remind them they had a patient to see. Now the nurse just collects this information knowing that the system is driving the information to another colleague or department.

## 6. Looming challenges

While integrated solutions, such as those applied at OLOL, hold great promise, statistics indicate that widespread implementation of computerized health care systems is still a long way off. Of approximately 7000 hospitals in the US, only about 200 per year are taking the leap forward to incorporate enabling technologies. Only about 4% of hospitals actually have a clinical data repository system, and only about 1–2% of the physicians in those organizations actually access the electronic chart [16]. Compounding the challenges is the expense and the organizational com-

plexity involved in implementing these systems.

Additional challenges also remain at the technical, educational, and organizational level. On the technical front, true efficiency in health care, reduction of medical errors, and safe patient care practices will not be realized until the industry is able to manage data at the clinical process level. This involves being able to get down to day-to-day causal relationships in the continuum of care in order to determine what works and what does not, where processes fall apart, and how to improve the overall process. Unfortunately, although the industry has done a reasonable job in capturing data from physiological monitors and the like, several barriers exist that make the capture of clinical process data difficult. A primary constraining issue is the lack of standardized representations of clinical processes and actions, particularly the absence of representation of nursing interventions, outcomes, and diagnoses.

While many may fail to see the importance of these formalized representations, one need only to consider a major point made earlier in this paper. While nurses play a pivotal role in the patient care and the prevention of adverse events, the nursing role often is not formally represented when it comes to studies of outcomes, effectiveness, efficiency, and patient safety. Patient care is a team process, with all members of the team making contributions to patient outcomes, both in a positive and in a negative manner. The inability to examine the impact that nursing makes in the process of patient care (and its subsequent impact on cost and outcome) grows progressively more unacceptable. This lack of acknowledgement also contributes to the concept of nursing invisibility, which has been demonstrated to impact job dissatisfaction, and in turn, retention of nursing staff. To be fair, it must be said that the nursing profession, itself, has been

unable to arrive at a consensus on how to represent the practice in automated systems, although some progress is occurring. Nursing itself may need additional governmental pressure to resolve this longstanding issue.

## 7. Making nursing more rewarding

The industry, in general, also faces the challenge of making nursing more rewarding, and not only financially. The Aiken study, mentioned previously, has shown that job dissatisfaction is not an issue limited to nurses in the US. In this survey, which was conducted in five countries, 30–50% of the respondents indicated that they plan to leave their jobs within a year. In the US, where salaries average \$20 per hour, compensation is also of concern, but it is not always the overriding factor affecting job satisfaction. A group of nurses recently told a House committee that eliminating mandatory overtime, setting a better nurse-to-patient ratio, and giving nurses a voice in hospital policy would be more effective than merely increasing pay [17].

A study of Magnet Hospitals, conducted by the American Academy of Nursing in 1983, clearly confirms the premise that nurse satisfaction, retention, and quality of care is tied to professional self-governance. This study specifically showed a correlation between nurse satisfaction and hospital organizations where nursing leadership is supported and fostered at the Board and executive levels. Over the past 25 years, Magnet Hospital organizations across the country have consistently outperformed peer organizations on morbidity and mortality rates, as well as on nurse retention rates [18].

Closely connected to the issue of job satisfaction is the role education plays both in attracting and retaining nursing candidates.

Health and Human Services Secretary, Tommy Thompson, recently announced the award of more than \$27.4 million in nursing scholarships and educational loan repayments for nurses in areas experiencing shortages. A bipartisan bill currently in the house is also slated to provide nearly \$350 million for scholarships for nurses willing to work in these underserved areas.

Beyond basic education, however, knowledge of nursing informatics also promises to empower nurses to become influential players in a transformed all-electronic work environment. Although the number of current nursing informatics programs is small, more nurses are joining the ranks of informatics specialists. A career outlook special section in the November 2000 issue of *US News and World Report* classifies informatics specialists as a one of the top five careers in health care [19]. A steady increase in Nursing Informatics Certification by the American Nurses Credentialing Center (ANCC) is also being noted. Since 1995, more than 500 nurses have achieved ANCC certification in the specialty of nursing informatics. Dozens of nursing informatics programs also have sprung up across the country, running the gamut from online courses to undergraduate and graduate courses [20].

While it is gratifying to see nursing students move into this leading-edge field, it is even more rewarding to see them move beyond the concepts of computing into the bigger picture, understanding how clinical decisions are made and how resources are allocated. It is an enormously satisfying moment when nursing students make the connection to what a particular set of data means, how data drive decisions, and the understanding of what the data actually represent. When they pull up a data set, and it suddenly dawns on them that “nursing” is invisible, they come to the realization of why it is not included in the

decision-making process. At that point, they are in a much better position to begin to make a difference.

As IT continues to be deployed across the health care system, organizations, like OLOL, are paving the way to greater visibility for nurses by endowing them with a leadership role. At OLOL, it is the role of the chief nurse and chief medical officer to be aware of issues, such as the IOM standards, to determine where the institution falls in terms of its performance and to deploy strategies to bring it up to par. Nursing participation also helps provide vision and goals, and it ensures that the nursing component achieves its full potential.

Many vendors also are beginning to seek out nursing input for their projects. The product management team that implemented the project at OLOL included senior nursing leadership and extensive nursing involvement. Today, it is not unusual to see clinical system implementation efforts that are led by the organization's Chief Nursing Officer (CNO). This is a dramatic change from even 10 years ago when CNOs, themselves, did not see the relevance of these computer projects to nursing.

Health care luminaries, like Lucian Leape, have long realized the importance of extending the teamwork concept to include the nursing component. He observed recently that teamwork is essential, and that it is important to improve interpersonal relationships among care providers. This includes giving nurses appropriate responsibility and authority and the time to carry out those responsibilities [21].

Although incorporating and integrating IT into health care systems will be a work in progress for a long time, it is expected that the long-term payoff to the nursing community will be positive. As they move into an electronic environment, nurses can be freed

up to do the work that only they can do. They can give up their roles as functional workers, return to positions of knowledge, and gain more time for direct patient care. Enabling technologies may very well help create a win-win situation for the nurse as well as for the patient.

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