



The Nursing Shortage: Can Technology Help?

The Nursing Shortage: Can Technology Help?

Prepared for:

CALIFORNIA HEALTHCARE FOUNDATION

Prepared by:

First Consulting Group

Authors:

Joanna Case

Mychelle Mowry, R.N., M.N.

Emily Welebob, R.N., M.S.

Acknowledgments

First Consulting Group is a leading provider of consulting, technology and outsourcing services for health care, pharmaceutical and other life sciences organizations in North America and Europe. More information about FCG is available at www.fcg.com.

The authors would like to thank the following people associated with First Consulting Group for their time and input: Erica Drazen, Katy Gladysheva, Judy Joy, Linda Lockwood, Keith MacDonald, Jane Metzger, Debbie Slye, Dona Stablein, Steven Vowels, Shelli Williamson and the Scottsdale Institute.

In addition, the following individuals were helpful in providing input and generating contacts: Elaine Batchlor, M.D., California HealthCare Foundation; Susan Fletcher, Pyxis Corporation; John Haughom, M.D., PeaceHealth; Linda Miller, Johns Hopkins Bayview Medical Center; Marcy Mishiwiiec, CliniComp International; Matthew Morgan, M.D., and Angela Jenkins, Per-Se Technologies; Marge Pike, Sigma Theta Tau; Harris Stutman M.D., Eclipsys Corporation; Amy Vance, VasTech, Inc.; and Robert B. Zaleski and Mary S. Zeringue, Alaris Medical Systems.

Thanks also to reviewers Kathleen Charters, Therese Morley, and Jean Ann Seago, as well as Elaine Batchlor, Sam Karp, and Tom Lee of the California HealthCare Foundation.

The **California HealthCare Foundation** (CHCF) is an independent philanthropy committed to improving California's health care delivery and financing systems. Our goal is to ensure that all Californians have access to affordable, quality health care. CHCF's work focuses on informing health policy decisions, advancing efficient business practices, improving the quality and efficiency of care delivery, and promoting informed health care and coverage decisions.

The iHealth Reports series focuses on emerging technology trends and applications and related policy and regulatory developments.

Additional copies of this report and other publications in the iHealth Report series can be obtained by calling the California HealthCare Foundation's publications line at 1-888-430-2423 or visiting us online at www.chcf.org.

ISBN 1-932064-00-1

Copyright © 2002 California HealthCare Foundation

Contents

5 I. Why This Research Was Conducted

The Nursing Shortage: Setting the Context

Shortages May Compromise Patient Safety

The Benefits of Successful Technology
Implementations

9 II. Systems to Support Nurses

Administration: Staff Scheduling

Communication

Clinical Decision Support

Medication Management

Documentation

Access to Information

21 III. Technology and Financial Considerations

23 IV. Insights from the Front Lines

26 V. Conclusions: Implications for Recruitment and Retention

28 Appendices

Appendix A: Interviews

Appendix B: Vendor references

Appendix C: Glossary

34 Endnotes

I. Why This Research Was Conducted

Throughout this report, nurses and industry experts respond to the question, “How can technology best be used to support nurses?”

“With many experienced baby boomer nurses leaving front line clinical care and more traveler and younger nurses joining staffs, it becomes especially important to goof-proof the health care system and systematize different processes.”

—Nurse, large California Hospital

TODAY’S HOSPITAL ENVIRONMENT IS MARKED by rising patient acuity, staffing difficulties, and burdensome paperwork—all factors that contribute to the stress often cited by nurses as their reason for leaving the inpatient setting. With a worsening shortage of nurses, health care organizations must seek out a variety of solutions, including technology systems, to enhance nurse efficiency and satisfaction.

The California HealthCare Foundation (CHCF) commissioned First Consulting Group (FCG) to explore how technology solutions can, and do, support nurses. FCG employed industry, client, and vendor contacts to connect with nurses, as well as clinical and IT staff at hospitals where technologies have been deployed. In all, 26 interviews were conducted, representing 19 hospitals and health systems, two experts from nursing schools, two experts from nursing associations, and one state senator. The interviews consisted primarily of open-ended questions to assess the impact, benefits, and challenges these systems posed for nurses and organizations.

The Nursing Shortage: Setting the Context

Current estimates of the nursing shortage suggest that average hospital vacancy rates are well over the 10-percent mark: In 2001, a major survey found national vacancy rates of 13.0 percent for registered nurses, 12.9 percent for licensed practical nurses, and 12.0 percent for nursing assistants.¹ This shortage will grow to unprecedented proportions; one expert predicts the national shortfall will reach 500,000 nurses by 2020.² The state of California—which has the lowest number of registered nurses per capita—will need at least 60,000 (31 percent more) nurses by 2020 to maintain current levels.^{3,4} As has been amply described in recent literature, the demand for nurses is increasing due to the rise in older and sicker patients and the greater complexity of care, while the supply of nurses is diminishing. The aging nurse population is one factor; by 2010, more than 40 percent of registered nurses will be over the age of 50,⁵ but as these nurses retire, they are not being replaced with new recruits. In order to mitigate the effects of the shortage on patient care, hospitals must find ways to increase nurse efficiency and satisfaction. (For more background on the nursing shortage, see *Understanding California’s Nursing Crisis* and related links at www.chcf.org/topics/view.cfm?itemID=19638.)

Experts speculate that other reasons for the decreasing supply of nurses include: (1) expanded job opportunities for women; (2) a negative perception of the nursing profession; (3) the rise of managed care and the subsequent layoffs of nurses in the face of declining provider reimbursement; and (4) increasing frustration with working conditions in hospitals. An industry expert at the UCSF School of Nursing says nurses are dissatisfied with the lack of control they experience in the workplace; with their inability to make decisions about patient care; and with the lack of recognition of their professional status. Nationally, one study found that 50 percent of nurses have considered leaving patient care for reasons other than retirement, and more than half of these cite the desire to have a job that is less stressful and less physically demanding as the primary reason.⁶ Another study indicates that 40 percent of nurses in the U.S. are dissatisfied with their jobs and one-third of the nurses under the age of 30 plan to leave their jobs within one year.⁷ This research shows the necessity of improving hospital working conditions to prevent the continued exodus of nurses from the direct care setting. (A recent CHCF-sponsored roundtable on the nursing crisis offers a broad range of approaches to solving the nursing shortage. See *Stakeholder Perspectives on California's Nurse Staffing Crisis* at www.chcf.org for more information.)

The growing shortage poses an immediate problem for hospitals, where nurses represent more than 23 percent of the full-time workforce.⁸ In an attempt to fill vacant positions, hospitals and health care organizations are employing a variety of recruitment and retention strategies including:

- Increased salaries and benefits;
- Flexible scheduling, child care, and other employee-friendly options;
- Sign-on bonuses; and
- Traveling/agency nurses.

Although some of these measures provide valuable and sustainable benefits, others do not. Hospitals recognize that these stopgap measures are not only costly, but do not provide long-term solutions. Hospitals and other organizations are involved in a number of initiatives to attract nurses to the profession, but unless they are able to improve conditions for these new nurses, they will be unable to meet the growing demand.

The consequences if hospitals fail to meet this demand are significant. Quality of care will be compromised if nurses do not have enough time to monitor patients and perform safety checks; patient access also will be jeopardized as emergency rooms become overcrowded and hospitals close down beds. If allowed to continue, these problems will be self-perpetuating as the working environment becomes even more stressful and more nurses leave the direct care setting.

Shortages May Compromise Patient Safety

Complicating both the demand and supply side are issues of patient safety, which are of enormous concern to nurses. A landmark 1999 Institute of Medicine report estimated that between 44,000 and 98,000 patients die each year as a result of medical errors.⁹ A *Chicago Tribune* article on nursing errors, published in 2000, estimated that the actions or inaction of registered nurses resulted in 1,720 deaths and 9,584 injuries to patients since 1995. Nurses quoted in the article expressed their anxiety about patient care and their awareness that time constraints might keep them from performing safety checks and monitoring patients as vigilantly as needed.¹⁰ As front-line caregivers, nurses must cope with the consequences of medical errors no matter who or what is the cause.

It is not surprising that technology systems installed by hospitals as part of a broad quality improvement effort were found to provide significant benefits for nurses. According to one expert, many of the changes that nurses have sought in technology systems are those that decrease the likelihood of making a mistake. Although technology systems that increase patient safety and clinical quality may not always increase nurse efficiency, they can relieve anxiety and enable nurses to provide safer, better care—which has a positive impact on job satisfaction, and potentially on nurse recruitment and retention.

A *“Technology can be used to address the nursing shortage by effectively implementing standards and protocols... to impact on patient safety and outcomes.”*

—Nurse Educator

The Benefits of Successful Technology Implementations

Although numerous examples exist of technologies that have *not* been beneficial to nurses—or actually made their work more difficult—this report focuses on implementations considered to be successful by interviewees. It is not a comprehensive review of nursing technologies; rather it provides examples of how technology has been used to support nurses. Its purpose is to illustrate the possibilities and share practical information among nurses and organizations.

The report cites the experiences of health care organizations that have implemented a number of technologies that benefited nursing in key areas, including:

- Nurse scheduling
- Mobile communication
- Patient education
- Messaging functionality
- Medication administration
- Clinical decision support functionality
- Computerized physician order entry (CPOE)
- Automated nursing documentation
- Computerized patient record (CPR)/Clinical data repository (CDR)

All of these solutions required changes in workflow and clinical processes, and many required the participation of other clinicians as well as nurses. Hospitals must be sure to address financial and technical issues as a part of every technology initiative. Insight provided by interviewees can help to guide organizations that wish to use technology as part of a plan to create a culture of safety and a supportive environment for nurses.

As the shortage gets worse, hospitals will need to use every means possible to support nurses. There are far too many examples in the industry of unsuccessful implementations and poor uses of technology that have created more work for nurses. But when the right technology is successfully implemented, monitored for effectiveness, and adequately maintained, technology can make a positive difference in the patient care environment. By increasing efficiency and alleviating some of the burden on nurses, technology can free nurses to concentrate on direct care. And, *as part of a comprehensive strategy to support nurses within the hospital*, it can help make the care environment more rewarding and thus help improve recruitment and retention.

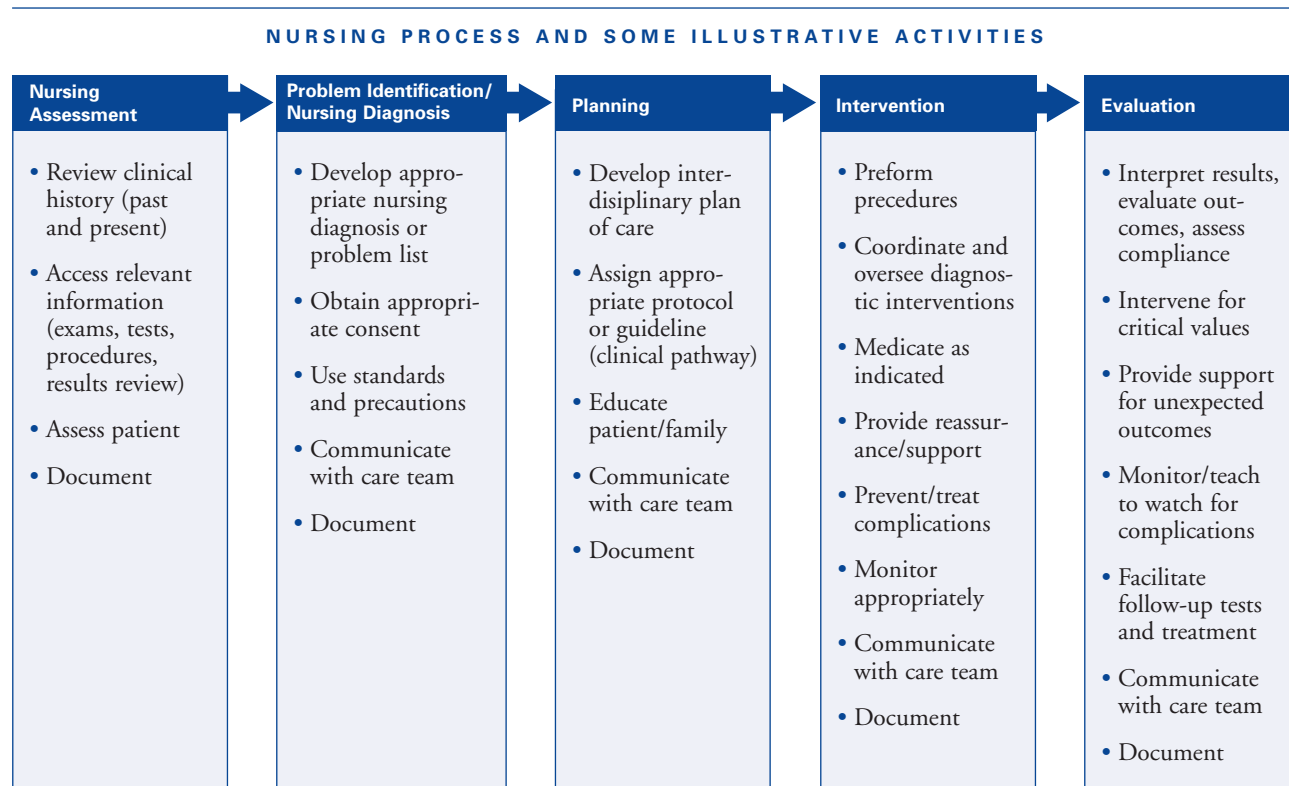
II. Systems to Support Nurses

“Since this shortage has limited the number of nurses, nurses should be gathering data through the use of technology, making decisions, and then delegating basic tasks to others.”

—Nursing Administrator,
large Eastern teaching hospital

The nursing process, as shown in Figure 1, involves gathering the appropriate information to assess, diagnose, plan, intervene, and evaluate the patient’s condition. Many organizations have technologies in place to support nurses in various aspects of the process. They cite the benefits of those systems in several functional areas, including administration, communication, clinical decision support, medication management, documentation, and access to information. Each of these areas presents opportunities for technology improvements that can make nurses more efficient and their work more satisfying—as well as safer for patients.

Figure 1. The Nursing Process



Based loosely on the five-step nursing process (Doenges ME, et al, 1995) cited in “Building Standard-Based Nursing Information Systems” Pan American Health Organization, 2001.

Administration: Staff Scheduling

Even small improvements in staff scheduling may have a big impact as hospitals struggle to ensure that they have enough nurses with the appropriate skill levels to provide round-the-clock care every day of the year. Research from the American Nurses Association as well as the Harvard School of Public Health suggests that staffing levels may affect patient outcomes of care, highlighting the importance of scheduling capabilities.^{11, 12} Enabling nurses to create schedules to suit their lifestyles is an important part of recognizing their professional autonomy, according to one expert at UCSF School of Nursing, which in turn can improve nurse recruitment and retention.¹³ The following are two examples of staff scheduling systems.

Nurse scheduling system When four units merged in the Department of Gynecology and Obstetrics at Johns Hopkins Hospital in Baltimore, Maryland, three years ago, the complexity of scheduling shifts and matching skill levels was too cumbersome to do manually. It took 40 hours each month to get the schedule in place, and even then it was not always successful. The Department of Nursing implemented the Nightingale scheduling system from VasTech because it was flexible and could meet the needs of multiple units. The system provides various tools to help manage unit scheduling, credential and certification tracking, and time and attendance.

With the Nightingale system, nurses enter their preferences for shifts via the Internet. Administrators enter the requirements for the unit, and the system then runs through algorithms to produce the schedule that best meets the needs of everyone. Producing the schedule now only takes about 10-12 hours per month.¹⁴ In addition, nurses can enter the system through the Internet and schedule at their convenience, and it “remembers” their preferences, which has helped to increase staff satisfaction with the system. The staff is reassured, knowing that nurses with appropriate skills will cover each shift.

Scheduling Web site Executives at St. Peter’s Hospital of Albany, New York asked an interesting question: Could something similar to Priceline and E-Bay help to solve the hospital’s nursing shortage? Looking to apply the success of these Internet start-ups to their own hospital, they built a Web site, RNJobs, in which nurses could bid for vacant shifts. In about two months, the hospital was ready to begin using the system on the units. They began slowly, by rolling out the system to two units in December 2000. Because the system is so easy to use, they encountered no major barriers and were able to continue the rollout.

The Web site allows nurses to go online and view shifts that have not been filled by the normal staffing process. They enter their skill-level and a bid for an hourly wage (the site lists a range of likely bids). A nurse manager reviews the bids, decides when to close the bidding, and which bids to accept. In order to ensure quality, nurses unknown to St. Peter’s Hospital must fill out an online application, take a written test, and participate in orientation before they may bid and work a shift.

Two-thirds of the users are nurses from St. Peter’s Hospital who are bidding for overtime shifts. In this way, nurses can get more work if they want it, and nurse managers no longer have to spend time calling around and posting messages to bulletin boards to fill vacancies. In addition, the Web site has become a recruiting tool for the hospital by attracting new nurses, some of whom become permanent staff members. Even temporary nurses say they feel a sense of control and belonging. The RNJobs system is one part of the hospital’s successful strategy to reduce its vacancy rate of registered nurses.

Communication

Nurses are at the center of information coordination among patients, physicians, staff, and families. They are extremely busy and highly mobile, which can create obstacles to timely communication. Delays and difficulties in communication create frustration for nurses, other clinicians, and patients, and may have a negative impact on patient care. A variety of tools, including mobile phones, patient education systems, and automated messaging and email, are used to facilitate communication.

Mobile communications. Wireless phones transmit to antennae in the units for nurses to use at Bridgeport Hospital in Connecticut. Each nurse picks up a phone at the beginning of the shift and has a regular seven-digit number to receive calls.

The system was implemented to solve several problems. First, patients complained about the noise associated with the nurse call system, which paged nurses in every room. Second, when nurses needed to reach physicians or physician offices, they had to leave the bedside to call from the nurses' station. Physicians returning calls were inconvenienced by having to wait while someone found the nurse. (This problem was exacerbated if there was a shift change or lunch break.)

With the new wireless system, nurses make and receive calls from anywhere on the unit. If a call comes in while the nurse is at the bedside, the phone vibrates, without disturbing patients. In the event of an emergency, the nurse can stay at the bedside and call for ancillary services. Nurses on the unit that piloted the system report great satisfaction with the technology.

Patient education. More than half of nurses (58 percent) reported in a national survey that at least once a week they do not have time for patient education and training,¹⁵ but at Adventist Health in California, patient education materials are accessible electronically through the Phoenix patient education system. Unlike printed materials, the electronic patient education materials can be easily modified to meet clinician and patient needs. Most are available in Spanish as well as English, satisfying patient needs and regulatory requirements. The system tracks which materials were given and by whom, as well as follow-up comprehension activities. In the acute-care environment, the system links education activities and documentation, making the education process more structured. The system has helped to improve workflow for nurses, enabling them to provide the education and support patients need.

The Phoenix system has provided greater benefits than Adventist Health anticipated; it has facilitated the transfer of information between the acute care and home care facilities, providing greater continuity and standardization.

Automated messaging Nurses spend a large portion of their time coordinating patient care services. Automated messaging—which may be a feature of clinical documentation, order entry, and electronic medical record systems—sends the needed information without extensive human intervention. Forrest General Hospital in Mississippi has found that the automated messaging functionality incorporated into their clinical documentation system has saved nursing time by improving the referral process. With the previous manual system, nurses would often have to spend time following-up on referrals to ensure that they reached the appropriate destination. Now, when a nurse documents that a patient requires assistance walking, for example, the system automatically sends a referral to a physical therapist. In this way, the system not only helps to save nurses' time coordinating services, but it also helps to ensure that the appropriate referrals are generated.

Email. As computers proliferate on hospital floors, email has become an effective communication method for nurses. Because of its asynchronous nature, nurses can communicate with one another even when they are not on the same shift or in the same department. ICU nurses at Stanford Medical Center use email to communicate with each other about problems encountered on the weekends, specific patient problems, and supply issues. The nurses even send each other kudos and feedback. Email also enables managers to communicate with and solicit feedback from many staff members at once.

Clinical Decision Support

Computer-based clinical decision support (CDS) functionality can provide access to information, generate alerts, increase access to and compliance with standards, and enable greater collaboration. CDS can be incorporated into a variety of systems to prevent errors and help caregivers adhere to standards of care—although it is not meant to override clinical judgment. A system does not have to be complicated in order to include decision support. The international nursing honors society, Sigma Theta Tau, maintains an online library so that nurses can access the latest research; and the order entry system at Vanderbilt Medical Center incorporates access to knowledge bases, including a drug database, patient education resources, nursing references, and hospital monographs.

The real power of online CDS is its ability to work in real-time, generating feedback based on the information entered into the system.

CPOE. Extensive CDS capabilities support nurses at Alamance Regional Medical Center in North Carolina through its computerized physician order entry (CPOE) system. New orders are flagged, and if a medication order is entered “STAT,” it is automatically sent to the nurse’s pager. The system has safety nets at the ready when the nurse logs on to verbally enter orders. If the name of the physician on the order does not match the name of the patient’s physician, for example, the system generates an alert. Overall, the one complaint that Alamance has received from the nurses regarding CPOE is that they wish all the physicians would use it.

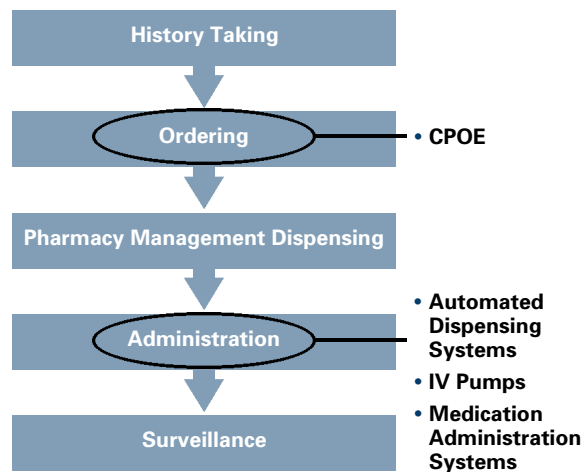
Automated nursing documentation CDS can present information in a way that supports adherence to standards and policies. One of the reasons that Forrest General Hospital implemented the Per-Se Technology's patient record system with automated nursing documentation was to improve compliance with Joint Commission on Accreditation of Healthcare Organizations (JCAHO) standards. The system provides automated reminders such as pain assessment follow-up, and helps ensure that needed information is gathered by requiring certain fields to be complete, such as the documentation required for use of restraints. Children's Hospital and Health System in San Diego noted that the ease of incorporating new standards and policies into their CDS system was a great benefit, and also increased the sense of ownership among the nurses who suggested changes.

Medication Management

Medication regimens have become more complicated, taking up more of nurses' time and contributing to medical errors. Studies indicate that 6 to 10 percent of hospital stays include an adverse drug event (ADE).¹⁶ According to a 1999 Institute of Medicine report, 7,000 deaths each year are attributable to medication-related errors.¹⁷

A variety of systems and technologies can be used to support the medication management process at the point of care. Their effectiveness varies depending on ease of use and the level of integration with other systems. When successful, these systems perform safety checks in real-time based on patient data, and are fully incorporated into workflow. Figure 2 shows an overview of the medication management process and specific technologies used to improve safety. It highlights the two areas carrying the highest risk: An estimated 49 percent of ADEs occur because of an error during ordering, and 26 percent occur during administration.¹⁸

Figure 2. The Medication Management Process in the Inpatient Acute Care Setting



Based on Kilbridge P. and D. Classen "VHA's 2001 Research Series: A Process Model of Inpatient and Information Technology Interventions to Improve Patient Safety." Prepared by First Consulting Group for VHA, Inc., 2001

CPOE has been proven to help reduce errors, but the primary benefit that organizations cite for nurses is that it enhances nurse efficiency by providing them with the information they need in a clear, legible manner. Nurses do not have to engage in lengthy transcription or verification of orders. Given that nurses often lack the time to perform safety checks for each administered dose, automating such checks at the point of decision relieves some of the burden on nurses. (See more on CPOE under "Access to information.")

"Anything to do with record keeping and orders, and communication between doctors and nurses [will help nurses]."

—Nurse Educator

The following are examples of some specific technologies in medication management.

“Smart” IV pumps. A “smart” IV pump was piloted on two units at Vanderbilt Medical Center in Nashville, where it is having a “considerable positive impact on nurse job satisfaction.”¹⁹ ALARIS Medical Systems has been working with nurses, physicians, and pharmacists there to improve the safety of IV infusion of medications. With traditional IV pumps, nurses program the dosage and the rate of administration. Linked to safety software, the Alaris Medley pump checks the nurse’s order against a database of drug information and predetermined limits that can be set for different units in the hospital. The pump alerts the nurse to any potential errors, much in the way that the CPOE generates alerts for physicians. For increased safety and ease of use, the Medley pump requires fewer keypunches and decisions than traditional pumps. One nurse at Clarian Health in Indiana notes that “A programming error is like making a typo”; the system doesn’t replace the nurse’s judgment, but guards against such inadvertent errors. (From a personal communication with Robert Zaleski, ALARIS Medical Systems, March 2002.)

Dispensing devices For other types of medication administration, a dispensing device, such as the Pyxis system, can assist nurses. Standalone systems are used to regulate access to controlled substances and provide inventory and charge functionality; as such, they have limited safety impacts. More advanced systems are most effective when tightly integrated with an order system, either through the hospital information system or the pharmacy information system, and with software to perform safety checks. A nurse at Catholic Healthcare West compared the Pyxis dispensing station to an ATM machine—the nurse requests medications for patients from the cabinet and, before permitting access, the system checks that the nurse is administering the correct medication for that patient at the correct time. At Tri-City Medical Center in California, the Pyxis stations have eliminated some of the hassles associated with medication administration. Nurses do not have to call the pharmacy to get the medications they need, and they can access drug information from the station.

One hospital, in order to make the system fit existing workflow better, bought medication carts in addition to the dispensing cabinets. Nurses took all the medications they needed for the day at once instead of returning to the dispensing cabinet for each patient. Despite its added convenience, this system introduces a step that could produce error and diminishes the benefit of the dispensing cabinet to ensure accuracy.

Medication administration systems. A more comprehensive medication administration system is a component of Per-Se Technologies' Patient1 computer-based patient record, in use at St. Francis Hospital in Oklahoma. It provides "closed-loop" medication management: Orders are placed online, routed to the pharmacist for approval and dispensing, and documented by the nurse when administered. Nurses like the system for several reasons. First, orders are legible and more timely; the instant an order is entered or changed it is available online. Second, the system features safety checks; for example, it generates an alert if a nurse attempts to administer a medication too soon. Third, the system integrates the ordering, dispensing, and administration processes.

However, it poses some problems for workflow. Nurses found the use of computers while they were preparing medications for administration disruptive. As a result, the hospital built a medication pre-administration report that the nurses generate twice a shift and use as worksheets to facilitate the process. This solved the immediate problem at St. Francis Hospital, but may not be the recommended solution for other sites.

Medication administration systems with bar-code technology. The Veterans Affairs (VA) Health System mandated the use of bar-code medication administration (BCMA) in 163 of its medical centers in 1998, and went live two years later. Tightly integrated with the CPOE and pharmacy systems, the BCMA technology uses a wireless notebook computer on top of a medication cart and a bar-code reader to enable nurses to administer medications and document online at the point of care. The nurse signs onto the BCMA wireless laptop, then uses the bar-code scanner to read the patient's identification bracelet and bring up the patient's medication record. The nurse then scans the bar code on the unit dose medication (placed there by the pharmacy); if there are any issues an alert appears. If not, the nurse administers the medication and enters any necessary notes in the system.

The Topeka VA Medical Center measured the impact of the system and found that the number of wrong medications dispensed was reduced by 75 percent, patient mix-ups by 93 percent, and dose errors by 62 percent.²⁰ Nurse focus groups agreed that BCMA is effective in preventing errors and cited specific examples of errors that would not otherwise have been caught. With the system, nurses have what they need at the point of care and do not have to interrupt medication administration. If a medication is missing, for example, they can send a message to the pharmacy immediately. On the other hand, nurses sometimes feel chained to the cart to get through a complete round of medication administration and to maintain security.

At both St. Francis Hospital and the VA Health System, implementing the medication administration system involved a great amount of change—organizational, cultural, and workflow. “It is hard to explain,” said a nurse at St. Francis, “but there is a comfort level working with what is known and familiar. Losing the paper MAR (Medication Administration Record) was disturbing to many nurses who had to learn to ‘trust’ the electronic MAR.” As difficult as the implementation was, however, nurses at St. Francis reported that the medication administration system has exceeded their expectations on their annual IS “report card.”

Documentation

Most organizations agree that documentation and paperwork demand a significant portion of nurses’ time and often take them away from the bedside. Documentation is a component of every step in the nursing process. One study estimates that every hour of patient care generates another 30 to 60 minutes of paperwork for nurses,²¹ who may spend hours at the end of the shift working overtime to catch up on it. Ideally, nurses would be able to easily record actions, interventions, and patient information in real-time as they provided care. In this way documentation would become a by-product of patient care, rather than a separate task. Automated nursing documentation systems can streamline documentation, ensuring that all the required information is gathered (and gathered only once), and can also improve the quality of patient information collected.

Nursing Assessment More than one-third (37 percent) of nurses surveyed nationally say there is not enough time to assess each patient on each shift.²² Yale-New Haven Hospital was able to reduce the time required to complete an assessment by half by using a wireless device to complete documentation. The hospital also streamlined and standardized documentation, eliminating unnecessary steps (growing concerns over liability and piecemeal growth of information systems have resulted in increased redundancy in documentation). Nurses on the unit like the system because they know exactly what they are required to document.

A “The place where technology can best be leveraged to support nurses is at the assessment and planning level... We need online decision support tools.”

—Nurse Administrator,
large, multi-state health system

***Imagine that you are a nurse, working in a hospital
in the not-so-distant future...***

- A message on your data phone indicates that a new patient, a diabetic with foot pain, is on his way to the unit from the emergency department (ED). You greet Mr. A as he arrives and complete his assessment in his room. There you pull up the nursing assessment from the ED to compare findings and avoid asking for duplicate information. Checking Mr. A's vital signs, physiological and functional status, you speak into a microphone attached to your collar. As you speak, the information populates the patient chart on the bedside monitor (use of a non-standard term causes a soft beep to sound).

Admitting orders for Mr. A's protective boot and crutches have already been transmitted; just like a FedEx package, you can log in and see that the materials are on their way. On the bedside monitor, you enter checks next to the "Physical therapy referral" and "Nutritionist referral" fields on the chart, and messages are automatically routed to the appropriate clinicians. As Mr. A recently lost some aspects of his health insurance, you schedule an appointment with a financial counselor, viewing the available time slots for financial counseling as well as Mr. A's schedule. Your admission assessment is complete (and immediately documented), discharge planning has been automatically initiated, which leaves you time to talk with Mr. A about his interests and preferences for care.
- In the hallway, you log into the computer with a swipe of your badge to confirm your schedule for the coming week (the scheduling system knows your shift preferences) and elect to pick up an extra weekend shift. You then check your email. You are pleased that there is a response from the committee on improving working conditions and regarding your suggestions for how to increase diversity among nurses at the hospital.
- You then administer medications using a cart equipped with a laptop and bar code scanner, scanning the bar code on your badge and the one on the patient's bracelet. The system confirms that you are administering the right medication to the right patient at the right time. (Any warnings about contraindications or dangers to the patient were generated at the time of ordering.) You administer the medication and document it with a single click.
- As you log on to the computer to check your worklist, a reminder appears that it is time for Mrs. B to proceed to the operating room. Based on Mrs. B's current weight, an automatic page has been sent to patient care technicians who will help transfer Mrs. B. The hospital has issued a policy for nurses to use other staff resources to help move patients in an attempt to cut down on staff injuries. Mrs. B's chart shows that all the preoperative tests, procedures, educational activities, and consents have been completed, and she appears to be calm as she leaves for surgery.
- Ms. C is scheduled for discharge shortly. In her chart you confirm that Ms. C has been educated about her condition and can monitor her own blood pressure. She does not have a computer at home, so you print out the tailored educational materials and discharge instructions for her.
- At the end of your shift, you are able to leave promptly, all documentation having been completed as care was provided. It was only a few years ago, you recall, when you spent an hour at the end of the shift just catching up on paperwork. Now you have time to complete all your documentation, to talk with your patients, and to complete required training and educational activities. You appreciate working in such a collegial, patient-centered care environment.

Online charting. The CareVue system in use at the ICU at Stanford Medical Center provides online charting throughout the nursing process. Nurses complete the admission assessment online and then can configure the individual chart to meet the patient's care plan. If a patient is on dialysis or IV infusion, the nurse indicates it in the chart; consequently, all the sections needed for documenting care for this intervention appear in the online chart. The system uses "click-and-drag" and "pick-list" functionality, which increases efficiency and standardizes terminology. The pick-lists are updated frequently.

The charting system also supports continuous patient monitoring. It "speaks" to cardiac monitors, urine collectors, and the laboratory information system, allowing the data from these sources to be captured automatically. To chart, nurses check the values that have been automatically collected from monitoring devices and accept them if correct; nurses can also add explanations if they choose. In this way, nurses do not need to enter data; they validate it. A nurse manager of the ICU hopes to continue to add other systems, such as ventilators.

Several institutions are using a particularly valuable feature of online charting that enables nurses to carry forward notes from one assessment to the next. Instead of re-writing the entire assessment, nurses can copy forward previous notes and edit them to document any changes in the patient's condition. Children's Hospital and Health System in San Diego found that this not only saves time, but also establishes an individualized baseline for each patient against which changes can be measured. However, this feature must be used with caution so that mistakes do not get carried forward as well.

"In the future, nurses could wear equipment that would record data as they speak; the information could be transmitted over a wireless network to complete documentation and be immediately available through the same device."

—Nurse/Clinical Systems Expert,
large California health system

A recent strike at a hospital demonstrated the power of automated charting to standardize documentation across care providers. One unit decided to continue using the electronic system during the strike and held training sessions each morning for new nurses. Because the system is intuitive, the new nurses were able to get up to speed and maintain high-quality documentation.

Measuring benefits of documentation systems.

In addition to providing anecdotes such as these, a few hospitals have attempted to measure and document the benefits of their automated documentation systems. At Sacred Heart Medical Center in Eugene, Oregon, a study found that overall nursing documentation time (excluding medication administration) was reduced from 24.6 percent to 18.4 percent. (From a personal communication with John L. Haughom, M.D., Peace Health, April 2002.) A study at Forrest General Hospital also found improvements in nurse efficiency. Nurses spent three minutes less on the nursing admission assessment and five minutes less on documenting shift assessment per shift. Nursing overtime was reduced by 1 to 1.5 hours per shift. Other benefits cited by the study include more rapid and effective use of allied health care referrals; enhanced documentation of patient education; elimination of redundant data entry; and safer and more efficient patient care due to the accurate and up-to-date documenta-

tion of medications and allergies, anesthesia history, and past medical history. Overall, nurses were able to spend more time delivering patient care instead of documenting it.

Non-acute care settings are benefiting from nursing documentation systems as well. Aurora Health System's 200 home care nurses use laptops to document the care they provide. The system has resulted in both productivity enhancement and increased levels of satisfaction among the nurses. Each night, the computer uploads the documentation from the day and downloads the next day's assignments and the associated records. Through this system, nurses avoid having to make a trip into a central office. The only drawback of the system is that the laptops can sometimes be awkward to use in the home; the nurses are hoping to find a smaller, more portable device that provides the screen resolution they need and is affordable.

Similarly, a California home care agency has found great success using PDAs—the system cut paperwork for its nurses in half. As word of the system spread, the number of employment applications rose by 40 percent.²³

Access to Information

Making timely information available to nurses supports high quality, knowledge-driven care, as well as efficiency. Charting systems that lack interdisciplinary documentation or integrated viewing capability require nurses to spend a great deal of time away from the bedside—ordering charts, calling other clinicians, looking for paper, or searching through screens online. Systems with clinical documentation functionality and order-entry systems can improve nursing efficiency by providing immediate online access to patient data and interdisciplinary documentation. As one expert put it, “Integration of information at the point of care frees up nurses from being data enterers to being data analyzers.”

“I think it’s to give clinical outcomes [information] to the staff.”

—Nurse Manager, mid-sized Eastern hospital

Interdisciplinary documentation. The time-savings associated with Aurora Health System's clinical documentation system have been realized because of faster access to interdisciplinary information. Nurses can get information when they need it and can document their activities. They can also track and trend data, which helps them to assess the significance of the data without looking up additional information. And, when calls come in from clinicians or concerned family members, nurses have information readily available.

The pitfall with providing greater access to information is that more information is not always better. When one organization put new monitors in an ICU to reduce staffing, the monitors actually increased the need for staff because nurses had to spend so much time sorting through data. The data must be presented in a way that is useful to nurses.

Collaboration on wound management Information technology can also help clinicians to collaborate on patient care. In one example, a nurse informatician in Buffalo created a wound management program in Microsoft Access that provides an interface between the hospital information system's basic patient information and the patient's Braden scores, recorded by nurses to document the level of skin breakdown. The informatician also wrote software enabling the program to operate on a personal digital assistant (PDA).

The wound management clinician uses the PDA (with updated patient and Braden score data) to see a list of patients at risk for skin breakdown, enabling proactive intervention. The program also provides reports to help the wound management clinicians, nursing administrators, and quality assurance personnel work more effectively.

CPOE. Alamance Regional Medical Center has found that with the Eclipsys CPOE system, orders are clear and concise, saving nurses time deciphering handwriting, calling the physician to clarify the order, or manually transcribing it into the system. Nurses also spend less time coordinating ancillary services and tracking down patients because the system has expedited delivery of the order to the appropriate department.

Organizations have found both positive and negative workflow issues for nurses as a result of having this new access to information. On the positive side, Boston Medical Center reports that nurse efficiency is improved by the increased legibility and correctness of the orders. The use of order sets in the CPOE system also supports nursing interventions. For example, if an order for patient-controlled analgesia is given, the associated requirements and nursing interventions are ordered automatically.

On the negative side, nurses must now log on to the computer more often to monitor new or changed orders. Nurses have accommodated this change in workflow because the benefits outweigh the drawbacks. They have less work on the back end to check orders, and they see lab values and overall trends more often as they access information in the computer.

III. Technology and Financial Considerations

Technology. Regardless of the system that is deployed, organizations must consider underlying technologies and end user tools to make these systems work in the various patient care areas. Internet technology and mobile computing both enable access to the real-time information critical to nurses and other clinicians.

At Cedars-Sinai Health System, nurses benefit from the clinical data repository, accessed by a Web-based front end. The organization chose this option over the complicated (and expensive) process of replacing the existing database, and was able to gain clinician buy-in for further initiatives when they saw how the Web technology made access to information easier.

Wireless local access networks also provide infrastructure to support highly mobile direct care nurses. The nursing department at Yale-New Haven Hospital found that as it promoted its initiative for a mobile nursing assessment tool, it was able to use the mobile technology already in place to support their CliniComp order entry system.

Although mobile computing and Web technology have created quite a buzz in the industry, the organizations regard them as enabling technology, similar to a database backbone or an operating system.

There is also much debate about the comparative strengths of different end-user devices in the areas of mobility, computing power, and screen resolution. Since no device can meet the needs of all users, bedside monitors, wall-mounted monitors, laptops on carts, tablets, and handheld devices all compete for use with these clinical applications. For example, although Maine Medical Center has had clinical systems in place for decades, they have not yet found one device for all users. The organization piloted a range of devices, including PDAs and bedside monitors. Some nurses are uncomfortable using technology in front of the patient, and others do not want anything more to carry. Today, every unit has about ten fixed devices and five to ten mobile ones, a device for every two to three patients in most units.

Considering the needs and preferences of the end users is paramount. One organization made a large investment in placing a computer at every bedside when it implemented an automated documentation system, but has since found that none of the clinicians are comfortable completing their documentation in front of the patient. The investment was wasted. Overall, when choosing an application, organizations must also consider the technologies needed to make them work in the various patient care areas.

Costs and benefits. The technologies examined in this research represent significant costs to hospitals, not only for the systems themselves, but also to support the implementations. Because hospitals' resources are limited, there is an increased interest in systems that can demonstrate a return on investment. As one nursing expert points out, hospital executives generally do not think that technology for nurses will provide a cost savings; the nursing shortage may have to get worse before they will change their minds.

In making technology decisions, financial concerns must be weighed against the benefits of technology, such as increased patient safety through medication administration, improved patient care through access to information and standards, and greater efficiency for nurses through automated documentation and easier modes of communication.

The systems identified in this research range in cost from thousands to “millions and millions” of dollars. At St. Peter's Hospital in Albany, the Web site on which nurses bid for shifts was developed in-house and was relatively inexpensive. The more extensive systems that support complex clinical processes are correspondingly more expensive. However, the cost of not doing anything may be greater, since anecdotal evidence suggests that technology can attract nurses to the profession and improve the work environment for nurses who are presently employed.

A “Information technology can help transfer the rich collective wisdom from experienced nurses to the next generation.

Otherwise, our nation will have to pay a tremendous price in dollars as well as lives lost to keep re-learning the same lessons the hard way.”

—Nurse, large California hospital

IV. Insights from the Front Lines

AS THE EXAMPLES IN THE PREVIOUS CHAPTER illustrate, technology can help to improve nurse efficiency and the hospital environment in variety of ways, but it also presents challenges. “Remember, it’s not easy,” said one hospital representative, “If it was, we all would have done it by now.” One nurse offered a first-hand account of the implementation of an automated nursing documentation system: “We thought it was agony switching to it.” Because there were no expert users to help nurses first learn how to use the system and configure it appropriately, it took three to four months to adapt to the online documentation system. During this time, there was an extra nurse on each shift to assist with the documentation. At the end of the period, however, when the system was taken down for a day for upgrades, the nurses found they hated going back to paper. Once they got used to it, the system made documentation faster and easier. Nurses could access vital signs at any time and not have to worry about missing information because it was recorded in the system.

The challenges of implementation can be overcome when the right technology is selected and is implemented in as painless and professional a manner as possible with the right resources and methods of communication in place.

■ *Address workflow issues.* If there was a workflow problem before, it will only be heightened in an electronic environment. It is crucial for organizations to optimize processes as they automate them. This provides the opportunity not only to solve problems, but also to transform clinical processes and incorporate best practices.

Marrying technology and workflow is one of the biggest challenges that organizations face, and it is complicated by the fact that systems must adapt to the various models of nursing at a number of sites and times with different interpretations of data. One nurse offered this advice: “Our success is 25 percent software and 75 percent process. Make software fit work processes and, at the same time, change work processes to leverage software.” Similarly, Maine Medical Center has found through experience that they should spend 60 percent of their time solving workflow/process issues to achieve successful implementations.

- *Support the staff with training and education.* Learning a new system is always difficult. Front-line clinicians working as “super users” can be effective both to provide education to the staff and to give feedback on how the system is working. At Children’s Hospital and Health System, San Diego, an accident led to an effective way to train staff members. One nurse injured her hand and was placed on light duty; she was recruited to work with the IS department on the implementation of their documentation system and became a convert to the new system. She is now an educator, and more effective than most because “she lived it.”
- *Involve all appropriate staff.* Beginning with the decision-making process, the only way that organizations are going to be able to meet their staffs’ needs and have successful implementations is if clinicians have every opportunity to provide feedback and input. Open lines of communication (with two-way mechanisms) and interdisciplinary collaboration can help with the implementation process. Just as nurses need to be involved when physician systems go online, other clinicians need to be involved when implementing nursing systems. The importance of staff involvement cannot be overemphasized.

Aurora Health System’s Metro Region hospitals have been recognized as Magnet hospitals, or ones that do an exceptional job recruiting and retaining nurses. Although Aurora has not looked to see if there is a direct correlation between automation and nurse recruitment and retention, the two may be related. The shared governance model allows nurses to be involved in system selections, implementations, and ongoing decision-making. Thus, nurses can be confident that the technology will meet their needs.

- *Watch for unintended consequences.* For every successful implementation cited in this report, there are many instances where technology made nurses’ jobs more difficult. One hospital was in the process of implementing a computerized order entry system but found that it was not working. From one nurse’s perspective, the system created more paperwork than it saved because there were not enough computers, and online charting for medication administration had not yet been implemented. Another difficulty was that the system required several screens to complete a medication order, and because there was no screen to review the order, residents said they crossed their fingers, hoping they got it right. Knowing this, nurses checked the orders for mistakes. Since the system was not providing the expected safety benefits, the implementation was suspended.

If the system does not meet the needs of its users, does not realize benefits, and creates more work than it eliminates, the implementation should be suspended until these problems are resolved. It is crucial to know when to persist through a difficult implementation and when to pull the plug on a system that is not working.

- *Have the right technology* Implementing change will be impossible if the technology is unfit to address the problems it was installed to solve; even the best technology will be useless without an adequate infrastructure. According to one nurse, investing in infrastructure is essential for clinical applications: “One of the reasons that nurses may not trust a new system is because it is not reliable enough to support clinical activities. The system has to *work*. Hospitals have historically not invested enough in hardware and network redundancy to ensure system reliability and fast response time. Once they do, nurses will trust and use systems for direct clinical care.”
- *Do a pilot.* One nurse manager volunteers her unit to participate in pilot tests. That way she can be sure that the technology will be useful and beneficial for nurses before the hospital makes a large investment or the system is implemented on other patient care units.
- *Keep it simple* One nurse who had been through the implementation of a medication administration system on all 20 units at once was particularly vehement about this point.

All of these pieces of advice speak to the larger issue of creating a culture of safety and support in the hospital. Technology systems are only a part of such a culture. Adequate staffing both to provide care and to support the technology is critical. As a representative from the Massachusetts Nurses Association noted, without adequate staffing, technology may actually increase the burden on nurses—machines beep and alarms sound for all the wrong reasons, creating even more time away from patient care.

V. Conclusions: Implications for Recruitment and Retention

A “Empowering nurses with the tools they need and reducing their frustration with paper-work can help to improve nursing retention and lessen the nursing shortage.”

—Nurse, large California hospital

ALTHOUGH AUTOMATION AND THE USE OF technology may not be directly correlated with improved recruitment and retention, it is becoming part of a comprehensive strategy to address nursing needs. Aurora Health System has learned through interviews that nurses come to them because of their use of technology. They have heard repeated comments expressing nurses’ satisfaction, such as “I would never leave here,” and “I can’t imagine going back to paper.” A human resources representative claims that there is no one predominant factor that helps Cedars-Sinai Health System consistently attract nurses, but “We do have an image of being top in patient care and having the tools to support it; people come to us because of that.”

Just as technology is embraced in the home and in schools, it will be increasingly important to nurses entering the field. Industry experts note that upcoming nursing graduates have come to expect a higher level of automation in their work. New nurses may be shocked when they arrive at large medical centers to find that documentation is not automated. Recruitment campaigns targeted at high school students are beginning to emphasize the technical aspect of nursing as well as the caring side, hoping to lure more students who are interested in careers in technology.

When nursing students from Tulsa University visited St. Francis Hospital, they were shown the Patient1 system and were very excited about it. “I believe that the level and sophistication of automation here will help with our recruiting efforts,” says one nurse; “Looking at the new generation of nurses entering the profession, one can expect these clinicians to be more computer savvy. This is the way the world operates for them. Why should nursing practice be any different? We have already seen the shift start to occur here. Recently we had to show some nurses how to use a paper MAR in the event of a down-time—these nurses had never charted on paper.”

A *“I can’t imagine pinpointing any one component of the nursing process. Either technology is integrated into the nursing process or it’s not.”*

—Nurse/Clinical Systems Expert,
large mid-Western hospital

There is no single solution or “magic bullet” technology that will immediately impact nurse recruitment and retention. The nursing process is complex, and—as the diversity of opinions expressed throughout this paper illustrates—there are many points where technology may be used to assist the nurse in patient care. With the growing adoption and advancement of technology, an increasing need for nurses, and a generation raised with computers reaching employment age, there is no better time for hospitals to explore the wide range of technology that can provide significant benefits for clinicians. This report has only scratched the surface of what is possible. There is hard work still to be done in the automation of clinical processes, but the benefits, glimpsed here, may be tremendous.

Appendix A: Interviews

This report would not have been possible if the following people had not volunteered their time to participate in the interviews:

Eric Anderson, R.N.

Director of Clinical Information Systems
Maine Medical Center
Portland, Maine

Margaret F. Budnik, R.N., M.A.

Faculty-University of Phoenix (Tulsa)
Project Lead, Clinical Applications
St. Francis Hospital
Tulsa, Oklahoma

Elizabeth Buff

Vice President, Patient Care Services
Medical Center at Princeton
Princeton, New Jersey

Janice Buhler

Director, Recruitment and Workforce Planning
Cedars-Sinai Health System
Los Angeles, California

Richard Chady

Public Relations Spokesperson
Saint Peter's Health Care Services
Albany, New York

Kathleen Charters, Ph.D., R.N.

Assistant Professor
School of Nursing
Department of Administration,
Health Policy and Informatics
University of Maryland
Baltimore, Maryland

Marie DiFrancesco, R.N., B.S.N., M.B.A.

Lead Clinical Analyst
Alamance Regional Medical Center
Burlington, North Carolina

John Gama, Pharm.D.

Pharmacy Clinical Specialist
Tri-City Medical Center
Oceanside, California

Brian Gugerty, D.N.S., R.N.

Assistant Professor
School of Nursing
Nursing Informatics Department
University of Maryland
Baltimore, Maryland

Karen Hughart, R.N., M.S.N.

Director of Systems Support Services
Vanderbilt Medical Center
Nashville, Tennessee

Lynn Jones, R.N., M.S.

Assistant Administrator,
Department of Gynecology and Obstetrics
The Johns Hopkins Hospital
Baltimore, Maryland

Linda Kresge

Chief Nurse Executive
Catholic Healthcare West
Redwood City, California

Don Lindamood, R.N.C.

Certified in Nursing Informatics,
Certified Professional Health Information
Management Systems
Manager, Clinical Systems
Adventist Health
Roseville, California

Linda Travis Macomber, R.N., M.B.A.

Clinical Informatics Analyst
Children's Hospital and Health Center
San Diego, California

Dorothy Upson McCabe R.N., M.S., Med.

Director, Nursing Department and
Career Services
Massachusetts Nurses Association
Canton, Massachusetts

Sharon McGourn, R.N.

Clinical Service Manager
Bridgeport Hospital
Bridgeport, Connecticut

Laura Miley, R.N.

Director of Clinical Information Systems
Forrest General Hospital
Hattiesburg, Mississippi

Therese Morley, Ed.D., R.N.

President, Association of California
Nurse Leaders
Senior Nurse Consultant
Kaiser Permanente
Pasadena, California

Judy Murphy

Director of Application Development
Aurora Health Care
Milwaukee, Wisconsin

Lisa O'Connor

Director of Nursing
Boston Medical Center
Boston, Massachusetts

Barbara Odin, R.N.

Nurse Manager
Stanford Medical Center
Palo Alto, California

Jeanette Polaschek, R.N.

Director of Informatics
Cedars-Sinai Health System
Los Angeles, California

Erin Popescu, R.N., M.S., C.N.O.R., C.N.A.

Operating Room Manager
Saint Joseph's Hospital
Atlanta, Georgia

Kathy Ryan

Clinical Instructor
Medical Center at Princeton
Princeton, New Jersey

Jean Ann Seago, R.N., Ph.D.

Assistant Professor
School of Nursing
University of California
San Francisco, California

Joanne Spetz, Ph.D.

Assistant Adjunct Professor
School of Nursing
University of California
San Francisco, California

Senator Leonard Teitelbaum

Maryland State Senate
Annapolis, Maryland

Nancy Tepping

Data Systems Coordinator
Yale-New Haven Hospital
New Haven, Connecticut

Appendix B: Vendor References

Vendor/Product	Contact Information	Relevant Functionality
Alaris Medical Systems* <i>MEDLEY Medication Safety System with Guardrails software</i>	10221 Wateridge Circle San Diego, CA 92121 www.alarismed.com (800) 854-7128	medication administration: infusion pumps
Baxter International/ AUTROS Healthcare Solutions, Inc.	One Yorkdale Road, Suite 310, Toronto, Canada M6A 3A1 www.autros.com ; www.baxter.com (800) 537-2255	medication administration
Becton, Dickinson and Company <i>BD Rx System</i>	1 Becton Drive Franklin Lakes, NJ 07417 www.bd.com (201) 847-6800	medication administration
Bridge Medical, Inc. <i>Medpoint</i>	120 South Sierra Solana Beach, CA 92075 www.bridgemedical.com (858) 350-0100	medication administration
Cerner Corporation <i>Millenium</i>	2800 Rockcreek Parkway Kansas City, MO 64117 www.cerner.com (858) 221-1024	hospital information system with clinical data repository, EMR, and CPOE functionality among others
CliniComp International*	9655 Towne Center Drive San Diego, CA 92121 www.clinicomp.com (800) 350-8202	computerized patient record, order-entry
Eclipsys Corporation* <i>Sunrise products</i>	777 E. Atlantic Ave., Suite 200 Delray Beach, FL 33483 www.eclipsys.com (561) 243-1440	hospital information system with automated nursing documentation, EMR, CPOE functionality among others
GE Medical Information Systems	8200 West Tower Avenue Milwaukee, WI 53223 www.gemedicalsystems.com	monitoring systems, hospital infor- mation system with automated nursing documentation, clinical data repository, order entry, clinical decision support, and messaging functionality among others
IDX Systems Corporation <i>LastWord/Carecast</i>	40 IDX Drive P.O. Box 1070 Burlington, VT 05402-1070 www.idx.com (802) 862-1022	hospital information system with automated nursing documentation, CPOE, clinical data repository functionality among others
McKesson <i>Horizon Clinicals</i>	5995 Windward Parkway Alpharetta, GA 30005 www.mckesson.com (404) 338-6000	hospital information system with clinical documentation, clinical data repository, CPOE, and messaging functionality among others

Vendor/Product	Contact Information	Relevant Functionality
MEDITECH	MEDITECH Circle Westwood, MA 02090 www.meditech.com (781) 821-3000	hospital information system with EMR, CPOE, patient education, and scheduling functionality among others
Per-Se Technologies* <i>Patient1, Resource1</i>	2840 Mt. Wilkinson Parkway Atlanta GA 30339 www.per-se.com (770) 444-5300	computerized patient record with clinical documentation and medication management functionality among others, staff scheduling
Pyxis Corporation* <i>MEDSTATION system</i>	3750 Torrey View Ct. San Diego, CA 92130 www.pyxis.com (858) 480-6000	medication administration
RNJobs*	www.stpetershealthcare.org	staff scheduling
Siemens Medical Solutions Health Services Corporation	51 Valley Stream Parkway Malvern, PA 91355 www.smed.com (610) 219-6300	hospital information system with EMR, CPOE, and medication administration functionality among others
Symbol Technologies, Inc.	One Symbol Plaza Holtsville, NY 11742-1300 www.symbol.com (631) 738-5200	mobile information/communications
3M Health Information Systems	575 W. Murray Boulevard Murray, UT 84123 www.3mhis.com (801) 265-4400	hospital information system with clinical data repository, CPOE, clinical documentation, and patient education functionality among others
VasTech, Inc.* <i>Nightingale Nursing Information Systems</i>	222 Severn Avenue, Suite 14 Annapolis MD 21403 www.vastech.net 877-7-VASTECH	staff scheduling, credential tracking, time and attendance
VisualMED Systems	391 Laurier West Montreal, Qc, Canada H2V 2K3 www.vmedsys.com (888) 333-0243	hospital information system with clinical data repository, EMR, and CPOE functionality among others

The above list provides contact information for representative vendors. Vendors marked with an asterisk contributed to this report.

Appendix C: Glossary

Adverse Drug Event (ADE)—An injury resulting from a medical intervention relating to a drug.

Clinical Data Repository (CDR)—A central clinical database that supports applications such as automated order entry/management, results display, and basic data entry of patient information (clinical and demographic).

Clinical Decision Support (CDS)—Information tools that support a health care provider in decisions related to diagnosis, therapy, and care planning of individual patients.

Computerized Patient Record (CPR)—Generic term describing a computer system that automates the care delivery processes and stores patient clinical data in support of inpatient care services (also referred to as an electronic medical record, EMR).

Computerized Physician Order Entry (CPOE)—Clinical software application designed specifically for use by physicians to write patient orders electronically rather than on paper. (The current industry focus is on inpatient CPOE, and the term generally refers to electronic ordering for hospitalized patients.) Although other providers may enter orders, the term Computerized Physician Order Entry is most commonly used to describe inpatient order-entry systems in which the provider initiating the order enters it directly into a computer.

Data Entry—The transcription of information from the original source into a machine-readable form. Although keyboard entry is the most familiar, other fast-growing methods include scanners, speech recognition, and automatic device-to-system technology.

Data—Pieces of information or commands.

Database—An aggregation of records or other data that can be updated. Databases are used to manage and archive large amounts of information. Also see relational database.

Electronic Medical Record (EMR)—Generic term describing a computer system that automates the care delivery processes and stores patient clinical data in support of inpatient care services (also referred to as an computerized patient record, CPR).

Error—Failure of a planned action to be completed as intended or use of a wrong plan to achieve an aim.

Handheld Device—See mobile computing device.

Handheld PC—Small hand-size, personal computer that uses a keyboard.

Hospital Information System (HIS)—Generic term used to describe computer systems that support the administrative and care delivery processes for a hospital.

Internet—An international network of computers that operates on a backbone system without a true central host computer.

Local Area Network (LAN)—A group of client computers connected to a server.

Medication Administration Record—Documentation associated with medication administration.

Mobile Computing—Any solution where the application is accessed from a portable device. Transport of data to and from the device can either be accomplished using wireless technologies or batch-processed from docking cradles attached to the local area network (LAN).

Mobile Computing Device—End-user handheld wireless computer device that displays, collects, and stores data.

Network—A general term for terminals, processors, and devices linked either by cable or wireless technology. Peripherals, programs, and applications can be shared by the network users.

Personal Digital Assistant (PDA)—Mobile, handheld devices, such as Palm series and Handspring Visors, that give users access to text-based information. Users can synchronize their PDAs with a PC or network using a cradle device. Some models support wireless communication.

Server—A computer on a network that manages a specific set of network resources. A server may manage network traffic, printer use, store files, or run remote applications.

Smart Phone—Cellular phone that supports a number of data transmission capabilities including a Web browser; sends and receives faxes and emails; provides organizer functions such as a calendar and address book.

Software Application—A non-customized computer program developed for sale to multiple customers. While some tailoring of the program may be possible, it is not intended to be designed for each user or organization.

Tablet—A flat-panel laptop that uses a stylus pen or touch-screen technology.

Web-enabled—Software programs that can be used directly through the World Wide Web, including financial and human resources applications. Web enabling extends the client/server concept to the largest server in the world—the Internet.

Web Site—A group of related files, including text, graphics, and hypertext links, on the World Wide Web. Accessed by typing its unique address, a site usually includes layers of supporting pages as well as a home page.

Wireless—Using radio frequency spectrum for transmitting and receiving voice, data, and video signals for communication.

World Wide Web—An international group of databases within the Internet that uses hypertext technology to access text, pictures, and other multimedia with a click of a mouse. Sites on the Web usually are created in HTML, Java, or both. A browser program is needed to access multimedia aspects.

Endnotes

1. First Consulting Group. *The Healthcare Workforce Shortage and Its Implications for America's Hospitals*. Commissioned by American Hospital Association (AHA), the Association of American Medical Colleges (AAMC), the Federation of American Hospitals (FAH) and the National Association of Public Hospitals and Health Systems (NAPH). Fall 2001.
2. Buerhaus, P., cited in "As their numbers shrink, nurses gain clout." *The Boston Globe*, February 2, 2002. A1, A28.
3. Coffman, J., J. Spetz, J.A. Seago, et al. "Nursing in California: A Workforce Crisis." California Workforce Initiative, January 2001.
4. "State Health Workforce Profiles," Bureau of Health Professions, www.bhpr.hrsa.gov.
5. Buerhaus, P. D. Staiger, D. Auerbach. "Implications of an Aging Registered Nurse Workforce." *JAMA*, June 14, 2000; 283(22):2948-54.
6. Peter D. Hart Research Associates. "The Nurse Shortage: Perspectives from Current Direct Care Nurses and Former Direct Care Nurses." Commissioned by The Federation of Nurses and Health Professionals, April 2001.
7. Aiken, L., S. Clark, D. Sloane, et al. "Nurses' Reports On Hospital Care In Five Countries." *Health Affairs*, May/June 2001;20(3):43-53.
8. "Hospital Statistics: 2002 Edition" *Health Forum*, 2002.
9. *To Err Is Human: Building a Safer Health System*. Linda T. Kohn, Janet M. Corrigan, and Molla S. Donaldson, editors. Institute of Medicine, 2000.
10. Berens, M. "Nursing Mistakes Kill, Injure Thousands: Cost-Cutting Exacts Toll on Patients, Hospital Staffs." *Chicago Tribune*, September 10, 2000.
11. "Nurse Staffing and Patient Outcomes in the Inpatient Hospital Setting" American Nurses Association, March 2000.
12. Needleman, J., P. Buerhaus, S. Mattke, et al. "Nurse Staffing and Patient Outcomes in Hospitals," U.S. Department of Health and Human Services, Health Resources and Services Administration and Harvard School of Public Health, February 2001.
13. "Nursing Shortage Demand Diverse, Personalized Approaches" American Organization of Nurse Executives press release, March 23, 2000.
14. Jones, L. and J. Spehmkouch. "Matching Skill Levels to Unit Needs." *Health Management Technology*, February 2002; 44, 48.
15. The Feldman Group, Inc. "The Shortage of Care." SEIU Nurse Alliance, January 2001.
16. Cited in Kilbridge P. and D. Classen "VHA's 2001 Research Series: A Process Model of Inpatient and Information Technology Interventions to Improve Patient Safety." Prepared by First Consulting Group for VHA, Inc., 2001.
17. *To Err Is Human: Building a Safer Health System*. Linda T. Kohn, Janet M. Corrigan, and Molla S. Donaldson, editors. Institute of Medicine, 2000.

18. Cited in Kilbridge P. and D. Classen "VHA's 2001 Research Series: A Process Model of Inpatient and Information Technology Interventions to Improve Patient Safety." Prepared by First Consulting Group for VHA, Inc., 2001.
19. "IV Pump Prevents Mistakes" *The Reporter*, Vanderbilt Medical Center, March 15, 2002.
20. "Veterans Affairs Bar-Code-Scanning System Reduces Medication Errors" American Society of Health-System Pharmacists, March 18, 2002.
21. PricewaterhouseCoopers. "Patients or Paperwork. The Regulatory Burden Facing America's Hospitals." Commissioned by the American Hospital Association, 2001.
22. The Feldman Group, Inc. "The Shortage of Care." SEIU Nurse Alliance, January 2001.
23. "Agency Attracts Nurses With PDAs." *eHealthcare Week*, September 10, 2001; 2(3):1.



**CALIFORNIA
HEALTHCARE
FOUNDATION**

476 Ninth Street
Oakland, California 94607
Tel: 510.291.1040
Fax: 510.293.1333
www.chcf.org

Printed on recycled paper.