

***Grant Final Report***

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**Tulare District Hospital Rural Health EMR Consortium**

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# Abstract

**Purpose:** To implement and evaluate an integrated IT system in a rural hospital.

**Scope:** Tulare District Hospital implemented an integrated IT system with multiple modules. This system was evaluated in partnership with the University of California, San Francisco.

**Methods:** Analysis of quantitative staffing, outcomes, and financial data; interviews with leaders and staff; surveys of staff.

**Results:** Tulare District Hospital successfully implemented many modules. The difficulties faced by TDH included: too aggressive an implementation plan; lack of consistent clinical leadership; severe turnover in the executive leadership; and the vendor did not have fully functional products in the timeline promised. There is no evidence that the IT system has had any benefit to patients. In fact, there is some indication that the disruption caused by the Patient Care Documentation system may have temporarily led to more patient care errors. However, the components designed to improve quality have not been in place for long enough to reap benefits. The experience of this first grant provides guidance specific to TDH about how to move forward over the next several years.

**Key Words:** information technology, rural hospital, patient falls, electronic medication administration, electronic medical records

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# Final Report

## Purpose

In September, 2004, Tulare District Hospital (TDH) was awarded a grant by the Agency for Healthcare Research and Quality (AHRQ) to implement and evaluate an integrated hospital information technology (IT) system. The project was a collaboration between the Tulare Local Healthcare District, Healthcare Management Systems, Inc., local clinics and physicians groups, and the University of California, San Francisco.

Healthcare Management Systems, Inc., (HMS) a partner in this grant, develops, sells, and supports integrated, single source hospital information systems. HMS had worked with TDH since 1997, implementing Financial Management and Revenue Cycle solutions to streamline the hospital's financial procedures, in addition to a number of clinical applications. For this grant, HMS provided a Principal Investigator, an experienced implementation team, and software, all at discounted rates.

The long-term outcome goals of the proposed hospital-based HIT implementation project were:

1. Successfully deploy a fully integrated EMR system using proven HIT practices to reduce medical error and improve overall patient safety at TDH.
2. To decrease the number of medication errors at TDH.
3. To provide private physicians and local clinic physicians the opportunity to utilize CPOE to reduce medication errors.
4. To provide private physicians and clinics in the hospital's service area the opportunity to access patient information remotely via a fully integrated EMR.
5. To evaluate and analyze data resulting from HIT implementation at TDH in order to assess the extent to which HIT contributes to measurable and sustainable improvements in patient safety and quality of care in rural hospitals.

The modules to be implemented in this project included:

- Pharmacy Management
- Electronic medication administration reporting
- Pyxis medication dispensing unit in E.D.
- Pyxis medication dispensing unit in nursing stations

- Laboratory Management
- Patient Scheduling
- Operating Room Management
- Computerized physician order entry
- Patient care documentation
- Bar coding
- Clinical View
- Scanning application
- Electronic signature
- Insurance eligibility
- Executive Information Systems

The University of California, San Francisco (UCSF), conducted the implementation and outcomes evaluation for this grant, as well as serving as the Institutional Review Board. The evaluation plan emphasized the measurement of changes in patient outcomes that may be attributed to implementation of the integrated IT system. As the implementation progressed, the evaluation was amended to examine staff response to and perceptions of the IT system. For the evaluation, UCSF conducted surveys of staff; conducted interviews with hospital leadership and staff; and analyzed data on staffing, hospital finances, and patient outcomes provided by TDH, the California Nursing Outcomes Coalition, and the California Office of Statewide Health Planning and Development. This report provides the results of the evaluation.

## **Scope**

### **Background**

Over the past decade, there has been a gradual increase in the number of hospitals adopting electronic medical records and medication administration systems.<sup>1-3</sup> By 2006, approximately 51% of hospitals had electronic nursing documentation, 43% had computerized physician order entry, and 35% had bar code systems for pharmacy administration.<sup>4</sup> These systems are expected to bring about improvements in patient safety, work processes, and staff morale,<sup>5,6</sup> and reduce rates of medication errors,<sup>7-9</sup> but thus far results have been mixed.<sup>10-16</sup> Hospital information technologies can have unintended consequences; they can be disruptive to the flow of patient

care, distract providers from care delivery, and damage staff morale. The implementation period is particularly important.<sup>17-18</sup> During implementation, new procedures and processes are being established, creating an environment in which change can beget error.

## Settings

At the time the grant was awarded, Tulare District Hospital, operated by the Tulare Local Healthcare District, was a 112-bed acute care hospital, employing approximately 500 staff members. Annually, the hospital cared for 27,600 emergency room visits, 59,000 outpatient visits, and 2,300 outpatient surgical procedures. Sixty-six percent (66%) of the hospital's patients are on Medicaid or Medicare, and 12% are uninsured. The service area of the hospital is a Primary Care Health Profession Shortage Area (HPSA), and serves a Medically Underserved Population (MUP). TDH is the only hospital in Tulare and the surrounding rural areas. The city of Tulare has a population of 43,994, according to the 2000 Census; 23.9% of all individuals in Tulare County live in poverty.

Prior to commencement of the project, Tulare District Hospital had established an extensive technology infrastructure, consisting of a gigabit backbone network (3Com Core and Switches), a new AS/400 supporting the IT applications already in place, six IBM X-series servers that drove all the personnel files, the intranet, e-mail, and various software applications, Novel and UNIX servers for clinical systems for the Pharmacy and the Lab, and additional servers for a remote radiology system and the new cardiac catheterization lab.

Over the previous seven years, various HMS modules have been installed at TDH, including accounts payable, general ledger, payroll/human resources, time and attendance, patient accounting, health information management, HIM State reporting, 3M encoder, transcription, materials management, order entry, advanced contract management, report archiving, electronic remittance, lab interfaces, and Quality Assurance/Risk Management. At the time the grant began, HMS's products in the area of financial management were well-developed, while the clinical applications were new. More than two years prior to this grant, hospital leadership had discussions with HMS about the direction of the technology environment. These discussions lead to a detailed plan designed to establish a complete electronic medical record, which began with a complete reengineering of the information systems infrastructure at the hospital. Bandwidth, hardware, and server issues all were addressed, and a detailed plan was in place for the collaborative implementation of the applications needed to support a complete electronic medical record. The TDH Board of Directors, local physicians, and top administration officials at TDH were actively involved in the development of IT plans at the hospital. By including physicians and local clinic management in the planning process, TDH hoped to ease the transition from paper charts to electronic medical records through this grant proposal.

Hospital leadership recognized that resistance to change was a potential obstacle to the successful implementation of the electronic medical record at the hospital. It was recognized that physicians and nurses in rural communities often have not had exposure to facilities with a high level of technology, and this lack of familiarity increases the level of resistance among clinical staff. The Clinical Information Systems Implementation Coordinator at TDH had experience working in other healthcare organizations that had implemented IT systems, and the HMS Implementation Team had experience in implementing systems, using basic change issue methodology to identify and address areas of resistance. Another obstacle faced by TDH was the

training of staff members in the use of the IT system. HMS recommended a “train the trainer” and “super user” training technique.

## Methods

The evaluation plan focused on the impact of the IT system on medication errors, patient safety, and hospital finances. Reduced medication errors were expected to result from eMAR, Pyxis, and computerized physician order entry. Patient safety was expected to improve as a result of the aforementioned modules, as well as the laboratory and operating room management components, bar coding, Patient Care Documentation, and Clinical View. Finally, the operating room management, Electronic Signature, bar coding, scanning, and Insurance Eligibility were intended to improve the hospital’s financial position.

The original evaluation plan also included interviews with the top management team, unit managers, the pharmacy director, the operating room manager, the human resources director, and head nurses. As the project progressed, and various successes and setbacks at the hospital became apparent, the evaluation team determined that systematic collection of qualitative and quantitative data from hospital leadership and staff would be valuable to understanding the implementation process, and how this process might affect ultimate outcomes. Thus, the evaluation plan was extended to include interviews with staff and leadership in October 2005, October 2007, and September 2008. All interviews were conducted with approval from the UCSF Institutional Review Board, and all participants gave their consent to participate in the interviews. Interviews were held in private conference rooms and offices. Staff were recruited through flyers posted at the hospital, and were given a gift card to thank them for their participation.

Surveys of staff were conducted in June 2005, Summer and Fall 2007 and Summer 2008. The initial survey provided an assessment of staff attitudes toward computer technology in general and its role in the healthcare setting. Subsequent surveys focused on staff assessment of specific IT modules with the intention of surveying staff several months after the introduction of each module. The staff survey in Summer 2007 assessed the current charting methods and staff’s expectations for the planned Patient Care Documentation module. In Fall 2007 staff were asked about their experience with the eMAR module. Finally, in Summer 2008 staff were asked about their experience with the recently installed Patient Care Documentation module. A quantitative analysis was conducted, largely following that original proposed in the grant application but without the same degree of statistical rigor originally planned, for reasons discussed below. The specific data and methods used to understand the impact of the IT system on medication errors, patient safety, and hospital finances, are presented in conjunction with the findings for each topic.

# Results

## Overarching Issues

**Training and Support.** TDH developed a novel strategy for providing IT and patient support to clinical staff on patient care units. TDH retrained clerical support staff from most inpatient and ancillary units as “Patient Advocates.” Each Patient Advocate learned to use the electronic system and was offered the opportunity to train in multiple areas. The primary goal of this change was to allow greater staff flexibility, and maximize use of the IT system. Three “patient advocate leaders” were selected to receive significant training in the new system as it was implemented and serve as super-users and peer trainers.

Most leaders were comfortable with the work of the patient advocates in the first year. During the third grant year, however, the Patient Advocates approach was dismantled: The patient advocates did not gain enough competency in all skills needed to operate and troubleshoot the IT system. Moreover, nurses wanted to have a clear assignment of clerks to their areas of work. Most of the patient advocates had been unit clerks before their new role was created; when the patient advocate positions ended, they returned to being unit clerks.

**Leadership Changes at Tulare District Hospital.** Tulare District Hospital established an aggressive timeline for implementation of its IT system. Changes in personnel both at TDH and HMS made it difficult to adhere to this timeline. During the first quarter of the grant, the project had a change in two key personnel members: the HMS Project Manager, and the TDH Clinical IT Implementation Coordinator.

The third year of the grant was extremely chaotic for TDH, due to a series of disruptive changes in senior management. In November 2006, the CEO of the hospital went on medical leave due to the development of a heart condition, and the COO served as interim CEO. One month later, the outgoing Board of Directors of the District voted to terminate the employment of the Chief Financial Officer. An interim CFO was appointed. In March 2007, the CEO’s leave became permanent, and the hospital appointed an interim CEO. During this month, a new interim CFO came to the hospital as well. Two months later, the Chief Nursing Officer was fired by the interim CEO, and the Chief Operating Officer quit in advance of her planned resignation. An interim CNO joined the all-interim management team in June 2007. During this long period of interim management, the IT implementation team continued the implementation process. The hospital operated with this interim team until March 2008, when a new permanent CEO was hired. As the evaluation ended, in Autumn 2008, the leadership of the hospital seemed stable for the first time in nearly two years.

**Vendor Issues.** By the end of the first year of the grant, most of Tulare District Hospital’s leaders recognized that there were some implementation problems. Many of the managers we interviewed expressed some frustration with HMS. They thought that HMS was still in a development stage for many of the IT modules, which made them concerned about the quality of the software and long-term ability to meet the implementation schedule.

Some of TDH’s leaders thought the HMS staff sent to provide training or present an overview of a module were not well trained; they reported that the HMS staff often did not know enough about the module to answer TDHS leaders’ questions. However, one leader noted that

all IT vendors have similar problems with customer support and service. The IT vendor staff that works with clients are not the same staff that do the computer programming, and thus their knowledge is inherently limited. One leader observed that HMS provides a good-value product for the cost, which is lower than the cost of many other vendors.

## **Results for Specific Components of the IT System**

Descriptions of each IT component are presented in Table 1.

The first components – the Pharmacy Management system and Pyxis medication dispensing units in the Emergency Room and Fast Track – were launched in October 2004. The bulk of the installation preparation was conducted before the grant began, and thus explicit evaluation of these components was not included in the evaluation. The implementation of Pyxis was universally praised by TDH management. Nursing staff were so pleased with the Pyxis system that the implementation was accelerated to all other hospital units. Hospital-wide Pyxis had been planned for the second year of the grant, but was complete by June 2005.

The electronic scanning module was scheduled to “go live” in March, 2005. It was not launched as planned, because the underlying software referred to a hard drive that could not be used for the application. HMS had to reprogram the software, and new hardware had to be ordered. The module was implemented in June 2006.

The Patient Scheduling system was launched in May, 2005, as planned. Hospital leaders reported that this module had few problems. One concern arose when the system was updated, and all preferences and codes were lost. One leader said the scheduling system is not as integrated into other systems as it should be, and another leader thought the electronic system took longer to register a patient than before the system was implemented. By the end of the first year, most TDH leaders thought the scheduling system had produced some benefit, primarily in uniformity of scheduling and elimination and pen-and-paper scheduling.

The bar coding system also was implemented in May 2005, but only for supplies. This module is called the “point of issuance” (POI) system. The POI implementation went fairly well, according to TDH leaders, although there were a variety of difficulties that arose. Some difficulty with POI was noted in the emergency room, where it was not possible to use the system due to the nature of emergency care. Some managers reported that there were problems with malfunctioning scanning equipment. Other specific problems included difficulties in the ICU, bar codes missing on some items, variable support from materials management, lack of support on weekends, slowness of the system, and durability of the equipment. Leaders at TDH thought they were reaping benefits from the POI system within a few months of its installation. The POI system’s main benefit came from improved inventory. Patient care units were not running out of supplies as frequently as they did before POI was installed.

**Table 1. Original IT system implementation timeline at Tulare District Hospital**

<b>Component</b>	<b>Description</b>	<b>Planned Launch</b>	<b>Actual Launch</b>
Pharmacy Management	On-line access to all vital pharmacy functions	Year 1	Oct 2004
Pyxis medication dispensing in ED	Automatically dispenses medication prescribed by Emergency Room physicians.	Year 1	Oct 2004
Bar coding	Bar codes on patient wristbands, medications, blood, vaccines and supplies.	Year 1 (May 2005)	May 2005, supplies
Patient Scheduling	Scheduling of outpatient surgery, physical therapy, speech/occupational therapy, sleep lab, radiology, catheterization lab, pulmonary rehab, mobile health clinic, etc.	Year 1 (May 2005)	May 2005
Operating Room Management	Schedules procedures, room resources, appropriate surgical staff, instruments, supplies and follow up lab/radiology.	Year 1	Jan 2006
Integrated scanning application	Archiving system stores patient information that can be accessed remotely. Physician notes can be integrated.	Year 1 (Mar 2005)	June 2006
Laboratory management	Provides one source for patient orders, results and laboratory control information.	Year 1	Jan 2007, not HMS
e-MAR	Electronically matches patient with medication.	Year 1	Feb 2007
Pyxis medication dispensing units at all nursing stations	Allows accurate dispensing of medication.	Year 2	June 2005
Clinical View	Provides physicians and nurses with real-time, web-based access to patient record.	Year 2 (Nov 2005)	Jan 2007
Patient Care Documentation	Bedside electronic charting by nurses.	Year 2	June 2007, withdrawn for RNs
Electronic Signature	Allows physicians to electronically sign orders.	Year 2	Dec 2007
Clinical physician order entry (CPOE)	Physicians can order pharmacy and ancillary orders at the point of care or from remote locations.	Year 2	March 2007
Executive Information Sys.	Provides management with an integrated and comprehensive financial summary.	Year 3	Jan 2006
Insurance Eligibility	Provides patients and billing department with description of insurance eligibility at time of admission.	Year 3	May 2006

The operating room scheduling and management components had been planned for launch in August 2005, but was delayed due to the construction necessary to implement an operating room inventory system. Implementation occurred in January 2006. When the implementation began, the hospital experienced electrical problems when all the computers were on. There was not enough current in the operating room to support the whole load of electrical equipment; some electrical work had to be completed before the system was fully functional.

The electronic medication administration record (eMAR) module was scheduled to be implemented in the first year, but was delayed. The delay was initially due to the fact that HMS was revamping the system to Java-based programming, and TDH decided to wait until HMS had completed the programming change. A second delay arose because the original bar code scanners would disconnect and lose communication while in use by nurses. The hospital had to purchase new scanners, and then the computer cabinets in each patient room could not accommodate a scanner. The cabinets were returned and replaced. Implementation was further delayed because the pharmacy had to determine how to bar code all medications. The eMAR

system was launched in February 2007. Shortly after eMAR was implemented, TDH experienced difficulties. First, nurses realized that the placement of the computers raised privacy issues for patients. In rooms where the computer is near one bed of a multi-bed room, the nurses must ask questions of the patients “over the head of the near bed to do the assessment for the far bed”, thus compromising patient confidentiality and potentially violating HIPAA regulations. The second problem with eMAR is that some medications are not bar-coded properly. Nurses can scan patient wristbands, but not medications; thus, some things are scanned and some are not. Two components originally scheduled for the third year were launched instead during the second year. Executive Information Systems was implemented in January 2006. Insurance Eligibility also was originally scheduled for the third year, but then an implementation date in September 2005 was planned. The system was delayed, however, because TDH learned shortly before implementation that they had to contract with a clearinghouse to access information about patient insurance eligibility. TDH had not picked a vendor, and going through the due diligence and research process was time-consuming. They selected a vendor, and then found that the vendor they selected had recently made changes to its interface for which the HMS system was not yet prepared. Installation occurred in May 2006.

The laboratory management system was scheduled to be implemented in the first grant year, and instead was launched in January 2007. The laboratory management product was not provided by HMS. When the laboratory manager first assessed the HMS product in December 2004, she identified some concerns with the HMS product, including a lack of flexibility in labeling, limited ability to analyze data for quality control, lack of user-friendliness for performing queries and reporting, and issues with coding and reporting for microbiology. Other vendors’ products had greater functionality and flexibility, and at the HMS could not deliver improvements in the timeline desired by the laboratory. An interface was established between the laboratory’s system and the HMS system, because the laboratory data are included in and billed by the HMS system.

Clinical View was made available to physicians in January 2007. This module allows physicians to access the electronic records remotely. Members of the TDH IT team went to physicians’ offices to train local providers to use Clinical View. However, most physicians are not using the system. At this point, the system provides physicians with the following information: radiology and laboratory reports, the electronic medication administration record, transcriptions, and nursing notes. At the end of the evaluation, 15 to 20 physicians were able to access the system, and managers estimated that about 30 percent are using it. A related module, Electronic Signature, became available for physicians to electronically sign orders in December 2007.

Computerized Physician Order Entry went live in late March 2007. The system was cumbersome and very time consuming for physicians to place orders. None of the physicians who were trained on CPOE used it; they all refused during the training sessions. At TDH, clerks continue to send orders for physicians, through electronic systems when available such as for the laboratory.

Patient Care Documentation was initially scheduled to launch in the second grant year. During a HMS User's Conference, TDH learned that HMS was converting the Patient Care Documentation program to a JAVA platform, which was expected to be more user-friendly. TDH determined that it would be advantageous to wait for this conversion to be complete before implementation. The implementation plan involved starting the Patient Care Documentation system on one unit, and then adding units as appropriate. Nurses were reportedly very

enthusiastic about the system for the first few weeks. However, after a few weeks of the system operating on a single medical-surgical unit, TDH shut down the system. Complaints were numerous, with the most significant issue being the speed of the system. Sometimes records could be loaded to a computer in 10 seconds, and sometimes it took 10 minutes. Nurses found themselves dropped from the system in the middle of a patient assessment, and they lost their data. After shutting down the Patient Care Documentation system, TDH leaders worked with HMS to rectify the problem with the speed of the system. The system was re-launched in early January 2008 in medical-surgical care. Numerous problems arose again, in part because the hospital was at full capacity during implementation. The initial patient assessment continued to be cumbersome, and the concerns about patient privacy had not been addressed. Many nurses refused to use the system, contending that the system was too slow. The combination of computer speed problems, the time demands of adapting to new systems, and a heavy patient load led to the system being untenable again, and it was shut down for nursing documentation after about six weeks. Some use of Patient Care Documentation is continuing; Certified Nursing Assistants use the system to record vital signs and bed checks. Physical Therapists use the system for patient assessments, and respiratory therapists are using the system except for ventilated patients.

## Outcomes

**Staff Response and Perspectives.** TDH leaders thought that staff accepted the new systems fairly well. Several observed that there is a generation gap in acceptance of new systems. Younger and more recently hired staff were more receptive to the systems, and older staff were, on average, more reluctant to adapt. Some nurses have complained about the systems, and managers had to remind front-line leaders that their acceptance of the system provided an important role model to staff. Traveling nurses were helpful during implementation, because many worked with IT systems at other hospitals and were comfortable with them.

At the time of our first interviews with staff, two major components of the IT system had been implemented: the POI system for scanning supplies, and the electronic scheduling system for ancillary departments. A common opinion, voiced both by staff who complained about the system(s) and those who were happy with installed modules, was that things seemed to be working fine, but that it was too soon to pass final judgment on the system. Several staff wondered aloud about how they would deal with a system crash once they were reliant on the computerized systems. Staff from various departments mentioned keeping paper notes that mirrored their electronic interactions. There was a widespread belief that HMS did not have the necessary understanding of their product, and that there was a lack of technical support from HMS.

A survey of staff was conducted in June 2005, before many of the IT modules had been implemented. This initial survey was intended to assess overall attitudes toward computer technology, and the role of computer technology in health care. Survey items were drawn from a previously developed instrument to assess acceptance of computer systems in the healthcare setting.<sup>19</sup> Staff participants were recruited through flyers posted at the hospital. The response to the invitation to participate in the survey was disappointing, with only 68 respondents. The low response makes drawing inferences with statistical significance difficult, but the data paint a picture of general readiness to adopt an IT system among the hospital staff. A majority of hospital staff indicated they have a computer at home, with over 90 percent of nurses indicating a

computer in the home. While 64 percent of staff indicated they use computers to assist with personal affairs, the nursing staff was much more likely to use computers in their personal affairs than non-nursing staff (81% vs. 48%). Staff generally reported that they were comfortable with computers; only 13 percent of staff agreed that computers cause them to feel uneasy. However, 32 percent indicated a feeling of helplessness when they don't know what to do when working on the computer. Nurses were less likely than other personnel to see the introduction of computer technology as a benefit to patient care and their work demands. Staff revealed some concerns about IT effects on the work environment and professional roles. Nearly 40 percent of nurses agreed that "health care providers will be monitored more closely," while 66 percent of non-nurse staff agreed. Only 24 percent of nurses and 46 percent of non-nurses agreed that "relying on computerized decision support enhances professionalism." Finally, although only 15 percent of non-nurses agreed that "computers have significantly increased the daily workloads of nurses," one-third of nurses agreed.

A survey of staff was conducted in early summer of 2007, before Patient Care Documentation was launched. This survey was intended to assess the time spent by staff collecting and entering chart data, as well as their expectations for the Patient Care Documentation module. Participants attending training for Patient Care Documentation were directed to a short, web-based survey at the beginning of their training session. The response to this survey was higher than for the first survey, with 133 respondents. Average times for data collection and entry activities prior to implementation of electronic Patient Care Documentation were higher for nurses than for non-nursing staff. During each shift, nurses reported spending over 50 minutes searching for charts, 90 minutes documenting, nearly 50 minutes collecting data, and 60 minutes reading documentation from other providers. Nurses were asked about their expectations for the Patient Care Documentation module. Most respondents agreed that Patient Care Documentation would provide an easier location to find needed information (66%) and a more complete medical record (69%). Nurses were less positive than non-nurse staff about whether an electronic medical record would be more complete than paper chart (55% vs 64%), and nurses were less in agreement than non-nurses that the present charting system resulted in a sufficiently complete record (66% vs 71%). Hospital staff overall reported spending a lot of time on patient documentation, and most expected that the Patient Care Documentation system would confer benefits in ease of retrieving data and completeness of patient records.

In October 2007, the evaluation team interviewed 11 staff members at Tulare District Hospital. Since the eMAR and Patient Care Documentation modules had been implemented earlier that year, staff were asked about both systems. The consensus among those interviewed was that the eMAR system worked, and most staff liked it. Most nursing staff did not have a complete understanding of the system or why certain errors occurred. All staff mentioned that using the system was time consuming. Logging on to the system and bringing up the eMAR application was reported as being slow. For some sporadic errors, such as a medication or patient not being found on the computer page, the solution used by most staff was to log out and log in again. Not all medications had barcodes on them, as discussed above, and there were periodic scanning problems associated with scanners not working and damaged barcodes. Nearly all staff we interviewed reported that they do not use the scanner to record medications. About half did not scan patients' wristbands. General complaints about the Patient Care Documentation system included slow performance, repeated re-entry of data, and frozen screens that often required shutting down and logging into the system again.

In October 2007, a survey was made available to TDH staff. For this survey, staff participants were recruited with flyers posted in the hospital and through the efforts of project staff at TDH. The recruitment flyer offered participants a gift card for their participation in the survey. Potential participants were given an envelope containing the recruitment letter, one-page survey, and return envelope from the nursing coordinator or the IT Grant Coordinator. Staff were instructed to seal their surveys in the envelope provided, and return the sealed envelope to Ms. Mello in exchange for a gift card. The survey had 117 respondents from a range of occupations at TDH. The survey included two questions about the training that staff received in preparation for the eMAR module introduction. Some staff comments indicated that the eMAR training was inadequate or could have been more effective, but 70 percent of respondents either agreed or strongly agreed that training adequately prepared them to use the eMAR system, and approximately 85 percent agreed they were comfortable using the system. Survey responses were consistent with complaints from staff that eMAR is slow. Nearly 60 percent of survey respondents agreed that eMAR increased the time it takes to administer medications; 18 percent thought that the time required has increased a lot. Forty percent of survey respondents felt that the increased time spent using eMAR impacted other duties such as direct patient care and charting. Most survey respondents thought eMAR was leading to improvements in patient safety, as seen in Table 2. However, nursing staff gave the eMAR module lower marks than did non-nursing staff on all three questions about whether eMAR had reduced medication errors or increased patient safety. Approximately 20 percent of survey respondents indicated that they had previous experience using an eMAR system at another workplace. These respondents had lower ratings of eMAR's functionality and performance.

**Table 2. Survey respondent views on whether eMAR improved patient safety**

	<b>Nurse</b>	<b>Non-nurse</b>
eMAR increases patient safety - % Agree	56.4	70.7
eMAR prevents medication errors - % Agree	41.0	70.7
Has using eMAR increased, decreased, or had no effect on the safety of medication delivery to patients? - % Increased	56.4	73.2

In June 2008 another survey was conducted, after the Patient Care Documentation module had been launched a second time. The survey process was the same as that used for the previous survey on eMAR use. The survey had only 50 respondents. The survey instrument incorporated revised questions from two previously developed scales to assess user satisfaction with and adaptation to technology in the workplace,<sup>20,21</sup> as well as questions from the previous Patient Care Documentation survey, to allow for comparison between the two surveys. Due to the failed June 2007 roll-out and subsequent second roll-out in January 2008, this survey was scheduled to measure staff responses after the module had been in place for a few months. As reported above, the Patient Care Documentation system was shut down for most functions within six weeks of the second launch. Because the Patient Care Documentation system was not fully implemented, it is difficult to interpret nursing staff responses to some questions. Survey respondents indicated that time spent documenting assessments, vital signs, assessments, and patient inputs and outputs, including time finding information in patient records, increased as compared with the 2007 survey. However, survey respondents were generally positive about the Patient Care Documentation module. The majority of staff, including nurses, assessed the system positively on every measure of accuracy, timeliness and completeness.

In September 2008, the evaluation team interviewed nine staff members at Tulare District Hospital. Three of the five RNs did not use the Patient Care Documentation system except to look up vital signs that had been entered by CNAs. The four non-nursing staff were using the system daily for at least 20 minutes and up to 4 hours a day. The CNAs had very little or no experience with older paper-based charting and had been using the documentation module since they began working at TDH. None of the non-nursing staff reported significant problems such as system crashes or loss of data. Their complaints were focused on the programming issues such as navigation and integration of data from multiple screens, as well as logistical complaints such as inadequate numbers and poor location of terminals. Both nursing and non-nursing staff remarked on the limited number of terminals available. As discussed above, many staff are not using the terminal in patients' rooms due to privacy concerns. The increasing demands of charting are already felt to be burdensome and it was frustrating to staff to also have to vie for time at the terminal.

Staff did not have a clear sense of hospital plans for the Patient Care Documentation system; they did not know whether management considered the module ready to implement further, or planned to eliminate the system entirely. Their perception was thus accurate, because in September 2008 the leadership of TDH had not made this decision. The lack of communication between management and staff and the lack of standardized, in-depth training are two themes that recurred throughout the interviews. The nursing staff, in particular, seemed to have little idea about the next steps with the partially implemented documentation module. Most were using the system, to lesser and greater degrees, without any statement from the management about what was expected of them. The lack of information about changes in the workplace seemed to be a source of dissatisfaction for some interviewees.

**Leadership Perspectives.** The gradual implementation process was perceived as useful by most leaders. Several noted that it had been good to install eMAR before launching the Patient Care Documentation module, because with eMAR staff had to get used to computer use as part of their daily routine. It would have been even more difficult to launch a complex module such as Patient Care Documentation if staff were still learning passwords and keyboarding. Staggering the implementation over time also allows the implementation team to modify the training and support based on the experience of previous units. It also offers the opportunity to delay launching a unit that is not ready, if necessary. A caution to staggered implementation was offered by one manager, however: staff who work on multiple units can find it difficult to switch between electronic and paperless systems. Assignments may need to be adjusted during the implementation period to ensure continuity for staff.

The management of Tulare District Hospital were satisfied with some components of this project at the end of the evaluation period. Many were proud of what had been done, and in hindsight thought they had done much more than would have been expected. As one leader said, "It's extraordinary what has been accomplished with a two-person staff." Several of the leaders we interviewed in October 2007 thought that the IT department was "woefully understaffed." Clinical leadership was not closely tied to the IT implementation. One leader observed that the implementation leaders had little support from the hospital education department, and had to develop IT training themselves.

At the end of the third year, hospital leaders expressed satisfaction with several of the IT modules that had been implemented. The scheduling, operating room management, and POI systems are regarded as "fine" at worst and "successful" at best. Staff were using the system,

although some compliance problems remained. Materials management staff were doing a daily inventory, which was time-consuming and could be avoided if there was perfect use of the system. Remaining problems with the scheduling system are attributed to user errors and some departments continuing to use duplicative methods. Leaders thought the eMAR system was generally doing what they wanted, but there was debate as to whether a wireless system should be implemented. Most nurses are using the system; one manager estimated that compliance was 20 to 30 percent at first, but is now over 90 percent. At least one leader thought eMAR had not improved the quality of patient care, because the system did not change basic processes for ensuring medication safety.

TDH leaders were disheartened with the roll-out of electronic Patient Care Documentation. All hospital leaders expressed frustration with this system. The main problem was with the speed of the system, although it was not clear if this was a hardware or software problem. Most leaders attributed the problem to the vendor, but some noted that customization of the system could be the root of the problem. Privacy concerns led nurses to record patient information twice, which was a poor use of time. Because there was no mandate to use the system, staff resisted. Leaders expressed concern about lapses in patient records that may have occurred due to problems with Patient Care Documentation, and hoped that staff in the medical records department was able to ensure all records were complete. The turmoil in nursing leadership during the time when Patient Care Documentation was being launched and re-launched contributed to the failure to fully adopt the system. The current leadership recognizes that there was not a strong clinical advocate for the system, and that this may have been needed to ensure success.

**Changes in Hospital Staffing during IT Implementation.** Implementation of an IT system is closely related to human resources at a hospital for two reasons. First, as noted by many of TDH's leaders, it may be beneficial to increase staffing of personnel who will use the IT system during a transition period, to ensure they have enough time during their shifts to both care for patients and learn the new system. Second, the disruption caused by changing workflow and processes during implementation may effect employee quits – or conversely may improve recruitment of new employees. The implementations of eMAR and Patient Care Documentation most impacted nursing staff at TDH, and thus these are the focus of our analysis.

To study the relationship between IT implementation and nurse staffing, we analyzed nurse staffing data reported by TDH to the California Nursing Outcomes Coalition.<sup>22</sup> CalNOC collects monthly data at the patient care unit level for adult medical, surgical, medical-surgical, critical care, step-down, and 24-hour observation units. The data submitted include hours of nursing care, hours provided by temporary or agency nurses, patient days, and selected patient outcomes (patient falls, restraint use prevalence, medication administration accuracy, and catheter-associated blood stream infections). TDH did not report nurse staffing data to CalNOC for the first quarter of 2006 (January – March), and did not report any data during the third quarter of 2007 (July – September). This latter period is immediately after the former CNO left the hospital and the interim CNO began her tenure.

Total nursing hours per patient day, which include registered nurses (RNs), licensed vocational nurses (LVNs), unlicensed aides, and other nursing personnel such as patient sitters, showed significant fluctuation in staffing levels from 2001 through 2003. The same is true for licensed nurse hours per patient day and RN hours per patient day. In January 2004, California's regulations mandating that all hospitals meet minimum staffing levels in inpatient units were

implemented. After the minimum staffing regulations were in place, nursing hours per patient day steadily increased at TDH. Licensed nurse, RN, and total hours per patient day dropped in the first quarter of 2007. This is the same quarter during which eMAR was launched, and is the quarter immediately after management upheaval began at TDH, as marked by the CFO's firing in November 2006. Staffing recovered in the subsequent quarter. It is not known whether staffing fluctuated again in the third quarter of 2007, after the firing of the CNO, but staffing was stable from the second to fourth quarters of that year.

**Relationship between IT System and Patient Outcomes.** A primary goal of the transition to electronic patient records systems at Tulare District Hospital was to improve the quality of care. The original evaluation plan for this grant included substantial, quantitative, rigorous analysis of patient outcomes and whether changes in outcomes could be associated with the implementation of the IT systems. However, because the implementation of key modules intended to improve the quality of care – eMAR and Patient Care Documentation – was delayed, sufficient data were not available to fully and rigorously assess their impact on patients. We extracted quality data from a variety of sources and treat these data as suggestive but not definitive.

**Medication Errors.** The Pyxis, eMAR and Pharmacy Management systems were most likely to lead to reductions in medication errors. Computerized physician order entry also should have affected medication error rates, if physicians had used the system. The evaluation team hypothesized that medication error rates would increase shortly after implementation of the systems in the first year or two, because these systems facilitate the identification and reporting of errors.

Tulare District Hospital collects data about medication errors for its Quarterly Review Reports. It should be noted that some hospital leaders think medication error reporting is too low, and thus there is some concern about the validity of the data. To examine the effect of IT on medication errors, we conducted simple comparisons over time. We examined whether there were apparent changes in rates of errors or types of errors after the systems are implemented. In our original evaluation plan, we intended to estimate multivariate regression equations to control for other factors such as patient acuity that may have affected patient outcomes, but this type of modeling was not feasible with the short period of post-implementation data available.

Figure 1 presents overall medication errors, measured as incidents divided by patient census, from January 2000 through July 2008. Most medication errors cause no harm to patients. Medication error rates fluctuate widely month-by-month, ranging from zero in several months to over 0.25 in May 2003. Medication error rates ranged from 0.013 to 0.06 from April 2005 to June 2007, with no unusual fluctuation that can be associated with management upheaval or the introduction of eMAR. However, medication error rates jumped sharply to 0.074 in July 2007 and then over 0.15 in August 2007, which are the two months after Patient Care Documentation was launched. After Patient Care Documentation was shut down, medication error rates returned to normal. A review of the incident reports from each month indicated that most of these errors were the omissions of scheduled medication administrations, which suggests that nurses forgot to perform some patient care functions – perhaps because they were overwhelmed by the effort to adapt to the new IT system. There was not any notable change in medication error rates after Patient Care Documentation was re-launched in early 2008.

**Patient Safety.** The information systems implemented at Tulare District Hospital were expected to improve patient safety, as noted above. Quality improvements were expected for a variety of reasons: complete patient records provide accurate information to all care providers, cross-checks on medication administration prevent medication errors, and computerized entry of orders prevents misreading orders. Patient safety encompasses a wide range of outcomes, and thus this component of the evaluation explored a large body of data.

The analysis of patient safety relied both on data in the hospital's Quarterly Review Reports and data provided to the California Nursing Outcomes Coalition. To study changes in patient safety measures, we again examined the data over time to learn whether there were apparent differences in each outcome. The outcomes available from the Quarterly Review Reports included total patient care incident rates, incident rates in medical-surgical units, procedure error rates, and patient complaint rates. As with the medication error rates in the Quarterly Review Reports, there is some concern that these data are under-reported. From the CalNOC data, we extracted patient falls per 1000 patient days, with and without injuries, for all units and for medical-surgical units.

**Figure 1. Medication error rates: number of errors per patient, January 2000 – July 2008**

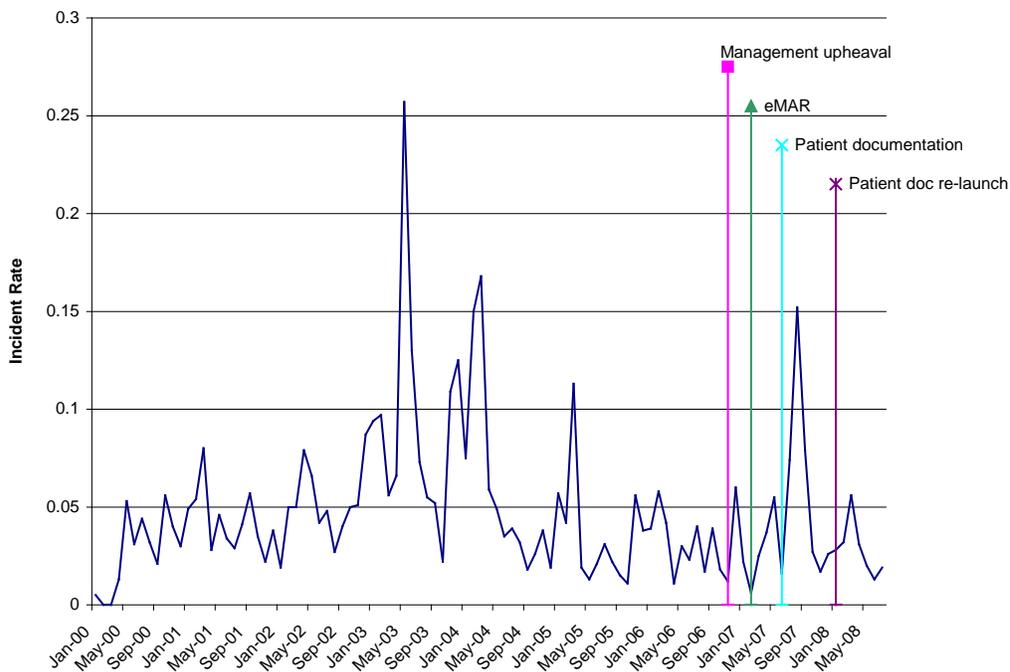
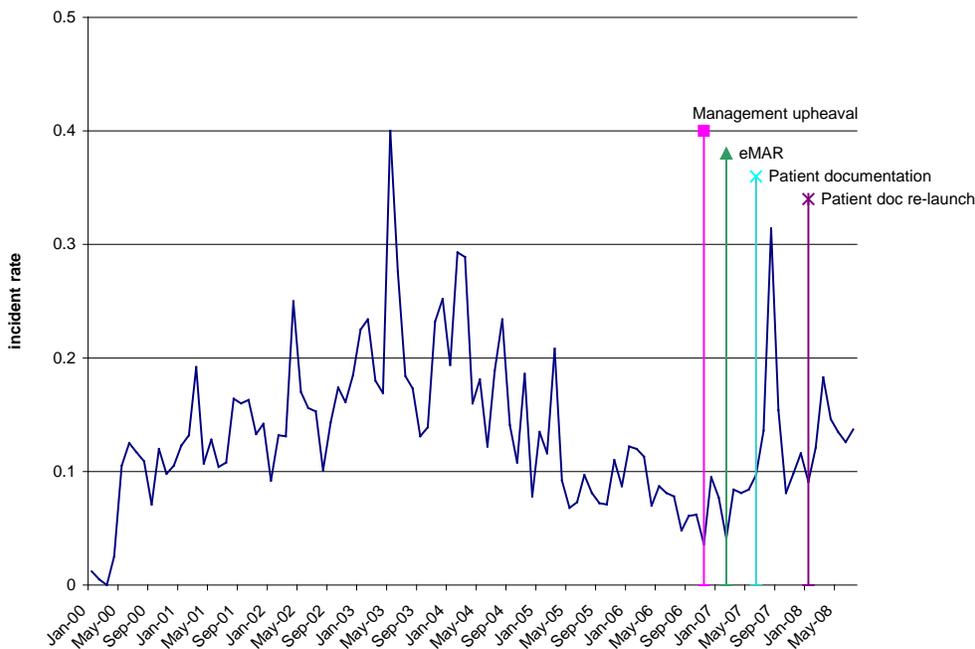


Figure 2 presents the rate of all patient care incidents, defined as incidents divided by patient census, from January 2000 through July 2008. The highest rate was in May 2003, at 0.4. The incident rate generally dropped from that time through June 2007, remaining between 0.036 and 0.122 between April 2005 and June 2007. The incident rate did not fluctuate from this range when eMAR was launched in February 2007. However, the rate rose to 0.136 in July 2007, after the CNO was fired and Patient Care Documentation was launched, and continued to rise to 0.314 percent in August 2007, when Patient Care Documentation was shut down. The rate dropped

after that time, returning to a somewhat higher range of 0.081 to 0.183 between October 2007 and July 2008. The incident rate in medical-surgical units reflects a similar pattern. As with the total incident rate, there was a sharp increase in procedure errors from a level below 0.04 since May 2002 to a rate of 0.104 in August 2007. The rate returned to its normal range after that month. Patient complaints did not change significantly over the time period studied here. It is possible that the increase in incidents observed shortly after the resignation of the CNO and first launch of Patient Care Documentation reflects efforts of the interim CNO to improve reporting, or that an electronic system identifies errors more frequently and accurately. However, if the primary reason for a higher reported incident rate was better reporting, there is no explanation for the drop in the incident rate after August 2007. If the primary reason was that the Patient Care Documentation system resulted in better reporting, one would expect that an increase would again be observed in early 2008, when the system was re-released, but this is not evident.

**Figure 2. Patient care incident rates, all hospital departments, January 2000 through July 2008**



The number of patient falls with and without injury, per 1000 patient days was examined for all units and for medical-surgical units. These data were obtained from the CalNOC database. There was a general trend toward fewer patient falls. The patient fall rate does not appear to have changed – and may have declined somewhat – after management changes began in November 2006. There was not a CalNOC submission in the quarter after Patient Care Documentation was released in summer 2007, and the CNO was fired, but in the last quarter of 2007, a substantial increase in the rate of patient falls was observed.

**Hospital Finances during the IT Implementation.** Many of the information technologies implemented during the period of this evaluation were expected to improve the hospital's

financial position. To learn more about how the information systems affected the financial position of TDH, we extracted financial data from quarterly reports provided to the California Office of Statewide Planning and Development. We aggregated these data to the annual level. We focused on four measures of hospital finances: total margin or profitability, which includes operating and non-operating revenue and expenses; operating margin, which includes only revenue and expenses associated with the core operations of a hospital; operating revenues; and operating expenses. We compared TDH's data to the average for all district hospitals in California, and focused on changes that may be associated with the implementation of specific IT modules.

The average total margin for California district hospitals was below zero in every year except 2003 and 2007. Tulare District Hospital's total margin was below zero except in 2004 and 2006, before the IT system was implemented. After POI and electronic scheduling were launched in 2005, TDH's total margin dropped, while the statewide average for district hospitals rose modestly. TDH's total margin recovered somewhat between 2006 and 2007, while the statewide average also improved. A similar pattern is observed for operating margins. The average operating margin for district hospitals hovered around -5 percent from 1999 through 2007. TDH's ranged between -22 percent and 1.3 percent, remaining negative in all years but 2004 and 2005. Operating margin dropped between 2005 and 2006, as the IT implementation had begun, and recovered somewhat between 2006 and 2007.

Overall, there is no evidence that the implementation of the IT systems had a beneficial effect on TDH's finances. It is possible that the implementation had a somewhat negative effect on operating and total margin between 2005 and 2006, but any negative impact was reversed at least in part the next year.

## Conclusions

Tulare District Hospital had many successes with their ambitious IT project. They implemented many IT systems in a short period of time, on a limited budget. Larger hospitals have invested much more money only to abandon the investment. The difficulties faced by TDH during the grant arose for four reasons. First, their implementation plan may have been too aggressive for the time period of the grant. Second, their implementation team did not have consistent clinical leadership or staff input. Third, the executive leadership of the hospital completely changed, and the hospital faced one year of interim leadership during the grant. Finally, their vendor did not have fully functional products in the timeline promised.

While health IT has promise to improve the quality of patient care, research supporting this potential is limited. At TDH, there is no evidence that the IT system as implemented thus far has had any benefit to patients. In fact, there is some indication that the disruption caused by the Patient Care Documentation system, combined with the near-simultaneous firing of the CNO, may have temporarily led to more patient care errors. As TDH moves forward, it is important for leaders to develop strategies to ensure a smooth transition to an electronic medical record. One key strategy will be to increase nurse staffing during the implementation period, so that patient care activities are not deferred while staff deal with the demands of learning the new system.

TDH leaders should be proud of their accomplishments during this grant. The experience of this first grant provides guidance specific to TDH about how to move forward over the next several years.

## References

1. Burt CW, Hing E, 2005, Use of computerized clinical support systems in medical settings: United States, 2001-2003, *Advance Data From Vital and Health Statistics of the CDC*, 353, 1-8.
2. Poon EG, Jha AK, Christino M, Honour M, Fernandopulle R, Middleton B, 2006, Assessing the level of healthcare information technology adoption in the United States: A snapshot, *BMC Medical Informatics and Decision Making*, 6(1), 1-9.
3. Pedersen CA, Schneider PJ, Scheckelhoff DJ, 2003, ASHP national survey of pharmacy practice in hospital settings: dispensing and administration—2002, *American Journal of Health Systems Pharmacy*, 60(1), 52-68.
4. Health Information Management Systems Society Analytics, 2008, Annual report of the US hospital IT market, 2007. Chicago, IL: Health Information Management Systems Society, retrieved September 8, 2008, from <http://www HIMSS.org/foundation/docs/2007AnnualReport.pdf>.
5. Coye MJ, Bernstein WS, 2003, Improving America's health care system by investing in information technology, *Health Affairs*, 22(4), 56-58.
6. Chaiken BP, Holmquest DL, 2003, Patient safety: Modifying processes to eliminate medical errors, *Nursing Outlook*, 51(3), S21-24.
7. Bates DW, 2000, Using information technology to reduce rates of medication errors in hospitals, *British Medical Journal*, 320, 780-791.
8. Coyle GA, Heinen M, 2002, Scan your way to a comprehensive electronic medical record. Augment medication administration accuracy and increase documentation efficiency with bar coding technology, *Nursing Management*, 33, 56,58-9.
9. Johnson CL, Carlson RA, Tucker CL, Willette C, 2002, Using BCMA software to improve patient safety in Veterans Administration Medical Centers, *Journal of Healthcare Informatics Management*, 16:46-51.
10. Kazley AS, Ozcan YA, 2008, Do hospitals with electronic medical records (EMRs) provide higher quality care? *Medical Care Research and Review*, 65(4), 496-513.
11. Menachemi N, Chukmaitov A, Saunders C, Brooks RG, 2008, Hospital quality of care: Does information technology matter? The relationship between information technology adoption and quality of care, *Health Care Management Review*, 33(1), 51-59.
12. Asch SM, McGlynn EA, Hogan MM, Hayward RA, Shekelle P, Rubenstein L, et al, 2004, Comparison of quality of care for patients in the Veterans Health Administration and patients in a national sample, *Annals of Internal Medicine*, 141(12), 938-945.
13. Patterson ES, Cook RI, Render ML, 2002, Improving patient safety by identifying side effects from introducing bar coding in medication administration, *Journal of the American Medical Informatics Association*, 9(5), 540-553.
14. Nebeker JR, Hoffman JM, Weir CR, Bennett CL, Hurdle JF, 2005, High Rates of Adverse Drug Events in a Highly Computerized Hospital, *Archives of Internal Medicine*, 165, 1111-1116.
15. Chaudhry B, Wang J, Wu S, Maglione M, Mojica W, Roth E, et al, 2006, Systematic review: Impact of health information technology on quality, efficiency, and costs of medical care, *Annals of Internal Medicine*, 144(10), 742-752.
16. Han YY, Carcillo JA, Venkataraman ST, Clark RSB, et al, 2005, Unexpected increased mortality after implementation of a commercially sold computerized physician order entry system, *Pediatrics*, 116, 1506-1512.
17. Ovretveit J, Scott T, Rundall TG, Shortell SM, Brommels M, 2007, Implementation of electronic medical records in hospitals: two case studies, *Health Policy*, 84, 181-190.
18. Kraus S, Barber TR, Briggs B, Kall G, Vernon TR, Moran B, Waggoner DM, 2008, Implementing computerized physician order management at a community hospital, *Joint Commission Journal of Quality and Patient Safety*, 34(2), 74-84.
19. Gardner RM, Lundsgaarde HP, 1994, Evaluation of User Acceptance of a Clinical Expert System, *J Am Med Informatics Assoc*, 1:428-438.
20. Doll WJ, Torkzadeh G, 2005, The measurement of end-user computing satisfaction, *MIS Quarterly*, 12, 259-274.

21. Kjerulff KH, Counte MA, Salloway JS, Campbell BC, 1981, Understanding employee reactions to a medical information system, in Proceedings of the Fifth Annual Symposium on Computer Applications in Medical Care, Los Angeles, CA, IEEE Computer Society Press, pp. 802-805.
22. Aydin CE, Bolton LB, Donaldson N, Brown DS, Buffum M, Elashoff JD, Sandhu M. (2004). Creating and analyzing a statewide nursing quality measurement database. *Journal of Nursing Scholarship*, 36(4): 371-378.

## List of Publications and Products

eMAR Survey. Keane D, Spetz J. Unique survey developed for this study. 2007. San Francisco, CA: University of California, San Francisco.

Patient Care Documentation Follow-Up Survey. Keane D, Spetz J. Unique survey developed for this study. 2008. San Francisco, CA: University of California, San Francisco.

Patient Care Documentation Training Survey. Keane D, Spetz J. Unique survey developed for this study. 2007. San Francisco, CA: University of California, San Francisco.

Spetz J, Keane D. Evaluating Success: Strategies and Challenges for Understanding IT Implementations in a Rural Hospital. *J Healthc Inf Manag*, in press.

Survey of Staff Readiness to Adopt Health IT. Keane D, Spetz J. Unique survey developed for this study. 2005. San Francisco, CA: University of California, San Francisco.