

Grant Final Report

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**Improving Health Care Quality via
Information Technology**

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Abstract

Purpose: The purpose of this project was to reduce medical errors and adverse events through the implementation of electronic health information systems and promotion of a “culture of safety.”

Scope: The setting is the 99-bed Southwestern Vermont Medical Center, and a number of clinical practices in the surrounding rural area.

Methods: Data analyzed included information on the “culture of safety” collected through interviews, focus groups, document analysis, and an annual “safety survey” of staff, data on the completeness and internal structure of nurse-to-nurse shift reports, and counts of medication transcription and administration errors.

Results: The “culture of safety” evolved to feature communication, information, and information technology as key factors in patient safety. Voice Care technology improved alignment of shift report content and organization to the hospital’s sanctioned shift-report protocol. The introduction of electronic medication administration records (e-MAR) reduced medication transcription and administration errors, and enabled us to catch “near misses” at ten times the rate of the old self-report system. Lessons learned include the importance of understanding and considering organizational structure and culture when planning and implementing information technology systems to improve patient safety.

Key Words: Patient Safety, Organizational Culture, Electronic Health Record, Electronic Medication Administration Record, Shift Report

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Final Report

Purpose

The purpose of this project was to reduce medical errors and adverse events at the Southwestern Vermont Medical Center through several information technology innovations including a) the expansion of electronic health records at the hospital; b) the introduction of EHR practice management software to the community; c) the introduction of bedside medication verification and electronic medication administration records; d) the use of recorded nurse to nurse shift reports; e) the implementation of computerized physician order entry; and f) the implementation of Midas+ clinical decision software. In addition, SVMC undertook a major initiative to improve organizational culture around patient safety. Leadership made a conscious effort to shift organizational culture from one that discouraged disclosure and blamed individuals for medical errors to one that promotes disclosure, seeks out root causes, and implements systemic improvements in clinical practice to improve patient safety.

The overarching research questions guiding this study concern the interplay between efforts to improve the patient safety culture, and efforts to improve safety through the introduction of health information technology:

- A1) Does organizational education about patient safety and the commitment of senior management improve the climate of safety in the organization?
- A2) Does the implementation of health information technology result in changes to the culture of safety?

In addition to studying of the interplay between culture and technology, we focused on two other evaluation questions related to some of the specific information technologies that were introduced as part of this project:

- B) Does the SNAP¹ protocol alone or SNAP with Voice Care technology improve the completeness and internal organization of nursing shift report as compared to the status quo?
- C) Will the implementation of bedside medication verification and electronic medication administration records decrease errors in medication transcription and medication administration?

¹ SNAP (summarize, narrate, analyze, propose action) is this hospital's modification of SBAR (situation, briefing, assessments, recommendation). See further explanation under "Scope" below.

Scope

Southwestern Vermont Medical Center (SVMC) is a 99-bed community hospital located in Bennington, Vermont. It serves a community of about 55,000 people living in southwestern Vermont, Rensselaer County, New York, and northern Berkshire County of Massachusetts. It is part of the non-profit Southwest Vermont Health Care (SVHC) which also runs a 150-bed rehabilitation and long term care facility, a home health organization, a cancer treatment center, and three community-based primary care practices.

The original scope of this project was to implement EHR technologies throughout SVHC's several organizations, and in privately-owned medical practices in the community. During the first year of implementation, however, it became clear that each of the various organizations involved had differing needs and agendas regarding the implementation of EHR, and that the job of moving forward with EHR at the hospital itself was a much larger and more complex task that had been originally anticipated. Therefore, the scope of the project was tightened, focusing in year two only on the introduction of EHR and related technologies at the hospital. By year four, some issues with the implementation of EHR in area private practices had been resolved, and again began to move forward, while implementation of EHR at the hospital continued.

Prior to the beginning of the project the hospital was using Meditech to maintain basic elements of a medical record for its inpatients and outpatients. Included in this record were lab results and reports on imaging studies, vital statistics for inpatient stays, and dictated physician notes. Within the hospital setting, the major accomplishments in expansion of EHR over the past four years have been as follows²:

1. Integration of a Master Patient Index across the three Health Center institutions: the medical center, the long-term care facility, and the home health agency.
2. Development of a data archiving capacity through Valco software to scan into the electronic health record all physical documents produced in the patient care process.
3. Development of medication bar-coding, bedside medication verification through scanning of patients and medications, and implementation of Meditech's electronic medication administration record (e-MAR) system in the hospital's four in-patient units (two medical/surgical units, Women and Children, and ICU).
4. Implementation of Midas + Clinical Decision Support System Quality Management, Infection Control, and Surgery modules to provide managers with system-wide information that will help them improve patient safety in their areas of expertise. The Quality Management module has replaced SVMC's old home-grown event reporting system. The event reporting system enables clinical staff to report medical errors and near misses.

² Some of these innovations have been funded through the AHRQ grant and some have been supported by the hospital own operating budget.

5. Use of ZYNX CPOE system to develop standardized order sets based on best practice as a precursor to implementation of a fully computerized physician order entry (CPOE) system.
6. Implementation of Medquist voice recognition software for dictation by radiologists, emergency department physicians, and physicians responsible for inpatient care to shorten the time for dictated notes to be available to other caregivers.
7. Implementation of computerized radiography to make images available electronically to all physicians with access to the hospital's EHR system.
8. Upgrading the wireless infrastructure to improve access to electronic records throughout the facility.
9. Purchase of 60 mobile computer units for nursing use on inpatient units.
10. Purchase of 14 hand-held mobile devices for physician access to lab results and nursing notes.
11. Implementation of Iatrics Visual Flowsheet program for charting by nurses in all four inpatient units.
12. Implementation of Voice Care software so that nurses deliver and receive recorded shift reports.
13. Implementation of EmpowER EHR system in the Emergency Department.

In addition to these technological developments to expand the EHR, the hospital has also undertaken a number of initiatives to enhance the "culture of safety":

14. Implementation of a system-wide patient safety training for all clinical staff as part of the hospital's orientation training. Note: 89% of current staff also received the training, as did all new staff hired after June 2004.
15. Implementation of safety walk rounds in which senior managers and administrators visit departments throughout the hospital to discuss safety concern informally with staff. This initiative underwent a hiatus from September 2007 to September 2008, but has been reinstated with a structure more in line with the IHI protocol. The intention behind the change in format was to improve both the quality of information received, and the follow up on issues raised.
16. Training for all nursing staff on the SNAP (Summarize-Narrate-Analyze-Propose a Plan) communication protocol adapted from the Crew Resource Management or SBAR protocol advocated by Dr. Michael Leonard. The Crew Resource Management protocol was originally developed to improve communication among airline personnel in order to reduce errors.

17. Implementation of various care protocols across several departments to improve safety (e.g. Invasive Procedure Protocol in radiology to insure that invasive procedures are not performed when the patient has anticoagulants in his/her system, Rapid Response Teams to assess and intervene when a nurse has a concern that a patient is deteriorating unexpectedly, Time Outs before any surgical procedure to insure that all personal understand the plan and that all appropriate precautions have been taken to insure a safe and accurate procedure, Fall Prevention protocol).

There were also two safety-related initiatives which ultimately stalled or were discontinued:

1. A new Safety Reporting System was developed to respond to barriers to reporting medical errors that were identified through a survey of 187 clinical staff members. However, the system was never implemented due to continued tensions between risk management issues and openness regarding events that impacted patient safety. However, this initiative is back on track with the implementation of the Quality Management module of Midas +.
2. IHI Safety Briefings were piloted on one of the medical/surgical wards but were discontinued both because staff found it difficult to make time to engage in the 5-10 minutes briefings on a weekly basis, and the safety concerns that were identified during these meetings were repetitious of those identified during the safety walk rounds.

At the beginning of this project only one of the hospital's primary care practices had an EHR system in place for clinical information. In the first year of the project, a committee of area physicians and hospital IT staff chose Lake Superior Software's EHR as the system to be implemented in the area's private practices. However, because of the costs to the practice (both financial and human) associated with implementation of the system, and growing concerns about compatibility with the other statewide EHR systems in development, only one private practice moved forward with implementation, and only implemented the scheduling and billing program components. As noted above, in year four of the project we began to make some headway in the implementation of EHR in area practices. A reconvened steering committee made other software options available which dovetailed more easily with the developing statewide EHR system, and restructured the financial incentives for implementation of EHR. To date, ten area practices have implemented or are in the process of implementing the clinical side of an EHR system.

Methods

Culture of Safety Study

To assess the evolving culture of safety at the hospital, the project evaluators analyzed the presence and prominence of "patient safety" in the hospital's strategic plans from 2002 to 2008. They also conducted focus groups with nursing staff from three hospital units that were more or less impacted by the technological changes introduced as part of this project – a medical/surgical

unit (high impact), the women's and children's unit (moderate impact), and the operating room (low impact). Focus groups were conducted in fall of 2005 and again in the summer of 2008. Nineteen nurses participated in the first round of focus group, and fourteen participated in the second round. Nine nurses participated in both the 2006 and 2008 groups. Transcripts from these focus groups were analyzed for nurses perceptions of the elements of "patient safety", attitudes toward technology and its relation to patient safety, communication among caregivers, and the way in which medical errors were dealt with in the various units. Interviews with four physicians who were employed by the hospital directly (as hospitalists or in the emergency department), or whose practices occasioned them to spend a significant amount of time in the hospital caring for their patients during in-patient stays, were completed in 2005-06 and again in the summer of 2008 examining the same themes as the focus groups with nursing staff.

The evaluators also observed various meetings of safety-related committees of the hospital, and accompanied hospital staff on their safety walk rounds. Field notes from these observations also contributed to the evaluator's analysis of the "culture of safety" over the study period.

Finally the evaluators examined the results of IHI safety surveys completed by hospital staff in 2004 (N=128) and 2005 (N=126), and of AHRQ safety surveys completed in 2006 (N=59), 2007 (N=129) and 2008 (N=98). The surveys were administered on-line through the hospital's computer network. Because of the change in the survey instrument during the study period, assessing changes in safety culture over time is difficult, and was supplemented by findings from the qualitative data described above.

Study of SNAP Shift Report Protocol and Voice Care Technology

Data for this study come from samples of actual nurse-to-nurse shift reports recorded at various time across the introduction of the SNAP protocol and the introduction of Voice Care technology:

Interval T1. The first recording took place after the initial classroom-based training for RN's in hand-off communication and SNAP protocol. Eight day-shift nurses of varying levels of experience volunteered to be recorded surreptitiously while they were giving report.

Interval T2. The second recording took place after all nurses on the two medical-surgical units had received additional on-the-job coaching to further hone their implementation of the SNAP protocol. The same eight nurses who were recorded at T1 were recorded over a four week period following this training.

Interval T3. About two months later, Voice Care technology was implemented on the two medical-surgical units at SVMC. Voice Care requires nurses to both give and received report via a phone-based recording system. All nurses received training in how to use this new technology. Between four and six weeks after the implementation of Voice Care, the evaluators did a random sampling of 164 recorded reports. This sample included six of the eight nurses recorded at the two previous times, and reports from an additional 27 nurses.

Interval T4. Between six and ten months after the implementation of Voice Care, we sampled 196 reports. This sample included 22 nurses from the previous T3 sample, as well as the eight nurses recorded at T1

Table 1. SNAP sampling

Phase	Interval	Dates	Description	Sample Size Report
SNAP Only	T1	October 2006	Manual audio recording of shift report following 4 hour SNAP training for RN's	N=23
SNAP Only	T2	December 2006	Manual audio recording of shift report following 4 hour SNAP training with additional on-the-job coaching; development of SNAP template.	N=26
Voice Care & SNAP	T3	March 2007	Automated recording of shift report (via Voice Care) 4-6 weeks following Voice Care implementation.	N=164
Voice Care & SNAP	T4	July to October 2007	Automated recording of shift report (via Voice Care) 6-10 months following Voice Care implementation and individual feedback for selected RN's.	N=196

Reports recorded at all four sampling times (T1-T4) were coded in two ways: the presence or absence of the four SNAP elements (summarize, narrate, analyze, propose action) and the placement of each SNAP element in the correct order. For differences between T1, T2, and T3, we used independent sample t-tests since we were unable to match the reports collected anonymously at T1 and T2 to specific nurses. Nurses were identified in the recordings at T3 and T4. Nineteen nurses were included in both T3 and T4 samples. Twelve nurses were included in T3 but not T4, and two nurses were included in T4 but not T3. We treated the T3 and T4 samples as independent in the analyses presented below, but also did a special paired analysis of those nurses who were present in both T3 and T4 samples, which yielded the same results.

Study of E-MAR's Impact on Medication Transcription and Medication Administration Errors

For six months prior to the implementation of e-MAR, during the five month implementation window, and for five months after full implementation, the head of Pharmacy examined all the medication-related events submitted through SVMC's internal reporting system (based on self-report), and identified actual errors in transcription, administration, and near misses for the four types of medication error (ordering, transcription, dispensing, and administration). These were then converted into rates per 10,000 doses. We used independent sample t-tests for difference of means to assess the change in error rates pre and post e-MAR. In addition, once the Meditech e-MAR system was implemented, a team of administrators, IS personnel, and the evaluator reviewed the reports available from the e-MAR system regarding system-generated warnings at the time of bedside scanning. Of the many types of warnings reported, we concentrated on understanding allergy warnings, interaction warnings, warnings related to a mismatch between medication and patient, and dosage errors (i.e. ordered dose more than or less than the medication being scanned). Numbers of warnings were converted into rates per 10,000 doses, and tracked over the period of implementation and for three months following full implementation.

Results

Study of the Culture of Safety at SVMC

By the beginning of this AHRQ study in 2005, SVMC had already made a significant administrative commitment to promoting a “culture of safety” at the hospital. Looking back to the 2002 and 2003 strategic plans for the hospital’s parent organization, Southwestern Vermont Health Care, there is only passing mention of “patient safety” as an organizational priority. None of the five organizational goals explicitly reference “patient safety”. Goal 2, “develop a well-coordinated continuum of quality care to achieve the best possible outcomes and customer satisfaction,” does include as one of its five strategies “assure a safe care experience for patients, residents, employees/staff, and the community, with consistent and predictable outcomes and customer satisfaction.” However, only one of the 21 objectives related to this strategy addresses patient safety: “Evaluate, and if feasible initiate, a Failure Mode Effects Analysis of the peri-operative services, or other high-risk procedure of service, towards enhancing the safety of patient care.”

By 2005, Goal 2 in the strategic plan read “Achieve best practices in all patient and resident care that is safe, clinically effective, cost effective, timely, efficient, equitable and patient/resident centered,” for the first time promoting “safety” to the level of a organizational goal.³ Furthermore, the strategies associated with that organization goal has been reduced from seven wide-ranging strategies in the FY04 plan⁴ to only two strategies, both dedicated to patient safety: 1) Build a committed “culture of safety”; and 2) Build the physical and information technology infrastructure needed to support safety.

Over the course of these four years (2002 to 2005) then, patient safety had become more and more prominent in the organization’s improvement plans and more closely coupled to developments in information technology. This shift in vision was accompanied by a flurry of activity that pervaded the organization at the beginning of this study. The new Patient Safety Department, which included some reassigned of positions (e.g. infection control positions were moved under the Patient Safety Department) and the creation of several new positions (V.P of Patient Safety among them) had been in existence for about a year. All clinical staff had participated in a two-hour patient safety training in the spring of 2004 that stressed that small mistakes, made by different people who care for patients can sometimes line up to harm patients. Further, SVMC wanted all employees to understand that the focus of the organization was now on identifying and correcting these systemic inadequacies that allow small mistakes to compound into major errors. Bulletin boards throughout the hospital were devoted to a public education campaign to build awareness of patient safety and this “Swiss cheese” model of adverse events (i.e. events occur when the “holes” -- small mistakes -- line up). The CEO and other senior administrators were doing highly visible monthly safety walk rounds to discuss safety issues with staff in all departments. Procedural changes in clinical practice, such as implementation of

³ In earlier plans safety has only been mentioned at the level of a strategy associated with a goal, or an objective associated with a strategy.

⁴ In FY04, these seven strategies to achieve the goal of improving patients care through making care “safe, effective, timely, efficient, and equitable” ranged from commitments to facility and technology development, to pursuit of HIPAA compliance, to achievement of national recognition for quality, along with two safety-related strategies.

fall prevention and aspiration prevention protocols, had begun to be introduced to improve the quality of care and reduce opportunities for adverse events.

It was in this context that we took our initial snapshot of the culture of safety in the organization. Results from Institute for HealthCare Improvement (IHI) safety surveys administered to SVHC staff in 2004 and 2005 confirm that a culture of safety was already well on its way, and on the rise.

Table 2. Percent who “Agreed” with key IHI Safety Survey statements

Statement	2004 (N=128) Agreed Slightly	2004 (N=128) Agreed Strongly	2005 (N=126) Agreed Slightly	2005 (N=126) Agreed Strongly
Leadership is driving us to be a safety-centered institution	38%	43%	19%	64%
Patient safety is constantly reinforced as the priority in this clinical area.	5%	2%	14%	40%
I believe that adverse events occur as a result of multiple system failures, and are not attributable to one individual’s actions	38%	37%	24%	55%
This institution is doing more for patient safety now than it did one year ago.	32%	38%	15%	71%

So how, then, did the culture of safety at SVMC evolve between 2005 and 2008? To answer this question we analyzed the results of focus group interviews with nurses on three units, and interviews with four physicians conducted in 2005 and again in 2008, as well as responses to the facility-wide AHRQ safety surveys that were administered to clinical staff from 2006 to 2008.

What is “patient safety”? When nursing staff and physicians discussed “patient safety”⁵, their comments fell into eighteen different categories. There was considerable overlap in the categories between the discussions of nurses and physicians and between 2005 and 2008.

Table 3. Categories of patient safety

Category	Description	Nurses Present in 2005	Nurses Present in 2008	Physicians Present in 2005	Physicians Present in 2008
Medications	Delivery of right medication to right patient in right dose and right time	X	X	X	X
Staffing	Staffing levels, shift length, type of staff available (physicians, anesthesiologists, technicians)	X	X	X	X
Staff Knowledge	Level of experience, technical knowledge of procedures & medications, in-house training	X	X		X
Patient Condition	Severity of illness, age and mental status of patient	X	X		X

⁵ Focus groups were asked three questions to elicit their understanding of patient safety: What comes to mind with your think about “patient safety”? What makes it “safe” for patients on your unit? What makes is “unsafe” for patients on your unit?

Category	Description	Nurses Present in 2005	Nurses Present in 2008	Physicians Present in 2005	Physicians Present in 2008
Communication	Among nursing staff, between nurses and physicians, between staff in various departments, between nurses and patients	X	X	X	X
Protocols	Hospital security policies & procedures, protocols for patient care of specific types (e.g. infection control, crisis intervention, prevention of falls, specific medical procedures)	X	X	X	X
Care Plans	Clarity and appropriateness of patient care plan	X			
Patient Relations	Quality of communication with patients; ability of staff to create an atmosphere of comfort and safety for patients	X		X	
Family Relations	Ability of staff to manage relations with families in a manner that serves the best interest of the patient; family involvement in patient's care	X	X		X
Environmental Conditions	Space issues, management of hazardous materials	X	X		
Equipment	Availability of appropriate medical equipment; condition of equipment	X	X	X	
Information	Availability of information on patients; quality of information	X	X	X	
Information Technology	Availability and condition of computers; software features and uses	X	X	X	X
Safety Culture	Staff attitudes toward patients safety; extent to which approaches to safety are shared among staff members	X	X		X
Staff Relations	Collegiality of staff, and staff morale	X	X		
Administrative Involvement in Patient Safety	Existence of and interactions with committees and non-clinical personnel that oversee patient safety	X	X	X	
Supervision	Adequacy of supervision of caregivers		X		
Teaming	Partnerships between nurses and physicians and among physicians from different departments and disciplines in the delivery of care			X	X

While the categories that impact “patient safety” remained relatively stable across the study period, the emphasis placed on different categories differed across nursing units, between nurses and physicians, and across time. (See table on following page.)

In 2005, each of the nursing three units studied focused most of their discussion on only a few of the areas listed above, while in 2008, there was more wide ranging discussion with attention spread across more categories. This difference suggests that while common safety issues were recognized throughout the study period, safety culture among nurses underwent a deepening across this period, with more issues reaching a higher common level of salience. Moreover, the issues that dominated safety culture in the three units became more similar over the course of the study period. Among physicians, the focus of discussion did not so much broaden. Rather, it changed to focus much more heavily on the newly salient dimensions of patient safety for the organization overall – safety culture and information technology.

Four major initiatives may have contributed to these shifts. First, the Patient Safety Department did considerable public education and training regarding the importance of efficient communication of the correct information in ensuring patient safety – hence the rise in salience of communication and information in nurses’ ideas about patient safety.⁶ Second, protocols to standardize care and conform to best practice were already well underway when the study began and expanded greatly during the study periods, perhaps accounting for the continued focus on care protocols as a factor in patient safety. Third, 2005 to 2008 marked a period of rapid expansion of information technology in two of the three nursing units studied (Med/surg and OB/gyn), and in other departments in which physicians practice (e.g. Emergency Department, Radiology). This led to a sharp rise in the extent to which both nurses and physicians discussed information and information technology as patient safety issues. Among physicians in particular discussions of IT were not only present, but were extensive in three of the four physician interviews of 2008. IT received only one brief mention in 2005, when a physician referred to the role of the then new and rather limited computer generated order sets in reducing “errors of omission.” The introduction of IT also was clearly linked to nurse’s rising concerns about equipment and environmental conditions. The text of those discussions focused on the arrival of mobile IT carts during the study period, which brought about significant changes in workflow and were significant new factors in already crowded workspaces.

Table 4. Top issues in safety culture among nursing focus groups and physicians⁷

Category	Nursing Med/Surg 2005	Nursing Med/Surg 2008	Nursing Ob/Gyn 2005	Nursing Ob/Gyn 2008	Nursing OR 2005	Nursing OR 2008	Physicians 2005	Physicians 2008
Medications							X	
Staffing	X	X	X	X		X	X	
Staff Knowledge	X	X	X	X		X		
Communication			X	X		X		
Protocols		X	X	X	X	X	X	X
Equipment				X	X			
Environment Conditions		X						
Information				X		X		
Information Technology		X		X				X
Safety Culture								X
Teaming							X	

⁶ Among physicians “staffing”, “communication”, and “teaming” received less attention in 2008 than they had in 2005. This may be because of the relative attention the SNAP and the “Swiss cheese model” of adverse events received in 2005. Physicians received their initial patient safety and SNAP trainings in 2005, but, unlike nurses, have had no follow up training since then. This may account for a heightened awareness of communication-related safety issues in 2005 as compared to 2008. As one physician commented in the 2008 interviews in regards to the SNAP protocol, “It was a big deal a couple years ago, but you don’t see it much anymore.”

⁷ Issues were identified a “top issues” by the number of times they surfaced in response to the three discrete questions used to assess the content of each unit’s “safety culture”. A category could be mentioned in response to one, two, or all three of these prompting questions. For 2005, the table includes for the nursing units all categories that were mentioned in response to all three prompts. In 2008, only one unit mentioned one category in all three discussions, so we included in this table all those categories that were mentioned in response to at least two of the prompts in 2008. Among physicians, we include categories that were mentioned by at least three of the four physicians.

Finally, the organizational focus on promoting a “culture of safety” clearly impacted physicians’ discussions of patient safety. Comments such as these peppered their discussions in 2008:

“Staff should have patient safety as a priority over other responsibilities (for example delivering non-urgent medications, getting coffee for patients).”

“The hospital is making an effort to change culture -- to bring to the fore errors of all types, from nurses aides to general surgery. In the last two years, they’ve really promoted [disclosure], taking away the stigma and risk for reporting. [It’s been a] major educational endeavor to take away responsibility and guilt.”

“The culture of safety, from nursing and ancillary personnel to doctors, [has been] inculcated in people. People believe in it...There’s been a shift from thinking about quality to thinking about safety.”

While “safety culture” itself was not discussed as extensively by nurses as by physicians, the nursing focus groups included similar statements:

“It’s all about safety really. Everything we do every minute of the day is about patient safety.”

“We use those words a lot, “We want to provide safe care of patients”. We use [these] words when we are advocating got new staffing, when we implement new systems. We way we’re implementing this new systems because it will improve patient safety – this is our goal.”

The lesson we draw from these analysis is that staff notions of patient safety have indeed evolved in particular ways that mirror the efforts of administration to promote improved communication, standardization of clinical practice, the use of information technology and the promotion of a “culture of safety” throughout the organization as their core strategies to improve patient safety. Among both nurses and physicians in 2005, patient safety was largely understood as a matter of having the right professionals delivering the right kinds of care to patients. By 2008, while the prior understanding continued, it was joined by an increased focus on systems of communication (particularly among nurses), the importance of access to information (particularly though the use of information technology) and a more frequently articulated sense that a “culture of safety” was important to the organization and to these professionals as they went about their work.

Communication, Information, IT and Patient Safety: How did they evolve? To say that communication, information, and information technology became more prominent in discussions of patient safety over the study period, however, is not to say that that their rising prominence indicates a uniformly positive impact of these factors on staff’s perceptions of patient safety at SVMC. Analysis of the trends evident in institution wide safety surveys and the focus group discussions and interviews suggest a complex picture of the way the organizational level changes described above are connected to patient safety in the minds of clinical staff.

In regards to communication, the safety surveys completed by a broad based sample of clinical staff over the study period confirm that an awareness of good communication and information exchange as important to patient safety increased throughout the institution. The 2004 and 2005 IHI safety surveys saw a dramatic increase in the proportion of staff members who “agreed strongly” that “briefing personnel before the start of a shift is an important part of safety”, from 59% in 2004 to 78% in 2005 (p<.01).

Clinical staff’s views of the extent to which good communication and information exchange were the norm at SVMC, however, show a gap between what staff believed to be important for patient safety and actual practice. Between 2004 and 2005, the percent who “strongly agreed” that “briefings are common here” increase only slightly (from 33% to 44% (p<.10)), and only 41% of staff surveys in 2005 strongly agreed that “the information I need to optimally care for my patients is provided to me at the time of a hand-off.”⁸

The AHRQ survey instruments used in 2006 and beyond focused on communication-related practices rather than on staff opinions about their relevance to patient safety. Here a more positive picture emerged, with a majority of staff seeing safety-related communication practices more firmly established. (Note: The up tick in negative opinions of communication in 2008 did not reach statistical significance in independent sample t-tests).

Table 5. Percent of respondents who “Agreed” or “Strongly Agreed” with communication-related statements on the AHRQ Safety Survey⁹

Statement	2006 (N=58)	2007 (N=133)	2008 (N=92)
Things “fall between the cracks” when transferring patients from one unit to another	39%	23%*	30%
Problems often occur in the exchange on information across hospital units	48%	23%**	34%
Important information is often lost during shift changes	54%	35%*	40%
Shift changes are problematic for patients in this hospital	51%	32%*	33%

* significant change from prior year p≤.05

** significant change from prior year p≤.01

In contrast to the improved communication and information exchange evident in the safety surveys, in the qualitative discussions of communication in focus groups and interviews “communication” was much more likely to be discussed as a negative in regards to patient safety, as opposed to a positive. While both nurses and physicians talked about the importance of good communication to patient safety, there was relatively little discussion of concrete communication patterns or protocols that contributed to patient safety.

In 2005-06, mirroring the early safety survey results, both nurses and physicians talked about the gaps in communication that occur because of frequent changes in personnel over the course of a patient’s stay, and their concerns about less than optimal communication between different disciplines and different departments with the hospital. Nurses also raised concerns about inconsistencies between physicians’ verbal and written orders, and the poor quality of physician handwriting. Finally, one nursing unit qualified their positive opinion of the fact that all nurses

⁸ This question was not asked in 2004.

⁹ We present only the responses of RN’s and physicians although the responses of all hospital employees surveyed mirror these trends.

heard report on all patients in their unit with a concern that report took too long, endangering patients who were without nursing care for an entire hour.

In 2008, communication issues had shifted to concentrate on the ways in which technology was affecting communication. Along with complaints that physicians and nurses were spending “too much time on the computer” and not engaging in enough face to face interaction, there was also a recognition that the Voice Care system that had been introduced to record and play back shift reports had improved communication among departments in some circumstances (particularly for patients moving out of medical/surgical units to other departments). While instances of poor communication across units surfaced in 2008, it did not dominate discussion as it had in 2005/06.

While the IHI and AHRQ safety surveys indicate improvements in communication among departments and between shifts, the qualitative data suggests that while some communication problems were ameliorated during the study period (such as unit to unit and interdepartmental communication), new issues related specifically to the rising use of technology to capture and communicate information were surfacing.

Information and information technology, as they relate to patient safety received much less attention in the focus groups and interviews of 2005-06 than those of 2008. In 2005-06, having access to complete historical information about a patient, and access to information about best practices was deemed important to patient safety, and there was little complaint about an absence of either. Information technology was rarely mentioned spontaneously and the focus of comments was on the lack of sufficient numbers of computer stations for all caregiver to be able to access information at peak times, and about the inconvenience of not having bedside access to computers.

By 2008, it was clear that information technology had come to play a greatly expanded role in the delivery of care and that nurses and physicians had strong opinions about both the positive and negative effects of these changes on patient safety. On the positive side, both nurses and physicians were appreciative of typed notes and information, finding them less prone to misinterpretation than handwritten notes and orders. Physicians in particular felt that the new standardized order sets that were generated with CPOE software to conform to best practice were helpful in preventing errors of omissions since they laid out “big pieces of information your brain doesn’t have to remember.” Staff uniformly appreciated the improved turnaround time for information that came with the introduction of new information technologies (especially lab results, images, and medication orders, but also dictated doctors’ notes that were processed with voice recognition software). Nursing staff saw the new e-MAR system, when it was working properly, as a safety benefit. It made sure that they were looking at the right MAR for the patient to whom they were about to deliver meds, and reminded them to give the correct dosages when the tablet dosage (e.g. 20 mg) did not match the ordered dosage (10 mg).

The safety downside of the new information technology systems generally revolved around their impact on quick and convenient access to information. When particular software application were not well organized internally or difficult to access (requiring long and repetitive logins), and when multiple information systems that did not interface requiring users to enter or retrieve information from multiple systems, staff feared that these inconveniences used up valuable time that would be better spent with patients. Time away from the bedside was uniformly believed to have a negative impact on patient safety. As one nurse commented, “When you’re fuddling with the computer and you have to call someone to fix it, it’s distracting from patient care if I can’t get into the computer. We can’t be experts in everything. When people get

distracted from what their core duty is, that's when patient safety gets compromised. That's when I see events that involve patient safety. It's the nature of what ends up consuming your attention." The "work arounds" that technology sometimes introduced were also seen as detrimental to patient safety. Nurses repeatedly brought up the issue of "learning how to cheat the e-MAR and be able to give the drug when it's telling you not to." While this was a necessary evil to make the e-MAR system workable, this knowledge and its use, nurses believed, ultimately made it less safe for patients.

A related but distinct connection between information technology and patient safety concerns the way in which computer technology is impacting the human interactions that nurses and physicians seem to believe is necessary to the safe delivery of care.

First, computers are coming between caregivers and patients, even when the technology is working properly and meets caregivers' information needs efficiently, there was a distinct sense in the conversations with nurses and physicians that if one was spending time on the computer (no matter how productive that time was in terms of information gleaned or provided to enhance patient care) that this time away from the bedside was inherently detrimental to patient safety. As a nurse in one of the focus groups commented, "We're seeing the shift in technology, using more, but not getting the staff to cover the time taken away to use the technology. We're getting all this technology. It's slowing us down. It's taking us away from the patient's bedside, yet we're not meeting that by getting more staff on board." Similarly, a physician worried that because of the computer technology, "Doctors aren't doing the doctor thing." They are relying on information gleaned from a computer screen rather than physical examination of the patient to make care decision. As nurses and physicians are spending less time at the bedside, nursing assistants are the ones left to interact with the patient, and are "not as capable of teaching or talking to the patient." Moreover, even when the computer technology is in the room with the caregiver, there is a sense that it's taking away from the relationship with the patients. As one nurse explained,

"If I have a lot of meds, I get a little anxiety. I wonder if this damn thing [the mobile computer cart used for e-MAR] is going to work. Then I'm not thinking about what I'm supposed to be thinking about. I'm thinking about the machine. I'm not thinking about the patient. Then you have to remember all the tricks [to make the system work]." ***You're not even looking at the patient.*** [emphasis added]

There is, then, this sense that interaction between clinical professionals and patients is critical for quality care, and that time spent on the computer is detrimental to the quantity and quality of those interactions.

Second, the introduction of information technology has impacted the interactions among caregivers themselves, which they also believe has a negative impact on patient safety. On several levels, nurses and physicians believe that their ability to tell and hear a patient's "story" has been negatively impacted by the new technologies. Many of the new information systems introduced over the past three years capture information by parsing and standardizing data entry through the use of check boxes. The cohesion of a narrative has been lost. In fact the IS department has made several modifications to these systems to try to bring the narrative element back in. Nonetheless, one older physician even had concern that typewritten narratives were still inferior to handwritten ones, believing it's hard to "get a qualitative sense of how things are going with a patient in a typed report...The info on a written report can be incomplete. It's harder to get a picture of the general well-being of the patient." Moreover, even when a narrative

component supplements the parsed information, nurses and physicians lament the absence of the face-to-face interactions that used to accompany the exchange of information about patients. They feel that the inability to ask questions, as they occur to you, to the caregiver supplying the information compromises safety because, “by the time you see them, you forgot your questions”, and it takes extra time and effort to seek them out to have your questions answered, time that most caregivers do not feel they have.

While these concerns would appear, at one level, to be connected to patient safety in that they require caregivers to access information in unfamiliar and perhaps more cumbersome ways, we believe that are also linked to a deeply held belief that the practice of medicine, at its best, is an intensely personal enterprise. This interpretation finds support in the discussion that emerged surrounding the fact patient safety is compromised by information technology because it has “cut down on the camaraderie of the staff.” As one nurse commented, “I can work in my unit all day and not see another nurse in the unit the same day.” Another added, “I think the human connection is missing now.” One of the physicians said that because of so much information is now digital, he tends to go back to his office to work, rather than spending time on the unit, in proximity to colleagues. Although these comments may seem to be about working conditions and job satisfaction, keep in mind that they were made in the context of a conversation around technology and patient safety. Early in our conversations, both physicians and nurses had described staff relations and morale, or teaming among caregivers as important elements in promoting patient safety.

It appears, then, that while the introduction of information technologies to promote patient safety are recognized by staff as making concrete positive contributions, they are also occasioning a change in the human, interactive characteristics of the delivery of health care that staff perceive as key to patient safety. Whether or not these changes *are* detrimental remains to be seen, but caregivers’ belief that they are losing something important in the practice of medicine as information technology becomes more pervasive may be an important factor to consider in how health information technology is designed and implemented.

In one of the nursing focus group in particular, our discussion of technology took a turn that poignantly captured a sentiment reminiscent of the responses to the introduction of new technologies that have characterized industrial innovations since the 19th century. Our focus group ended with the following exchange among the participants:

“People feel there is money being spent on [technology] and not on staffing.”

“We depend on the machine, and they’re dumbing us down.”

“We’re waiting for a screen to come up and tell us ‘Wait this is wrong; this is the wrong patient.’ And you can’t do that with everything.”

“We’re spending time worrying about the technology, not thinking about the patient. We’re becoming more robotic.”

“This time next year, we *will* be robots.”

“We won’t be able to think.”

“We’ll be COWS [the acronym for computers on wheels – the mobile computer units] and be mooing at you.”

Attitudes Toward Medical Errors. Both the IHI and AHRQ safety surveys placed a good deal of emphasis on an institution’s response to medical errors and situations that could lead to adverse events as factors of a “culture of safety”. As noted above, SVMC leadership in general and the Patient Safety Department in particular have done much over the past four years to promote a culture that values the reporting and analysis of adverse events.

Between 2004 and 2005, there was little change in staff perceptions of the systems for report and acting upon adverse events and potentially unsafe conditions. None of the differences in the following table were statistically significant.

Table 6a. Percent who “Agreed Strongly” with statements on the IHI Safety Survey

Statement	2004 (N=128)	2005 (N=124)
The culture of this clinical areas makes it easy to learn from the mistakes of others	38%	45%
Medical errors are handled appropriately in this clinical area	59%	57%
My suggestions about safety would be acted upon if I expressed them to management	43%	48%
I am encouraged by colleagues to report any safety concerns I have	68%	66%
I know the proper channels to direct questions regarding safety	70%	74%

Similarly, in the AHRQ safety surveys administered in 2006, 2007, and 2008, there was no discernable shift in staff opinion about key features of the safety issue reporting system.

Table 6b. Percent who “Agreed Strongly” with statements on later IHI Safety Surveys

Statement	2006 (N=59)	2007 (N=135)	2008 (N=95)
Percent who “agree” or “strongly agree”			
Staff feel that mistakes are held against them	56%	56%	56%
When an event is reported, it feels like the person is being written up, not the problem	58%	47%	47%
Staff worry that mistakes they make are kept in their personnel file	39%	33%	47%*
My supervisor/manager seriously considers staff suggestions for improving patient safety	72%	76%	78%
Percent who indicate “most of the time” or “always”			
We are given feedback about changes put into place based on event reports	50%	43%	45%
We are informed about errors that happen in this unit	60%	54%	51%
In this unit, we discuss ways to prevent errors from happening again	76%	73%	73%

* significant change from prior year p<.05

While the quantitative results suggest little shift in staff views of the way medical errors and unsafe conditions are handled within the hospital, the focus groups and interviews do suggest a clear positive evolution of staff views. In 2005/2006, among focus groups and interviews, all but one of the nursing units noted that reporting an error was “seen as a negative thing”. People were clearly reluctant to report on one another for fear of “hurting [someone’s] feelings,” because of concern that the person one reported on would be “penalized”, or concern that if you reported on

someone, that person would be more likely to report your mistakes in the future. By 2008, this sentiment was completely absent from the focus groups and interviews. Physicians commented explicitly on the new “culture of openness” regarding mistakes, and one described his own new “vigil[ance] about the quality of care provided by other physicians” and his newfound willingness to report concerns to management. When asked why this change had occurred, he said that this philosophy of openness around safety issues was “pervasive from the board on down” and that there was “constant repetition,” and that it was a consistent topic of conversation at staff meetings.

In addition there was a shift in perceptions of the efficacy of the event reporting system in bringing about changes in practices to improve patient safety. In 2005, all focus groups and interviewees were in agreement that the event reporting systems was generally a “black hole” and that staff members were not systematically made aware of errors that had occurred. They were rarely were cognizant of the connection between errors and changes in practice made as a result. By 2008, each group clearly saw a connection between event reports, causal analysis, and changes in practice that results. As one physician commented, “[There is] more loop closing than there used to be. If it’s something that can be corrected, it’s addressed.” By 2008, “root cause analysis” had entered clinical staff vocabulary in their discussion of the event reporting system.

The disparity between the lack of change in beliefs that surround reporting of adverse events and near misses and institutional responses to these concerns revealed in the survey, and the clear shift in tone around these issues in the focus groups and interviews is puzzling. The only possible explanation we can think of concerns the position of the interviewees in the SVMC hierarchy. One of the four physicians interviewed was a department head (in 2008 but not in 2005), and another was active on a hospital committee. One of the three nursing focus groups in 2008 consisted solely of nurse designees (the equivalent of charge nurses). By virtue of the more managerial functions these individuals played in the organizations, it is possible that their exposure to and interaction with the event reporting subsystem was more developed than that of the rank and file clinical staff who dominated in the survey.

In summary then, our finding in regard to our first research question (Does organizational education about patient safety and the commitment of senior management improve the climate of safety in the organization?) is a qualified yes. The efforts of management around patient safety are correlated with both a deepening appreciation of the importance of good communication to safety and a belief that communication systems have improved, and for at least some staff, are correlated with an improved openness to the reporting and analysis of adverse events. However, the fact that communication is now more reliant on information technology, staff believe, has had both positive and negative impacts on patient safety.

The discussion above quite clearly shows that in regards to our second research questions (Does the implementation of information technology results in changes to the culture of safety?), the factors staff believe affect patient safety have come to focus much more intently on information technology. Staff clearly see all the information technology innovations over the past four years as “safety issues”, though the affects are believed to be both positive and negative.

It would be impossible to separate the impact of these cultural changes on *actual* patient safety from the impact of all the procedural changes and information technology changes that have occurred along side them. However, it is reasonable to consider that staff attitudes toward patient safety, and their beliefs about the connection between information technology and patient safety should be considered as health care organizations plan the implementation of new technology systems to maximize their patient safety benefits.

SNAP, Voice Care and Nursing Shift Report

Our research goal was to understand if the SNAP protocol by itself, or the SNAP protocol in conjunction with Voice Care technology, improved the completeness and internal organization of nursing shift report. As a practical matter, hospitals must comply with the Joint Commission’s requirement that there be a standardized approach to all patient “hand offs”. SVMC’s leadership adopted a standardized approach (i.e., “SNAP”) but then was looking for a methodology that would engender more reliable use.

In that context then, this research sought to understand the relative effectiveness of teaching the protocol versus using the protocol and technology. Our results, described below in detail, lead us to conclude that the Voice Care technology brought about the most significant improvements.

The table below shows the percent of shift reports that contained each of the four required SNAP elements. Each shift report was reviewed for the presence or absence of each element against a set of criteria.

Table 7. Percent of reports containing each SNAP element

	Summarize	Narrate	Analyze	Propose Action
T1 (N=23)	91%	100%	78%	83%
T2 (N=26)	69%*	92%	92%*	81%
T3 (N=164)	100%*	100%	73%*	84%
T4 (N=196)	100%	100%	90%*	95%*

Note: T1 – after the initial SNAP training; T2 – after additional on-the-job coaching; T3– 6 to 10 weeks after the implementation of Voice Care; and T4 – 6 to 10 months after the implementation of Voice Care

* indicates significant difference ($p < .05$) from prior period

The most striking feature displayed here is that the nurse’s ability to reliably address the SNAP elements increased for all four of the SNAP elements. When we compare T1 to T4, independent sample t-tests show significant differences only at the $p < 0.20$ level, largely because of the small sample size at T1. However, when we compare T3 (shortly after the introduction of Voice Care), at which time the presence of the four SNAP elements was nearly identical to their prevalence at T1, to T4 (6-10 months after the introduction of Voice Care, we find highly significant differences in the presence of both analysis and plan ($p < .001$). It is clear, then, that the introduction of Voice Care technology had a much greater affect on the inclusion of the four SNAP elements in shift report than did the on-the-job coaching that occurred between T1 and T2.

Table 8. Percent of reports containing SNAP elements in correct sequence

	Summarize	Narrate	Analyze	Propose Action
T1 (N=23)	57%	65%	11%	26%
T2 (N=26)	94%*	83%	0%	19%
T3 (N=164)	100%	84%	17%*	42%*
T4 (N=196)	100%	100%*	59%*	77%*

* indicates significant difference ($p \leq .05$) from prior period

The most striking feature displayed here is the nurse’s ability to more reliably sequence their reports consistent with the SNAP protocol. This is particularly true for the sequencing of the “analyze” and “propose action” portions of report, which showed improvement at the $p < 0.01$

level. Six to ten weeks after the introduction of Voice Care, nurses had substantially improved their ability to correctly place their analysis and care plan within the shift report. After their initial SNAP training, and follow up one the job coaching, none of the 26 reports we sampled contained “analyze” as the third, clear and distinct report element, and only five of the 26 (19%) “proposed action” at the end of the report. In contrast, six to ten weeks after the introduction of Voice Care (T3), 17% of report contained “analyze” in the correct location, and 43% of reports “proposed action” at the end. By T4, six to ten months after the introduction of Voice Care, 90% of reports contained an “analysis” of the patient’s condition, and 59% of reports had this “analysis” in the correct location, and 95% of reports contained a plan of care, and in 77% of reports this plan of care was correctly placed at the end of the shift report.

The prolonged use of Voice Care, then, is correlated with an improvement in nurses’ implementation of the SNAP protocol. The technology only forced nurses to begin their report with a summary of the patient’s case. (This summary was recoded only by the first nurse to receive the patient, and then automatically became part of the “report” that every subsequent nurse entered.) The presence and organization of the remaining SNAP elements were totally under the control of the nurse giving report.

There are several reasons why the introduction of the Voice Care technology may have improved the quality of shift report. First, instead of trying to give and receive report on a busy floor with many people around and many interruptions, report was now given and received in a quiet room away from the nurses’ station and patient rooms. Second, without nonverbal feedback and questions from the nurse receiving report, the nurse giving report may be more likely to focus on the coherence and organization of the report she now presents as a soliloquy. Third, some nurses, in order to help them prepare to give report without the dialogue they were used to, developed written templates, based on the SNAP protocol, to help them organize their thoughts and remember all the details they wanted to include in their report. With the introduction of Voice Care, there was no other nurse present to prompt them if they happened to leave something out. And lastly, there could have been a rise in professional expectations as other nurses began hearing these more organized reports, they may have begun to change their own practice in response.

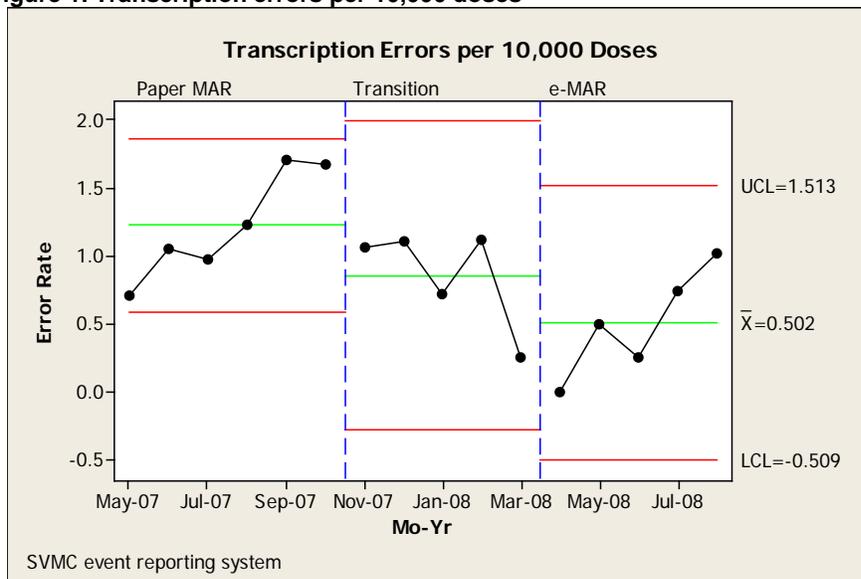
E-MAR’s Impact on Medication Transcription and Medication Administration Errors

Our research goal was to understand if the implementation of bedside medication verification and the use of an electronic medication administration record (eMAR) would decrease certain types of medication errors. Error reduction has been a hallmark of the patient safety effort at SVMC, so the introduction of this technology was seen as a critical component. Through this study we examined two types of medication errors: a) transcription errors and b) administration errors as we felt that bar coding and eMAR technology had the greatest potential to reduce the error rate.

Transcription errors: As long as there is a human interface between the physician’s written order and the medication administration record, there is the potential for transcription errors. While, the implementation of eMAR at SVMC did not eliminate the process of transcribing a handwritten physician order onto the MAR, our project does show a reduction in the reports of those types of errors. When we compared rates of transcription errors before, during and after

the implementation of eMAR, we found that as we anticipated, the number of reported transcription errors decreased significantly.

Figure 1. Transcription errors per 10,000 doses



The difference between the mean transcription errors in the pre E-mar (paper) period (1.22 per 10,000 doses) and the period after implementation was complete (0.50 per 10,000 doses) is significant at the $p = .01$ level.

It should be noted that the implementation of e-MAR included a change in the transcription process, which we believe is largely responsible for the drop in errors. Prior to e-MAR, a nurse would transcribe a physician’s medication order from a hand-written note into the Meditech system, a second nurse would review the Meditech transcription and sign off, or if the order was incorrectly transcribed, work with the nurse who entered the order to correct it. “Transcription errors” were reported when BOTH nurses missed the error, and somewhere down the line someone realized that the medication, as entered on the patient’s electronic chart and delivered to the bedside and perhaps even administered, was not the medication, dosage, or means of delivery (i.e. injection, oral, IV, etc.) the physician had ordered.

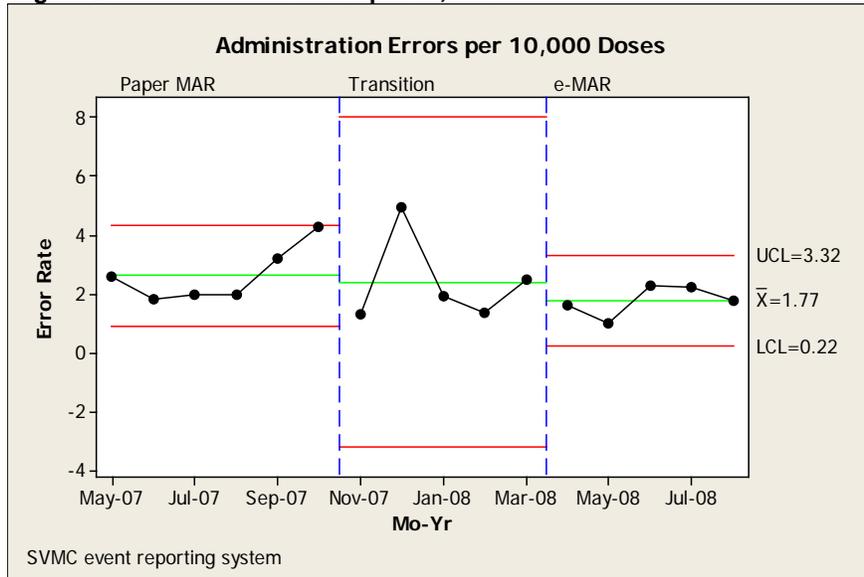
With the implementation of e-MAR the original physician order (still hand written) was now faxed directly to the pharmacy and entered into Meditech by a pharmacist. The nurse responsible for the patient on the unit would then review the order and either sign off, or contact the pharmacy to have the order corrected. This did not generate a report of a transcription error, as it had become a routine step in the transcription process. The staff is now reviewing the e-dialogue between nursing and pharmacy to better understand the nature of correcting orders. We have learned that in both the pre- and post- eMAR systems, nurses would often make corrections on the MAR to intercept transcription errors. Since many of these transcription errors were never reported through the event reporting system, it is unclear what their incidence was. Similarly in the post eMAR environment, nurses and pharmacists work together to correct the order and do not report it as an error. What is significant here is that nurses and pharmacists consider it a

central part of their duty to get the order right. The technology has changed the process of doing that, but has not changed their sense of responsibility.

Administration errors: Administration errors are those that happen during the process of giving the medication to the patient. Assuming the nurse even knows that s/he gave the wrong medication, these types of errors tend to be reported more often than transcription. A major goal of the eMAR system was to intercept potential administration errors before they occurred, but alerting the nurse that there was some mismatch between the patient, the medication, and the MAR.

Perhaps because of the eMAR warning system, administration errors also decreased over the study period, with means of 2.63 per 10,000 doses prior to e-MAR, 2.41 per 10,000 doses during implementation, and 1.77 per 10,000 doses after implementation was complete. This difference between the pre and post-implementation periods, however, did not reach robust statistical significant ($p = .20$).

Figure 2. Administration errors per 10,000 doses



One of the key promises made by our eMAR vendor was that the software would alert a nurse about a potential error before s/he actually administered the wrong drug. It turned out that, in fact, the software issued so many warnings that the nurses adapted by ignoring many of them. This set up a risky situation that no one had anticipated.

Also, the software issued warnings that were poorly understood. Our evaluation team (patient safety, IT, nursing, pharmacy) spent months trying to decipher the error mechanisms involved behind seven of the warnings that we felt had the most potential to stop an administration error. We wanted to know what type of error was prevented by the warning and how serious it might have been.

The seven priority warnings include:

- Allergy warning – the patient is allergic to the medication the nurse is about to give.
- Interaction warning – the medication the nurse is about to give has an interaction warning with a medication the patients has already received.
- Medication is not on patient’s MAR – the nurse is about to give a medication that is not in the patient’s current list of medications that have been ordered.
- Compound verification wrong med – the nurse is about to administer a compounded medication that does not match the compound characteristics as ordered.
- Patient unit number does not match – the patient wristband the nurse has just scanned does not math the patient record of medication orders that the nurse is currently looking at on the computer screen.
- Ordered dose exceeded – the medication the nurse has just scanned is in a dosage that exceeds what has been ordered for the patient.
- Admin amount less than ordered amount – the medication the nurse has just scanned is in an amount less than what was ordered for the patient.

Our data show a rate of 200 warnings per 10,000 doses over the 5 month period of evaluation, but the frequency of warnings from each of the seven types was highly variable. During the evaluation period we issued 78,628 doses of medication and never once did the allergy warning sound. The team wanted to know if this is because there were actually no potential allergy errors or if the warning was not set up properly to capture these errors. We learned that the software did not provide enough patient-specific information to ever tell us. This information was promised in a future release from the vendor.

On the other end of the spectrum, another of the warnings accounted for about half of the total number of warnings – “medication not on patient’s MAR” (or 100 per 10,000 doses). The team felt that it would be imperative to track this down. They learned that this warning type appeared during situations when the nurse tried to administer medications to patients were admitted during the night shift and the pharmacist had not yet entered the orders into the system. The team concluded, then, that this warning was not actually “catching” a potential error, but was activated because a portion of the work flow had not been completed.

The most promising data that we believe may be accurately capturing true near misses concerns the dosage warnings and the interaction warnings. When a nurse receives an “ordered dose exceeded,” “administration amount less than ordered amount,” or “interaction” warning, he or she has the opportunity to document in the e-MAR system that he she gave the medication despite the warning, or that he/she chose not to give the medication. (The other warnings we studied did not allow the nurse to document administration in the e-MAR system, so we have no idea whether the medication in question was actually delivered or not). With these three types of errors, however, the nurse does have a choice about his/her action once the warning has been received – the medication can be documented as administered or not administered. We believe

that when a nurse receives a dosage error and makes the choice NOT to administer the medication he/she has just scanned, this may represent a true near miss. The nurse was about to give a medication, but the e-MAR warning caused the nurse to stop.

Rates for doses not administered because of a dosage error were 2 per 10,000 doses for overdoses, and 1 per 10,000 doses for underdoses, and considerably less than 1 per 10,000 for interaction errors. Adding these together, this would be a near miss rate, just for these three types of medication errors, of at least 3 per 10,000, far higher than the 0.29 per 10,000 doses “near miss” rate indicated by our self-report event reporting system over the past two years. These results suggest that with the introduction of e-Mar we are able to document 10 times as many near misses as through the self-report system. (Anecdotal evidence from focus group interviews with nurses (see discussion of Culture Study above) suggests that nurses do feel that the introduction of e-MAR has helped prevent errors that would previously have gone undetected, such as forgetting to split a pill when the ordered dose is less than the tablet amount.)

Additional Lessons Learned. Through our experiences implementing new health information technology systems over the past four years, and through our study of staff attitudes toward patient safety, there are several lessons to be learned about the ways in which organizational structure and culture and technological innovation interact. We hope can inform the work of health care institutions as they introduce new technologies to improve patient safety:

- 1. Internal EHR initiatives must take account of the extra-organizational EHR environment.** While the focus of our work was on implementation of EHR components at the hospital, the need to link the hospital; to other entities significantly slowed progress. SVMC encountered potential technology links with state EHR initiatives, private practice EHR systems, and the EHR systems of entities within the SVHC organizational umbrella, all of which slowed the ability of SHMC to move forward with new technology. Clinical staff at SVMC had connections to these other entities and were leery of implementing new technologies that did not fit with the current capabilities or future directions of these other entities.
- 2. Consider the leverage your organization has over the users of your intended IT innovations.** Implementation of new technology for physician use proved particularly difficult (as compared to nursing staff) because few physicians in SVMC actually work for the hospital. Physicians are organized into a Medical Executive Committee that is empowered to make most decisions regarding how medicine is practiced within the hospital. Both the Information Systems and Patient Safety Departments are part of the hospital’s internal management team. The management team is governed by the Board of Directors. While the Board and management team may want to implement new technologies to improve patient safety, that implementation can be effectively slowed or halted by the Medical Executive Committee, which represents the interests of physicians. Since we are facing a physician shortage in our area (we currently have about 30 open positions), the Board and management team have little interest in moving forward with technologies that are not supported by the Medical Executive Committee. The independence of the Medical Executive committees and their primary focus on the working conditions for physicians are at odds with the focus on the Patients Safety and IS department on the larger issue of the use of technology to improve patient safety.

Moreover, as independent businesses, physician's private practices can also make software purchases that are at odds with the community-wide initiative supported by SVHC. The divergent interests of the three prongs of the organizational management structure create a barrier to implementation of best practices.

- 3. Let ideas for technology change originate with end users.** The head of our information systems department described this as “leading a horse to water”. While one cannot rely on end users to think of innovations totally on their own, the strategic introduction of small changes in practice can lead to a user-led rather than top-down demand for increased information technology (the latter of which tends to engender user resistance.) An example can be found in our approach to the implementation of CPOE. Rather than purchasing and implementing a full blown CPOE system, the IS department made the strategic choice to begin by standardizing order forms. The demand for this has arisen from physicians who complained about the different forms being used in each department. IS worked with clinicians on form design and then put the forms online for physicians to print out and fill in. Soon physicians began asking why they couldn't just fill in the forms on line and then print them. IS staff were then again able to make a technological change that moved them toward their goal (CPOE) but appeared to physicians to be a response to their needs. Taking baby steps toward a full CPOE system seems to be working with less resistance to change.
- 4. A heightened “culture of safety” can only lead to improved safety to the extent that people have clear roles and the authority to bring about changes in practice.** While there is clear evidence that awareness of and concern with patient safety at SVMC has increased at all levels of the organization over the past few years, there is still at some level a sense among staff that “fixing” any and all safety hazards is the responsibility of the Patient Safety Department. This may have developed because the event reporting system and the safety walk rounds rely on a one way flow of information about safety concerns *to* the Patient Safety Department. All the training and promotion of patient safety done by the Patient Safety Department over the past few years has done its job in raising staff awareness and making them more likely to report events and conditions that compromise patient safety. However, as one member of the Patient Safety Department recently pointed out, “The more you learn, the more stuff there is that you can't do anything about.” Patient Safety staff are now turning their attention to clarifying their role in the patient safety system. While they can and should coordinate efforts to make systemic changes that span multiple departments, managers and department heads must take on the responsibility of improving practice within their areas, and clinical staff must shift from a reactive stance – “I will do what I need to do today to keep *my* patients safe” (an attitude that leads to a multitude of work arounds) – to a viewpoint that empowers them to suggest and pursue permanent changes within their units that will improve patient safety. They must not only be able to say “this is unsafe”. They must also be able to generate and pursue ideas to eliminate the unsafe conditions. This will be the next step in the evolution of the culture of safety at SVMC.

List of Publications and Products

Still, CJ. Using Video to Enhance Training. *Meditech Magazine* 2007 September; Internet publication.

Lanoue E, Still CJ. Patient Identification: Producing a Better Bar Coded Wristband. *Patient Safety and Quality Health Care Magazine*; 2008, Vol 5 Issue 3, page 12.

Lanoue E, Still CJ. Special Report: Closing the Medication Loop. *Health Data Management Magazine* 2008 December; Volume 16, Number 12; page 34.