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Editor’s Report: The Evolution of the Primary Caregiver

Focus: Process Improvement

Features
The Evolution of the Primary Caregiver

Computerization and Interdisciplinary Process Change

W ith the advent of advanced computerization and rising demand for multi-talented, multi-faceted caregivers, the need for interdisciplinary function in healthcare has never been more evident than today. This will not be the burden of individuals; more likely it will resemble a coordinated healthcare unit comprised of nurses, physician extenders and medical specialists. Computerization and process refinement will help make the transition between care providers transparent to the patient, but the need for change must be accepted as the process evolves.

The trend for moving more services outside of the traditional acute-care domain will continue. More recovery services will be done at the home or in another suitable outpatient setting. As hospitals continue to decentralize, there is real fear of losing the direct control of a patient’s recovery. Thus, interdisciplinary caregivers will be key for hospitals to maintain a common thread between the acute-care setting and the ambulatory recovery process. To do this effectively, IT and process change must be the primary driver for change. Clinicians will need to embrace IT as a tool that will help collect, analyze and distribute key data elements to all providers along the continuum of care.

In the past, clinicians were notorious for reticent behavior toward the utilization of computerization as a result of anything that threatened traditional care. Statements such as, “I am only concerned with patient care,” or “I will leave the computers and paperwork for administration,” were commonly accepted arguments in healthcare because the rapid increase in the demand for services made the clinician a scarce resource. Mandates for process change and automation were dismissed as fear tactics. Ultimately, many organizations capitulated to avoid turmoil and turnover within the clinician population. More recently, the mandate for change has come from external groups (JCAHO, IOM, IHI, the Leapfrog Group, etc.), lending credence to administration’s call for change and, thus, giving organizations new toolsets to bring about a fundamental transformation in healthcare delivery.

As we continue to look for ways to do more with less and at the same time improve quality and safety, interdisciplinary transparency will be critical to success. We have seen this in the broader role that nurses have undertaken in many organizations. As reimbursement shrinks, hospitals will look for ways to reduce specialized support services that are not absolutely required. Since many of these services are essential for a positive patient outcome many nurses and other caregivers will assume more responsibility for therapeutic and social functions that were once provided by specialists.

If this premise holds true, caregivers at all levels of the continuum will need to add more responsibility to the traditional direct-care provider role. Ambulatory care facilitator, data collector and organizer, post-acute care reminder and follow-up, social service scheduler, discharge instruction educator, homecare transfer facilitator and long-term care placement coordinator are just a few of the gaps that must be filled. The analogy of the hotel concierge comes to mind when we think about all of the processes that must be coordinated for each patient. Impossible? Many nurses are performing some or all of these functions now. But without new toolsets, these responsibilities can be a major source of frustration and job dissatisfaction. Role ambiguity combined with a general dearth of meaningful, comprehensive and timely information is a recipe for failure.

IT fuels the change process at light speed. Getting IT staff, change agents and the areas targeted for improvement to embark on a team approach is a challenge worth undertaking. But without persistent and visible leadership support, a cultural transformation will never occur. (Brown and Duthe, pg. 34)

Hess portrays another approach to join IT with process change using Business Process Management. Although BPM is a well-documented tool used in many industries to unite process change with
technology, healthcare has been slow to adopt. BPM breaks down every workflow process from start to finish using a rules engine that automates the process and “... allows for a much higher degree of reproducibility, decreased variation, ... fewer errors, decreased workload, and ultimately improved outcomes.” (Hess, pg. 27)

Using BPM, Chester County Hospital has been able to increase various core-measure reporting compliance 30 percent to 50 percent for various key measures. This is the quintessential example of process and technology-aided change that actually helps caregivers improve quality by facilitating process improvement without adding additional workload.

IT has made much progress. From wireless access at the bedside to standard protocols for the transmission of healthcare data sets, healthcare IT has set the stage for interoperability and access. But without a fundamental change in the way we work and process information we will continue to spend billions of dollars on technological advancements just to do the same inefficient things, only faster.

The Winter 2009 issue of JHIM contains an assorted collection of special interest columns and articles on topics and applications that focus on IT driven process change. These contributions and case studies provide useful knowledge and analyses on the deployment of IT driven process change for optimal performance. In addition, special interest columns and articles provide valuable information and insight on healthcare trends, nursing informatics, HIPAA privacy controls, data standards and much more.

Finally, I would like to thank the professional staff at HIMSS, the peer reviewers and the editorial review board for all the behind-the-scenes work that goes into producing each issue. JHIM continues to look for new ways to provide relevant, important and useful information for healthcare professionals, academicians and HIMSS members. If you have any comments or suggestions that could help us improve in any way, please feel free to e-mail me at rlang@dh.org.
The amount of money wasted in healthcare today is every bit as embarrassing as the number of lives lost to medical errors. Dozens of studies published in respected journals suggest that somewhere between one-quarter and one-third of medical spending contributes nothing to a healthier population. Waste permeates all aspects of healthcare, from the way services are produced to the way they are reimbursed. Wastefully spending 25 to 33 cents of each medical dollar is even more problematic at a time when healthcare’s share of the GDP is peaking. Other national priorities (energy, education, defense, financial services) have become as economically important as medical care. Their needs will almost certainly absorb resources that would have gone to healthcare in the past. Producers in the medical marketplace can no longer grow just by getting a bigger piece of the GDP pie. Instead, providers must identify existing resources that are being used unproductively and then reallocate them to productive use within their organizations.

**RECYCLING WASTED RESOURCES**

Performance improvement is a management process ideally suited to this task. PI is implemented with a set of tools—including lean management, Six Sigma and the Toyota Production System—that are specifically designed to get more output from existing resources. PI provides a structure for improving an organization from the inside, an important consideration under economic circumstances that offer little to no hope of more real resources (i.e., dollars adjusted for inflation) coming from outside the organization.

PI is not the only way to increase the quantity or quality of care, but none of the other approaches is feasible in today’s medical marketplace. For example, increasing the workforce is not a realistic solution to healthcare’s problems in 2009. All practitioners are in short supply, and educational institutions simply do not have available resources to train more health professionals. Even if schools did have funds to expand programs now, nearly a decade would be needed to increase the number of caregivers.

Trying to improve performance by building more hospitals and buying more equipment is also not feasible under current economic circumstances. At the same time medical expenditures are likely hitting a GDP plateau, information and telecommunications technologies are moving healthcare from high-cost hospitals to less-expensive care settings like homes, worksites, drug stores and other locations. Again, the sensible solution is to focus providers’ primary efforts on transforming processes to improve the production of healthcare services, wherever they are delivered.

**PI REALLY WORKS**

PI is a well-established management methodology. The principles and procedures of PI have saved many American industries from extinction over the past 50 years. Banking, transportation, manufacturing, retail and agriculture all have successfully used PI to transform the way they do business in response to competition and other economic threats.

Caregivers need to understand what PI can do for them, but they should not do it all by themselves. Like IT, performance improvement generally requires a dedicated staff of professionals who can help caregivers work efficiently and effectively. It is a team activity where clinicians and
PI experts work together to define problems and to implement solutions. It is also an ongoing activity because performance can always be improved, especially in a scientifically and technologically dynamic industry like healthcare.

ADVANCING FROM ART TO SCIENCE

Providers have traditionally resisted efforts to systematize the delivery of healthcare. They argue that medicine is an art, a professional activity that cannot be reduced to cookbook-like production formulas. Important aspects of provider-patient relationships can be an art, but performing clinical procedures is rapidly becoming a science. Recent improvements in patient safety can be attributed almost entirely to standardization in production processes, supported by state-of-the-art information systems. PI and IT work together to eliminate unexplained variation in care, a key cause of high cost and low quality when defenders of “medical art” hinder applying management science to providing medical services.

PI is a common denominator across health systems that have harnessed waste and reallocated reclaimed resources to produce high-quality care as inexpensively as possible. Ironically, global competition in the form of medical tourism is another reason why American health systems must begin using the tools of performance improvement. Several foreign countries positioning to become destinations for medical tourists have formed partnerships with American health systems and IT vendors that have used PI to master quality and safety. These new global health systems can readily implement efficient and effective processes because they are free from the constraints of tradition.

SERIOUS ECONOMIC UNCERTAINTY

American healthcare providers have not been compelled to become efficient and effective because the domestic economy has grown for nearly 75 years. They have enjoyed a special status, both economic and political, that allowed healthcare to grow faster than any other industry over the past 50 years. However, the global economic crisis of 2008 raises serious doubts about continued growth.

Indeed, business as usual does not look promising. Tough economic times lie ahead for every industry, including health care. Performance improvement may be a bitter pill for providers to swallow, but its effectiveness has been proven. Providers must respond to lean times with lean management (or one of the other tools of PI). JHIM

Dozens of studies published in respected journals suggest that somewhere between one-quarter and one-third of medical spending contributes nothing to a healthier population.

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Over the past year, I have been involved in one of the most exciting information technology projects of my career. Called the Knowledge-Based Nursing Initiative (KBNI), the project involved translating research evidence into actionable recommendations, and embedding them into automated decision support and documentation tools in order to support nurses’ use of the nursing process to individualize care.

At first I thought the initiative was distinctive because it was about supporting evidence-based practice and using automation to drive best-practice care to benefit our patients by achieving the best outcomes. Then I decided that I was excited because the project was accomplished through the healthcare industry’s first applied research collaboration, a unique partnership forged between Aurora Health Care, Cerner Corporation and the University of Wisconsin-Milwaukee, joining nurse researchers, informaticists, clinical practitioners and software suppliers. While both of those are true, I came to realize that there was another, more important reason that I was so energized. It was related to the project ownership. This project was owned solely and squarely in nursing. It was not an IT project.

And that is how I came to realize that the best IT project is not an IT project.

Let me explain.

Many of us working in healthcare IT have long heard the mantra that HIT adoption is 10 percent technology and 90 percent socio-cultural issues like change management, leadership, risk tolerance and incentives. In my last JHIM column (Fall 2008), I asserted that IT implementations, which create care transformation, are those that account for the interplay of people, process and technology, and that getting these three elements aligned is absolutely essential to project success. But I never totally identified that IT sometimes needs to take a supportive role to the people/process/practice change being enabled by the technology. I never really internalized that IT implementations are about delivering real business value, and the only way to do that is to use IT to change the business; in our case, healthcare delivery. I never completely acknowledged that IT is a means to an end and not an end unto itself.

Craig Schiefelbein, a great friend and colleague, discusses this in his book Get Out of I.T. While You Can. “The only IT individuals who ...have the respect of business and board leaders don’t see themselves as being ‘in IT’, but as being in the same industry that their employer is.”

This illustrates the position that we are not in the business of IT; we are in the business of healthcare. And that successful IT projects are not about the implementation of technology, but the clinical changes and patient impact that is enabled, supported and facilitated by technology.

BUILDING THE PROJECT SUCCESS FACTORS

So, let me elaborate on some of the specific factors that made the KBNI project so different and so successful. First of all, the project was initiated by nursing as a professional practice change, recognizing that for evidence-based practice to become a reality nursing would need to change its practice model, as well as all the corresponding job expectations, processes and workflows. Second, the project was owned, sponsored and championed by a clinical nursing team; including the enterprise-wide chief clinical officer, the individual hospital chief nurse executive, two research scientists, the two pilot unit nurse managers, the two pilot unit clinical nurse specialists and six key staff nurses identified as Clinical “Transformers.” You can imagine how valuable the project team meetings were with buy-in and participation like that! The project was clearly seen as the most important thing these nurses were doing. They were empowered and knew they were creating the future of nursing at Aurora.

A third factor had to do with the involvement of the clinical nursing project team in training, go-live support, and post-implementation support. The training materials were put together by the clinical nursing project team. All training was done by the clinical nursing project team. All go-live support was done by the clinical nursing project team. Post-implementation support is also being done by
leaders, with membership built on broad committee is led by top business and clinical over-simplified; but I do think it is worth not naive to think this is easy, nor can it be selected, delivered and evaluated. I am within which IT projects are proposed, this is not about doing a readiness assessment to determine if the timing and what practice and care changes are required, then solicit proposals from the strategic business units who are respon-

A fourth factor was the way training was done. There were five training modules. The first three had nothing to do with the IT application, and were about the professional practice change, what evidence-based practice is and how to use the nursing process to individualize patient care. Only the last two modules described the specifics of the application and how it supports the practice illustrated in the first three modules.

I think you can see how these factors could be applied to other difficult clinical system implementations to promote project success. Imagine a groundswell of staff nurses looking to implement patient safety measures to ensure a practice where there is accurate medication administration, rather than the implementation of bar-coded medication administration. Envision a group of physicians who want to provide evidence-based, best practice medical care, rather than the implementation of computerized physician order entry. This is not about doing a readiness assessment to determine if the timing and culture is right to do a particular IT implementation. This is not about picking a clinical IT sponsor or about having clinical champions for your project. This is about questioning the very infrastructure within which IT projects are proposed, selected, delivered and evaluated. I am not naive to think this is easy, nor can it be over-simplified; but I do think it is worth your reflection.

CREATING THE RIGHT INFRASTRUCTURE

Let’s start by talking about IT governance. In the ideal scenario, the governance committee is led by top business and clinical leaders, with membership built on broad representation from key business and clinical departments. In addition to evaluating and ranking IT proposals brought to them, they take responsibility for generating an overall roadmap to use to compare each proposal against. They set guiding principles for concepts like integration vs. best-of-breed systems. They consider where the organization needs to be going and what practice and care changes are required, then solicit proposals from the strategic business units who are respon-

There is just no question that successful projects are owned and sponsored by the leaders and staff that will be making the practice change and will be benefiting by the change.
role and is responsible for the day-to-day progress of the project.

IN CLOSING

I write this with a bit of trepidation. After all, I have some ambivalence about all this, as I am a nurse who works in IT. I’d like to think that I can be all things to all people on all projects. Isn’t that why I came into IT in the first place? But then I realize that my place is to know the IT side of the project, and to serve as liaison, translator, facilitator and informatics subject matter expert. I ensure the IT department has the knowledge, budget and staff to do the clinical projects. And I am able to do that well, as I have background in both IT and nursing.

So, this is a lesson well learned for nursing informatics specialists working in IT as well as those who work as specialists within nursing departments. Although we are critical to getting the projects organized and executed, the best practice clinical project implementation is one owned by practicing clinicians. Only they can sponsor, champion, and create the practice transformation required to make complex clinical applications truly successful. Yes, the best IT project is the one that is not an IT project.

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Crack Down

Proper HIPAA Privacy Controls and Training Could Help Prevent Criminal Liability for Wrongful Access and Disclosure

A recent wave of patient data security breaches by employees of HIPAA-covered entities have led to the government's growing commitment to more aggressive efforts to identify and criminally prosecute HIPAA violations. Accordingly, in May 2008, a nurse employed by an Arkansas clinic was criminally convicted of wrongfully disclosing individually identifiable health information for personal gain and malicious harm. The nurse pled guilty to allegations stemming from her improper access of private medical information of a patient November 2006, and her subsequent disclosure of the medical information to her husband. Her husband intended to use the information against the patient in an unrelated legal proceeding. In connection with her conviction, the nurse faces criminal penalties under HIPAA, along with a term of supervised release up to three years.

Similarly, in April 2008, a UCLA Medical Center employee was indicted on a felony count of illegally obtaining individually identifiable health information for commercial advantage and faces imprisonment of up to 10 years, if convicted. The employee, who resigned her position as an administrative specialist, allegedly accessed the private medical records of celebrity patients and sold confidential information to a national media outlet.

Since these privacy violations were disclosed, California state legislators have discovered that more than 120 other employees of UCLA Medical Center illegally accessed celebrity medical records and other personal information between January 2004 and June 2006. California state regulators have blamed the medical center for not taking adequate steps to maintain patient confidentiality and have launched an investigation into the medical center's privacy practices and safeguards. As a result of this ongoing investigation UCLA Medical Menter was cited for deficiencies and is required to submit a plan of correction to the California Department of Health.

HIPAA holds any person who knowingly obtains or discloses any individually identifiable health information relating to a patient criminally liable. The penalties for these violations include a minimum fine of $50,000 and imprisonment up to one year. If the violation was committed with the intent to sell, transfer or use the health information for commercial advantage, personal gain or malicious harm, the penalties include a fine of up to $250,000 and imprisonment of up to 10 years.

While only a handful of HIPAA criminal cases have been prosecuted since the 2005 deadline for compliance with the rule, this recent prosecution may mark a new initiative of heightened government scrutiny and serves as a reminder of the consequences for breaching HIPAA privacy protections.

“What every HIPAA-covered entity needs to realize and reinforce to its employees is that the privacy provisions of HIPAA are serious and have significant consequences if they are violated,” says Jane W. Duke, United States Attorney for the Eastern District of Arkansas. “Long gone are the days when medical employees were able to snoop around the office files for information to share outside the office. We are committed to providing real meaning to HIPAA. We intend to accomplish this through vigorous enforcement of HIPAA's right-to-privacy protections and swift prosecution of those who violate HIPAA for economic or personal gain or malicious harm.”

Similarly, the California State Senate recently passed a bill that would require healthcare providers to implement safeguards to protect patients' individually identifiable medical information. If passed, this legislation would create a statewide Office of Health Information Integrity within the California Health and Human Services Agency. The director of this newly established office would be vested with the power to assess fines of up to $250,000 against violators of the patient privacy rules, and make recommenda-
tions on further investigations, discipline and licensing decisions.

The recent prosecutions against an Arkansas nurse and a California administrative specialist may also indicate a trend toward holding individuals, in lieu of or in addition to covered entities, accountable under HIPAA for wrongfully accessing and using patient private information for personal gain. While a 2005 memorandum opinion prepared for the General Counsel of the HHS and the Senior Counsel to the Deputy Attorney General described a narrow scope of liability under the HIPAA criminal provisions, the recent prosecutions against employees of covered entities demonstrate movement toward a more expansive scope.

The 2005 memorandum opinion indicated that, depending on the facts, the scope of the HIPAA criminal provisions include covered entities and only “certain directors, officers and employees of [covered] entities, in accordance with general principles of corporate criminal liability.” Similarly, Department of Justice guidelines issued in 2005 indicated that covered entities, such as physicians, hospitals and health insurers, would face criminal penalties for unauthorized disclosures, not necessarily individuals, such as employees.

In contrast, the criminally prosecuted individuals in the most recent cases have been low-level employees whose actions would be difficult to impute to the covered entity itself. It is also significant to note that neither the Arkansas clinic nor UCLA Medical Center have yet been charged in connection with the case. Similarly, while previous cases have included additional charges, including fraud and identity theft, it is noteworthy that each of these cases was brought solely for unlawful privacy disclosure under HIPAA.

While employees are increasingly targeted for improper use of patient information, covered entities also may be investigated and held civilly liable for negligence where such entities do not have in place proper privacy controls. For example, in July 2008, Seattle-based Providence Health & Services entered into a Resolution Agreement with HHS to settle potential HIPAA violations in connection with security lapses that allowed medical records of 386,000 patients to be stolen. Providence’s home services division stored these patients’ records without protective encryption on computer disks and digital tape that an employee had access to take home at night. This information was stolen from the employee’s car in two separate break-ins. Pursuant to the Resolution Agreement, Providence was required to, among other things, pay $100,000; implement a corrective action plan to safeguard patient information; train employees on safeguards; and file compliance reports for three years.

Covered entities can avoid criminal and civil sanctions against themselves and their employees for wrongful disclosure of patient information under HIPAA if they have adequate protections in place. Accordingly, covered entities should focus on developing staff training and implementing safeguards to reduce and prevent data breaches. Furthermore, covered entities should regularly educate and reinforce to employees the importance of maintaining patient confidentiality.

Correspondingly, covered entities should develop policies and procedures for effective logging practices for employees who access private patient information. Such logging procedures promote better reporting regarding access to electronic patient medical records. Effective log management for HIPAA is accomplished by having in place a logging system that features the following characteristics:

• Automatic collection and consolidation of log data;
• Automatic analysis of the data and generation of reports related to protected health information control and access;
• Regular event management, including monitoring for unauthorized software, login attempts or other suspicious behavior and discrepancies; and
• Effective identification and response to incidents.

To maintain the integrity of private patient information, a covered entity must maintain adequate security controls to monitor the access and use of such information. To that end, senior management must work together to develop clear statements of objectives and procedure and provide regular security training for log administrators and employee users. JHIM

A recent wave of patient data security breaches by employees of HIPAA-covered entities have led to the government’s growing commitment to more aggressive efforts to identify and criminally prosecute HIPAA violations.

NOTE: This article is informational and should not be construed as legal advice or legal opinion on specific facts. Henry Fader, Esq.; Nirvana Harris, Esq.; and Sharon Klein, Esq., are attorneys and members of the Healthcare Practice Group at Pepper Hamilton, LLP and can be reached at faderh@pepperlaw.com, harrisan@pepperlaw.com and kleins@pepperlaw.com, respectively.
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Interoperability describes the ability to communicate and exchange data accurately, effectively, securely and consistently with different IT systems, and to accomplish this in such a way that the meaning of the data is preserved and unaltered. That data must be shared securely across the spectrum of healthcare’s stakeholders: providers, payors, hospitals, employers, government and consumers. To unlock the power of this information and to remove the many roadblocks on the information highway, these information systems must become interoperable.

Interoperability with quality programs and performance based reimbursement.

Common data standards are a prerequisite to connecting healthcare’s stakeholders via interoperability. Today, most electronic data systems do not speak the same language, and the resulting “tower of babble” makes critical data unavailable. The answer is to eliminate these inconsistencies with data standards that bring order to the jumble of healthcare legacy and proprietary systems, terminologies, and data formats that populate the industry. But the problem with healthcare data standards is that there are so many of them, with no consensus to implement a select few. Terminologies remain an issue, as does attribution. To complicate matters further, newer versions may not communicate with prior ones within a single standards framework. HL7 is an example: version 2.5 does not communicate with the newer HL7 version 3.0, nor is it likely to in the absence of expensive modifications. That’s changing, slowly but surely.

Technology-driven interoperability promises to remove many of the frictions and fractures that plague the industry by enabling the exchange of clinical data from multiple touchpoints, including hospitals, physicians, payors, lab, pharmacy and the consumer.
Organizations like CCHIT and HITSP are working to establish a common framework for healthcare data standards, while national organizations like the e-Health Initiative and the IHE are proponents of imbedding standards within workflows and point of care solutions like the EMR.

The private sector is getting involved, too. Initiatives like Dossia, led by major employers like WalMart and Pitney Bowes is an effort to create portable, standards based employee health record.

Will this flurry of standards development usher in the era of interoperability? The short answer is no. Taken within the larger context of technology solutions in healthcare, it must be remembered that no remediation strategy for healthcare's ills can occur in a vacuum. There are larger obstacles to address, including privacy and security, incentives, utility, legal, policy and access. Carol Diamond of the Markle Foundation explains it this way: “Computers are amplifiers. If you computerize an inefficient system, you will simply make it inefficient, faster.”

While IT provisioned with interoperable standards is a powerful enabler, it is not a cure-all for the complex ills currently afflicting our health system. There needs to be a fundamental re-engineering of the healthcare delivery processes and business models to spark widespread interoperability in healthcare. Part of that re-engineering must include policies further defining how health information can be appropriately shared in a safe, secure manner that protects a patient's right to and control over their privacy. Similarly, we must recalibrate the health care reimbursement system to reward rather than inhibit the sharing of data. Finally, healthcare information won't be shared on a broadcast basis until all parties sharing data trust each other.

It’s likely that systemic interoperability in healthcare will be driven by a complex interplay of factors: process redesign, incentives and standards development, all which will continue to evolve and permeate the industry. Value-based services, reporting and reimbursement, the push towards transparency and other business trends will further trigger the industry's embrace of interoperability. And let’s not forget the end result: becoming interoperable and breaking down the silos that isolate critical health care data will improve care and reduce cost.

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Medication Management
More than the Sum of Its Parts

I am a nurse. I spent 12 years in clinical practice before transitioning into the healthcare information management field. Over the course of 35 years, I actively participated in the complex process of administering medications to my patients or worked behind the scenes implementing information systems to support this process. Administering medications has always been a complex activity, but with the release of the Institute of Medicine’s seminal work, “To Err Is Human”, focus on improving this process has moved to the forefront of hospitals’ patient safety strategies. The Leapfrog Group, the Institute for Safe Medication Practices (ISMP) and the Institute for Healthcare Improvement (IHI), have set the bar for patient safety around the medication process, and clinical information systems are a key enabler in achieving a safer and more effective process.

You can’t pick up a healthcare industry magazine today without seeing ads for information technology solutions supporting medication management. Stand-alone medication reconciliation applications, bar-coding medication administration systems, computerized provider order entry (CPOE) and evidence-based knowledge libraries all offer help in automating components of one of the most complex clinical processes. Yet medication management is a tightly integrated process requiring real-time access to detailed patient and drug information at the point of care. If we don’t look at this process in total and understand the information management implications, we may find ourselves cobbled technologies together to provide the information integration the process needs.

What is the medication management process? Medication management broadly describes a set of interactions, processes and decisions through which healthcare providers and patients work together to produce specific drug outcomes and prevent or address medication-related adverse events. Medication management requires the collaboration of physicians, pharmacists, nurses and the patient in collecting, communicating and managing critical information. The main components of medication management include updating the patient’s medication history; making a clinical decision and ordering the medication; verifying the order and dispensing the medication from the pharmacy; and safely administering the correct medication to the correct patient. Each of these components has major information management challenges that niche applications cannot completely address. An integrated clinical portfolio of CPOE and pharmacy and clinical documentation provides the foundation for enabling a safe and effective medication management process.

The medication management process begins well before a clinician initiates any medication therapy for a patient. The first step in this process is collecting the patient’s current and past medical/medication history. This includes all oral and injectable products (prescriptions, OTC, herbals, homeopathics, etc.), respiratory therapy agents, medications used in diagnostic studies, anesthetics and investigational drugs.

Best information management practices include:
• Taking and updating a complete medication history on all patients. This includes the identification of all forms of medications used and any history of illicit drug use. The automated clinical documentation system captures this information online in the patient history record, prompting the documenter for complete information. Responsibility for taking and updating the medication history is shared by the physicians, nurses and pharmacists caring for the patient. This information is captured and retained in an area of the record that is accessible to all who need to see it and add to it.
• All pertinent patient history, both inpatient and outpatient, is readily available and accessible to the provider in the treatment setting.
• All allergies are verified and document-
ed in the electronic record. There is one single “record of truth” for allergies and this information is consistently carried forward to all subsequent encounters and transmitted to all other clinical systems.

• Medication reconciliation, at all points in transition of care, is completed in conjunction with the patient’s transition.

Much of the clinical information technology need to support this activity in the medication management process is available in computerized physician documentation (CPD). However, only 0.9 percent of healthcare organizations have CPD implemented on at least one service in the inpatient setting. For most organizations, CPD is still far in the future. Regardless, even before automated documentation is implemented, hospitals need to define a minimum medication history dataset that will be utilized across clinical environments and implement it in manual records. Developing this data-set prior to automation allows the clinicians to road test its effectiveness and will drive how both the inpatient and ambulatory clinical documentation systems are configured. A strong policy on managing allergy information and identifying the “record of truth” will help to develop any interface strategies that will be required across systems and clinical settings.

Once the history is taken and clinical assessment is completed and documented, the clinician makes a treatment decision and medications are ordered. Best information management practices include:
• Providers have ready access to all patient information, both inpatient and ambulatory, at time of ordering.
• There are standardized drug protocols and product information, guidelines and dosing scales readily available wherever prescribing occurs.
• Clinical decision support alerts and prompts are integrated into a computerized order management application that informs prescribers about unsafe orders and offer decision rules for the use of medications.

Over the last several years, more and more hospitals have moved forward with implementing CPOE. And although HIMSS reports that less than 3 percent of hospitals have implemented CPOE, we have enough anecdotal information to identify new and better ways to use the capabilities. Initially, organizations implement CPOE with order sets designed to make the ordering process more convenient for providers (to enhance adoption) and with rules and alerts designed to influence behavior rather than clinical decision making. Implementing CPOE in support of the medication management process requires that we establish a clinical committee structure responsible for developing evidence-based order sets by specialty or diagnosis. Teams of clinicians should routinely review these order sets for improvement or retirement. Order sets, alerts, rules and reports needed to monitor compliance and assess outcomes are defined as evidence-based packets and maintained in both the CPOE and CDS library.

At the pharmacy, a pharmacist evaluates the orders and then selects, prepares and dispenses the medication to the care unit. Best information management practices include:
• All-important patient information is readily available and accessible to pharmacists when reviewing orders. This includes inpatient and ambulatory encounters, lab results, and medication histories. The computer system automatically screens for allergies, drug interactions and maximum doses.
• Medications should not appear on the EMAR or be available through the automated dispensing machines until the pharmacist verifies and approves the order in the pharmacy information system.

Many pharmacy systems are legacy applications implemented early in an organization’s clinical systems rollout. CPOE applications and clinical documentation applications are often being interfaced to these third party products. Pharmacists toggle between systems to review orders and patient history. Managing interfaces between CPOE and pharmacy is a harrowing responsibility fraught with opportunities for error. The industry has recognized the importance of integrating pharmacy and CPOE to maximize the power of rules, alerts and order sets. And while this may mean replacing the third party pharmacy system, the benefits of integration between CPOE, the EMAR and pharmacy can not be overstated.

Medication administration begins when the drug is brought to the unit. The nurse verifies that the correct medication has been delivered, identifies the patient, educates the patient on the drug and administers the medication. The patient is then monitored for his response to the medication and the administration and the response is documented in the patient’s record. Best information management practices include:

An integrated clinical portfolio of CPOE and pharmacy and clinical documentation provides the foundation for enabling a safe and effective medication management process.

• Patients are educated on all medications prescribed to them and are given patient-centric educational materials on these medications.
• All staff are educated on both the medication management process and clinical documentation on the EMAR. Physicians, as well as nurses, should be able to understand how medications are documented on the EMAR.
• Once the five rights have been verified and the patient receives the medications, the nurse will document electronically at the location/time the medication is given.
• Links to online drug references are available to nurses at the point of care.
• Clinical documentation system prompts nursing staff to document patient’s response to medications in a follow-up assessment/note.

The medication administration component of the process has the most opportunities for technology support. Automated dispensing machines and bar-coding documentation make safely delivering and charting medication administration much easier. However, most hospitals are a long way from implementing bar-coding documentation. The key technology tool associated with this activity is the EMAR.
And the major challenge in implementing the EMAR is to get the nursing staff to use it as the official record to dispense medications against and to chart real time at the bedside. Changing nurse behavior from “batching charting” after medicating all patients to real-time, bedside charting is an important step in improving the safety of the medication administration process.

Niche applications are always intriguing because they solve very specific problems within a complex process. However, as healthcare organizations strategize on how to improve the medication management process, it is imperative that we not take our focus off building the clinical information systems foundation that these niche products can enhance: integrated CPOE, clinical documentation and pharmacy. JHIM

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Sublicensing of EHR and Related Systems
Licensing and Contractual Considerations

Many healthcare entities are endeavoring to share their healthcare information technology with other healthcare entities in their communities, as part of a RHIO, HIE or otherwise. The underlying goal of many of these endeavors is to create the local building blocks that will eventually become a national network of interoperable health records. In addition, some healthcare entities have found these arrangements useful to provide non-electronic health record information technology to other local healthcare facilities that may not be able to afford such systems by themselves.

There are typically two contracts required for these transactions. The first is the agreement between the software manufacturer, which I will refer to as the “Software Vendor,” and the healthcare entity originally licensing the application, which I will refer to as the “Original Licensee.” This first agreement is referred to herein as the “Software Vendor Agreement.” The second agreement, which I will refer to as the “Sublicense Agreement,” is between the Original Licensee and the unrelated local healthcare entities, which I will refer to herein as the “Sublicensees.”

It is important to note, the arrangements described above raise numerous other legal issues that are not addressed in this article. For example, any healthcare entity that desires to provide access to a software application to another unrelated healthcare entity or clinician must be aware of the physician self referral prohibition (Section 1877 of the Social Security Act) commonly known as the Stark law, the federal anti-kickback statute, and, depending on the data being exchanged, the Health Insurance Portability and Accountability Act, commonly known as HIPAA. In addition, significant anti-trust issues could arise if the software allows the Sublicensees to share financial information. These additional legal issues are not addressed in this article.

The Software Vendor Agreement must contain specific provisions allowing the Original Licensee to provide access to (which I will refer to as a sublicense) the software application to the employees of the Sublicensee. The Original Licensee should not assume that it can provide access by simply executing the Software Vendor’s standard form license agreement. All license agreements contain a license grant section that specifies the parties and individuals that can use the software. In most instances, it is limited to employees of the legal entity that signs the contract. In addition, most license agreements specifically prohibit the use of the software to process information for, or use the software for any other benefit of, any third party. The contractual language allowing the Original Licensee to provide access to the Sublicensee can take many forms. It may be as simple as expanding the definition of an authorized software user to include any other individual authorized by the Original Licensee to use the software. Alternatively, the license grant may specifically state that the Original Licensee may sublicense or provide access to the software application to a third party and set forth the conditions under which it can do so.

The Software Vendor Agreement should also address what happens in the event of termination of all, or some portion, of the Software Vendor Agreement. Will the sublicenses that have been granted to the Sublicensees also terminate?

The second agreement that is required is the Sublicense Agreement, which is the contract between the Original Licensee and the Sublicensee. The Original Licensee should put careful consideration into the drafting of this document. There are a number of issues that could arise for the Original Licensee if certain issues are not addressed in this agreement. Each Sublicense Agreement will need to address these issues based on the particular transaction at hand.

The Sublicense Agreement should address how fees will be structured and paid. As mentioned above, the Original Licensee should create a pricing structure for the products and services being provided.
ed to the Sublicensee, with legal oversight regarding Stark and anti-kickback issues. The Original Licensee will need to think about how these payment terms could produce problems in the future. For example, if the Sublicensee is allowed to pay for installation and start-up costs as a component of an ongoing monthly fee, what happens if the Sublicense Agreement is terminated prior to this fee being paid?

The Sublicense Agreement should address how the Original Licensee will control the Sublicensee's use of the software. In addition to the terms and condition contained in the Sublicense Agreement itself, the Sublicense Agreement should allow the Original Licensee to establish a set of policies and procedures to govern use of the system, and allow the Original Licensee to modify these policies and procedures from time to time as necessary.

The Sublicense Agreement should address who will have access to what information. If the system allows all Sublicensees to have access to the information entered by all other Sublicensees, especially with regard to patient information, the Sublicense Agreement should consider what issues this might raise, especially from a HIPAA perspective. Will the system notify the Original Licensee when a Sublicensee accesses information of another Sublicensee? What restrictions will be in place regarding access to information of another Sublicensee?

The Sublicense Agreement should address who will be allowed to access the system. The Sublicense Agreement should contain a procedure for requesting use rights for each individual user. The Sublicensee and the authorized user should address certain relevant issues with regard to the user, including scope and length of the use, acknowledgement that the requisite training has been completed, and terms regarding non-disclosure of confidential information.

The Sublicense Agreement should address what will happen if all, or some portion, of the Software Vendor Agreement is terminated. Will the Original Licensee continue to be obligated to provide access even if it no longer has the right to do so? What if maintenance and support for the software terminates or expires or is not renewed under the Software Vendor Agreement? Will the Original Licensee continue to be obligated to provide maintenance and support services to the Sublicensee?

The Original Licensee should require the Sublicensee to agree to the same or similar terms and conditions to which the Original Licensee agreed with the Software Vendor. The Original Licensee should obtain the right in the Software Vendor Agreement to disclose certain terms and conditions to the Sublicensee for the purpose of requiring the Sublicensee to comply with the terms. The Original Licensee may want to attach certain relevant terms from the Software Vendor Agreement in an exhibit or attachment to the Sublicense Agreement.

The Sublicense Agreement should clearly lay out which party is responsible for the equipment and technology required to gain access to the software. Typically, the Sublicensee is responsible for obtaining and maintaining all equipment and software located at its site that is required for it to access and run the software. The Sublicense Agreement should also address which party will be responsible for errors that occur during transmission between the parties, such as third-party carriers, utilities and internet service providers.

The Sublicense Agreement should carefully spell out the Original Licensee's obligations, responsibilities, and potential liability. Will the Original Licensee provide any warranties to the Sublicensee with regard to the performance of the software? What are the Original Licensee's obligations and responsibilities if the software does not function correctly? What is the Original Licensee's potential liability under the Sublicense Agreement? The Original Licensee should also include a provision requiring the Sublicensee to indemnify the Original Licensee for damages arising out of certain events, including Sublicensee's breach of the Sublicense Agreement, Sublicensee's use of the software, and Sublicensee's violation of laws and regulations.

The Sublicense Agreement should also address what will happen when the Sublicense Agreement terminates. Will the Original Licensee be able to provide a copy of the data entered into the system by the Sublicensee? If an individual's electronic medical record has been modified by more than one Sublicensee using the system, how will a particular Sublicensee's data be separated on termination? On a related note, the Sublicense Agreement should address the situation where the Sublicensee does not pay its fees. Can the Original Licensee simply terminate or suspend access to the software? How would this affect the Sublicensee's ability to provide patient care?

Providing such access to software systems can be beneficial to the healthcare entities involved, as well as the communities they serve. However, the parties should be aware of the contractual issues which must be addressed with regard to these relationships in order to avoid legal, business and healthcare service problems in the future.

Many healthcare entities are endeavoring to share their healthcare information technology with other healthcare entities in their communities. The underlying goal is to create the local building blocks that will eventually become a national network of interoperable health records. There are typically two contracts required for these transactions.
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Social network analysis has been applied in different disciplines for more than six decades. Recently, the relationship between network structure and organizational and individual performance has emerged as an important focus of this research.\textsuperscript{1} The increasing formalization and quantification of social network analysis, as well as the wide availability of computing power, fostered works that examined the relationship between social network structure and group performance.\textsuperscript{2} While social network analysis has been used frequently for analyzing medical applications such as spreading of infectious diseases and substance abuse,\textsuperscript{3} little work has been done in correlating social network structure with individual and group performance of medical knowledge workers. This is where our study contributes.

An area where significant process efficiencies can be realized in a hospital is the surgery patient flow process that involves a number of intermediary departments. Since there are typically heavy infrastructure investments in the operating rooms and downstream ancillary departments, improving patient throughput will also result in significant cost savings.

The focus of this study is the surgery patient flow process of a large Boston-area teaching hospital. A dynamic Social Network Analysis\textsuperscript{4} was conducted with the aim of observing communica-

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**KEYWORDS**
Social network analysis, patient flow, process efficiency, workflow redesign, IT.

**ABSTRACT**
We propose a novel approach to improve throughput of the surgery patient flow process of a Boston area teaching hospital. A social network analysis was conducted in an effort to demonstrate that process efficiency gains could be achieved through redesign of social network patterns at the workplace; in conjunction with redesign of organization structure and the implementation of workflow over an integrated information technology system. Key knowledge experts and coordinators in times of crisis were identified and a new communication structure more conducive to trust and knowledge sharing was suggested. The new communication structure is scalable without compromising on coordination required among key roles in the network for achieving efficiency gains.
tion patterns in social networks at the clinical workplace in the Post-Anesthesia Care Unit (PACU). The hypothesis being tested was that the pattern of social interactions will correlate with process efficiency, thus redesign of social networks in conjunction with redesign of workflow would help improve surgery patient process throughput.

Patients having completed surgery in the operating rooms and those not needing constant supervision, travel for “wake up” from anesthesia to the PACU. Patients typically stay in the PACU for several hours and then are transferred to their assigned beds in other parts of the hospital. The PACU is a critical intermediary step in the surgery patient flow process since delays here cause further hold ups upstream in the operating rooms resulting in surgery schedule disruptions, overtime work to staff and productivity losses. The PACU is susceptible to downstream delays due to problems with bed assignments in other parts of the hospital that patients are transferred to.

PROBLEM IDENTIFICATION

For the period of March 1-31, 2007 the PACU received 1,398 patients, an average rate of 60 per day. The average length of stay was 3.1 hours. The PACU experiences considerably higher patient throughput and length of stay as compared to other same-day recovery areas of the hospital (In comparison, the adult same-day surgery area receives an average of 48 patients per day with an average length of stay of 2.07 hours). Higher length of stay at PACU may be attributed to process inefficiencies; therefore length-of-stay data was analyzed over its weekly cycle (no surgeries on weekends) and plotted against time of departure from the PACU. (Fig. 1a).

It is observed that for each day of the week there are two peaks in length of stay between 1 p.m. and 5:30 p.m. The curves for Thursday are shifted forward by two hours since surgeries start two hours later on that day. Though there are peaks in length of stay outside this time window as well during some days of the week, the PACU staff corroborated our assumption of this time window for analysis with their observation that PACU was most stressed during this time period. Furthermore, within this time window it was analyzed that the first peak in length of stay occurs roughly between 1 p.m. and 3 p.m. and the second peak occurs roughly between 4 p.m. and 5:30 p.m. (except Monday, when both peaks occur between 1 p.m. and 3 p.m.).

Data analysis further revealed that delays due to bed unavailability in other parts of the hospital accounted for 99.6 percent (239 cases) of the total 240 cases of delayed patients. This delay occurs when the patient is ready to leave the PACU but there is no bed available for the patient to be transferred to in another part

A social network analysis was conducted in an effort to demonstrate that process efficiency gains could be achieved through redesign of social network patterns at the workplace, in conjunction with redesign of organization structure and the implementation of workflow over an integrated information technology system.

![Fig. 1a: Length of stay in PACU at different times of day.](https://www.himss.org)
of the hospital. The trigger for calculating this type of delay time occurs when the attending nurse (PACU Registered Nurse) makes an entry in a log maintained by the PACU Charge Nurse that the patient is “ready to leave.”

Patient delay time, when plotted against time of departure from PACU, shows seasonality roughly similar to patient length of stay during same time intervals. The first peak occurs between 1 p.m. and 2:30 p.m. and the second peak between 3 p.m. and 5:30 p.m. (Fig. 1b) The curves for Thursday are shifted forward by two hours since surgeries start two hours later on that day. Therefore, it is evident that variations in patient length of stay are directly related to delays occurring due to beds not being available downstream in other parts of the hospital.

To translate this patient delay into a process flow problem, the length of stay and delay times were mapped with the occurrence of the IN waitlist and OUT waitlist. The IN waitlist comprises patients waiting to enter PACU from the upstream operating rooms and the OUT waitlist comprises patients waiting at PACU to be transferred to other parts of the hospital. It was found that the waitlists also peaked during the two time bands of 1 p.m. to 3 p.m. and 4 p.m. to 5:30 p.m. which corresponds roughly with the peaks in patient length of stay and patient delay times. (Fig. 1c)

Further analysis revealed that though both waitlists always occurred simultaneously the OUT waitlist (black) had greater magnitude and persistency than the IN waitlist (grey). This suggested the OUT waitlist as the cause of the IN waitlist. Therefore, the process flow problem of build up of OUT waitlist could be directly attributed to causing the increase in patient length of stay due to delay in transferring patients out of the PACU.

**METHODS**

**Workflow Analysis.** The downstream workflow between the PACU and the other hospital floors was analyzed in order to identify issues that result in the formation of the OUT waitlist. The following three areas in the hospital were involved in the workflow for transferring patients out of the PACU—{the PACU} itself, Admitting Office and the other hospital floors.

It was found that lack of process discipline in updating the information technology systems at the downstream hospital floors resulted in inaccurate data on bed availability or expected discharges being displayed upstream at the IT systems in PACU. Therefore, manual coordination between PACU, Admitting Office and floors was required to overcome deficiencies arising from performing bed assignments/scheduling based on inaccurate data in the IT system. Manual coordination requires extra process steps as compared workflow performed on the integrated IT system. Such extra process steps caused patient delay that in turn caused holdups of PACU beds (buildup of OUT waitlist); thereby making upstream patients having completed surgery in the operating rooms to go on the IN waitlist. This reason for delay accounted for 99.6 percent of delayed patients at PACU.

The critical roles in the surgery patient flow process were identified. In the PACU these were:

- Operations Assistant who performs bed assignments at PACU and monitors the IN waitlist.
- PACU Charge Nurse, who liaisons with downstream Admitting Office and other hospital floors to perform manual bed assignments/scheduling and reduce buildup of OUT waitlist.
- PACU Registered Nurses who, once their patients start getting delayed, liaison with the PACU Charge Nurse, and also sometimes directly with the other hospital floors.
In other hospital areas the critical roles were OR Nurse and OR Desk for the operating rooms(OR) that are upstream and charge
nurse and operations assistant for individual floors that are down-
stream as well as the admitting office.

SOCIAL NETWORK ANALYSIS

The goal of the social network analysis was to find a relationship
between group interaction patterns in the PACU and workflow
processes. A survey was conducted in the PACU to log the face-to-
face, phone, page and email interactions that different roles have
with each other during the course of their daily work. Respondents
filled out survey sheets to report all interaction and also
indicated whether they were feeling “Not Busy At All,” “Some-
what Busy,” “Really Busy” or “Maxed.” The roles covered by the
survey were the PACU Charge Nurse, Operations Assistant and
PACU Registered Nurses. These are the critical roles identified
earlier in the workflow analysis. All other roles had only clinical
responsibility and did not affect workflow throughput. Only a
representative sample of five PACU Registered Nurses was sur-
evied at any time, but they were sufficient to report interactions
with all nurses in the PACU.

The survey was administered to capture the weekly cyclicity
of PACU workflow over a period of two weeks between March 26
and April 6, 2007. Survey responses were collected over two suc-
cessive 30-minute intervals during periods of OUT waitlist build-
up identified earlier as the two time bands of 1 p.m. to 3 p.m. and 4
p.m. to 5:30 p.m. during the weekday.

A total of 2,258 interactions were logged among 119 actors. Sur-
vey results were analyzed using CONDOR, social network analy-
sis software developed at the Massachusetts Institute of Technol-
ogy (MIT). CONDOR depicts graphical plots for three computed
variables that offer interpretation of the network dynamics.

Betweenness Centrality (BC). BC can be computed individu-
ally or for networks. For networks (Group BC) it is 1 in a star
network where several peripheral nodes (persons) interact exclu-
sively through one central node; and 0 in a fully connected net-
work where all nodes communicate equally with one another. For
individuals (individual BC), an example of high BC is the node
(person) at the center of the star network while the nodes at the
periphery have low BC.

Density. This is network specific and refers to the total num-
ber of interactions out of all possible interactions between all the
nodes (persons) in the network. Therefore, high network Density
is experienced during occurrence of high waitlist at the PACU
when communication between the nurses increases.

Degree. This is individual specific and refers to the total num-
ber of incoming interactions and outgoing interactions for any
individual. An interaction occurs when a person is being talked
to or communicated with on a one-to one basis. In any network,
certain individuals will have higher degree than others.

RESULTS

The Group BC for the PACU social network showed a consistent-
ly high value during occurrence of the OUT waitlist. This means
that there is a consistent cluster of highly central people in the
network; like a star network with one or more central roles domi-
nating communication with peripheral roles. This is typical of a
hierarchical organization structure.

Furthermore, a time plot of the Group BC, Density and Degree
reveals the evolution of the social network dynamics during peri-
ods of high OUT waitlist. (Fig. 2) Each spike represents one of
the days for which the survey was conducted. The OUT waitlist
occurred only on the last four days of the seven plotted here (last four on right).

The following are observed: During occurrence of OUT waitlist, there is a sharp increase in Group BC (black) and a corresponding drop in network Density (gray). During occurrence of the OUT waitlist both the PACU Charge Nurse and Operations Assistant have high individual BC and also high individual Degree (both not shown in Fig. 2).

We found that during the occurrence of the OUT waitlist the PACU Charge Nurse and OA become more central (high individual BC) and interact increasingly with other roles (high individual Degree). Also the network Density drops indicating that the other roles interact less amongst each other (and more with the network central roles). However this does not preclude the possibility of other roles being central in the star network as well.

Further analysis revealed the names of seven PACU Registered Nurses that exhibit the same characteristic variation in individual BC and individual Degree. Therefore, these seven PACU Registered Nurses are also central in the star network structure within the PACU during occurrence of waitlist. The central nodes (PACU Charge Nurse and seven PACU Registered Nurses) serve as gateway points for the other PACU roles. The gateway points in turn interact with the Admitting Office and other hospital floors to perform manual bed assignments/scheduling in order to reduce build up of OUT waitlist.

Furthermore, the social network analysis also made it possible to identify external roles that link to the PACU during OUT waitlist formation. These external linkages form strongly when the PACU is stretched to capacity and nurses indicate times of feeling “Really Busy” or “Maxed.” It was found that these roles were also critical from the workflow analysis presented earlier. They are the OR Room Nurses, OR Desk, Floor Charge Nurses, Floor Operations Assistants and Admitting Office.

This finding served as an indication that the social network pattern correlates with the underlying workflow processes. A test for correlation was performed between Group BC and Number of patients delayed per day (area under OUT waitlist curve in Figure 1) that provided the value for correlation coefficient as −0.506 (R sq = 0.256, n = 15). This indicated an inverse relationship between the formation of a hierarchical network structure in the PACU and the magnitude of the OUT waitlist, therefore by the reasoning presented earlier, the duration of patient length of stay and patient delay times. On days when the social network structure for communication within the PACU is more hierarchical there is lower patient delay time. This happens when the PACU Charge Nurse and seven PACU Registered Nurses tightly channel all communication between PACU and other areas of hospital (i.e. become highly central in a star network).

Since this relationship is established it is inferred that re-designing social networks for improving communication is an important criterion for improving workflow process efficiency.

**DISCUSSION**

Since the causality between OUT and IN waitlist has been established, the ensuing discussion will focus on reduction of the OUT waitlist since this effect will ripple upstream and impact overall patient throughput.

The hierarchical management structure at PACU centralizes all manual coordination thereby preventing individual PACU Registered Nurses from interacting directly with roles in downstream areas of hospital. The result is lower patient delay due to elimination of redundant process steps and improved coordination. Manual coordination is necessary since there is inaccurate data on bed availability or expected discharges displayed on the IT systems at PACU. This owes to lack of process discipline at the downstream hospital floors for updating the integrated IT system with accurate data.

However, the social network analysis also indicates the central role (PACU Charge Nurse) getting stressed during times of occurrence of waitlist due to increased volume and frequency of interactions. This since all communication between PACU and other areas of hospital is channeled through this central role (both high individual BC and Degree). This is a bottleneck situation and is partially alleviated when the seven PACU Registered Nurses informally take on the role of the PACU Charge Nurse and start acting as parallel gateway points for communication with other areas of the hospital.

Identifying key knowledge experts, formalizing and re-defining their importance is a well-established social networking “best practice.” Furthermore, an effective crisis prevention technique is to identify key coordinators in times of crisis and to increase their availability. The seven central PACU Registered Nurses identified through the social network analysis can be considered for such formal roles.
Though this is a viable solution in the short run, it suffers from the inherent drawback of a lack of scalability. If the bed capacity of the PACU were to be increased, the number of key coordinators/knowledge experts will also have to be increased to handle the extra communication load. This cannot happen indefinitely, since there are inherent co-ordination and division of responsibility issues between the key coordinators/knowledge experts themselves. Only when the number of such network central roles is small are such issues manageable. Another factor is physical location; incase the PACU were spread over different areas of the hospital rather than at one location, the coordination between such network central roles will be impacted adversely.

Based on our analysis, the overall patient flow process should be improved by moving from the current star network structure to a galaxy network structure. (Fig. 3) The network diagram on the left-hand side represents the existing star (hierarchical) network communication structure at PACU. The PACU Charge Nurse channels all communication downstream thereby becoming overloaded. During situations like this other PACU Registered Nurses become central in the star network by interacting informally with the other areas of hospital (depicted by dashed lines in the star network).

Migration to a galaxy network communication structure will entail reducing the dependence on network central roles to perform centralized coordination. This centralized coordination (high Group BC) was the key factor in reducing OUT waitlist therefore patient delay. The coordination can be better performed by the integrated IT system of the hospital provided the users follow process discipline in updating accurate information. Such process discipline is fostered by an environment of trust and information/knowledge sharing. Currently the users at the downstream floors of the hospital do not update correct bed availability or expected discharges data on the IT system thus necessitating manual coordination between PACU, Admitting Office and floors.

Furthermore, the transparency introduced through sharing of accurate information will result in converting the current patient “push” workflow to a patient “pull” workflow. Floors downstream would now pull patients from the PACU into available vacant beds by sharing accurate information on bed availability; thereby reducing unnecessary manual coordination initiated by the PACU to push patients downstream.

The galaxy network communication structure is depicted on the right hand side of Figure 3. The integrated IT system takes on the task of centralized coordination thus reducing dependence for the same on a hierarchical communication structure around the PACU Charge Nurse. Therefore a democratic communication pattern will result since all central PACU Registered Nurses will have equal access to bed availability information on the downstream floors. Such a communication structure is scalable since any number of additional nurses can be given access to the IT system that performs coordination irrespective of the number of users.

The above discussion points to a holistic methodology for reducing patient delay at the PACU. This methodology necessitates a common process oriented functioning of disparate hospital departments (PACU, hospital floors etc.) brought about by implementing common workflow processes over an integrated IT system. An environment for trust and sharing of information enables process discipline among users to update accurate information on the IT
system. This coordination approach among team members fosters a galaxy network type communication structure whereby information is available universally (democracy as opposed to hierarchy) yet coordination is centralized on the IT system backbone.

**LIMITATIONS**

The survey was limited to the PACU and a representative sample of five PACU Registered Nurses was administered out of a possible 24 at any given time. There may be other central PACU Registered Nurses in the star network who were not covered by the survey. The survey responses may suffer from a recall effect since the nurses’ clinical duties took priority over entering survey responses. Also the short survey sampling time frame may be insufficient to capture complete network dynamics and there may be personality specific variations in communication patterns of the roles.

Furthermore, administering the survey in the other areas of the hospital may reveal new insights into the external linkages with the PACU network.

**CONCLUSION**

Given its limitations, this analysis demonstrates a linkage between social network patterns in the PACU and workflow process efficiency. Manual workflow processes at PACU necessitate a hierarchical communication structure that suffers from inherent bottlenecks causing build up of OUT waitlist thereby resulting in patient delay. This delay propagates upstream thereby causing schedule disruptions at the operating rooms and translating to financial loss. It was calculated that eliminating the minimum delay of 1.4 hours (Fig. 1) for all delayed patients in March, 2007 would increase patient throughput by 19 percent. This can only be attempted though the holistic methodology presented earlier that includes redesign of social networks, inculcation of process discipline and implementation of common workflow processes across departments.

A follow up study is currently under way wherein wearable social tags are being used to continuously log all interactions within the PACU. This is intended to corroborate these preliminary results and also form the basis of a future follow on study that tests the effects of reconfiguration of social network patterns.

Patient care processes in healthcare environments possess a sufficiently large element of human involvement and this will continue to be in the future. This is not the case with some other industries where processes can be completely automated. Therefore, the design and performance of social networks is an important factor in improving process efficiencies within hospital organizations. Workflow redesign and implementation over an integrated IT backbone has to complement social network design in order to achieve an efficient integrated healthcare delivery system.

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Chandrika N. Samarth was a Sloan Fellow from the MIT Sloan School, business manager with Siemens Health Services and SAP R/3 consultant. Samarth specializes in value delivery, governance and policy aspects of IT in healthcare.

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Today's healthcare environment is extremely daunting. Hospitals have been challenged with increasing complexity of care, decreased resources and increased regulatory requirements such as CMS core measure reporting. The quality of care delivered is under expanded scrutiny and hospitals have employed various process improvement methodologies such as Lean and Six Sigma to improve and optimize their processes. Many of these process improvement strategies have been successful.

However, as multiple optimized processes are given to clinicians, it becomes difficult to juggle all the requirements of the various initiatives. The manual nature in which healthcare is provided predisposes care delivery to errors and omissions due to human factors.

This paper reviews the use of a Business Process Management engine to provide automated control of processes in an acute healthcare setting resulting in the realization of more consistent and positive outcomes. It will review several process improvement efforts at The Chester County Hospital in West Chester, Pennsylvania, and how Business Process Management (BPM) was incorporated into the infection control, smoking cessation education and congestive heart failure (CHF) processes. It will provide evidence that process automation provided a vital component which was needed to obtain the successful outcomes realized by The Chester County Hospital.

OVERVIEW OF BUSINESS PROCESS MANAGEMENT

According to Mark Treat from the BPM Institute, “Business Process Management (BPM) is a disciplined approach to identify,
design, execute, document, monitor, control, and measure both automated and non-automated business processes to achieve consistent, targeted results consistent with an organization’s strategic goals. BPM involves the deliberate, collaborative and increasingly technology-aided definition, improvement, innovation and management of end- to-end business processes that drive business results, create value and enable an organization to meet its business objectives with more agility.9 BPM has been used successfully in many industries.9 However, the healthcare sector has some unique challenges and consequently has been slower to adopt the technology when compared to other industries.9

BPM is a comprehensive approach to process optimization. At the heart of BPM is an engine that automates and manages processes for the end-user. The Workflow Management Coalition defines a workflow (business process) management system as “a system that defines, creates and manages the execution of workflows through the use of software, running on one or more workflow engines, which is able to interpret the process definition, interact with workflow participants and, where required, invoke the use of IT tools and applications.”10 Key elements of process automation include the process flow being input into a system, creation of rules and business logic that allow the system to manage the process, interactions with people, and the system directing activities. An important aspect of BPM is Business Activity Monitoring (BAM) which is defined as a focused monitoring and measuring of business activity across systems and processes.11 It is beyond the scope of this paper to give an in-depth overview of BPM. A good primer of terms and definitions can be found on the Workflow Management Coalition Web site.12

There are many robust BPM systems on the market today. The challenge for any healthcare institution is the ability to integrate the BPM system with the hospital’s HIS system to the degree that it can monitor events within that system and provide directions to the system and its end-users. Most BPM engines are designed to interact with other systems. Unfortunately, many HIS systems are much less open and accessible. This roadblock should diminish as HIS vendors come out with the next generation of systems that employ service oriented architecture and newer interoperability standards.

**PROCESS IMPROVEMENT**

The Chester County Hospital (CCH) uses FOCUS-PDCA14 as its primary process improvement (PI) methodology. A PI opportunity is identified and a multi-disciplinary team is convened to evaluate the process. In many cases the objective is clear such as meeting a CMS core measure requirement. Once assembled, the team begins by documenting and flowcharting the current process looking for variability, errors, bottlenecks, and other items that impede the desired outcomes. A new and optimized process is developed, tested and deployed. While the process is “improved” sometimes the desired results do not materialize.

The problem that occurred at CCH was not the optimization of one process but the collective effect of many “optimized” manual processes on the clinical care team. Each process, even if efficient, added a level of burden and complexity that had the cumulative outcome of making it extremely difficult to effectively handle the volume of tasks required. Examples include multiple screening assessments, extra data collection requirements and new complex order sets and checklists which needed to be followed or completed. This was compounded by extreme clinical workloads as well as variable levels of staff skill and experience. The result was that the team often ended up not achieving the goals it had set.

**ADDING BPM TO PROCESS IMPROVEMENT PROJECT**

Gartner describes BPM as “the management of explicit processes from beginning to end.”15 In every PI project there is an explicit process with the goal of managing it as efficiently and effectively as possible. A workflow or BPM engine is used to accomplish some or all of that management electronically. BPM automation allows for a much higher degree of reproducibility, decreased variation in the execution of each process step, decreases in missed or delayed steps, fewer errors, more timely completion of the process, decreased workload for the staff and ultimately improved outcomes. Accomplishing this automation requires the successful determination of how steps on a flowchart can be made electronically “discoverable” to the BPM system and how that system can seamlessly interact with the clinician. Consequently, the resource that will be creating the automated process logic needs to be included on the PI team from its inception. This is a key factor in achieving success.

The PI team meets and conducts its work according to the FOCUS-PDCA methodology with several steps added. The first steps are determining if key data exists in an electronic format and whether the system can determine if an action is occurring. The team must ascertain whether the information is in a consistent format. Data that exists from free-text input is generally unreliable. It is usually necessary to convert from free-text items to defined data inputs. Another challenge is establishing the exact business logic for evaluating and managing condition or state. In traditional PI plans there are many decisions that have a level of ambiguity and require intuitiveness on the clinician’s part. A BPM system needs precision and exact rule logic to follow. The team also needs to work on how the process can be monitored in a real-time fashion and who will be responsible for the monitoring. A final hurdle is deciding how the system will interact with the end-user. Questions that must be answered: What information do they need? How will they get it (pop-up alert, pager, telephone, etc.)? How will they respond? What will the system do with their responses?

CCH has taken the stance that system generated alerts should have three characteristics. The first is that the information should be new and valuable to the recipient. Nuisance alerts with stale or redundant data quickly disenchant the staff. The second principle that the hospital follows is that the notification must be actionable. The person needs to be able to do something with the information. Finally, the alert should reduce the work burden for the individual. These are keys for end-user buy-in. Whenever possible, the team tries to have all three elements in place.

BPM success is closely tied to the level of staff acceptance which is correlated to the staff perception of benefit and to the ease of use of the system. Process automations are usually very complex, but they cannot be cumbersome to the end-user. Ultimately the success of most PI efforts comes down to how well the end-users
buy into the new process. The more change is thrust upon them or they see no benefit, the less they will embrace it. This is one of the main challenges for all PI teams to master. Automation offers great opportunities to improve staff acceptance of new processes, but only if it is done well. Overcoming this challenge is a key to successful process improvement.

**CLINICAL EXAMPLE: MRSA ALERTING**

Decreasing hospital acquired infections is a major patient safety concern and the focus of CMS and other regulatory agencies. Methicillin-Resistant Staphylococcus aureus (MRSA) is one organism that has received a considerable amount of attention over the past several years in the medical world and the community at large. CCH convened a Resistant Organism Task Force to specifically address how it should handle the challenges of several problematic organisms. MRSA was one of the microbes being addressed. A person infected with MRSA is considered to be a carrier for life. Consequently, a primary requirement for the institution is the identification of all patients who have a known history of MRSA so that they can be properly isolated until screening tests determine if the organism is still present.

There are multiple steps involved in assuring that the proper identification, notification, and screening occurs for each potential MRSA patient. The team's review of its data showed a high dependence on a manual process which allowed some MRSA positive patients to go unrecognized. Identifying and alerting the staff regarding these patients was an ideal process for automation. Many of the key elements already existed within the HIS system or were electronically discoverable. The results for all hospital performed lab tests resided in the clinical repository. Admission assessment data from nursing was stored electronically and all new lab results where in HL7 transactions which could be scanned for relevant information as they came into the system. By developing proper logic the BPM system was able to identify every patient that had a history of MRSA or a new positive MRSA culture. The system was also programmed to listen for negative MRSA screen tests that would allow a patient to come out of isolation.

A BPM process was set up that was triggered on admission. The system would check for a history of positive MRSA cultures and for notations of MRSA in the admission assessment. If the history existed the system created a text-to-speech message which is called to the nursing bed manager/supervisor alerting her to the condition. The bed manager must acknowledge the call via the telephone keypad or the system will call back. Along with the bed manager, the doctor, staff nurse, and the infection control department are also notified via system alerts or e-mail. The notification includes the source of previous infections and the need for a MRSA screen if the patient is a history-only patient. The system then listens for screen results to determine whether or not the patient should stay in isolation. In all cases the information is pushed immediately to the appropriate person so isolation status is optimized. Figure 1 shows part of the MRSA automation process as it is defined in the BPM engine. Note the graphic nature of the steps. Each icon, if clicked on, has scripting code, a SQL stored procedure, XML, or other programming methods behind it.

Pennsylvania Act §2 which requires proactive MRSA screens for patients identified as “high risk” went into law in 2007. The BPM process was modified to evaluate all non-MRSA patients
for high-risk status and to alert clinical staff to obtain a screening test when needed. The system automatically maintains and updates the infection control database with the patient’s latest information. It alerts laundry via a printed report of exact floor census, including isolation patients, so that the proper number of isolation gowns is available on each floor. It alerts housekeeping to the fact that the room held an isolation patient and needs an “isolation clean” any time the patient is transferred or discharged. The process was further extended to request the proper supplies from Central Supply, to monitor that the correct isolation flags are set in the system, to set the flags when appropriate, and to create nursing notes for the clinical staff. This saves them documentation time and assures accurate and complete notes.

The PI committee worked on many other facets of infection control as well. These included elements such as proper hand washing, strict adherence to gowing, as well as other isolation practices. The committee ran multiple educational programs, worked on optimizing test turn-around from the lab, developed the list of “high risk” patient groups, tracked multiple resistant organisms, and conducted other PI activities.

Nationally, the prevalence of MRSA has risen significantly over the past several years. At CCH we have seen a 123 percent increase in newly diagnosed MRSA patients between 2003 and 2007. From 2003 through 2005 the hospital acquired MRSA rate increased along with the total volume of MRSA patients. This increase placed a substantial stress on the manual notification process which, while being consistent with current practice guidelines, was not robust enough to handle the additional burden effectively. The automated process went into full effect in 2005. Over the next two years new cases continued to rise but the incidence rate of hospital acquired MRSA infections dropped by 38 percent. This is the key metric defining success, a drop in hospital acquired MRSA. Figure 2 shows these results graphically.

This rate drop cannot be attributed solely to the BPM process. It was a multi-disciplinary PI effort of which BPM automation was only a piece of the solution puzzle. However, based on the success of the infection reduction efforts with MRSA, the Chester County Hospital has moved forward with using BPM automations as a key element of its strategy to reduce other hospital acquired resistant organism infections.

### CMS Core Measure Automations

CMS has enacted a program where hospitals are required to collect and report key quality metrics which will be available for public review. The need to be compliant with these metrics has been a focus of multiple PI teams at CCH. BPM automations have played a role in several of these efforts. This paper will focus on two of these processes. The first will be smoking cessation education which is a core measure in three categories: AMI, CHF, and pneumonia. This review will focus on metric compliance, the ability to customize automations, and the subsequent outcomes of this automation. The second example is Congestive Heart Failure (CHF) which will focus on the automation of tasks to assist the staff in managing key elements of the process.

#### Smoking Cessation

Smoking has been identified as a major health issue in the United States and CMS has developed requirements that hospitals provide smoking cessation education to smokers during their stay in the hospital. CCH convened a multi-disciplinary PI team to look at the smoking cessation education process and to optimize it. The team determined who would best provide the education, what to include in the education, and the elements of proper documentation that met the criteria for CMS compliance. Key activities necessary for success included identifying all smokers, making sure that the proper staff member was notified to provide education, tracking that the education was completed, and assuring that proper documentation was created.

A BPM process was developed to assure that the identified tasks were completed properly. Upon admission the system was...
The hospital also created automated processes to assist the CHF nurses with their management of the CHF patient population. CHF represented the largest non-obstetrical patient population in the hospital. Since these cases are often complex the workload exceeded staffing resources. Consequently, the hospital was not able to identify and properly manage all the aspects of CHF patient care nor was it able to achieve the levels of compliance needed to improve patient care. A PI team was convened and process automation was part of the endeavor.

BPM is a comprehensive approach to process optimization. At the heart of BPM is an engine that automates and manages processes for the end-user. The team looked at all aspects of the CHF care plan. The first major challenge was identifying patients who currently have or previously had CHF. The BPM process was called upon to evaluate every admission for criteria that would indicate CHF. This included a history of CHF from previous admissions, an admitting diagnosis suggesting CHF, a history of a low ejection fraction, a high BNP blood level, participation in the outpatient CHF program, or a nursing admission assessment noting CHF. The system also evaluates all new BNP values and new ejection fraction values. If any of these conditions are present a CHF alert was created and the patient was added to the CHF census that is used by the CHF nursing team.

This workflow, while supporting core measure compliance, is designed to help the nurse manage his or her workload. It does much of the patient assessment work and provides the nurse with a list of items needing attention. These items include a check of what medications the patient is on every 12 hours with alerting for the need for certain medications. It also checks and reports the most recent left ventricular ejection fraction and/or alerts for the need to perform an echocardiogram. It manages the patient educational requirements and writes the education note for the nurses when they indicate the education has been given. It checks and reports several other items and manages a database of information on each patient for easy abstraction and analysis. The biggest provision for nursing is the comprehensive list of patients and automated census management capabilities. They can easily update or alter the patient’s status and the information is always current for a seamless handoff to the next care provider.

The CHF core measures have been difficult to advance but the automated process has made its impact by helping to increase the ACEI/ARB medication compliance from 63 percent to 90 percent, providing written discharge instructions from 23 percent to 78 percent, and by raising LVF assessment to 100 percent. The next logical extension of the workflow is to push notifications to other members of the care team instead of just to the CHF nurses. This includes the ability to offer physician alerts of key medications that are needed (beta blocker, ace inhibitors, or Angio Retention Blockers) and giving them one click ordering capability if they agree with the system recommendation. These items while created are not live as of the writing of this paper. They should be live at the time of publication.

GENERAL RESULTS AT CCH

The Chester County Hospital has been working with BPM since 2003 and now has over 55 processes automated. These processes check and/or manage something on every patient registered at the hospital with the exception of recurring outpatients. The system has sent out over 350,000 text pages, made over 15,000 telephone calls, created over 85,000 e-mails, and written over 30,000 clinical notes. Process automation has become a stan-
standard part of the hospital’s PI efforts so much so that the list of desired automations is backlogged with many requests. The ability to improve outcomes while reducing workload is indeed compelling. These BPM augmented PI efforts have resulted in significant improvements to many key quality metrics. This data is regularly shared with the patients and community. However, the transition did not occur easily and there have been a lot of challenges along the way.

**KEY ISSUES AND LESSONS LEARNED**

The decision to move into BPM should not be made lightly. A hospital must assess the cost and conduct its due diligence carefully. First and foremost is the choice of which BPM engine to use. There are many quality BPM vendors on the market today which have robust engines. The Workflow Management Coalition has a list of basic elements to use in the evaluation process. These should include a graphical process definer, a process runtime engine, a monitoring (RAM) system, and system integration options. Most BPM engines are designed to integrate with other systems. A bigger challenge will be the HIS system allowing the integration. If the system is locked-down or built on older technology it may not allow this linkage. At least one vendor has taken a commercial BPM engine and integrated it into their product. This integration allows the engine a full palette of options including alerting, writing notes, using the system’s security and master files, and creating, modifying, or discontinuing orders. These are very powerful capabilities and greatly enhance the value of the BPM system.

Once the BPM system is chosen and the HIS integration is established the state of the electronic data in the hospital’s systems must be assessed. What data exists in an electronic format? How consistent is the data capture? What holes exist in the data? How stringently are the rules guiding data input adhered to? Are inputs free text or are they standardized choices? What interfaces can be read? These questions run to the heart of how effectively a BPM process can be used and greatly alter the likelihood of achieving success. Missed alerts, false positives, and false negatives lead to staff dissatisfaction and can create unsafe conditions.

The automation team needs to be a part of the PI process from the beginning as their knowledge of the clinical world is extremely important. Understanding the process is often much harder than designing it in a good BPM system. When creating the process flow diagram for the PI effort each block must be evaluated for several things. How will the system know this step is happening? Does the data exist in the electronic world? If not, how can it be captured? What is the quality of that data? Who needs to be contacted and how? What can that person do and how will the system know their choice? Exact definitions (rule logic) need to be developed for each step. The system cannot intuitively figure something out. The team must ask questions like “where are the key bottlenecks?”, “what are the escalation paths for no response?”, “how will the system handle unexpected responses?”, “how should the process be monitored and by whom?” and “what metrics need to be captured and in what format?” These questions only represent a sampling but addressing them will take a team a long way down the road to successful BPM automations.

Once a process is built it must be tested thoroughly. This cannot be stressed highly enough. The good thing is that the BPM system will do exactly what it is told to do. The bad thing is that the system will do exactly what it is told to do. If the process logic is incorrect the system will follow the flawed logic every time. The staff very quickly gets accustomed to the automation and stops paying attention to the process. Consequently, testing must be very comprehensive. There needs to be a monitoring and reviewing mechanism to evaluate what the system is doing. If the results are not as expected, they must be investigated immediately.

Process automations usually involve many departments. All must be involved in the review, testing and sign-off. However, one department should be assigned the primary ownership of each process. This group should be the ultimate “owner” of the process, not the IT department. That department should be the one reviewing the outcomes on a periodic basis. They also need to check the business logic at least annually. Healthcare is not static. Elements, dosages, and guidelines change constantly. Process automations must be altered to meet these ever changing protocols and the process owner should oversee this work.

At the Chester County Hospital the use of a BPM engine to automate processes has resulted in measurable success in achieving its desired goals. The engine has reduced the staff’s workload and key processes are occurring with far fewer variations than before.

**CONCLUSION**

BPM systems have been used in many industries for well over a decade to successfully automate and manage processes. Healthcare is a very complex environment which has not embraced BPM. The magnitude of work and the regulatory burden that now exists for the average clinician is overwhelming and can result in medical errors and inefficient care. The healthcare industry has recognized this and is focusing energy on process improvement efforts. While laudable, these efforts are hampered by the manual nature and sheer volume of the interventions that need to be followed. The use of a BPM engine to automate control these processes can assure the processes occur as specified and reduce the workload at the same time. The BPM engine can provide the missing link to PI success for institutions that are struggling to obtain and/or maintain the gain that they desire.

At the Chester County Hospital the use of a BPM engine to automate processes has resulted in measurable success in achieving its desired goals. The engine has reduced the staff’s workload and key processes are occurring with far fewer variations than before. The use of this engine is transitioning how safe and effective care is being delivered to its patients. The results have been compelling
and other institutions should consider evaluating this technology as they move forward with their PI and patient safety efforts. 

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REFERENCES


In 2004 Northeast Health embarked on a journey to become a “Lean” organization. Located in New York’s capital region, Northeast Health is a not-for-profit integrated delivery system, including two acute-care hospitals, rehabilitation services, a primary care network and The Eddy, a regional network of long-term care and residential services for seniors. In 2003 Northeast Health researched many quality initiatives, including Lean, a customer focused approach to the design and the improvement of work that leads toward an ideal state. A Toyota Production System, Lean provides people at all levels of the organization with the skills and a shared way of systematically thinking to drive out waste and to standardize work by improving activities, connections and flows. The Board of Directors ultimately chose Lean based on its ease of understanding and involvement of the “front-line staff.” A critical requirement was for Northeast Health to choose an initiative that crossed both the acute-care and long-term care divisions of the system, continuing integration efforts across the care continuum.

LEAN LEARNING ORGANIZATION
Cultural transformations create tension within an organization as employees are forced to move from the familiar to the unfamiliar.
Lean requires employees to change how they think and work. To sustain the transformation, Northeast Health believed that a critical mass of employees needed to internalize the behaviors, thinking and tools associated with Lean. Lean had to become a habit. Employees had to naturally question processes during their day-to-day activities. Northeast Health used learning as the vehicle to introduce and to effect this organizational transformation over a period of time.

Northeast Health chose to work with a consultant who had a mix of manufacturing and healthcare experience, with the intent to transfer the knowledge and competencies in-house.1 Northeast Health kicked off the Lean journey with a two-day Lean retreat for management staff in Spring 2004. From there, the system purposefully decided to begin slow and hit some “quick wins” rather than mass-train 4,000 employees. A two-pronged approach was chosen: One-week Kaizen (Japanese for “continuous improvement”) events—with four events held the first year—and learning laboratories with the first lab launched later that year. Kaizen events bring cross-functional staff to the table to fix an existing problem or to improve a working process in a one-week concentrated effort that includes teaching the principles of Lean and sharing the tools. Since 2004, more than 35 Kaizen events have been held, approximately eight to 10 each year.

However, Northeast Health did not want employees to think a Kaizen event was synonymous with Lean, but rather understand that a Kaizen event is strictly a tool of Lean; Lean thinking is much broader. Therefore, the organization launched Lean learning laboratories. A learning lab is a small, discrete area or department where Lean thinking and the tools of Lean are utilized day-to-day. The unit chooses the learning lab based on various factors: a problem area, complicated processes, first point of entry or customer service. A learning lab requires intense monthly training sessions, application of the learning and day-to-day huddles to facilitate communication. Through the learning labs, Northeast Health first saw visible results of a cultural change. Since 2004, Northeast Health launched over 10 labs; the labs continue with varying levels of maturity.

Kaizen events and learning labs touch a limited numbers of employees each year. After two years of utilizing the Kaizen and lab tool, Northeast Health decided to reach more employees. A six session series, the Taste of Lean, was rolled out in 2006. Training modules include the rules and principles of Lean, waste elimination, 5S’s, standard work, visual management and problem solving. Each session is one hour in duration and the sessions are purposefully staggered over a five- to six-month period to allow students to apply the material to their work environment (“homework”).

Homework is reviewed at the beginning of the subsequent session. The series may be offered to departments as a whole so that the entire department shares the experience at the same time. During the hour, students receive brief training and application and have time to reflect on the previous learning. This has proven to be a beneficial way for departments to ease into Lean. However, it is strictly a “taste” and Northeast Health management hoped the series would generate interest in Lean and that departments would then want to take advantage of the Kaizen or lab structure. Amazingly the series generated more than just passing interest – it actually had and continues to have an impact on departments – seeing waste in their processes and taking action to improve their work. Management was pleasantly surprised.

Besides the labs and Taste series, short training sessions on selected topics are integrated within the Kaizen workshop. These sessions reinforce the concepts, tools and techniques for the experienced and provide an introduction for the novice. In 2007 a formal training laboratory was also held where 20 staff members from across the acute- and long-term care divisions went through an intense year of training. The purpose was for this core group to utilize their new skills in their respective affiliate locations. All trainers have full-time jobs, but had a genuine interest in Lean and a belief that they could make a difference. They are all now successfully embedding Lean in their affiliate cultures through a variety of means, including applying tools and concepts to particular issues within their respective departments, teaching the Taste series, leading project teams, process mapping and supporting departments with scoreboards and huddles.

Northeast Health continues to build on the Kaizen, lab, and

Cultural transformations create tension within an organization as employees are forced to move from the familiar to the unfamiliar. Lean requires employees to change how they think and work.

LEADING THE CHANGE

Cultural transformation is incremental, but organizations need to effectively manage transformation continuously to ensure long-term sustainability. Leadership is critical to creating a learning organization, especially the selection of a Lean champion and the role of executive management.

At Northeast Health, the Lean champion is a vice president’s position, a direct report to the CEO. The reporting relationship correctly positions Lean’s strategic importance to the organization’s mission. The champion’s role combines a technical background in engineering, strong interpersonal skills and a passion to jumpstart the process. The individual must be able to easily work with all positions in the organization’s hierarchy, from frontline staff to management. This person is the chief architect, translating the vision into action. In the early years, the champion needed to pull people into Lean, as it was viewed as additional work that there was not time to do. The champion had to sell it to
Cultural transformation is incremental, but organizations need to effectively manage transformation continuously to ensure long-term sustainability.

our affiliates (acute care and chronic care). Also, executive management issued an edict ensuring that all divisions of the system participated in the Kaizen events. Executive management set an expectation of eight Kaizen events each year, with four in acute care and four in long-term care. As people begin to understand the process and see the value to their own departments and staff, the marketing of Lean became much easier. Affiliate management staff began to knock on the champion's door. The Lean champion needs the tenacity and perseverance to provide the guiding hand to move the organization slowly forward.

The executive team's persistent visibility with respect to Lean is critical to sustain the initiative. The visibility is a strong message that Lean is a strategic initiative and is here to stay, not another "flavor of the week". Staff easily senses the sincerity in both the non-verbal and verbal messages that the executive team continuously send. Our Northeast Health executive team visits the project team during the Kaizen week to understand the process, listen to the team's challenges and lend support. The final day of a Kaizen workshop is a debriefing for executive management. During this last session, a majority of the executive team is present to listen and to question the team both about their particular process chosen, as well as their experience with the Lean process. Participants are personally thanked by the CEO and receive a certificate of recognition and token gift. Each member of the executive team has also participated in Kaizen events and continues to be trained in all of the modules of the learning lab. The executive team periodically attends huddles of the learning lab, discussing issues with frontline staff. Northeast Health's CEO of the Acute Care Division leads the hospital's senior management on a weekly visit to a department to listen to how that department has integrated Lean principles and tools into their routine work environment. Our Vice President for Corporate Affairs, the Lean champion, reports monthly on Lean events and continues to be trained in all of the modules.

INFORMATION SYSTEMS CONNECTION

Information Systems department struggled with Lean. IS is a system asset, whose development time is allocated to the affiliate organizations in the form of a management fee. The affiliates have a strong interest in the value derived from their investment in IS resources. The financial model places pressure on the IS service delivery model to align IS time with the diverse business needs across the continuum. Managing resource time and project priorities is essential to providing value.

The Lean process is both proactive and reactive. While looking for improvement opportunities, the Lean management has to react when a need arises. The Lean organizational structure responds to identified needs and problems as they occur throughout the year. The process requires some agility, wherein resources can mobilize within a brief period to address an issue. Since 2004, the IS department has been involved in 79 percent of the Kaizen events. As systems analysts have a unique understanding of the intersection of technology and workflows, 65 percent of these events required a significant IS time investment. This knowledge is invaluable when a team of stakeholders are trying to get a deeper understanding of a process as well as designing a new workflow.

The Kaizen impacted IS on two fronts, an unplanned need for a resource to attend a Kaizen workshop and then to complete the subsequent tasks assigned in the post-Kaizen action plan. Each Kaizen workshop requiring an IS resource presented an opportunity cost for other work that would be delayed. This frustrated the IS staff as well as the end users who had their work delayed. The struggle is centered on managing the tension between supporting an agile organization that requires flexibility and planning resource allocation to accomplish work priorities. Every organization will need to manage this tension as Lean is introduced into the organization.

At Northeast Health, we are experimenting with improving communication between the Lean leadership and IS management. One approach includes an IS management resource at each Kaizen planning session. At least one month before the Kaizen event, a detailed four-hour planning session is held between the process owner, key team members and the Lean facilitator. The deliverable from the planning session is a project charter that identifies

the senior level executive sponsor, process owner and team members. Other topics covered in the team charter are the process start and end points, known failure modes, key goals, potential benefits and measurement efficiency and effectiveness. The facilitator also works with the group to develop a block diagram of the high-level process steps. The participation in the planning sessions enables IS to estimate the level of involvement and anticipate the volume of work that may come from a Kaizen.

Each division has a senior level Steering Committee, which prioritizes IS projects based on a business case analysis. Given the lead time between the Kaizen planning session and workshop, IS will be able to estimate the resource and time commitment for the Kaizen. When over-allocations occur, those conflicts will be directed to the IS Steering Committee, a governance body with authority to reprioritize projects to accommodate Lean initiatives. Previously, the selection of Kaizens has been like throwing darts. The organization is now looking at concentrating its efforts on a value stream analysis of core system processes that have a major impact on the delivery of care. A review of this high-level value stream map, like patient flow from the emergency department through admission to a unit, may result in four or five Kaizen events all related back to the original value stream map.

One major benefit is that Lean has helped to break down language barriers between IS and internal customers. When implementing new purchased technology, customers generally have a difficult time understanding that the software has an inherent logic that gets imposed on their business process. This requires the user to rethink how work gets done. At times there is a language barrier as IS talks about the technology’s impact on workflow. Through

The organization is now looking at concentrating its efforts on a value stream analysis of core system processes that have a major impact on the delivery of care. A review of this high-level value stream map, like patient flow from the emergency department through admission to a unit, may result in four or five Kaizen events all related back to the original value stream map.
the diverse Lean education opportunities customers are becoming more familiar with process-centric approach to understanding problems and their respective solutions. Users have become fluent in the process lexicon, breaking down communication barriers that previously existed between IS and the customer.

INFORMATION SYSTEMS KAIZEN CASE STUDY
During the traditional Kaizen five-day event, the facilitator uses a systematic problem-solving process. The first two days involve team review of the charter, mapping the current state to understand the steps of the process and identifying waste or steps that do not add value to the process. At the end of the second day, the team begins the ideal state design, as if there are no limitations. This enables the team to brainstorm on fresh ideas as well as to provide an opportunity to articulate those big-ticket solutions. Focusing on large dollar solutions becomes a barrier to implementing a more practical solution.

On the third day, the team begins to map the future state, closing the gap between the current and desired states. All barriers and causes are reviewed in detail. The future state presumes no unbudgeted capital expenditures, low cost or no cost, but may pull ideas derived from the ideal state. A road map and associated action plan are developed to move from the current state to the future state. The plan includes the key goal, action steps necessary to reach the goal, responsible party assigned to complete the task and a timeline. The Northeast Health decision-making process centers on high agreement wherein the process owner and team members work through an understanding and agreement about the process changes. The facilitator guides the team through any conflicts, focusing on the respective parties’ interests and working toward a mutually agreed upon solution. During the fourth day, the team builds upon this action plan by starting the implementation, researching some of their ideas and actually taking action on their ideas.

In 2008 IS management interviewed internal customers. Customer feedback revealed a perception that IS led implementations for new technology produced inconsistent outcomes and missed expectations. IS staff perceived that variability in end user accountability, role definition and decision-making was the root cause for missed expectations. The perceptions were symptomatic of a larger problem, an underdeveloped implementation process that included elements from both perspectives. While best practices are available from standard bodies such as the Project Management Institute or the Information Technology Infrastructure Library, IS needed to translate these best practices into a standardized process either by hiring consultants or trying to implement the standards themselves.2,3

IS management decided to leverage the Kaizen format, as the forum to develop a new process for several reasons - to engage staff buy-in, to increase the probability of sustaining the change, and to provide a cost effective rapid response to the problem. However, this approach did not have a tight fit with the traditional Kaizen model. In the traditional Kaizen, some aspect of the existing process is measured and the measurement becomes a performance objective when waste is removed from the process. IS staff experienced in the traditional Kaizen event, saw inherent conflict in applying traditional Kaizen tools and techniques to this problem. They did not see how a Kaizen event could help improve their process. The reason is that the traditional Kaizen looks to remove waste but IS management was looking to redesign the process. In this case, there was no way to measure the improvement. IS management wanted to include customers as well as staff in the redesign process. It benefited the process to involve some naysayers, as they sometimes become the champion to sell the improvements to their peers after the event.

The Lean leadership also struggled with finding the appropriate approach, as they knew there was an opportunity to capture the buy-in of a key Northeast Health department, which impacts the full system. Historically, IS was a “support” function to Lean and Kaizens, that is, strictly for purposes to help a department or team reach their goal and use technology to improve processes. IS had not used Lean to help them with their own processes. This was a key junction in Northeast Health’s Lean journey. Lean leadership researched and identified a different methodology to use within the Kaizen structure for this specific project. Developed by Dr. David L Cooperider and Dr. Ronald Fry, founders of the Case Weatherhead School of Management at Case Western Reserve University, the Appreciative Inquiry tool provides a means for the facilitator to identify what works best in a process as well as the barriers.2 This enabled the team to identify attributes that contributed to successful implementations and the barriers that caused an implementation to be difficult. What attributes could be gleaned from those successful implementations and made standard for future implementations?

Using the Appreciative Inquiry tool, the facilitator was able to assist the team to design a new process to select and to implement projects using the Kaizen framework. The Kaizen tested a new concept and tool, using a positive perspective. When does a process function at its best versus always looking at what’s wrong in a process, the issues, barriers and causes. The new tool was applied within the five-day workshop structure. Northeast Health did not limit itself by the traditional boundaries imposed by the standard Kaizen tools and techniques. Instead, Northeast Health experimented with a different approach and adapted the model and tools to accommodate new situations. This approach was well received by all involved and has since been utilized in a mini-Kaizen, an abbreviated workshop for staff experienced in the Kaizen tools, to redesign the IS problem management process.

Three months after the Kaizen workshop, the facilitator scheduled an action review to monitor progress on the action plans. These reviews of action plans keep pressure on the team. During the three months, some teams focus on the key goal measure but not on the tasks or timeline identified in the action plan. Other teams follow up on the action plan steps and not the key goal. Both items are important to success. In order to establish accountability, decision-rights need to be established.

SUMMARY
Organizations thinking about embarking on the Lean journey need to realistically manage the change and the tension that naturally comes from an organizational transformation. One method to effect change is to become a learning organization centered on
Lean. Start slow, gradually introducing the organizational structures and behaviors that provide the learning experience and ensure that your champion has the attributes and visible support from executive management to guide the corporation.

Lean will affect the Information Systems workload. Bringing IS into the process early enables IS to find a means to manage the struggle of meeting current workloads while supporting this new unknown initiative. Lean is a living process. After you become familiar with the traditional Lean structure, you can begin to thoughtfully adapt the process as the healthcare landscape around you changes.

Four years into the journey, Northeast Health, while making significant progress, is still transforming the culture one step at a time. Staffs are taking individual initiatives within their functional areas, requesting for a Kaizen to address problems, thinking about using Lean tools. Lean management is now experimenting with value streams of core processes and using this tool as a top down approach. The behaviors still need to become hardcoded or part of the natural way of doing business. The organization continues to get lean, the Northeast Health way. JHIM

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Clinical Decision Support
How CDS Tools Impact Patient Care Outcomes

By Bonnie B. Anton, RN, MN; Jason J. Schafer, PharmD; Andrea Micenko, BS; Debra M. Wolf, PhD, MSN, BSN, RN; Susan DiNucci, BSN; Pam Donovan, RN, MSN; and Barbara Jordan RN, MSN

KEYWORDS
Clinical decision support, collaboration, patient outcomes, antibiotic therapeutic drug monitoring, alert, rules, pharmacy, infection.

ABSTRACT
Clinical decision support tools are important components of the electronic health record and can directly improve patient care outcomes and the performance of healthcare organizations. These tools can be used within order sets, electronic alerts, reference materials that are readily available, reports related to patient data, as well as clinical guidelines that were developed by regulatory agencies. The development and use of CDS tools at the point of care offers clinicians the ability to analyze and work with patient data in real-time while making critical decisions. In the future, CDS tools will be important when changes in financial reimbursement related to patient care outcomes become the primary focus for many insurance-related organizations. This financial shift will have a tremendous impact on healthcare organizations bottom line. This article presents outcome data resulting from the implementation of several electronic CDS tools within a community hospital where all physicians enter orders electronically and clinical staff use electronic documentation.

Clinical decision support tools are important components of the electronic health record. These tools directly impact patient care outcomes and the performance of healthcare organizations by improving the quality of clinical decisions. These tools include order sets, electronic alerts, reference materials readily available to clinicians, and reports related to patient data as well as regulatory agency clinical guidelines. Clinically, CDS tools affect care throughout a patient's hospitalization.

To gain acceptance from end-users, CDS tools should improve workflow processes, not impede them. Too many alerts, for example, lead to “alert fatigue,” negates the importance of alerting the clinician to evidence-based information that may impact patient care. End-user acceptance may ultimately depend upon input from all institutional stakeholders when these tools are in the development and planning stages of implementation.

Development of CDS tools requires medical information based on peer-reviewed medical literature, logical procedures and patient data. Developing, building and maintaining CDS tools are not easy tasks and require a committed team of expert and valued stakeholders. Current, evidence-based practice guidelines must be adhered to and implemented as the need arises.

Development of artificial intelligence and decision support systems began in the 1970s when rules-based expert systems, such as the one implemented at the University of Pittsburgh for diagnosing patients with complex medical problems, were created. Other examples of early clinical decision support systems include the automated antibiotic recommendation system developed by Intermountain Healthcare at Latter-Day Saints Hospital in Salt Lake City, and Regenstrief Medical Record System at Indiana University.
Today, CDS tools vary. One tool includes electronic tasks generated by data entry on admission/pre-admission assessment; clinicians are electronically notified of consults, patient education needs, immunization needs, and notification of DVT, fall and nutrition risk factors. Another CDS tool includes alerts designed to notify staff of critical lab results, as well as evaluations of patient data for patient transfers from high-level critical-care units to step-down units, which impacts total patient hospitalization days.

These tools also provide clinicians access from within the patient’s EHR to electronic library resources and patient education materials. Commercial surveillance tools also are available for prevention and management of infections. Finally, CDS tools are used within electronic order sets to include content that addresses and meets regulatory agency initiatives.

Next generation CDS tools will look beyond one-step alerts and use knowledge in a more sophisticated manner. Multi-level references will filter information for clinicians. Systems also will be able to evaluate patient information and based on clinical information and diagnostic testing, will create precise education material. Knowledge-based “infobuttons” will not only give information related to a requested disease process, but also direct links to evidence-based references. Presently, federal agencies are awarding funding contracts to health institutions to develop, implement and evaluate best practices in clinical decision support. Work groups from the American Health Information Community and the HHS IT advisory panel also are developing CDS recommendations.

The use of CDS tools within an EHR can be rewarding for clinicians and healthcare organizations, but there are challenges. Funding advanced technology at the bedside is, of course, always a looming issue in any organization. If the technology is present, beside clinicians may not grasp the functionality of CDS tools or not accept it as critical to achieving positive patient outcomes. Vendors and analysts may misinterpret the needs of bedside clinicians. Recognizing these factors is essential to successful integration.

A strategic plan that addresses these challenges will aid in supporting favorable outcomes. When collaboration and communication between end users and EHR developers is supported by executive administration, successful outcomes can be achieved. The following describes how one community hospital used CDS tools to support collaboration between the IT department, a pharmacist, an infection-control nurse and a critical-care committee to improve patient outcomes.

**CDS USAGE AND INFECTION CONTROL**

Urinary tract infections (UTI) account for more than 40 percent of all healthcare-associated infections. Approximately 80 percent of UTIs are associated with the insertion of indwelling urinary catheters. It is estimated that between 16 percent and 25 percent of patients in the United States have a catheter inserted at some point during hospitalization. For approximately 21 percent of these patients, it is suggested that the insertion of these catheters is unnecessary. The risk for infection is clearly linked to the duration of catheter dwell time. It is estimated that 5 percent of patients will become colonized for each day of catheterization beyond 48 hours; 10 percent to 25 percent of colonized patients will develop symptomatic UTIs.

Catheter Associated Urinary Tract Infections (CAUTI) markedly increases patient discomfort, immobility and length of stay. In addition, these healthcare-associated infections are the second most common cause of healthcare acquired bacteremia, which is associated with increased morbidity/mortality, antibiotic resistance and overall increased healthcare costs.

A two-year upward trend in CAUTI, from January 2005 to December 2006, was identified by our Infection Control Department. The Centers for Disease Control and Prevention definitions were utilized in the determination of CAUTI. These infections comprised 39 percent of our total hospital-acquired infections, with a rate of 7.1 infections per 1,000 catheter days from January 2006 to December 2006.

To address this issue, a multidisciplinary task force comprising an infectious disease physician, an e-record informatics nurse, clinical nursing staff, nurse educators, pharmacists and quality improvement specialists was convened in April 2006. The role of this task force was to analyze data, review the literature and recommend procedure and policy changes to be implemented with the ultimate goal of reducing CAUTI.

The task force literature search noted CAUTIs were more likely to occur when catheters are left in place longer than four days. It was also noted that several studies of new product technology such as the silver-coated hydrogel catheters showed positive results in reducing the risk of CAUTIs.

As a result, silver-coated catheters were approved and used hospital-wide beginning in December 2006. However, our most focused efforts were targeted at decreasing the duration of urinary catheter dwell time.

To meet this objective, e-record technology and CDS tools were used. These tools were designed by the e-record team to remind nurses to reassess patients with indwelling urinary catheters and document the need to retain the catheter or to notify the physician for a discontinuation order.

Two CDS tools were developed for this purpose. The first was a daily catheter list, implemented in June 2006. The list prints automatically and notifies clinicians of patients who have had an indwelling catheter in place for three or more days. Also, certain criteria was established for insertion and retaining a catheter, including bladder irrigation; urine output in critically ill patients; comfort measures; non-urologic surgery less than 24 hours old; stage III or IV sacral/perineal pressure ulcer; surgical/trauma indications in perineal area; urinary retention; and urologic surgery. If none of the criteria is met, discontinuing the catheter is discussed with the rounding physician.

The second CDS tool developed is an electronic daily reminder to nurses to reassess catheter necessity. This rule automatically

**Development of CDS tools requires medical information based on peer-reviewed medical literature, logical procedures and patient data.**
triggers three days after an order is placed for a catheter. The rule also searches for orders to remove or discontinue the catheter. If such a rule is not found, an electronic task triggers a reminder to the nurse that a reassessment is needed. An associated electronic task also is sent for the nurse to document the assessment on the genitourinary assessment form. As long as the patient continues to have a catheter in place, this rule will automatically send a daily electronic reminder to the nurse taking care of the patient.

As a result of interdisciplinary teamwork, results show a sustained reduction in catheter use over the 12-month period from January 2007, when interventions were implemented, to December 2007. Most significantly our CAUTI rate decreased during this period. We were able to decrease catheter device days from an average of 1,560 to 1,470 per month and our CAUTI rate decreased by 41 percent (71/1000 catheter days to 41/1000 catheter days).

**CDS AND PHARMACY KINETIC MONITORING SERVICE**

Another CDS tool that impacted patient care at this facility was antibiotic therapeutic drug monitoring. Pharmacokinetic monitoring of vancomycin as a means to achieve goal concentrations is a long-standing and essential function performed by pharmacy clinicians. The timing and subsequent interpretation of these serum levels are vital to provide proper drug dosing. This concept is especially important for vancomycin in the management of infections due to methicillin resistant *Staphylococcus aureus* and those in areas of poor vancomycin penetration (i.e., pulmonary tissue).

From July 2006 to June 2007, the hospital’s chemistry laboratory reported that 26.3 percent of all vancomycin levels were ordered incorrectly. These errors included improperly timed orders entered by physicians, resulting in inaccurate laboratory values. The division of infectious diseases expressed concerns that as a result of improper interpretation of mis-timed vancomycin drug levels, dosing regimens were being altered inappropriately, which could lead to non-therapeutic and possibly toxic concentrations. As a means to address this problem, a multi-disciplinary committee was formed that included infectious diseases physicians, nursing, information systems and pharmacy personnel. The result of this committee was the creation of a pharmacy centered antibiotic therapeutic drug monitoring process.

In July 2007, with the approval of both the institution’s pharmacy and therapeutics and medical executive committees, the pharmacy department began providing pharmacokinetic monitoring of vancomycin and aminoglycoside antibiotics. The policies approved by these committees designated a team of pharmacists as responsible for the dosing and monitoring of the antibiotics per pharmacy protocol. Specifically, these responsibilities included evaluating and changing empiric doses as necessary, ordering drug levels, interpreting levels and subsequently changing doses as necessary. To perform these services efficiently, CDS tools were utilized.

An electronic intravenous vancomycin order set was built within the institution’s CPOE system. The order set contains a pre-checked consult order for the Antibiotic Pharmacokinetic Monitoring Service. This order is accompanied by a note that informs the ordering physician of the responsibilities assumed by the pharmacy team. The service is automatically started for patients at the time a physician orders vancomycin unless the aforementioned pre-checked order is unchecked. The physician is given the option at this time to remove the consult order, thereby retaining dosing and monitoring responsibilities.

When the Antibiotic Pharmacokinetic Monitoring Service consult is placed, notification appears on the electronic chart in the “consults” section of the order matrix and on the Caredex under “interventions.” The vancomycin medication order also is sent to the order matrix and appears under “medications.” An electronic medication administration report allows nurses to chart medication when it is administered following electronic order verification by a pharmacist.

As a means to notify the monitoring service of a new consult, an electronic rule is utilized. This rule is triggered by the presence of a pharmacy consult order. It sends e-mail notification to a designated pharmacokinetic monitoring service e-mail account. The e-mail received by pharmacists includes the patient’s name, medical record number, date of birth, patient location, time of the order and the medication.

Within 24 hours of receiving the e-mail, the medication dose and schedule are evaluated. The pharmacy kinetic team member will then order serum drug concentrations for the appropriate time. Once levels return, the pharmacist will determine the accuracy of the observed concentration using pharmacokinetic calculations and principles. If dosage and/or schedule adjustments are required, the pharmacist will enter new orders into the CPOE system.

Finally, all documentation of pharmacy services is placed in the clinical notes section of the electronic chart. A template note was specifically built for pharmacy kinetic monitoring services and includes the following sections: visit information, reason for consultation, and impression and plan. This template ensures that all pertinent information is consistently included in the pharmacists’ electronic clinical notes.

In the first year of service, the pharmacy kinetic monitoring program at this institution completed 902 consults for vancomycin therapy, or an average of 75 consults per month. A total of 942 vancomycin levels were obtained during this period. This corresponds to a rate of 12.9 levels per 1,000 patient days. In the year prior to service implementation, a total of 708 levels—or 9.9 levels per 1,000 patient days—were obtained. The observed increase in vancomycin monitoring could be due to the greater attention given to vancomycin therapeutics, which is likely a direct result of service implementation.

Total vancomycin levels and laboratory monitoring errors for the year prior to and following service implementation are presented in Figures 1 and 2, respectively. In the year following service implementation (Fig. 2), the error rate associated with ordering vancomycin levels decreased to 1.2 percent compared to 26.3 percent (Fig. 1) in the previous year (p <0.0001). In addition, the total number of monitoring errors decreased following service implementation from 186 to 12 (p <0.0001). Total cost avoidance associated with this decrease was estimated to be $1,128 for the hospital (hospital cost=$7 for labor and equipment per vancomycin level) and $35,703 for patients ($90.25-patient cost per vancomycin level).
Therapeutic drug monitoring is an essential function for pharmacists. The implementation of an antibiotic pharmacokinetic monitoring service in this institution has improved patient care, reduced laboratory errors and prevented unnecessary costs. These outcomes, as well as the overall impact of this service, are directly correlated to the successful application of technology and decision support tools. In addition, this service has created a forum for education as well as provided lessons for the pharmacy department with respect to the implementation of future services using CDS tools.

**An interdisciplinary team approach [to CDS] results in a strategic plan that may resolve issues that prevent positive patient outcomes.** Many times, frequently used procedures utilize an educational process that is assumed to be effective, but ultimately needs to be reassessed.

An interdisciplinary team approach [to CDS] results in a strategic plan that may resolve issues that prevent positive patient outcomes. Many times, frequently used procedures utilize an educational process that is assumed to be effective, but ultimately needs to be reassessed.
without having to exit the alert screen and click in a new screen to place the order.

To illustrate this functionality, the following process flow demonstrates how CDS was integrated into the electronic health record and viewed by a physician. (Fig. 3) When a physician is logged into the electronic medical record, and is attempting to place orders on a patient, a rule will fire (behind the scene, not visible to physician) to detect if a code status order exists on the patient. If an order does not exist, the system will fire a visible alert (pop up screen) informing the physician that no code status order exists. This pop up alert screen also provided the physician the ability to place a code status order from within the alert. The alert screen would list all the possible code status orders allowing the MD to select the appropriate one.

The same process would occur when a physician attempted to place any order on a patient whose length of stay within the IMCU or step-down unit was greater than 48 hours. The physician would receive an alert which listed the top five criteria for transferring a patient out of IMCU or the step-down unit. This alert screen also included the ability to select one of four orders/order sets. The orders included the transfer a patient to another unit; select the flex monitor order set; re-alert the doctors in 24 hours for reconsideration of transfer; a discharge order set.

Finally when the physician placed an order on any patient outside of the IMCU/step-down unit with an existing flex monitor order that was more than 48 hours old, the physician received an alert asking to reassess the patient’s needs and allowing the MD to reorder or discontinue from within the same alert screen.

The number of code status rule alerts decreased 61 percent within one year (January 2007 to December 2007), from 10,000 to about 6,000 a quarter, indicating that more patients had a code status order placed within 24 hours of admission. Within a four-month period of initial go-live (October 2007 to January 2008) the critical care transfer alert increased the number of times fired from 1,025 to 1,225, informing physicians of the potential for patient transfer. The flex monitor rule alerts resulted in a 4-percent decrease in use of flex monitors resulting in an increase availability of monitors allowing their ability to transfer patients out of the critical care setting. The percentage of total flex census decreased from 26 percent to 22 percent over seven months. This decrease in usage resulted from the increased number of alerts firing from 1,000 times a month to 1,600 alerts firing a month. Although this resulted in an increased number of alerts seen by a physician, they considered the alerts to be smart alerts and were favorably received, as noted by the lack of physician complaints received within the department.
Common needs or concerns regarding CDS systems are identified and managed within the institution by a dedicated multidisciplinary committee that over sees all EHR functionality. The committee works closely with expert clinicians with in various departments who are responsible for following rules and regulations set forth by the Joint Commission, Department of Health, and the CMS. Examples of these clinicians include Infection Control Nurses, Director of Care Management/Quality. These individuals are seen as the knowledgeable experts within the facility for they maintain a knowledge base that is current within most recent guidelines set for the accreditation agencies.

Request for changes or alterations in rule parameters are handled with great caution. A formal process has been established that reviews each request individually, explores the impact/magnification of the change. Discussion with the appointed person who oversees that area of specialty takes place for any decision is made. Once the change is approved the request is prioritized based on patient safety/impact and other pending needs. Frequently, CDS leads to the development of new clinical processes that outline best practices. The success of these initiatives was greatly due to the collaboration of all clinicians, especially physician, nurses and analysts, to work together bringing their expertise to the table to address the needs of the hospital in an effort to improve patient outcomes. With the administrative support creating the opportunities, resources and funding, these major accomplishments would not have been possible. The combined efforts of the PRC and the EHR Department resulted in very favorable outcomes. Their wide range of specialties and clinical expertise led to a well balanced set of expectations that were realistically achievable. Rochon, et al., also found this to be true when they attempted to integrate CDS with CPOE within a long-term care facility.

**CONCLUSION/LESSONS LEARNED**

CDS tools are effective in influencing patient care outcomes. Whether these CDS tools are used alone or with other interventions, there are several key components that must be considered based on how they will influence outcomes. An interdisciplinary team approach results in a strategic plan that may resolve critical issues that prevent positive patient outcomes. Many times, frequently used procedures utilize an educational process that is assumed to be effective, but ultimately needs to be reassessed. Paramount to achieving successful outcomes is administrative support. This support includes the CEO, CNO and CIO. This serves as a message to all clinical staff that this
organization is committed to measurable improvements in how we care for patients; adhere to clinical standards while maintaining cost containment. JHIM

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Increasingly, healthcare is becoming a shared, community-based responsibility involving diverse healthcare providers providing services to a common population of patients. This is particularly true of community-based primary care and tertiary care providers who serve ethnic minority, immigrant, homeless or otherwise vulnerable populations. Vulnerable populations experience many barriers to healthcare, including inaccessibility to care; fragmentation of care, especially for ethnic minorities and immigrants; and cultural language barriers.

Not surprisingly, a growing body of research suggests that as a result of these barriers, vulnerable, underserved populations often receive suboptimal care and have poor outcomes.

There is a need to actively address fundamental transitional care issues, including patients inadequately prepared for the next care setting, conflicting advice for illness management, inability to reach the right practitioner, and family caregivers repeatedly completing tasks left undone.

The definition of transitional care is: “A set of actions designed to ensure the coordination and continuity of healthcare as patients transfer between different locations or different levels of care within the same location. Transitional care encompasses both the sending and the receiving aspects of care.”

The patients served by the Holomua Project are shared by community health centers (CHC) and tertiary care (TC) facilities and...
who have either planned or unplanned visits to the ER and/or inpatient services. A planned visit refers to patients who enter the ER or inpatient services with the knowledge and participation of their primary care provider (PCP). An unplanned visit refers to the patient deciding, without the primary care provider’s knowledge, to visit the ER. It also recognizes that these same patients who enter the ER and/or inpatient services will also require a transition back to their PCP.

The Holomua Project is a partnership between CHC and TC facilities committed to improving the quality of care for their shared vulnerable patient population transitioning between healthcare facilities. The Holomua Project partners include the Hawai‘i Primary Care Association, the Kaliihi-Palama Health Center, Kōkua Kaliihi Valley Comprehensive Family Services, Hawai‘i Pacific Health and The Queen’s Medical Center. The name Holomua was taken from a statement in a Hawaiian proverb, “Pupukahi i Holomua” which means “United in Order to Progress.” It was chosen to represent the unified partnership and spirit of collective effort across disciplines and organizations that is being forged among community, primary and tertiary care members. This further reflects the spirit and commitment that participating healthcare organizations have to using appropriate technologies and systems to improve patient safety, quality and continuity of care for vulnerable patients who experience transitional care between CHCs and TC facilities.

Funding was provided by the Agency for Healthcare Research and Quality (AHRQ) to improve the transitional care process for patients during the hand-off process between healthcare facilities and the CHC patient population through technical and non-technical solutions.

The technical solution is the development and implementation of a Holomua Master Visit Registry (HMVR) as a means of sharing information between health systems. With a Master Patient Index and a Master Provider Index, the HMVR is a connection broker between institutions that identify the types of service and who provided that service within the health system. The HMVR allows the treating provider to review a list of the patient’s visit history, identify which visit is pertinent to his/her case and then enable them to contact the host partner, via phone or electronically to request the patient’s medical record. The raw patient data remains at the host institution.

The Holomua Project believes that people and organizational issues are critical in both implementing health information systems and in dealing with the altered organizations that these new systems often create. Therefore, the project is building in several processes and activities that will address the human-organizational aspects of improving continuity of care. The non-technical solutions involve identifying the challenges in the transitional care process, improving non-technical work flow guidelines relative to the hand-off process, and using open dialogue and communication to facilitate improved transitional care. These processes and activities include: workflow analysis, redesign, education and communication.

For the purposes of this paper, we will focus on the non-technical solutions for process improvement.

**KEY FINDINGS**

**KEY BARRIERS.** We identified several key barriers. Some ER patients did not have a primary care physician or outpatient clinic assigned to them upon discharge, so they did not have a medical home and therefore no identified PCP or health clinic to receive follow-up care. There is currently no mechanism to book follow-up appointments with the PCP before discharge from the ER/inpatient services. It was sometimes difficult to reach a live person at the CHC for immediate follow-up appointment. TC/ER staff are not aware of the availability of urgent care/triage services at the CHCs, and how to contact PCPs after hours. There is often a delay in fax/mail of discharge documents (resulting in a lack of access to timely laboratory and diagnostic test results). Also, the process in providing the discharge documents varies. For instance, one hospital automatically faxes ER reports and hospital discharge summaries to the identified PCPs, another hospital mails the documents one to three days after discharge, a third hospital faxes the documents only upon request from the PCP or CHC. The discharge/ER notes are often too generic or provide too much information. The receiving providers would like a synopsis of relevant and succinct information that will help them make appropriate decisions more quickly. Some healthcare providers gave their patients variable copies of health visit documents to take to their next appointment or to the hospital/ER, but oftentimes, the paperwork is lost in the transition. These documents varied from medication lists only, to problem lists and/or test results. Often times, the ER patient who is discharged does not show up for follow up care at the CHC.

After barriers were identified, we organized a work group comprised of key healthcare professionals representing management at both TC and CHCs facilities. Sitting at the same table—historically a rare occurrence—these professionals discussed barriers to transitional care and how to address them, concluding that there was significant value in the exchange of open face-to-face dialog that addressed shared transitional care issues.

**METHODS**

We prepared questionnaires and distributed them to healthcare providers at TC facilities as well as CHCs. The questions were designed to identify current practices that individual providers follow transitioning a patient to another healthcare facility. We also followed up using individual and cluster interviews and roundtable discussions to identify existing barriers and challenges and to make basic recommendations to improve the transitional care of shared patients between facilities. Barriers and challenges to information flow were identified. Subsequently, healthcare providers met multiple times to improve the flow of information.
Here are the challenges that the work group identified:
1. There is a general assumption that healthcare facilities are no longer responsible for a patient’s care upon discharge. Therefore, there is a discontinuity of care during the hand-off process.
2. This led to the realization that the concept of transitional care is unfamiliar to most providers (i.e., they were unaware of the terminology, as it was not often discussed.)
3. Most healthcare providers are unaware of the independent transitional care processes adapted by colleagues. They either assume that everyone is handing off patients the same way they are and passing on the same documents and/or verbal information, or they are merely oblivious to what others are doing. We learned, for instance, that, as part of their personal hand-off processes, a couple of providers initiated follow-up appointments directly with the CHC for the patients upon discharge rather than expecting their patients to initiate a follow-up appointment themselves. This increased the likelihood that the patient would come to the CHC for their follow-up care.
4. CHC providers are not all aware that ER physicians are open to and welcome direct provider-to-provider telephone contact. By bypassing the clerical staff and non-clinical staff, this enables smoother verbal communication of relevant patient information. The ER staff expressed that they do welcome any information about the patient, whether it is brought in by the patient or caregiver, or via a direct phone call from the referring provider.
5. TC providers expressed that they are unaware of what types of services were provided at CHCs. Also, they were not aware that urgent care and walk-in services were available at most of the CHCs, nor did they know the contact numbers for PCP during business hours as well as after hours.
6. Effective streamlined transitional care processes are lacking and need to be identified and developed. Different providers were following different individualized and preferred personal processes.

Based on the recently open dialogue and communication that was achieved, the healthcare professionals’ workgroup made the following recommendations:

First, develop effective transitional care guidelines to improve continuity-of-care. The Transitional Care Guidelines\(^6\) suggest simple and practical processes for healthcare providers to follow, for example:
- A. Use a sample script when a PCP is referring a patient to the ER:
  - “I’m sending a (age)-year old, (primary language)-speaking, (Ethnicity) (sex), with what appears to be (presumptive diagnosis) or (primary signs and symptoms). He/She is known/not known to us. He/She has (pertinent past medical history) and has been on (current or recent meds) and (hospitalization / surgical or ER history) and has been to see (consultants) who recommended __________. He/She came in today with (chief complaint and brief history) and on exam he/she had (vitals, pertinent exam). I (treatments or interventions done) and will be sending him/her by (mode of transport). He/she has/doesn’t have allergies but has the following special needs. He/she is reliable/not reliable and will need (special needs). I gave him/her a copy of their med list and problem list (if available). Call me or the on-call doc at ________ if you have any questions.”
- B. Encourage direct provider-to-provider contact, by informing CHC providers that ER providers will take their direct calls, and by providing ER providers the direct contact numbers to speak with CHC providers during and after clinic hours.
- C. Encourage TC providers to identify a patient’s PCP, if it exists, and copy the provider on all discharge summaries and documents so that they can receive them in a timelier manner.

Second, prepare a list of Hawaii’s Community Health Center contact information, to include: clinic location, hours-of-operation, availability of walk-in and triage services, direct provider contact information for immediate accessibility and after-hour inquiries.

As a result of these invaluable findings, The Holomua Project Health Center Resource Listing\(^6\) was created and distributed to all the partner emergency rooms and some inpatient departments at the tertiary care facilities. Additionally, to educate the healthcare providers and increase awareness of transitional care we gave presentations at different departmental meetings at both the CHCs and TC facilities to introduce the Transitional Care Guidelines and to disperse the Health Center Resource Listing.

**IMPLICATIONS**

When there is strong agreement to come together for a common purpose like improving the transitional care process, relationships between healthcare providers and institutions can be significantly strengthened. Specifically, when healthcare providers who work in different environments and at different levels of healthcare systems are committed to opening up dialogue and communication about how to improve transitional care, they can learn what processes each is following and what processes each is willing to change. Subsequently, effective tools can be built to enable devoted healthcare providers to begin overcome existing challenges and to improve the hand-off processes for shared underserved patients in vulnerable populations.

**NOTE:** The authors would like to acknowledge the following healthcare professionals and the Holomua Project Healthcare Professionals Workgroup for their input into the development of the Holomua Project Transitional Care Guidelines: David Derauf, MD; Michael Walter, MD; Daniel Saltman, MD; Laura DeVilbiss, MD; Daniel Smith, MD; Marsha Durbin, RN; Don Wilcox, MD; and Mark Baker, MD. We would also like to recognize Alice Tse, PhD, APRN, RN, the Holomua Project research director, for providing guidance in developing the provider questionnaires. The findings, conclusions, (etc.), of this study do not necessarily represent the views of The Queen’s Medical Center or of Hawaii Pacific Health.
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The Care and Outcomes Management Plan and Kardex

A Design for Improving Documentation of Nursing Plan of Care and Patient Outcomes

By Carole Crabtree, RN-BC, MSN; Patricia B. Howard, PhD, RN, CNAA; and Peggy El-Mallakh, PhD, RN

KEYWORDS
Kardex, clinical pathway, care plan automation, nursing care plan, electronic documentation.

ABSTRACT
The gradual transition from paper records to electronic records presents challenges for nurses. In particular, split paper/electronic records can interfere with staff communication during shift change reports. A project was implemented to facilitate documentation of individualized care plans and improve staff communication during shift change report. The hospital’s critical pathway was incorporated into Kardex to create a single electronic medical record for use during shift change report. This combined electronic outcomes plan and Kardex improved access to patient information during shift report and facilitated nurses’ ability to update the care plan with the most current patient information. Future strategies will include collaboration with the hospital’s information systems staff to make the COMPdex compatible with the hospital’s electronic documentation system, so that pertinent patient data will populate from the current electronic chart into the COMPdex forms for printing and to include patient outcome data in the electronic medical record.

As hospitals move away from paper documentation toward totally electronic documentation of patient care, nurses are struggling in their efforts to document how they provide safe, effective and efficient care. Although some outdated practices are being discarded, the nursing Kardex continues to be a valued source of information and communication.

Shriners Hospitals for Children in Lexington, KY, provides orthopedic and physical rehabilitation care for children. Children may be admitted to the inpatient unit for evaluation, surgery, treatment, rehabilitation or infusion therapy. This type of setting requires current accurate documentation in order for nurses on each shift to know a patient’s status of care.

The ongoing electronic healthcare record implementation project, guided by multi-disciplinary teams, impacts every department of the hospital. Teams use Care and Outcomes Management Plans (COMPlan) for details of critical pathways from outpatient visit through inpatient care and outpatient follow-up visit. The COMPlan documentation is multi-disciplinary, covering not only outpatient, inpatient and perioperative nursing, but also interventions provided by physicians, graphic arts, prosthetics, orthotics, radiology, motion laboratory, research and physical, occupational and recreational therapy departments. COMPlans have been in use for several years as a paper-based document outlining specific clinical measures for care planning. COMPlans are stored in the paper chart, which is seldom accessed now that nurses’
clinical flow sheets, CPOE and medication administration record are electronic. The traditional Kardex is stored in a multi-patient binder for access during shift change report. Long range plans for the electronic record include provision for clinical pathways, but in the interim, nurses have found that the split paper/electronic record has created gaps which interfere with communication, especially during shift change report. Failure to record individual plans of care when documenting on the COMPlan has resulted in pertinent information being omitted from shift change report. The purpose of this paper is to describe an effort to bridge a gap in nursing communication created by the staged implementation of clinical documentation.

CONCEPTUAL FRAMEWORK: PARETO THEORY

Pareto analysis facilitates decision-making when a number of disparate factors contribute to a problem. Eighty percent of a problem can be resolved by the correction of 20 percent of the causes. The analyst identifies causative factors and groups them into relevant categories with logical units of measurement, such as frequency or cost. The analyst then constructs a bar chart with categories ranked in descending value with cumulative percentages of the overall total, identifying the point at which the cumulative percentage equals 80 percent. Correcting the majority of causes for the documentation failures should result in near perfect resolution of the problem according to Pareto theory.

In this project, a Pareto analysis of causes for incomplete documentation on the COMPlan revealed that the major impediments to completeness were location of the document and the lack of blank spaces for data entry. (Fig. 1) Combining the Kardex and COMPlan into a single document not only improved the efficiency of the nurse when accessing the documents, it also reduced the chance for error because the nurse had the COMPlan at every shift change. This access provided staff with the opportunity to update changes in the patient status or needs. In addition, it reduced reliance on memory, thereby increasing accuracy and efficiency of shift change report.

OVERVIEW OF THE LITERATURE

The word Kardex, although used universally in healthcare, is not a PubMed MeSH term. Rather, the name refers to a visible index card data filing system created in 1898 by James H. Rand, Sr. Kardex has become a generic term for the patient care information sheet used by nurses and pharmacies. A search of the PubMed database using the combined terms “Outcome Assessment (Health Care)”[Mesh] and “Critical Pathways”[Mesh] and “Kardex” found no results. Articles dating back to 1970 about combining Kardex with care plan were found using Google Scholar.

Searches in PubMed and Google Scholar using the term “Kardex” alone yielded two types of articles: those published in nursing journals about discontinuing use of the Kardex during the
1980s or 1990s; and those published in medical journals listing the nursing Kardex as a source of patient data for research studies as recently as 2004.4-6 It is interesting to note that medical researchers viewed the Kardex as a valuable source of patient information, confirming the belief that it should be brought into the age of technology instead of being discarded. However, care plans are generally viewed by bedside nurses as holding little or no relevance to direct patient care.7 Indeed, if the care plan is going to be useful, it must follow patient care processes closely and require a minimum of documentation. Moreover, use should foster and facilitate practice and not be an additional task. It is also critical for the care plan to reflect the actual processes in place across the patient encounter or illness episode.8 The care plan outlines the expectations for a typical patient, while the Kardex supplies specific data about the individual patient. Essential to the shift change report is the declaration of where the patient is along the clinical pathway.

Changes in nursing shift change process resulted in increased analysis and interpretation of patient care plan and an improvement in the documentation of evaluation of patient responses to the plan of care.9 Shift change report was viewed as ritualistic, though necessary for communicating about patient conditions.10 Pertinent commentary supplied in the verbal report may be omitted from a rigidly structured historical report. This inclusion of relevant, anecdotal information requires critical judgment by the experienced nurse, and could never be programmed into an automated report generator software program.

A primary purpose of shift change report is to communicate vital information, but other objectives include time for social interaction, support and education of novice staff.11 Interestingly, shift report is also a source of dissatisfaction for nurses.12 The most commonly cited reason for dissatisfaction was the insufficient amount of information exchanged during report. Therefore, a printed sheet of handover information along with the verbal report resulted in the least amount of data lost during shift change report and reduced sources of irritation.13 Efforts to streamline the handover process resulted in improved quality and reduced amount of time spent in report. Written handover report also improved accuracy and inclusion of vital information by reducing dependency on memory alone.14

The Joint Commission on Accreditation of Healthcare Organizations was a source of information required for a complete handoff report.15 An automated report would improve inclusion of lab and other test results, medications, and relevant demographic data. An electronic system should be utilized to maximum capacity possible to facilitate nursing processes. A low-tech solution should be considered when a full enterprise installation is not feasible.16 An electronic Kardex in use by Taiwanese nurses utilizes commercially available office software that gathers information from a mainframe database and applies that data into a usable document.17

**DEVELOPMENT OF COMPDDEX**

The COMPdex for “Surgery with Cast” was piloted for twelve patients and evaluated for effectiveness in improving documentation and more complete shift change report. The COMPPlan documents were developed through the collaborative efforts of a multi-disciplinary committee. Suggested revisions were made and the pilot COMPdex was submitted to nursing administration for final approval. The remaining COMPlans were converted to the new format and added to the computer. Information Systems staff was consulted to make the COMPdex interface with the hospital’s electronic documentation system so that pertinent patient data populated from the current electronic chart into the COMPdex forms before printing. Patient demographic data from the electronic patient record was fed to a separate database used by patient registration. This database will be tapped to feed patient information into the COMPdex.

Care was provided by nursing and other departments, but documentation on the COMPPlan was entered by the patient’s primary nurse as coordinator of care. The existing COMPlans were updated to encourage individual care planning and documentation prior to conversion to the COMPdex format. Additional items were added to allow for entry of important aspects of care like discharge planning and home care needs. Medication reconciliation process information was included to allow for check off notes about medications from home and resulting review with the patient and family that included proper storage requirements and security for controlled substances. Other information included accounts for any missing data confirmed with primary care physician or pharmacist.

Prior to the pilot study, the Kardex and COMPPlan were stored in separate locations thus compromising good use of the systems. For example, the Kardex was in a designated multi-patient three ring binder, usually located at the unit secretary’s desk or in the report room, whereas the COMPPlan was stored in the individual patient’s chart, a three ring binder that was seldom accessed now that nursing and patient care clinical documentation are fully electronic. Although nurse managers frequently remind staff to individualize and document on the Kardex and COMPPlan, doing so is inconvenient and often incomplete. The result is an incomplete patient record which leaves gaps in both documentation and the oral exchange of patient information. The nurse who is reporting prior to leaving the unit must rely on memory to complete the gaps, and the nurse who is reporting for work may not realize that gaps exist if he/she is not familiar with the patient.

A number of inpatient unit nurses have created their unique versions of information sheets which they maintain for their own use. Although the use increases their own sense of thoroughness and efficiency, it further discourages them from completing the authorized forms. Observation during shift change report

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**Pareto analysis facilitates decision-making when a number of disparate factors contribute to a problem.**

Eighty percent of a problem can be resolved by the correction of 20 percent of the causes.
revealed that the unauthorized forms contained vital information which was not written on the patient’s record.

To eliminate these problems, sections of the COMPlan Interventions that duplicated information were eliminated from the Kardex. (Fig. 2a, b, c) Then patient data was organized for report purposes into four columns. The first column specifies information related to diagnosis and reason for admission; information is retrieved from the admission scheduling information form completed by the admitting physician, and the patient’s electronic record. The second column contains basic history relevant to the admission, transcribed from the admission scheduling information form. The third column focuses on parents, custody and discharge planning, and also specifies the primary nurse and care coordinator, since those are relevant in discharge planning. The fourth column contains a minimal amount of physician order information that is passed along in report, but not found in the COMPlan interventions. This data will come from the orders matrix of the electronic patient record. The Kardex area is printed in a medium gray to provide visual contrast to the handwritten information which is read quickly during shift change report.

Workflow process changes incurred by the new documentation were minimal. The advantage to combining the documents was that the plan would be used at with every shift change. A disadvantage was that the Kardex became a part of the permanent record. Therefore, entries could no longer be written in pencil or erased. In the change, all handwritten entries would be recorded using black ink and a yellow highlighter was used to emphasize outdated information or completed tasks. The primary nurse starts a new, updated copy when the first form is full of handwritten entries and the original form is filed in the paper chart with a notation that a revised copy is now in use. The highlighter use will provide focus on incomplete tasks or current status, enabling more rapid shift change report.

**EVALUATION**

Nursing staff first to use the new COMPdex were introduced to
the grassroots project through group and individual in-service sessions. The importance of staff input and feedback was emphasized as a “by us, for us” process improvement. The Surgery with Cast COMPdex forms were placed in the charts of patients scheduled for admission along with evaluation forms. The idea was well-received and staff commented that the change was important.

Nursing staff were encouraged to give feedback and they were given progress reports as revisions were made and when use of the COMPdex forms was implemented. Formative evaluation will continue after the project is fully implemented through chart audit. Summative evaluation will be anticipated with the next Joint Commission survey with the expectation that content will satisfy the recommendations for documentation and hand-off report completeness and accuracy.

CONCLUSION

Evaluation feedback was organized around three categories. Unit secretaries commented that information was missing from the Kardex section, but when it was explained that data spaces were removed if they were duplicated in the COMPlan sections, they were pleased at the reduction in their transcription process. With the pilot study limited to only one care management plan, nurses giving report from a mixture of old Kardex forms and the new COMPdex commented that switching back and forth between the two slowed down their shift report by breaking their focus and concentration. This should be resolved when all patients are on the new forms. A third category was a finding from the pilot study that nurses seemed reluctant to use the highlighter on the COMPlan sections to cross off completed tasks. This reluctance should resolve with time, problem solving, and increased familiarity with the change.

As clinical use of electronic documentation evolves, further study is needed to evaluate and measure the impact on nursing workflow processes and the impact on patient care. Nurse informaticists are uniquely qualified to ensure that the electronic patient care record is not just a data input-only burden for bedside nurses, but a source of information on clinical trends and pathway progression. Information output can enhance nursing care when cognitively processed through the expert nurse’s knowledge and wisdom.

Carole Crabtree, RN-BC, MSN, works at Shriners Hospitals for Children and helped develop their clinical documentation content. She is a member of HIMSS and is board certified in nursing informatics through ANCC.

Patricia B. Howard, PhD, RN, CNAA, is Associate Professor and Associate Dean for MSN and DNP Studies at University of Kentucky College of Nursing. Research interests include family caregiving and advanced practice psychiatric-mental health nursing.

Peggy El-Mallakh, PhD, RN, is an Assistant Professor at the University of Louisville School of Nursing, researches self-care for co-morbid chronic mental and physical illnesses, and implementation of evidence-based practices in
### References


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### Fig 2c: COMPdex Interventions—Surgery with Cast.

<table>
<thead>
<tr>
<th>DAY OF ADMISSION</th>
<th>DAY OF SURGERY</th>
<th>POSTOPERATIVE DAYS</th>
<th>DAY OF DISCHARGE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physician Orders</strong></td>
<td><strong>Physician Orders</strong></td>
<td><strong>Physician Orders</strong></td>
<td><strong>Physician Orders</strong></td>
</tr>
<tr>
<td>SHCIS Admission Care Set:</td>
<td>SHCIS Post-operative Care Set:</td>
<td>SHCIS Discharge Order Set:</td>
<td></td>
</tr>
<tr>
<td>- Vital signs every 4 hours</td>
<td>- Vital signs per post-op routine: every 1 hour X 2, every 2 hours X 2, then every 4 hours</td>
<td>- Vital signs every 4 hours &amp; 12 hrs</td>
<td>- Discharge</td>
</tr>
<tr>
<td>- Baseline oxygen saturation (if respiratory disease evident)</td>
<td>- Intake and output X 24 hours and while IV infusing</td>
<td>- Incentive Spirometry as indicated</td>
<td>- Discharge</td>
</tr>
<tr>
<td>- Assess Neurovascular status</td>
<td>- Incentive Spirometry as indicated</td>
<td>- Neurovascular status assessed every 4 hours</td>
<td>- Return to clinic visit</td>
</tr>
<tr>
<td>- Beta Hbg (female 16-10 yrs)</td>
<td>- Neurovascular status assessed every 1 hour</td>
<td>- Turn every 3 hours</td>
<td>- Continuing</td>
</tr>
<tr>
<td>- Up ad lib</td>
<td>- Pain level assessed every 4 hours</td>
<td>- Pain level assessed every 4 hours</td>
<td>- Postoperative</td>
</tr>
<tr>
<td>- Resolution of def for age</td>
<td>- Turn every 2 hours</td>
<td>- Assess skin integrity every 8 hours</td>
<td>- Postoperative</td>
</tr>
<tr>
<td>- NPO after MN prior to OR</td>
<td>- NPO; advanced as tolerated</td>
<td>- Assess voiding pattern</td>
<td>- Postoperative</td>
</tr>
<tr>
<td>- Surgical permit signed</td>
<td>- Post operative care and cast care teaching</td>
<td>- Voided post-op</td>
<td>- Postoperative</td>
</tr>
<tr>
<td>- Surgical Site initiated</td>
<td>- Assess cast integrity</td>
<td>- Post op care and cast care teaching</td>
<td>- Postoperative</td>
</tr>
</tbody>
</table>

**Nursing**
- Orient to Unit
- Pre-op teaching
- Assess home resources needed for discharge
- Transportation needs assessed:
  - Home_van
  - Temple_van:
  - Speciality care seat
  - IZ Vest:
- Other:
- Release of information updated
- Review plan of care
- Admission assessment
- Medication reconciliation initiated

**Therapy**
- Assess psychosocial needs
- Pre-operative education class (if appropriate)

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**COMPDex Interventions Surgery with Cast**

![Shriners Hospitals for Children]

Care plan initiated/revised by ______________________  Date ______________

[Patient ID Label]
Real Option Analysis
Improving Project Selection in Healthcare Settings

By David K Wyant, PhD

KEYWORDS
Real options analysis, project planning, project selection, health administration, healthcare management, healthcare IT.

ABSTRACT
The effective selection of information technology projects is crucial for achieving gains from healthcare IT. This article introduces through example “real options analysis,” a project selection best practice. The author discusses the applications of real options analysis, with emphasis on healthcare settings, and addresses the importance of organizational characteristics on real options analysis. The real options approach is an improvement over net present value analysis, which uses single estimates of future revenue and costs. Additionally, thinking of projects in terms of options helps design and manage investment strategies by identifying and valuing alternatives inherent in a project.

This article discusses a best practice in healthcare information technology project selection. The approach is called “real options analysis.” An understanding of real options analysis will help HIT professionals perform several vital roles as members of a project selection team. These roles are related to the financial planners’ need for input from HIT professionals. Because the HIT professional is an expert in the business processes of HIT, they can ensure that the financial plan incorporates all of the project’s costs and benefits, and that the time frame for developing the project is reasonable. HIT professionals also need to review the financial plan’s technical feasibility. In addition, HIT professionals serve as representatives for both internal and external customers by ensuring that the financial plan will result in a system that meets users’ needs. Finally, HIT professionals need to be concerned that the financial plan is consistent with the effective and efficient day-to-day operation of the eventual project. The following narrative shows that all of the roles of these professionals are enhanced by an understanding of the benefits of real options analysis.

AN EXAMPLE OF REAL OPTIONS ANALYSIS
The real options approach emerged as an improvement to the tra-
ditional approach of net present value analysis (NPV). NPV uses a single estimate of revenue and costs for each future period to develop a scenario that estimates the profitability of the project. Frequently, financial analysts develop several different scenarios for a particular project, perhaps labeled “best case” and “worst case” by the financial planners.

Consider a project where a CIO considers an eight-year contract to provide outsourced IT services to a hospital in a nearby city. One possible benefit of this project is that after four years there is the likelihood of contracting with a second small hospital owned by the same client. For this project, the CIO meets with the hospital’s financial analysts and they outline likely costs and benefits of this project. They consider both best-case and worst-case results. A summary of the financial analysts’ projection is in Table 1. In the best-case results scenario, revenue in each of the first four years exceeds cost by $2.5 million. Under the assumption of a contract with a second hospital after four years, the benefit doubles to $5 million each year for years five through eight. Under this scenario there is a profit of $30 million over eight years. Under the worst-case scenario the projection loses $2 million per year for years one through four. After the first four years, additional costs for new equipment increase the loss to $5 million per year.

The CIO wants to know how much could be saved if, as part of the eight-year contract, the CIO retains the right to walk away after four years.

This reflects the fact that often midway through the project life, the outcome of a crucial event leads to a branching of the scenarios. The branching process with multiple scenarios can be diagrammed

An understanding of real options analysis will help HIT professionals perform several vital roles as members of a project selection team.

<table>
<thead>
<tr>
<th>Table 1: Net Present Value Analysis (thousands of dollars).</th>
</tr>
</thead>
<tbody>
<tr>
<td>t=1 t=2 t=3 t=4 t=5 t=6 t=7 t=8 Total</td>
</tr>
<tr>
<td>Payoff year 1 (a) Payoff year 2 (b) Payoff year 3 (c) Payoff year 4 (d) Payoff year 5 (e) Payoff year 6 (f) Payoff year 7 (g) Payoff year 8 (h) Total Payoff (a) to (h)</td>
</tr>
<tr>
<td>Best Case Results</td>
</tr>
<tr>
<td>$2,500 $2,500 $2,500 $2,500 $5,000 $5,000 $5,000 $5,000 $30,000</td>
</tr>
<tr>
<td>Bad Case Results</td>
</tr>
<tr>
<td>-$2,000 -$2,000 -$2,000 -$2,000 -$5,000 -$5,000 -$5,000 -$5,000 -$28,000</td>
</tr>
</tbody>
</table>
(i.e., the expected financial gain for the hospital) of this project is $600,000.

However, the CIO also asked the analyst to calculate the value of the project if there is an option to stop before stage two in the event that the project goes badly. The right-hand column of Table 2 shows the payoffs with the option to terminate the project before stage two. If the project ends up under the best case, the option to terminate would not be taken, and the project would proceed through stage two. Consequently, under the best case the payoffs are the same with or without the option. But if the bad case occurs, the option to terminate the project avoids the losses that would have occurred in stage two, which substantially reduces these losses. Consequently, the weighted average return is now $9 million.

In this example, the difference between having the option to stop before stage two and not having the option is $9 million-$600,000=$8.4 million. There may be costs associated with creating this option. For example, it may require the right to cancel contracts after four years. But if these costs are less than $8.4 million, there is value in creating the option as part of the planning and contracting process. The value of the option in this case is $8.4 million, less any additional expenses, such as cancellation fees. Calculating the value of an option in this manner is often called “option pricing.”

It is noteworthy that in this example there is a rather large difference between the value with the option and the value without the option. Although the results in this example depend on the particular numbers used in the example, it is reasonable to assume that accounting for the ability to make changes midway through a project’s life can have a significant effect on a project’s financial results. In the example the uncertainty in the plan came from a potential large new client, from avoiding equipment upgrades, and from terminating the project early given the prospect of deepening losses. All of these types of events can materially influence the profitability of a project. This demonstrates that there is potentially a high return on the time spent carefully modeling the possibility of options during the planning stage.

In this example, the HIT professional’s input was crucial to the success of identifying options. Typically the financial analyst will depend heavily on the HIT professional’s knowledge of business processes, the customer base and technical constraints. If the HIT professional also has an active knowledge of real options analy-
sis they may be able to point out options that a financial analyst would not recognize.

**BENEFITS OF REAL OPTIONS ANALYSIS**

In contrast to NPV, real options analysis does not assume that once a project is started it will necessarily proceed along a single path to full conclusion. Real options allow the analysis to branch at points where critical events will have major impacts on the success of the project. But the decision trees that are created are much more than maps that managers follow passively. Amram and Kulatilaka suggest that real options analysis is a type of strategic thinking that incorporates the possibility of contingent decisions. Managers can make decisions at each critical point, such as whether to terminate a project.

This analysis is useful in planning projects. Clearly, if managers are uncertain about the long term outcomes of a project it can be valuable to plan in advance to have an option to "exit" at some point. An option to exit at a particular point can be created prior to the beginning of the project during the planning stage. This is done by making sure that at the designated exit point all contracts with customers and suppliers could be cancelled.

Creating an option may be costly. For example, if the CIO wants an option to end the project in four years, he may need to include the right to cancel leases in four years. Landlords might then want to negotiate a higher rent. Importantly, as was demonstrated in the example, real options analysis provides a method for assigning a dollar value for structuring a project to include options (e.g., What is the most that should be paid for the right to terminate a lease after four years?). So real options analysis provides both information concerning where exit points should exist, and information concerning the value of having the option to exit at a particular point.

A basic principle from the study of options is that the value of options increases as the variability in the possible outcomes increases. For example, we can contrast a case where managers know ahead of time that the outcome from a particular project is certain with a case where the outcome is extremely uncertain. In the case with a certain outcome, managers either know that the project is profitable, so they would not pay for an option to terminate midway through, or they know that it is unprofitable, so they would not do the project. Either way, they will not pay for an option to terminate midway through the project.

---

**Table 2: Real Options Analysis (thousands of dollars).**

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 2</th>
<th>Probability</th>
<th>Branch Total</th>
<th>Contribution</th>
<th>Contribution with Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability of event at Stage 1 (a)</td>
<td>Payoff at Stage 1 (b)</td>
<td>Probability of event at Stage 2 (c)</td>
<td>Payoff at Stage 2 (d)</td>
<td>Joint Probability (a)(c)=(e)</td>
<td>Payoff (e)+(f)=(g)</td>
<td>Expected Payoff (e)(g)=(h)</td>
<td>Payoff with option to skip Stage 2 (k)</td>
</tr>
<tr>
<td>.5</td>
<td>$10,000</td>
<td>.4</td>
<td>$10,000</td>
<td>.2</td>
<td>$20,000</td>
<td>$4,000</td>
<td>$4,000</td>
</tr>
<tr>
<td>.6</td>
<td>$20,000</td>
<td>.3</td>
<td>$30,000</td>
<td>.9,000</td>
<td>$9,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Best Case Results</th>
<th>Bad Case Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>.5</td>
<td>$8,000</td>
</tr>
<tr>
<td>.6</td>
<td>-$20,000</td>
</tr>
<tr>
<td>Total Expected Value</td>
<td>$9,000</td>
</tr>
</tbody>
</table>

Calculations in Table 2

The probability of any one of the four branches on the decision tree occurring is the probability of stage 1 of the branch multiplied by the probability of stage 2 of the branch. This is column (a) multiplied by column (c), resulting in column (e). For example, the probability of the combination of the best case scenario in stage 1 and a $10,000 payoff in stage 2 is .5 * .4 = .2.

For each of the four branches the joint probability is then multiplied by the payoff from that branch to get the contribution of that branch to expected return. For example, for the upper row: .5 * $20,000 = $10,000.

When there is no option to terminate the project prior to stage 2, the contributions from each of the four rows are summed down column (g) to get the expected value of the project.

When there is an option to terminate the project prior to stage 2, if the best case scenario occurs in stage 1 both stage 2 branches are possible. In this case, the decision is to continue after stage 1. As a result, the first two rows column (h) or equal column (g).

However, when stage 1 results in the bad case scenario both stage 2 branches increase the total loss. Therefore, if stage 1 is in the bad case scenario, decision makers terminate the project prior to stage 2. In this case, the contribution to the expected return is column (k) multiplied by column (b), resulting in column (g).

Without option expected payoff = $4,000 + $9,000 - $4,000 - $8,000 = $0

With option expected payoff = $4,000 + $9,000 - $1,000 - $2,400 = $9,000

Value of option = $9,000 - $600 = $8,400

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In contrast, prior to the beginning of a project, managers might believe that the project could be either extremely profitable or extremely unprofitable. In this case the managers may be willing to pay a significant amount for the option to terminate the project early. Taking this principle into account Smyth and Swinand point to the increasing uncertainty in healthcare finance. They suggest that this uncertainty increases the value of real options analysis in a healthcare setting. Given the uncertainty involved with many HIT projects, this may apply even more to a particular HIT project.

Incorporating real option analysis into the project selection process may also positively impact other roles of the HIT professional. For example the HIT professional may believe that a particular project is essential to fulfill the HIT professional’s day-to-day management tasks. In this case, identifying the real options inherent in a project and incorporating their value into the analysis could lead to the approval of a project that otherwise is not approved. The HIT professional also might expect to be the individual responsible for the success of the proposed project. In this case the effort to plan an exit strategy in advance of beginning the project may be far less than the effort involved if the HIT professional is locked into a struggling project.

TYPES OF REAL OPTIONS

Authors of papers on real options frequently provide a typology of the options a manager might encounter. Some examples of likely types of real options in HIT:

Options to terminate. In the example above, the decision tree incorporates the option to terminate the project prior to stage two. All projects should consider including exit strategies, which are defined points at which the project can be fully terminated for a defined cost. As the example showed, option pricing can be useful in considering exit strategies.

Options to scale back. In the example above, there was also an option to scale back equipment purchases.

Options to expand. Mun uses an example of a CIO trying to justify a new operating system to explain an expansion option. If a CIO tries to justify a new operating system on a stand alone basis by looking only at the direct costs of the system and the direct savings, the project is difficult to justify. The value of the operating system is not captured unless the financial projection considers the values of all the additional projects that become technically feasible once the new operating system is installed.

Sequential options. Mun notes that the installation of the operating system may also lead to sequential options. For example it may lead to the feasibility of a bar coding system for inventory control that then leads to a system designed to reduce prescription medication errors using bar coding.

LIMITATIONS OF REAL OPTIONS ANALYSIS

The real options technique has two parts. First, the options need to be identified and valued. Second, the options need to be managed during the project. The process of identifying the options has two major limitations. One limitation deals with mapping a time line. Although the decision tree forks into branches at exact points, in practice the decision-making point may not be exact. For example, several years ago a CIO might have planned a decision tree for a particular software system, which included a branch where Vista would be added. The plan might have been that there would be a review of that system given the new Vista environment. But when the time came to change to Vista, the implementation of Vista and the decision on the support system may have been postponed. This would be very difficult for a CIO to accurately predict in advance.

Typically the financial analyst will depend heavily on the HIT professional’s knowledge of business processes, the customer base and technical constraints.

A second problem with identifying options is that the characteristics of the option may be uncertain. In the example provided earlier in this article, the CIO was not sure whether the success with the first hospital would lead to a contract with a second hospital. However, the CIO might also question whether a second contract could be negotiated to provide the same level of revenue. Similarly, there may have been many other aspects of the possible contract that were uncertain. So both the timing and the characteristics of real options may be uncertain. This is an important difference between real options and financial options, which give the holder rights to make transactions in investment securities at a definite price up to a definite time.

There are also two critical considerations with managing options. A critical issue is whether, when the results after initial stages indicate that it is time to terminate a project, the project actually will get terminated. Consider, for example, a real options analysis of a proposed diagnostic imaging device that results in an implementation that allows the hospital to discontinue volume if the volume is below a certain level. After three years, volume is low. So the finance department indicates that the plan calls to get rid of the imaging device. Will that happen? Or will the political support for the imaging device be such that the project continues?

Similarly, as Copeland and Tufano note, to effectively manage options the decision process must react reasonably quickly. It does no good to have a contractual option to terminate at a certain point if an organization isn’t able to gather the relevant data and get closure on a decision rapidly enough to exercise the option.

Real options analysis developed from recognizing that some of the practices used in the analysis of options for investment securities could be applied in the analysis of investments for projects involving physical assets (i.e., “real” assets). However, some of the attempts to borrow techniques used with financial options have caused problems. Consequently, managers should be wary of borrowing techniques used with financial options unless those techniques have a track record of success.
CONCLUSIONS

Real option analysis provides a powerful tool for the HIT project selection process. But the selection team is likely to produce better projections if they have input from HIT professionals who understand real options analysis. The HIT professional can bring to the analysis their knowledge of HIT business processes, customers and technical constraints. This knowledge is likely to be very helpful to the analysts developing a financial projection using the real options method. JHIM

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REFERENCES

Evaluating Success
Strategies and Challenges for Understanding IT Implementation in a Rural Hospital

By Joanne Spetz, PhD, and Dennis Keane, MPH

KEYWORDS
Healthcare information technology, computerized patient records, inpatient care, hospitals, rural.

ABSTRACT
In 2004, a small rural hospital in California received a grant for the implementation of an integrated IT system. As part of the grant, the hospital worked with a university team to evaluate the implementation. The evaluation plan emphasized quantitative analysis of medication errors, patient safety and hospital finances. As the implementation progressed, it became clear that the quantitative methods would be marginally useful; qualitative methods gained greater importance. The evaluation team added more interviews and several staff surveys to the evaluation. The results of the surveys helped the hospital team understand how well staff was prepared for the technology and how they were responding to implementation. The best practices emphasized in this paper include: work with independent evaluators who can provide anonymity and lend objectivity; focus on surveys and interviews to understand the difficulties faced by staff and how they might affect outcomes; and collect key outcomes data in advance of beginning the implementation.

OVER the past decade there has been a gradual increase in the number of hospitals adopting electronic medical records and medication administration systems.1-3 By 2006, approximately 51 percent of hospitals had electronic nursing documentation; 43 percent had computerized provider order entry; and 35 percent had barcode systems for pharmacy administration.4

These systems are expected to bring about improvements in patient safety,5-9 but so far results have been mixed.10-16 Hospital information technology can have unintended consequences: Poor design can compromise patient care or distract providers from care delivery. The implementation period is particularly important.17,18 During implementation, new procedures and processes are established, creating an environment in which change can beget errors.

Because the implementation period is important to eventual success of IT systems, it is essential that IT installations are evaluated. This paper describes a prospective evaluation of an IT implementation in a rural California hospital. The hospital received a grant from AHRQ for the implementation of an integrated IT system and worked with a university-based research team to develop an evaluation. As described here, the initial evaluation plan proved to be infeasible and minimally useful. Thus, the evaluation strategy was changed to meet the needs of the hospital as well as expand knowledge that can guide other hospitals implementing IT systems. This paper reviews the lessons learned in developing a useful, successful evaluation when preparing for an IT implementation.

BACKGROUND
In September 2004, a 112-bed acute-care hospital in a rural community was awarded a grant by the AHRQ to implement and evaluate an integrated hospital IT system. The hospital is operated by a local healthcare district and is located in a Primary Care
Health Profession Shortage Area (HPSA). The hospital serves a medically underserved population, with 66 percent of the hospital’s patients on Medicaid or Medicare, and 12 percent uninsured.

The hospital received the grant in partnership with a health information system vendor, which had worked with the hospital since the late 1990s. Previously, the hospital had installed the company’s financial management products, as well as a few clinical applications. For the new grant, the hospital planned to implement numerous components to create an integrated IT system with an electronic medical record. The new components included pharmacy management, laboratory management, operating room management, patient scheduling, insurance eligibility verification, bar coding for supplies and medications, Pyxis medication dispensing system, electronic medication administration records, electronic patient care documentation, computerized provider order entry and Web-based access to hospital records by community physicians. The project had five stated goals:

1. Successfully deploy a fully integrated EMR system using proven health IT practices to reduce medical error and improve overall patient safety.
2. To decrease the number of medication errors.
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 health IT implementation in order to assess the extent to which health IT contributes to measurable and sustainable improvements in patient safety and quality of care in rural hospitals.

Because the hospital did not have the capacity to evaluate the effect of the IT system on patient safety, they contacted the University of California, San Francisco, to conduct the evaluation.

We had no previous relationship with the hospital, but were familiar with the community in which the hospital operates and were conducting other research in the region. We were completing a multi-site retrospective evaluation of computerized patient records and bar-code scanning for medication administration in the Veterans Health Administration, and had conducted several prospective evaluations of workforce development programs. We had not previously conducted a prospective evaluation of an IT installation.

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, using a written guide to provide some structure to the interviews. The primary purpose of the interviews was to assess the financial impact of the IT system. It was expected that top management would report satisfaction with the systems because they have better access to information about hospital operations. Front-line managers were anticipated to think that initial implementation of the systems was difficult but that the IT system was beneficial by the end of the project. The proposal did not focus on the process of implementation, nor did it specify the frequency of interviews or include non-management hospital staff.

By the end of the first year, it was clear that some aspects of the implementation were going well and others were problematic. As we scheduled the first set of interviews with hospital leaders, we also decided to recruit staff for interviews.

Financial data would be obtained from both the hospital and a state regulatory agency.

Quantitative analyses were framed by specific hypotheses, which focused on potential differences between the short-run and long-run effects of IT. It was expected that short-term patient safety indicators and medication error rates would appear to worsen, due to improved accuracy in identifying errors with electronic systems. In the long-term, error rates would improve. The data analyses would first involve simple comparisons over time, and then multivariate regression equations would be estimated to control for other factors that may have affected patient outcomes, such as patient acuity. These multivariate regression equations would be estimated using ordinary least squares and econometric models appropriate for count data, and would control for correlations within patient care units. The data requirements for this quantitative approach were significant, and IT systems had to be implemented according to the proposed schedule to have enough data for a reliable pre/post-analysis.

The initial evaluation plan emphasized quantitative analysis of medication errors, patient safety and hospital finances. Reduced medication errors were expected to result from the eMAR, Pyxis and CPOE. 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, electronic patient record documentation and physicians’ Web-based access to records. Finally, the operating room management, bar coding, scanning and insurance eligibility components were intended to improve the hospital’s financial position.

The hospital would provide most of the data required for the quantitative evaluation. The hospital’s incident reporting system would provide data on medication errors by type, procedure errors, patient complaints and other incidents. The hospital submitted data on nurse staffing, patient falls and decubitus ulcers quarterly to a statewide quality improvement program. We also planned to compute Patient Safety Indicators and Inpatient Quality Indicators using software developed by the AHRQ. Finally,
agement system and Pyxis medication dispensing units—were launched within the first month of the grant, because the bulk of the installation preparation was conducted before the grant began. The implementation of Pyxis was universally praised by hospital management, and the roll-out was accelerated due to staff enthusiasm. During the remainder of the year, the hospital planned to install electronic patient scheduling; a bar coding system for supplies; operating room management; a scanning application for archiving records; electronic laboratory management; and eMAR. Of these, only two more modules were launched in the first year: electronic patient scheduling and bar-code scanning for supplies.

Setbacks came during the first quarter of the grant and continued throughout the year. First, the IT vendor’s project manager left and the hospital’s clinical IT implementation coordinator went to another hospital. The replacement project manager was a long-time non-clinical employee of the hospital, who had been in various roles in the clerical and administration departments. The Chief Nursing Officer (CNO) of the hospital was charged with training and supporting nurses, pharmacists, physicians and other clinicians. The next setback came with the electronic scanning module, because the underlying software referred to a hard drive that could not be used for the application. The IT vendor had to reprogram the software and new hardware had to be ordered, setting the implementation behind schedule; this module was implemented more than one year late. Other modules scheduled to be implemented in the first year were delayed, including operating room scheduling and management and eMAR.

**Adding surveys to the evaluation.** As difficulties with the implementation became apparent, we decided to augment the evaluation with interviews and surveys to learn how staff were perceiving and responding to the implementation. The first survey was intended to measure overall attitudes toward computer technology, and the role of computer technology in healthcare, before many of the IT modules had been implemented. Survey items were drawn from a previously developed instrument to assess acceptance of computer systems in the healthcare setting. A variety of survey instruments have been used in previous research. A useful resource is Anderson and Aydin’s *Evaluating the Organizational Impact of Healthcare Information Systems.*

Survey participants were recruited via flyers posted at the hospital. The response to the survey was disappointing. Some survey responses suggested that there was distrust of management among some staff; the fact that the hospital is small might have raised privacy issues for staff respondents. In general, participation in evaluation efforts may be influenced by political, social, labor and personal issues at the hospital and among staff. It is important for evaluators to develop protocols to increase staff comfort with participation in surveys and interviews. The low response rate of 68 convinced the evaluation team to use different dissemination methods for future surveys.

The second survey added to the evaluation plan was designed to learn about nursing documentation before the electronic patient documentation system was released. For this survey, participants were recruited at the beginning of their training class for the patient care documentation system. The trainer directed class attendees to a short Web-based survey, which had been adapted from a survey developed by Russ Cucina at UCSF and shared through personal communication. They survey asked staff to report the time spent collecting and entering chart data, as well as their expectations for electronic patient care documentation. The response to this survey was nearly double that of the first survey, with 133 respondents. Making the survey readily available to respondents during a dedicated time was an effective strategy to ensure good response while maintaining confidentiality.

A third survey, conducted about six months after the eMAR system had been implemented, was to explore how well staff thought eMAR training had prepared them for its launch, and whether eMAR was perceived as increasing patient safety, saving time and providing useful warnings and alerts. This survey was adapted from one developed by Julie Sakowski for unpublished research on the Sutter Health System’s bar-coding system for medication administration, received through personal communication. Neither of the two previous survey administration strategies was considered for this survey. 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 could obtain an envelope containing the recruitment letter, a one-page survey and a return envelope from one of the managers involved in the IT implementation. Staff was instructed to seal the survey in the envelope provided and return the sealed envelope to the IT implementation coordinator in exchange for a gift card. This survey method resulted in 117 respondents from a range of occupations at the hospital.

A final survey was distributed after the second launch of the patient care documentation system, which had been implemented and shut down the previous year. The survey process was the same as that used for the previous survey on eMAR use. Staff participants were recruited with flyers posted in the hospital and through the efforts nursing management, who identified staff that had experience with the module. As before, participants received a gift card for their participation in the survey. The survey had only 50 respondents, likely because the patient care documentation system was not being used by most staff due to a variety of ongoing hardware and software problems. This final survey asked about time spent collecting and entering chart data, to compare the data received from the pre-training survey with the post-implementation data. The survey also asked about ease of use, completeness and accuracy of the electronic record, and satisfaction with the system. These survey questions were extracted from several previously published surveys.

**Expanding the scope of interviews.** By the end of the first year, it was clear that some aspects of the implementation were going well and others were problematic. As we scheduled the first set of interviews with hospital leaders, we also decided to recruit staff for interviews; the experiences of staff were regarded as key to the overall success of the IT implementation. We recruited staff for interviews by asking the IT implementation coordinator to post flyers at the hospital, offering a gift card as an incentive, and instructing staff to call UCSF to schedule an interview. To ensure confidentiality, 10 staff members were interviewed in
a private conference room at an off-site fitness center owned by the hospital. Staff members were generally satisfied with the IT system, although several complained about problems they were having with the software. Others thought that the IT system had been selected without enough research.

The first interviews with hospital leaders were conducted in an office at the hospital. All interviews were one-on-one and were not tape recorded. Most of the hospital's leaders recognized that there were some implementation problems. Several expressed some frustration with the IT vendor. At the end of the first year, leaders were uncertain about whether there would be improvement in quality of care when the IT system was fully installed, and leaders were divided as to whether they anticipated a positive long-term financial gain from the electronic systems. Hospital leaders reported that the IT system was more expensive than expected in the first year.

A second set of staff interviews was scheduled for the end of the second grant year, but was deferred. The primary reason for delaying the second site visit was that neither the eMAR nor the patient care documentation system had been implemented during that year. These were two of the most important components of the IT system. Moreover, the IT vendor informed the hospital that the CPOE module was not yet ready for use, and they could not estimate when it would be ready. We decided to delay the site visit until after at least one of these modules had been implemented.

While we were waiting for progress at the hospital, the hospital went through a year of turmoil. There was a series of disruptive changes in senior management, starting with the CEO of the hospital going on medical leave. One month later, the CFO was fired. Over the next several months, the CEO retired due to his medical condition; the Chief Nursing Officer was fired; and the COO resigned. The IT implementation coordinator, hospital IT manager and a nurse manager continued to push forward with the implementation plan, but with no high-level continuity because the hospital was managed by an all-interim executive team. Over a year after the upheaval began, the hospital's board appointed a permanent CEO, providing stability to the hospital for the first time in nearly two years.

The site visits started again six months after the eMAR system was launched, while the interim executive team was in place. Interviews were conducted with these interim leaders, as well as 11 staff members. The staff had been recruited through flyers posted at the hospital, as before, and interviewees were offered a gift card to thank them for their time. Interviews were held in a private conference room at the hospital. Conducting interviews in a closed-door room was the key to ensuring confidentiality and candor. Due to scheduling difficulties, some staff asked to conduct their interview by telephone after the site visit. We found that these interviews were less useful, for several reasons. First, we suspect that staff did not reveal as much in the telephone interviews, because they could not develop a rapport with the interviewer as easily as they could in person. Second, we could not observe the body language or facial expressions of the interviewee; non-verbal cues often led us to follow-up questions during in-person interviews. It is preferable to conduct all interviews in person, if possible.

A final set of interviews was conducted during the last month of the evaluation period. We interviewed nine staff members, using the same recruiting and interviewing strategy as for the previous set of interviews. During that final visit, most of the permanent executive team was in place, and we interviewed the CNO as well as the leaders involved directly with the IT implementation. This was the third time we had met the IT implementation coordinator, IT manager, and nurse manager leading the implementation. The final interviews with the leadership team provided an opportunity to ask closing questions such as: “If you had the chance to do this implementation again, would you do it, and what would you do differently?” We also were able to provide some feedback about approaches the hospital might consider for future IT implementation.

Scaling back the data analysis. The implementation delays experienced at the hospital meant that there was not sufficient post-implementation data to assess the impact of the IT system on patient outcomes. Moreover, the nuances of the implementation suggested that any improvements would not arrive for many years. The quantitative analysis was modified, because the degree of statistical rigor originally proposed was not feasible. We obtained data from the hospital's incident reporting system, state-filed financial records, and nurse staffing and quality data. Some hospital leaders thought the medication error reporting as too low, and thus there was some concern about the validity of those data. We graphed each of the key outcomes—such as patient falls, operating margins and medication errors—and indicated on the graphs when each of the major IT modules had been implemented. Most of these simple analyses did not show any apparent changes in rates of patient safety incidents, but a few indicated that there may have been a worsening of outcomes after the patient care documentation system was implemented.

Several recent studies have used innovative strategies to prospectively or retrospectively collect data on patient safety, and how IT might affect patient outcomes. Poon et al.,23 developed a protocol to directly measure errors in pharmacy dispensing before and after a new bar-code dispensing system was implemented. A research pharmacist inspected all medications after normal dispensing and verification processes, and classified each error. A panel of internists then reviewed and rated the severity of each error. This research method was labor-intensive but produced reliable counts of errors pre- and post-implementation. Sakowski et al.,24 retrospectively audited warnings and errors reported generated by a bar-coding medication administration system to estimate how many medication errors had been averted by use of the system.

CONCLUSIONS AND RECOMMENDATIONS

As health information technology systems diffuse through the healthcare industry, it is essential that knowledge about how to effectively implement these systems be obtained and disseminated. Formative evaluation, which focuses on the process of implementation rather than the outcomes, can enable organizations to make changes while they are in the midst of an implementation, and can provide essential information about implementation strategies that work.25

Many healthcare organizations do not have the capacity to
conduct their own evaluations, and even those that do may benefit from working with an external evaluation team. Independent evaluators can lend objectivity to the research, because they do not have professional relationships with hospital staff and leaders that might compromise neutrality. Moreover, non-employee evaluators can provide anonymity to staff who may be concerned about whether their candor puts their standing in the organization at risk.

Qualitative evaluation of the implementation process is needed to understand how IT systems are affecting staff workflow, morale, and perceptions of quality of care. Three qualitative data collection strategies can be considered: focus groups, interviews, and surveys. Focus groups provide an efficient method to learn how staff is adapting to IT, but these groups do not provide staff with anonymity. If staff are worried that their views will not be popular or might place their professional reputation at risk, they will not speak candidly in groups. One-on-one interviews are advantageous because they give the interviewee the opportunity to discuss concerns and successes privately. Anonymous surveys also can provide useful information during an implementation, and a growing number of survey instruments for IT evaluations are available. For all qualitative data collection methods, it is useful to offer staff an incentive to participate, such as a gift card.

Quantitative data collection is needed to evaluate the outcomes of health IT implementations. Careful prospective data collection can be time-consuming expensive; the work by Sakowski and Poon involved large research teams and intensive data collection and review. This effort was rewarded with the ability to accurately measure the impact of health IT. Retrospective analysis of previously collected data is less expensive, and thus attractive to hospitals that cannot afford a large research budget, but there is a trade-off with respect to the quality and reliability of the quantitative evaluation results.

Organizations should use published studies along with their internal research findings to develop and refine their IT implementation strategies. As IT modules are launched, data on how staff perceives the quality of training, whether support is adequate, and the emergence of unintended negative effects can be used to ensure that subsequent launches work better. The evaluation effort is worth at least minimal investment and, as with many other things, greater investment often leads to greater rewards.

Joanne Spetz, PhD, is an Associate Professor at the UCSF School of Nursing. Her expertise includes the nursing workforce, the hospital industry, information technologies, and quality of patient care.

Dennis Keane, MPH, is a Research Analyst at UCSF. He is the Center for the Health Profession’s project manager for survey research, having conducted surveys of California physicians, nurses, dental hygienists, and other health professionals. He also has been involved in surveys of San Francisco General Hospital emergency room patients, California physicians, California public health clinics, and a multi-state survey of ABS patients. Dennis received his M.P.H. in Health Education from UC Berkeley in 1987.

REFERENCES


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