Workflow Redesign in Support of the Use of Information Technology Within Healthcare

A HIMSS Toolkit
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INTRODUCTION

Today, the healthcare industry is at a critical juncture as it pursues an electronic medical record (EMR) and/or an electronic health record (EHR)-centered model. For several years, there have been external pressures for healthcare organizations to move in this direction. Now, with enactment of the American Recovery and Reinvestment Act of 2009 (ARRA), there is not only pressure to make this a reality, but financial incentives as well.

Implementation of information technology requires a certain amount of workflow redesign in order to be successful. The degree to which redesign is needed depends on the existing process. If the current process is already supported by information technology, and that technology is being replaced or upgraded, then the level of redesign may be minimal and simple to manage. However, if the technology to be used is designed to support a manual or paper-based process, then the workflow redesign efforts associated with the use of that technology may be substantial. This toolkit provides guidance and best practices that will help enable provider organizations to successfully approach a workflow redesign initiative as part of an EHR or EMR implementation.

Much has been written about why the healthcare industry should embrace information technology. Stakeholders across the industry have different reasons for wanting to see this effort materialize. What follows is a brief description of several of the key stakeholders and their respective positions on this topic.

Private Sector. Many major American companies provide healthcare benefits for their employees. The cost of these benefits is reflected in the price of American goods in the global marketplace. Because most other industrialized countries provide these benefits through government, the cost of healthcare in these countries is not reflected in the price of their goods and services, which puts American companies at a cost and competitive disadvantage. This phenomenon has contributed to a loss of jobs in as American companies have moved their operations to other countries in an effort to lower their manufacturing or service costs, remain profitable and preserve shareholder equity. It has also contributed to loss of market share for these same companies in the United States. Because of the cost differential, foreign competitors sell their products in the United States at a lower cost. The private sector needs the cost of healthcare go down in order for them to be globally competitive. This sector believes that automation is one tool that can make this happen.

Government. As with the private sector, one of the major drivers from a government perspective is cost. Spending for both Medicare and Medicaid continues to grow. The Board of Trustees of Social Security and Medicare has predicted that the trust fund supporting the Medicare program will be insolvent by 2019.
Another government driver is quality. Published statistics reveal that we spend nearly twice the average of other developed countries for healthcare, but have higher morbidity and mortality outcomes. The Congressional Budget Office (CBO) has estimated that the ARRA stimulus plan, although contributing to budget deficits in the short term, will reduce Medicare spending and begin to provide savings to the government in 2014. This cost savings coupled with the potential to improve quality by standardizing care, improving process controls, providing clinical decision support, increasing access and improving communication across the continuum of care is appealing to all levels of government.

From a government perspective, we can also learn from other countries that have been at this much longer than the United States. For example, several European nations have been building IT infrastructure focused on increasing patient access, sharing information, contributing to high quality care, and increasing efficiency for at least 10 years. This follows the use of electronic health records in general practitioner offices and hospitals for at least 20 years in these same countries. In addition to Europe, there are exciting initiatives being undertaken Canada, Australia, and China, where the sharing of health information across the continuum of care is supported by federal governments.

**Changing Healthcare Workforce.** Clinicians entering the workforce today have grown up using computers. Exposure to automation began for this generation in elementary school and has been nurtured throughout their educational experience and personal life. These young professionals are comfortable with both personal computers and electronic devices such as DVDs, Blackberries, iPods and PlayStations that provide entertainment and help to organize their lives. These clinicians are far more comfortable charting on a computer than documenting on paper=. They prefer an electronic record.

**Shortage of Healthcare Workers.** There has been a shortage of healthcare workers, especially for those in the clinical disciplines, for years, and it will only get worse. Many young people are not embracing a career in healthcare, instead choosing to work in other professional fields. The U.S. National Academy of Sciences reported in its book *Retooling for an Aging America: Building the Healthcare Workforce* that 29 of 38 states surveyed reported a shortage of direct-care workers that was either “serious” or “very serious.” Shortages exist in most clinical disciplines, including certain physician specialties, nursing, pharmacy and in many ancillary disciplines. In addition, as the population ages, there is a growing demand for workers who can provide home health services, such as personal and home-care aides.

**Consumerism.** The healthcare industry today is dealing with an educated consumer that expects the same level of service from a healthcare organization as it receives from other service-related agencies. A consumer’s expectation of quality most likely differs from how a care provider defines quality. Today’s consumer expects open communication; fast, reliable service and information; and low prices. Price sensitivity is growing as patients take on more of the actual cost of their care due to changes in insurance benefits and the increased rate of uninsured within the United States. Technology assists in meeting consumer needs.
Retiring Baby Boomers. Because of the sheer size of this segment of the U.S. population, the retiring baby boomers will challenge the healthcare industry. According to the U.S. Census Bureau, there are 78 million Americans living who were born between 1946 and 1964, the “baby boom” years. As patients, baby boomers are, for the most part, more educated, mobile and independent than their predecessors. They demand information on their healthcare status. As a whole, they will live longer than previous generations. Their numbers, coupled with their increased expectations and a shortage of workers, are already beginning to tax the healthcare industry. Information technology, such as electronic medical records, is seen as a way to manage this generation of patients.

Information Technology Proliferation. Historically, most information technology developed for clinicians was modeled after software packages that had been designed to automate administrative processes. This model has not necessarily suited the healthcare worker as it is based on a non-mobile workforce that primarily performs administrative functions at a desk. New designs in both hardware and software have introduced technology that is more suited for a mobile workforce. This is increasing interest for technology within the healthcare industry.

As noted, the public cry for healthcare automation is growing. The time has come to fully automate the healthcare industry. Until now, there has been little incentive to eliminate the paper processes that exist today. Many organizations could take on this type of initiative due to the costs associated with such an endeavor. The reimbursement received from payors could not support this level of investment. The federal government has recognized this and provided a financial means to make this happen through ARRA. Beginning this year, every healthcare provider should be focused on information technology, as its future Medicare and Medicaid reimbursement will be based automation. This toolkit serves as one means to assist organizations as they begin technology implementation, especially in clinical areas.

To prepare this toolkit, we interviewed 10 healthcare organizations in various stages of system implementation. Our intent is to share their stories and best practices so that your organization can benefit from those that undertook the rigors of workflow redesign and technology implementation. All of the organizations interviewed identified the overarching goal for an undertaking such as this must be centered on the patient with an eye towards patient safety and quality improvement. The means to achieving these goals was through a transformation of how work is done with health information technology as a key enabler for this change. The primary goal was not and cannot be the technology itself. The goal must be to improve the experience and health of the patient. The organizations we spoke with who focused on the patient derived other benefits that were important to their key stakeholders, including improved quality, greater efficiency and lower costs. The needs of many were satisfied through a workflow redesign and information technology implementation process with a focus on the patient.

We provide basic information on workflow improvement concepts, theories and components. We review software applications that can be used to support analysis of the way people work.
And we finish by sharing the stories of ten organizations who participated in the development of this toolkit. It is our hope that your organization will derive benefit from the material we have incorporated into this toolkit on *Workflow Redesign in Support of the Use of Information Technology*.

**HIMSS EHR Adoption Task Force**
CONCEPTS

Workflow analysis plays an important role in aligning people, processes and technologies when implementing an EMR or EHR. Information technology includes hardware and software which support specific tasks and functions such as order entry, resource planning and accounting. This technology serves as an enabler to improve business processes within a healthcare organization. However, the data defining a key business process, such as an “order,” may be fragmented within different databases within an enterprise. In addition, the process itself may get embedded within the task-aligned software application. When this occurs, it often becomes impossible to change a business process without changing the associated software application or reconfiguring the existing software to achieve the desired result. To achieve desired organizational outcomes it is imperative to analyze and align the workflow for a key business process before implementing a technology solution.

Healthcare organizations implementing computerized systems for an EHR or EMR often undergo business process management (BPM) activities to increase efficiency and improve productivity, customer satisfaction and profits. In addition to BPM, other project considerations that impact success include planning and scheduling, flow controls, project management, change management, issues management, quality testing and continuous quality improvement. This section of the toolkit discusses these concepts in detail.

Addressing Processes
Process mapping is a key preparatory task for implementation of an EMR or an EHR. Current state assessments are completed to account for all possible configurations and job requirements. In designing the future “ideal” state for operations in the electronic world there are multiple concepts and methodologies that build upon each other both in the initial design and continued optimization. These methods are discussed below.

Business Process Management (BPM): A management concept where all components within the business cycle are accounted for and then re-engineered with innovation that leverages technology to gain efficiencies through automation. Also called Business Process Re-engineering (BPR).

Business Process Automation (BPA): BPA utilizes IT to supplement or replace manual processes and manage information for the organization. BPA is the output or result of the review cycle an organization undertakes to streamline its operations.

Extension of Current IT Systems: The integration of disparate IT systems within an organization to automate processes with functionality already available to satisfy both the workflow and functionality needs of specific operational units, while meeting the overall needs the organization.
**Business Process Modeling:** The act of documenting and analyzing the steps within a single process or multiple processes within a business unit and/or the organization. A workable model captures both the current state of the process(es), as well as the future “ideal” state.

**Business-Driven Development (BDD):** The act of developing and implementing an IT system to satisfy the current and future business requirements of the organization. The drivers of system development are the business-process owners (i.e., a business analyst or nurse), not the traditional IT model. For BDD to be successful it requires that key stakeholders in the organization be engaged in the process. Examples include:
- Clinical Transformation. The act of analyzing and re-engineering clinical workflows to streamline a process utilizing IT as a tool to assist the organization in reaching the ideal state of efficient and effective patient care. Once implemented, and to remain effective, the organization must remain in a continuous state of optimization.
- Revenue Cycle Management (RCM). A review of the business operations cycle to identify new opportunities for revenue capture, to identify inefficient process, streamline back-office operations and leverage IT effectively. Once initiated, the organization must remain in a continuous state of optimization along the revenue cycle.

**Planning & Scheduling**
Planning and scheduling for the deployment of an EMR or EHR requires a change in culture. Depending on the organization and how it embraces technology, this could be an easy assignment or it could be a difficult assignment. If an organization does not have the necessary champions to embrace change, the system will not succeed.

To successfully get started, it is recommended that an organization:
- Form a multi-disciplinary team/committee with representatives from all departments to determine the best way to migrate to an electronic system. The team should be tasked with identifying:
  - The needs and goals of the project;
  - risks; and
  - team member roles and responsibilities.
- The organization should assign a project leader to manage the work effort. The project leader, with assistance from the project team and key stakeholders, will:
  - Establish goals and objectives;
  - prepare and manage the budget;
  - develop a communication plan that will address communication to employees, patients, and other stakeholders;
  - define an organizational structure and meeting plan;
  - establish timelines;
  - manage required resources, including human resources;
  - identify and manage the costs associated with the effort;
  - assure the acquisition of required hardware and software;
  - document deployment of hardware and software including an analysis of where equipment will be placed and when, how, and who will deploy;
• develop and execute a training plan for use of the new electronic system that defines who, what, where, when, why and how;
• coordinate the vendor relationship;
• assure the development and implementation of the interfaces required between systems; and
• execute a quality management plan that conveys how processes will be measured and controlled.

- Create a policy review committee responsible for reviewing and determining what current policies have to change in order to transition to either a wholly electronic or hybrid environment.

Time spent planning is an often overlooked phase of the overall process. Upfront planning is vital to the success of the EMR or EHR project throughout the development and implementation phases. Project planning is not just about concrete deadlines and schedules; rather, it is about creating a collaborative project team with a shared sense of responsibility.

**Flow Controls**

Flow control applied to workflows involves managing speed and volume in processes. Typically workflows require analyzing flow controls from four perspectives: logical order of tasks; data flow, which describes the information exchange between tasks; resources, which describes the originators of tasks; and access control, which refers to the security protection of the data and security privileges of the user to view the data.

Two accessories for flow control are control flow diagrams and software applications. To provide ease of analysis, a control flow diagram with geometric figures and arrows representing and describing the sequence of steps for an activity provides a graphic picture, which is easier to analyze than text. There are software applications designed to assist with flow control management. One example we found in our research is BMC’s Remedy IT Service Management Suite for change management.

There are three types of flow controls:
• Change control flow used in project management.
• Process control flow used in business process re-engineering projects. The process control flow addresses both the flow of information throughout the organization and the optimization of tasks and activities.
• Quality control flow used in quality design and control processes, such as Six Sigma.

**Project Management**

Project management, regardless of the specific methodology utilized, includes five major stages: initiation, planning and design, execution or production, monitoring and controlling systems, and completion.

Although many project management methodologies have been developed, the most popular are those developed by the Project Management Institute (PMI). Founded in 1969, PMI develops global standards for project management and drives adoption through a popular certification program. Their mission is to improve the understanding and practice of project management. The PMI focuses its efforts on identifying, defining, documenting and championing generally
accepted project management practices. The PMI has also developed a common project management lexicon. PMI recently completed updates on its four foundational standards, including A Guide to the Project Management Body of Knowledge (PMBoK Guide), now in its fourth edition. When HIMSS Davies Award winner Eastern Maine Medical Center managed their successful CPOE implementation, they relied on the project management best practices of PMI. For more information, visit the PMI Web site.

Another project management philosophy, Critical Chain Project Management (CCPM), is a method of planning and managing projects that puts more emphasis on the resources required to execute project tasks. It is an application of the Theory of Constraints (TOC). The goal is to increase the rate of throughput (or completion rates) of projects in an organization. Applying the first three of the five focusing steps of TOC, the system constraint for all projects is resources. To exploit the constraint, tasks on the critical chain are given priority over all other activities. Finally, projects are planned and managed to ensure that the critical chain tasks are ready to start as soon as the needed resources are available, subordinating all other resources to the critical chain. Go online for more information about the CCPM methodology.

Other popular project management methodologies for software projects include Agile or Scrum. Though primarily geared toward software development, these iterative concepts and processes are valuable for managing software implementations. An iterative project management methodology is based on three, basic tenets:

- Quality. Identify issues early and reduce output of defects at end stage through regular re-evaluation and prioritization of outstanding features.
- Simplicity. Software implemented with a process that improves productivity and reduces waste.
- Customers. Engage key stakeholders early and often to ensure you deliver what they need.

For more information on iterative software methodologies such as Agile and Scrum, refer to the resource links in the reference section of this toolkit.

**Change Management Concepts**

The purpose of change management is to develop two aspects of user readiness—skill and will—to create an environment where users successfully transition to meet and sustain new expectations. This does not happen in a vacuum; it requires a supporting infrastructure.

This section of the toolkit provides a high-level overview of key success factors in change management. The concepts that follow are called by different names, but all are universal and apply to most change management efforts. The order in which these ideas are addressed depends on the situation. This is not a linear process, but one where the various components overlap and influence each other over the course of the project. What follows are key outcomes change management seeks to deliver, along with suggestions on how to achieve them.

**Effective, Committed Sponsorship**
The sponsor role is critical to success. Change efforts are always more successful when there is clear and present leadership supporting and modeling the change. For large organizational change projects, sponsorship is required at the executive level and must cascade throughout the organization. The sponsor role is to own the change; communicate about it effectively and frequently; model and reinforce desired new behaviors; provide resources and remove barriers; and stay the course. Sponsorship is the single most important determinant of success. Sponsors often need coaching and reinforcement to perform this role well.

Clearly Defined Change
People need to know what the actual change is, why the organization is making the change and what will happen if it is not successful. Be as clear as possible about where you are going—what is the future state and what will it be like when you get there? It is also very important for people to understand what is not changing as this provides some stability. Effective future state descriptions are compelling and behavioral. They engage people and help them understand their role in the process.

Engaged Stakeholder Groups
Bring people to the table to build a comprehensive approach that meets everyone’s needs and ensures operational integration. Remember, in big projects there are many groups that are impacted. It is very important that groups or stakeholders are clearly identified and that plans are made for engagement. Different groups require different approaches and levels of detail and this varies over the course of the project. Get to know your stakeholder groups—what’s important to them; how they communicate; what they stand to lose and gain in the change; what motivates them; and who their informal leaders are. It is very difficult to effectively engage people if you do not understand your audiences. One size does not fit all.

Communication that Builds Awareness and Commitment
There is no such thing as too much communication. Communicate frequently and regularly. Remember, communication is verbal, behavioral and written. Use all vehicles at your disposal. Provide the broader context for the change, as well as the details of what the change means. Be specific in a way that gains commitment. Prepare leaders to reinforce key messages. Be clear about the new expectations, how the company will prepare and support people to success and timelines for implementation. Provide feedback loops for two-way communication. Be consistent with messages. When you do not know the answer to something, say so, and talk about what you are doing to get an answer. Tell the truth.

Training and Support that Prepares Users for Job Changes
The purpose of training is to prepare people to meet new job expectations. Even in software implementation, training is not about technology but about preparing for effective performance. Training needs to be role-based and focused on the job as opposed to focused on features and functions of the software. Ensure people understand how to do their job, with the
software as a key tool. Most people need to practice something new in order to develop competence and confidence. This is why sandboxes and dress rehearsals are so important in software implementations. Developing proficiency over time requires more than just initial training. Peer support, one-on-one coaching, advanced training, and Website updates are examples of ways to help ensure individual success and that the new behaviors become part of the fabric of the organization.

**Strong Local Champions**

Peer-to-peer influence is one of the most effective ways of moving change forward. Identify and leverage local, informal leaders to model the new behaviors and support the change. Their role is to serve as effective change agents. Get these change agents involved early and gain the benefit of their perspective to improve the approach and content. Get their help to understand what resistance there may be and how to manage it. Engage these informal leaders in problem resolution. Support them to effectively socialize the coming changes in their areas/units. Savvy organizations institutionalize the role of local champions, leveraging their value long term in multiple ways.

**Reinforcement Program**

Reinforcement is the second most important success factor. It is pretty simple. An organization gets what it recognizes and pays for. A big pitfall in change management efforts is neglecting to align incentives. We ask people to change behavior and then we continue to incent/pay them for old behaviors. Reinforcement comes in many forms and must include consequences as well as rewards. Prepare managers to excel at reinforcement by providing them with clear guidelines. Assist them in defining what the new expectations are and what a good job looks like. For the greatest impact, encourage managers to tailor reinforcement so it is meaningful to their team members.

**Change Management from a Technology Perspective**

Change management includes tracking of changes; assessing the impact, cost, benefit and risk of proposed changes; developing business justification and obtaining approval; managing and coordinating change implementation; monitoring and reporting on implementation; and reviewing and closing change requests.

The Information Technology Infrastructure Library (ITIL) defines the change management process this way: The goal of the change management process is to ensure that standardized methods and procedures are used for efficient and prompt handling of all changes, in order to minimize the impact of change-related incidents upon service quality, and consequently improve the day-to-day operations of the organization.

A well-planned and well-documented change management procedure facilitates speedy issue escalation and resolution through the use of defined procedures for tracking and decision-
making. Successful healthcare IT implementations have benefited from a tight governance structure as part of a streamlined change management procedure.

Additionally, with healthcare IT implementations, a key part of any change management strategy is a plan to facilitate acceptance of the new solution and workflow. Many change management models center on the following principles:

1) **Awareness.** An individual or organization must know why a specific change or series of changes are needed.

2) **Desire.** Either the individual or organizational members must have the motivation and desire to participate in the call for change or changes.

3) **Knowledge.** Knowing why one must change is not enough; an individual or organization must know how to change.

4) **Ability.** Every individual and organization that truly wants to change must implement new skills and behaviors to make the necessary changes happen.

5) **Reinforcement.** Individuals and organizations must be reinforced to sustain any changes making them the new behavior. If not, an individual or organization will probably revert back to their old behavior.

When selecting and defining a change management process to guide your software implementation, consider your organization’s level of awareness, desire, knowledge and ability along with your ability to reinforce the change after implementation. Use the evaluation of these five principles to select and customize a change management strategy:

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Empirical-Rational</strong></td>
<td>People are rational and will follow their self-interest, once it is revealed to them. Change is based on the communication of information and the proffering of incentives.</td>
</tr>
<tr>
<td><strong>Normative-Re-educative</strong></td>
<td>People are social beings and will adhere to cultural norms and values. Change is based on redefining and reinterpreting existing norms and values, and developing commitments to new ones.</td>
</tr>
<tr>
<td><strong>Power-Coercive</strong></td>
<td>People are basically compliant and will generally do what they are told or can be made to do. Change is based on the exercise of authority and the imposition of sanctions.</td>
</tr>
<tr>
<td><strong>Environmental-Adaptive</strong></td>
<td>People oppose loss and disruption but they adapt readily to new circumstances. Change is based on building a new organization and gradually transferring people from the old one to the new one.</td>
</tr>
</tbody>
</table>

For more information on these popular change management strategies, read the classic book *The Planning of Change* by Bennis, Benne and Chin, published by Holt, Rinehart & Winston⁴.
**Issues Management**

Issues can have significant impact on the EMR or EHR project timeline, cost, scope and quality. These need to be tightly managed and their potential risks considered. Early detection of issues, effective communication and a well-developed plan are the keys to successful issue management.

An issue is a formally-defined problem that will impede the progress of the project and cannot be totally resolved by the project manager and project team without outside help. The definition of an issue can be broken down in the following manner:

- **A formally defined problem.** You must be able to document a problem if you hope to resolve it.
- **Impede the progress of the project.** Issues must be resolved since they are impeding the progress of your project.
- **Cannot be totally resolved... without outside help.** If the project team can resolve a problem it does not raise to the level of an issue. If they cannot resolve it, this is the time to ensure that a process is in place to make the appropriate people aware of the issue and then resolve the issue as quickly as possible. The steps required to identify and manage an issue are outlined in Figure 1:

**Figure 1: Issue Management Steps**

<table>
<thead>
<tr>
<th>STEP</th>
<th>REQUIRED ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Identify and record issue clearly.</td>
</tr>
<tr>
<td>2</td>
<td>Use issue forms to document issues properly.</td>
</tr>
<tr>
<td>3</td>
<td>Determine the impact of each issue.</td>
</tr>
<tr>
<td>4</td>
<td>Prioritize issues and report on their status.</td>
</tr>
<tr>
<td>5</td>
<td>Review all issues and decide on a course of action.</td>
</tr>
<tr>
<td>6</td>
<td>Assign actions to staff to resolve issues.</td>
</tr>
<tr>
<td>7</td>
<td>Take the steps needed to resolve issues quickly</td>
</tr>
<tr>
<td>8</td>
<td>Monitor the outcome of the actions taken.</td>
</tr>
<tr>
<td>9</td>
<td>Report on the status of issues to management.</td>
</tr>
</tbody>
</table>

Managing issues is a critical responsibility that cannot be over emphasized. Effective issue management will make the difference between an EMR or EHR system implementation’s success and failure.

Even after an EMR or EHR system has been in place for awhile, facilities should continue advancing implementation and utilization through staff training, process assessments and focused deployment of software updates.


**Quality Testing**

Quality testing involves monitoring the process of software development and implementation to ensure standards and procedures are followed; problems identified and worked out; and processes are improved. Quality testing serves several important purposes. First, it detects defects in the software application or operation of a system; and second, it provides stakeholders with information regarding validation and verification that the software meets business and technical design requirements and stakeholder expectations.

The scope of quality testing checks that the software performs at the highest level of achievement in doing “what it is supposed to do and needs to do”36.

Quality testing involves making decisions in regard to the following questions:

- How and what to test?
- Who performs the testing?
- When to start and stop testing?
- How to integrate testing with the rest of the project team?

Testing involves checking the operation of the system and applications by setting up scenarios and assessing the testing results. The following describes a typical cycle for testing:

- **Testing Cycle.** Software testing starts after determination of the requirements and coding completion. Quality testing occurs throughout the software development and implementation life cycle.

- **Test Plan (Strategy).** The test plan is designed for the purpose of maximizing the product quality. Many activities occur during testing and a plan helps to focus the testing objectives.

- **Test Development.** During test development test scripts are created. The scripts should:
  - Test the largest number of operating scenarios;
  - Test the expected or normal condition to make sure the software performs as expected;
  - Test the abnormal condition to see how the software performs when it does not receive the expected data;
  - Include destruction testing (trying to break) by testing erroneous, erratic or way off behavior to assess how the software handles this type of input. The application needs to be indestructible by end-users; and
  - Test compatibility both upwards and downwards. For example, a programmer may develop a new version of software and test on the current operating system, but the program may not be compatible with the older mixture of hardware/software being used.

- **Test Execution.** Software testers following the test scripts will perform the testing scenarios and note results as pass or fail.

- **Test Reporting.** Documentation of the test results. Software that passes testing is ready for release, but software that fails needs to be reported for analysis.

- **Test Result (defect) Analysis.** Software that fails testing needs to be evaluated. Some defects need to be addressed and fixed. Other defects may be thrown out or postponed until later.

- **Defect Retesting.** Defects that are fixed by the development team require retesting by the software testers to determine if the new code fixed the problem.
• **Regression Testing.** After the latest delivery of software code, such as a fix or new code, a small test program is run to check that the application is still working correctly and that the changes did not take away or regress functionality.

• **Test Closure.** Testing stops when the application has been determined ready for release and acceptable to the stakeholders. Documented test activities such as results or lessons learned need to be stored in the project archives to serve as a reference.

Quality testing software involves both functional and non-functional types of testing. Functional testing checks that the software works accurately and design requirements are met. Whereas, non-functional testing checks that the software works appropriately when receiving unanticipated inputs.

Functional testing includes:

• **Function.** Tests to assure that the software works as expected.

• **Reliability.** Tests to assure that the software consistently produces the expected outcomes.

Non-functional testing includes:

• **Performance (Stress).** Tests to assure that the software will perform under circumstances when the volume of data and users are high, which simulates a real time system.

• **Stability (Load or Endurance).** Tests to assure that the software continuously function for an acceptable period and beyond.

• **Usability.** Tests to assure that the user can easily use and understand the software.

• **Security.** Tests the software to assure the system cannot be intruded by hackers. Although all data should be tested for security, confidential data must undergo this type of test.

Testing levels generally used include unit, integration, system and acceptance testing. Regression testing is performed at any and all levels following installation of a software modification.

Testing Levels:

• **Unit.** Tests individual sections of code, such as modules or discrete functions, and establishes that the detailed design has been correctly implemented.

• **Integration.** Tests multiple, interrelated modules and interfaces between multiple systems to establish they will work together as a system.

• **System.** Tests operation of the complete, fully integrated software and hardware programs for all systems.

• **Acceptance.** Tests verification and validation for customer business requirements, as well as design specifications.

Assigning the responsibility of quality testing may vary within an organization. Common are teams comprised of software testers and developers working closely together. Project managers oversee monitoring the quality control processes. Recently, “software tester” has developed into a separate profession with certifications, and different roles have been established, including “manager, test lead, test designer, tester, automation developer, and test administrator”\(^3^6\).
Tight schedules and budgets for software projects often leave quality testing facing constraints of time and resources. Automation of software quality testing provides a solution for this constraint. The following vendors provide quality testing software:

The Hewlett-Packard (HP) Quality Center Application Lifecycle Management (ALM) product includes:
- Test activity management:
  - Gathering requirements
  - Planning and scheduling tests
  - Analyzing results
  - Managing defects and issues

The IBM Rational TestManager product includes:
- Test activity management:
  - Initial test case planning
  - Test development
  - Execution of the tests
  - Reporting and analysis of the results, track product defects and issues
  - Supports pure manual test approaches to various automated paradigms including unit testing, functional regression testing, and performance testing

The Pragmatics Software ALM products include:
- Requirements.
- Test Case Management:
  - Detect and issue management
  - Support ticket management
  - Project management

The Seapine Software Application Lifecycle Management (ALM) products include:
- TestTrack Pro – Development workflow and issue management
- TestTrack TCM – Test case planning and tracking
- Surround SCM – Software configuration management
- QA Wizard Pro – Automated functional and regression testing

The TechExcel ALM products include:
- DevSpec. Manages requirements, specifications and knowledge
- DevPlan. Manages timelines, resources and dependencies
- DevTrack. Manages tasks, issues and bugs
- DevTest. Manages test cases

**Continuous Quality Improvement**
Continuous Quality Improvement (CQI) is a methodology that places optimization on a process that is not linear, but rather circular in a lifecycle which requires constant review in order to remain in an ideal state. The goal of CQI is not only to assure that processes remain intact, but to take advantage of new tools or methodologies as they become available. Organizations will
want to ensure that all of the key resources, critical success factors and monitoring metrics applied to create the ideal state for an EMR or EHR do not go away. Identifying new process and new metrics will allow the organization to become proactive in its approach and keep the culture of change and innovation alive.
WORKFLOW IMPROVEMENT THEORIES

There are several workflow improvement theories available for use in healthcare. These theories include Total Quality Management (TQM), Business Process Re-engineering (BPR), Plan-Do-Check-Act (PDCA), Six Sigma, LEAN Systems and LEAN Six Sigma. When used rigorously, these methods help organizations achieve desired outcomes. What is important to note is for these methodologies to be useful, they must be consistently applied. What follows is a definition of each of these theories.

Total Quality Management (TQM)

TQM is the term used to describe an organization's philosophy about quality, as well as a family of programs and initiatives that emphasize incremental improvement in work processes and outputs over an open-ended period of time. Components include:

- **Culture.** Ensures that staff understands the purpose and value of TQM, acts to "get it right the first time" and takes responsibility for fixing problems at the source rather than passing them on to others.
- **Strategy.** Provides a clear direction for quality improvement and sustainability, accompanied by measures and effective policy deployment.
- **Improvement.** Effectively making use of all the capabilities within the organization to review and strive for continuous improvement in quality.
- **Tools.** Resources that support the above activities.

TQM is defined by the following characteristics:

- **Level of Change** → Incremental
- **Starting Point** → Existing Process
- **Frequency of Change** → One-time/Continuous
- **Time Required** → Short
- **Participation** → Bottom-Up
- **Typical Scope** → Narrow, within functions
- **Risk** → Moderate
- **Primary Enabler** → Statistical Control
- **Type of Change** → Cultural

Seven key practices combine to support TQM:

- Top management involvement.
- Adoption of a quality philosophy.
• Emphasis on TQM-oriented training.
• Focus on the customer.
• Continuous improvement of processes.
• Management by fact.
• Use of TQM tools.

According to industry experts, an organization must implement, to the greatest extent possible, all seven TQM practices to achieve its full potential. Experts emphasize the importance of focusing on the depth of implementation, not just the mere presence of a TQM program. Full implementation of TQM is a critical determinant in enhancing organizational performance. A brief description of the basic set of TQM tools can be found in the Appendix.

**Business Process Reengineering (BPR)**

Whereas TQM emphasizes incremental improvement, BPR is a problem-solving approach that emphasizes radical redesign (wiping the slate clean) to achieve dramatic improvements in critical measures of performance, such as cost, quality, service and speed.

BPR is defined by the following characteristics:

- **Level of Change** → Radical
- **Starting Point** → CLEAN Slate
- **Frequency of Change** → One-time
- **Time Required** → Long
- **Participation** → Top-Down
- **Typical Scope** → Broad, cross-functional
- **Risk** → High
- **Primary Enabler** → Information Technology
- **Type of Change** → Cultural/Structural

The five-step consolidated methodology for BPR:

1. **Prepare for Re-engineering.** Begin by identifying the department/process needing improvement and list the BPR objectives. There must be a significant need for the process to be re-engineered. Objectives might include:
   - Increasing service levels.
   - Reducing total process cycle times.
   - Reducing waiting times.
   - Increasing throughput.
• Reducing activity costs.
• Reducing inventory costs.

As typical BPR projects involve cross-functional collaboration and significant changes to the status quo, the planning for organizational changes requires direction from the top. Another important factor to be considered while establishing the goals for the re-engineering effort is to understand the expectations of your customers.

2. Map and Analyze the As-Is Process. The main objective of this phase is to identify where your existing process falls short of meeting your requirements. This is done by making use of the various TQM modeling methods available (flowcharts, cause-effect diagrams, etc.). Then, the amount of time that each activity takes and the cost that each activity requires in terms of resources is calculated through activity-based costing (ABC).

3. Design the To-Be Process. The objective of this phase is to produce one or more alternatives to the current state which satisfy the strategic goals of the organization. Benchmarking is the first step in this phase. Benchmarking compares the performance of the organization’s processes with the way those processes are conducted with relevant peer organizations in order to find areas in need of improvement.

Having identified the potential improvements to the existing process, the development of the To-Be model is done using the various modeling methods described elsewhere in this toolkit. Then, similar to the As-Is model, you will perform ABC to analyze factors such as the time and cost involved. By performing trade-off analysis, the best possible To-Be scenario is identified for implementation.

4. Implement the Re-engineered Process. This step involves developing a transition plan from the As-Is to the To-Be process. The plan must align the organizational structure, culture, information systems and the business policies and procedures accompanying the redesigned processes. Using prototyping and simulation techniques, the transition plan is validated and its pilot version is designed and demonstrated. Training programs for the staff are initiated and the full-scale plan is executed.

5. Improve the Process Continuously. Two things have to be monitored—the progress of action and the results. The progress of action is measured by how informed the staff is, how committed management is, and how well the change teams are accepted in the broader perspective of the organization. As for monitoring the results, this monitoring should include such measures as employee attitudes, customer perceptions, supplier responsiveness, etc. TQM methods are well suited to handle the various problems encountered during the BPR effort and to continuously improve processes.

**Plan-Do-Check-Act (PDCA)**

PDCA, also known as Deming’s Cycle of Continuous Improvement, is a process improvement approach that evolved from W. Edwards Deming, who is considered the father of modern quality. It is based on the concept that business processes should be analyzed and measured to identify product variations that deviate from customer requirements. The method involves the placement of business processes in a continuous feedback loop so that managers can identify
and change the parts of the process that need improvement. (Figure 2). The PDCA cycle is summarized in the following:

**Plan.** Design or revise business process components to improve results.
**Do.** Implement the plan and measure its performance.
**Check.** Assess the measurements and report the results to decision makers.
**Act.** Decide on additional changes and implement in a larger scale.

**Figure 2: Deming’s Wheel**

A fundamental principle of the PDCA model is the iteration in Figure 3. Once a hypothesis is confirmed or negated, executing the cycle again will extend the knowledge further. Repeating the PDCA cycle can bring an organization closer to the goal of a perfect operation and output.

**Figure 3: Iterative Model**

The following summarized steps can be used in applying PDCA to improving processes:

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Plan.
- Identify the process/workflow improvement to be made; the beginning and end of the process; and the stakeholders.
- Identify the current state process and develop a future state process.
- Identify the gaps between current state and future state (gap analysis).
- Check best practice and brainstorm on solutions to address the gap.
- Define key performance measures.
- Develop a plan.

Do.
- Implement the changes or actions defined in the plan. This should be done on a small scale initially.

Check.
- Review evidence, create measures, evaluate measures and evaluate the success of the changes.

Act.
- Standardize and roll out changes.
- Repeat.

**Six Sigma**

Six Sigma is a management philosophy and a methodology for improvement. The primary goal of Six Sigma is to improve effectiveness around meeting and exceeding the needs and requirements of the customer and to improve efficiency in regards to resources consumed in becoming effective. Effectiveness can be measured in terms of time, cost, labor or value. Six Sigma originated at Motorola in the 1980s, but gained recognition in the 1990s due to its adoption and success at General Electric.

There are three Six Sigma methodologies:
- **DMAIC** is an acronym for define, measure, analyze, improve and control, and is used to address the improvement of an established process.
- **DMADV** is an acronym for define, measure, analyze, design and verify, and is used to create products or processes.
- **LEAN**. Quick-hit methodology uses a modified set of tools with the goal to drive out inefficiencies.

Three key elements of Six Sigma:
**Strategy.** Six Sigma is a management philosophy that demands management be active participants, not just supporters. In addition to communicating the strategic business objectives of the organization, management is responsible for identifying the key processes of the organization that will be analyzed in regards to their effectiveness and efficiency. Six Sigma functions as an enabler to obtain strategic business objectives.
Tactics. Five steps of Six Sigma tactics provide the structure for the improvement methodology. Each step contains “tollgates,” which represent specific work a project team must complete. These five steps are commonly referred to as DMAIC.

1. Define. This step includes defining the project team, developing a charter, identifying customers, determining customer needs and requirements, and creating a high level process map.
2. Measure. This step includes developing and implementing a data collection plan.
3. Analysis. This step includes analyzing the data, process and root cause for current performance. This step is considered the most important step to ensuring project success.
4. Improve. This step includes generating and selecting solutions.
5. Control. This step includes choosing and implementing a form of technical control over a new process, as well as creating a response plan.

Culture. In an organization where Six Sigma is practiced, employees at all levels are trained and business leaders function as team leaders on various projects. It is a culture that is focused on team dynamics as well as implementing and managing change, with the customer being the focal point of that change.

Six Sigma is a top-down-driven approach; leadership is both active and visible. Through Six Sigma, leadership is able to manage with facts and data, resulting in a disciplined approach to ensure customer satisfaction. A brief description of the basic set of Six Sigma tools can be found in the Appendix.

LEAN
LEAN is a strategy for improving processes that focuses on identifying and eliminating waste and increasing customer value. Simply stated, “LEAN thinking” is using less to do more, focusing on achieving waste reduction and efficiency while simultaneously increasing product quality and customer value. LEAN is about smooth process flows—practicing activities that add customer value, while eliminating those that do not.

The LEAN method classifies waste as follows:
- Muri (unreasonableness) focuses on the preparation and planning of the process or what work can be avoided proactively by design. Muri is all the unreasonable work that management imposes on workers and machines because of poor organization.
- Mura (unevenness) focuses on how the work design is implemented and the elimination of variations in operation.
- Muda (waste) is unproductive activity and is discovered after the process is in place, and is dealt with reactively.

Guidelines for reducing or eliminating waste include:
- Organizing the workplace.
- Arranging everything to "flow."
- Standardizing work.
- Making small batches.
- Introducing pull systems (take only what the customer orders).
• Never stopping continuous improvement.

The following steps can be used in applying LEAN thinking to improving processes:

1. **Identify the set of activities or key processes that create value.** While this may seem a monumental task due to the vast number of processes in the healthcare setting, one can start by identifying the primary processes that directly serve the external customer (patients and their families) and then drill down into supporting or secondary processes.

2. **Determine the current state activities for identified processes and the sequence.** The deliverable from this step is the creation of a current state Value Stream Map (VSM). (Figure 4).

3. **Eliminate activities from the current state that do not add value and create a future state VSM.** (Figure 5).

4. **Implement changes to achieve the future state.** This may include re-assigning activities to different roles. Additionally, the process must flow horizontally as demonstrated in Figure 5 across organizational boundaries. Traditional organizations may find this to be a significant change as most are organized in a vertical alignment.

5. **Continuously improve the process (start over).** Monitoring and measuring changes are important to sustain efficient processes. It also provides incentives to assist the people in making incremental changes and maintaining consistent processes.

VSMs allow for the visualization of the entire process and the identification of steps that do not add value. While the format of the VSM can vary, it should be explicit about the flow and value of each step in the process.

**Figure 4: Current State VSM (provided by IHI Going LEAN in Health Care)**
**Figure 5: Future State VSM (provided by IHI Going LEAN in Health Care)**

**LEAN Six Sigma**

LEAN Six Sigma is a powerful methodology that combines the quality-improvement methodology of Six Sigma with the waste-elimination methodology of LEAN to improve delivery time, quality and cost simultaneously. LEAN Six Sigma recognizes that you cannot do “just quality” or “just speed.” Instead there needs to be a balanced organizational focus on improving service quality as defined by the customer within a set time limit.

Like Six Sigma, LEAN Six Sigma follows the DMAIC (define, measure, analyze, improve and control) structure for problem-solving. These steps lead a team logically from defining a project through implementing solutions and establishing best practices. The structure of DMAIC encourages creative thinking within boundaries. See the Six Sigma section for details on DMAIC.

There are two options for implementing DMAIC within LEAN Six Sigma:

**Project team approach.** In this typical Six Sigma approach a project team is lead by a “Black Belt” who is dedicated to Six Sigma efforts full-time. A “Black Belt” is an individual who has been formally trained in and is skilled at process improvement and statistical analysis. There is a project team whose members work on the improvement project in addition to their day-to-day responsibilities. Each member is involved in all phases of DMAIC. The duration of the project can be one to four months, depending on the scope of the project.
**Kaizen approach.** This is a rapid, intense program that goes through all the phases of DMAIC except for full implementation. Preparatory work on the “define” and “measure” steps are done by a subgroup. The remainder of the work is done by the full group over several days where the group is only working on the improvement project. Due to the total commitment of the team members, the duration of this effort is normally three to five days. The Kaizen approach should be used when the scope and boundaries of a problem are clearly defined and understood. It also can be used when the implementation risk is minimal or results are needed immediately.

LEAN techniques include:

- **Muda** is the minimization of non-value added activities, such as:
  - Over production. Producing too much at a particular point in time.
  - Inventory. This is considered a non-value-added activity in that it does not add value to the product and will require space, transportation and material to accommodate it.
  - Repair/rejects. The repair or rework of defective parts involves a second attempt at producing a good item, causing additional costs.
  - Motion. The efficient use of the human body is critical to process. Extra, unneeded motions are wasteful.
  - Processing. Consists of additional steps or activities such as an inspection.
  - Waiting. Occurs when one process is idle while waiting on another process. Waits can be characterized by long changeover times, uneven scheduling of work or long and unnecessary meetings.
  - Transport. All forms of transportation are considered waste.
- Cycle time reduction.
- Principles of motion study and material handling.
- Just-in-time Principles. A system for producing and delivering the right items at the right time in the right amounts.
- Poka-yoke Techniques. A mistaking-proofing device or procedure to prevent or detect an error which adversely affects the product, and results in the waste of correction.
- 5S Approach. The process of creating workplace cLEANliness and organization, including visual signals. The five steps include sort, straighten, scrub, standardize, and sustain.

LEAN Six Sigma is flexible in the sense that the methodology is not intended to be static. It has been very successfully used in transactional and service industries. Successful LEAN Six Sigma efforts require committed leadership, education and institutionalization.
WORKFLOW COMPONENTS

A workflow is described using flow diagramming techniques, showing directed flows between processing steps. Single processing steps or components of a workflow can be described by three parameters:

- **Input.** The information, material, and person required to complete the step.
- **Transformation.** The process steps, business rules, and algorithms which may be carried out by humans, machines or a combination of the two to transform the input to an output.
- **Output.** The information and material produced by the step and provided as input to downstream steps.

The inputs and outputs can be internal in nature or flow between multiple organizations, interested parties and multiple applications. Each input/output task is performed by an actor. An actor can be computer, human or a combination of human and computer. Some steps can be performed by computers without human interference. Other steps require human intelligence. For instance, computers can show all the appointments scheduled in the system, however, it may not be able to make decisions on how to allocate time in case of an emergency. Human interference is required to manually adjust the schedule and take care of the emergency.

In general, the output of one previous set of steps is equal to the mandatory input requirements of the following step. The algorithms or rules descriptions need only be included when there are several alternative ways to transform one type of input into one type of output—possibly with different timings, speed and accuracy. See Figure 6 for an example of a workflow.
Figure 6: Workflow Components Example

Workflow Sample

<table>
<thead>
<tr>
<th>Components</th>
<th>Diagram Examples</th>
<th>Actors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>Receive calls for appointment.</td>
<td>Service Clerk</td>
</tr>
<tr>
<td>Output</td>
<td>Appointment is booked.</td>
<td>Service Clerk, Computer</td>
</tr>
<tr>
<td>Transformation rule</td>
<td>All the steps in between are the business rules/algorithms to find a possible slot for the patient.</td>
<td>Service Clerk, Computer, Nurse, Physician</td>
</tr>
</tbody>
</table>
WORKFLOW APPLICATIONS

A workflow application is an automated software tool which assists in identifying the relationship to all steps of a given process. Healthcare workflow processes are unique as compared to other disciplines and businesses. They are complex and often yield variable, sometimes unpredictable outcomes. The most recent generation of workflow applications allows for the design and automation of key business processes across disparate applications, departments and individuals. The challenge is to select an application that will provide a comprehensive review and simulation of all the workflow elements in the complete process.

Most importantly, an organization must clearly define the workflow process that requires evaluation. The basics of understanding and clearly defining the who, what, where, when, why and how are critical components in any healthcare workflow. Reaching a consensus on the START and END of a process is the first step in selecting the workflow application best suited for the evaluation of any given process.

Healthcare Workflow Application Selection

The Internet offers a vast selection of resources for a healthcare workflow application tool. A simple search with “Healthcare Workflow Applications” yields numerous hits. An application selection will be unique to the healthcare process under evaluation. Also, colleague networking among and across industries and disciplines often provides practical insight into a healthcare workflow application software selection.

Most recently, healthcare software vendors have recognized the value and cost efficiency to their own business operations as well as those of their clients by offering a Workflow Team to evaluate workflow processes. Often a workflow redesign is established for newly automated processes. This vendor service addition has reduced system implementation interruptions for the customer as well as the vendor. Increased customer satisfaction and significant financial savings are the impetus to now provide this service as a standard contracted component in health system implementations.

Following are typical healthcare services and processes reviewed for their workflows:

- Emergency preparedness
- Safety initiatives (medication errors, falls, critical value reporting)
- Disease/health protocols
- Patient capacity analysis
- Staff/resource planning
- Equipment logistics plan
- HIPAA/Joint Commission analysis
- Emergency department productivity and throughput
- Department-specific processes (lab, clinics, radiology, billing, operating room)
**Workflow Modeling Applications**
Workflow modeling applications are software tools that assist in identifying the relationship to all steps of a given process, as well as the interconnectedness between the process steps. The graphical representation of business process has proved effective for presenting it to business stakeholders, including business analysts and system developers. The tool also helps to think hard about the process steps and helps to streamline and optimize the processes for greater overall system effectiveness. Reasons for using a software tools for workflow design:

- Productivity, as the software will enable a disciplined approach to process management.
- Sharing future state processes with the Project and Operations Teams.
- Promotion of a process-centric view of the organization rather than a department-centric view. Good practices and the associated knowledge can be deployed across the whole organization, not just where the more skilled individuals are involved
- Allowing for quick understanding of the linkages among the various departments.

Depending on the project and organizational requirements, it is best to choose the most important processes for workflow modeling. For example, an organization could focus on problematic and non-standard processes first, and then at a later date, delve into other processes which are not as problematic.

The visual modeling tools used to represent business processes include Business Process Modeling Notation (BPMN) and Unified Modeling Language (UML). BPMN is a graphical representation for specifying business processes in a workflow. The objective of BPMN is to support business process management for both technical users and business users by providing a notation that is intuitive to business users yet able to represent complex process semantics. The primary goal of BPMN is to provide a standard notation that is readily understandable by all business stakeholders. These business stakeholders include the business analysts who create and refine the processes, the technical developers responsible for implementing the processes, and the business managers who monitor and manage the processes. Consequently, BPMN is intended to serve as common language to bridge the communication gap that frequently occurs between business process design and implementation.

The modeling in BPMN is made by simple diagrams with a small set of graphical elements. Its intent is to make it easy for business users as well as developers to understand the flow and the process. The four basic categories of elements are:

- Flow objects: Events, activities, gateways.
- Connecting objects: Sequence flow, Message flow, association.
- Swim lanes: Pool, lane.
- Artifacts: Data object, group, annotation.

These categories provide stakeholders with an opportunity to make a simple business process diagram. Flow Objects and Artifacts are used to make the diagram more understandable. For example, the BPMN mechanism can use an Inclusive Gateway (a diamond with a circle internal marker) to define the process. See Figure 7 for an example. The outgoing sequence flow from the gateway will have BooLEAN expressions that will be evaluated to determine which sequence
flow should be used to continue the process. When a token arrives at the gateway, all the expressions will be evaluated and for each expression that is determined to be true, the corresponding sequence flow will be chosen and a token will continue down that path. For a single incoming token, there may be a token generated for one to all of the outgoing sequence flow.

**Figure 7: BPMN Process Flow**

UML diagrams are activity diagrams. UML is a loosely defined diagram technique for showing workflows of stepwise activities and actions, with support for choice, iteration, and concurrency. Activity diagrams can be used to describe the business and operational step-by-step workflows of components in a system. It also defines the overall flow of control. Activity diagrams are typically used for business process modeling. These diagrams consist of:
- Initial Node
- Activity Final Node
- Activities

The starting point of the diagram is the initial node and the activity final node is the ending point. An activity diagram can have zero or more activity final nodes. In between activities are represented by elongated circles. The UML activity diagram uses a fork node where the outgoing control flow has guards to create the multiple choice pattern, as displayed in Figure 8. The fork node creates a set of parallel paths. When a token arrives at the node, it will be divided into multiple tokens for only the outgoing control flow whose guards are evaluated to true.
There is no significant difference between the above two notations. The software tool to be used should be based on the skill level of the project team and potential familiarity with the software.

The modeling tools generate process definitions that are stored in a repository with version control and management. The definitions are available to the implementation team members and end-users so that everyone can collaborate on the best possible solution. If a modeling tool is not feasible, at a minimum, it is suggested that organizations use a flowcharting tool such as Microsoft Visio to define business process activities. More flowcharting tools available in the market can be found in the next section.

**Flowcharting**

Flowcharting maps a workflow process from start to end. Flowcharts consist of different symbols connected by lines outlining process steps in the correct sequential order. Flowcharts provide an understanding of the organization’s structure in evaluating both efficiency and effectiveness of redesign activities or system analysis. Based on a research study by Ungan, the author describes the following steps for developing a process documentation flowchart:

- **Selecting processes for documentation may be:**
  - Any
  - Based on importance
  - Problematic
  - Need standardization

- **Objective of mapping includes:**
  - Improving
  - Standardizing
  - Re-engineering
  - Describe a process

- **Determine level of detail based on the purpose of documentation:**
  - Improving:
    - Processes that work well - limited details
    - Problematic processes – detailed map to identify root causes
• Standardization – very detailed with minute details
• Re-engineering – detailed maps
• Describing:
  ■ Detailed map if deep description
  ■ Overview – not detailed

• Form a team or select an interviewer:
  o Improving
    ■ Processes that work well – interviewer
    ■ Problematic processes – use a team
  o Standardization – use a team
  o Re-engineering – use a team
  o Describing
    ■ Detailed map – use a team
    ■ Overview – interviewer

• Flowchart design:
  o Activity represented by a rectangle and means a task.
  o Path by which processes flow through the diagram consists of connecting lines between activities.
  o Input indicated by an arrow, which enters an activity.
  o Output indicated by an arrow, which leaves an activity.
  
  o An arrow connects one activity to another, showing the movement of the diagram.
  o Decision indicated by a diamond is a point at which the process flow can take one of several possible paths based on a defined criterion.
  o Parallel activities are mapped as split outputs. A split is made by defining multiple paths from a single activity to a set of activities. After a parallel task has been performed, outputs of those activities which performed the parallel task could be mapped to enter a single activity; this is called a joint input.

Business Process Management Suites

Business process management suites are software suites that permit design and implementation of automated business processes that send the right information to the right person at the right time, and that monitor and manage the completion of tasks in these business processes.

Business process management suites comprise the following functions:
• Build-time functions: These functions allow process professionals to create graphical process definitions using a process definer similar to Microsoft Visio.
• Run-time process control functions (workflow enactment service): At run-time the process definition is interpreted by software which is responsible for creating and controlling instances of the process, scheduling the various activities steps within the process and invoking the appropriate human and IT application resources, etc. These run-time process control functions act as the linkage between the process as modeled within the process definition and the process as it is seen in the real world, reflected in the runtime
interactions of users and IT application tools. The core component is the workflow “engine” responsible for process creation and deletion; control of the activity scheduling within an operational process; and interaction with application tools or human resources.

- **Round-trip engineering:** Some business process management suites allow dynamic alterations to process definitions from the run-time operational environment. This function allows process professionals to visualize any changes in their graphical process definitions as a result of changes to the process execution models in the run-time operational environment. Thus, process professionals can continue to be involved alongside technical programmers in the refining of automated process solutions.

- **Run-time activity interactions:** These are run-time interactions with human users and IT application tools for processing the various activity steps. Individual activities within a workflow process are typically concerned with human operations, often realized in conjunction with the use of a particular IT tool (for example, form filling), or with information processing operations requiring a particular application program to operate on some defined information (for example, updating an orders database with a new record). Interaction with the process control software is necessary to transfer control between activities, to ascertain the operational status of processes, to invoke application tools and pass the appropriate data, etc. See Figure 9 for a diagram of a business process management suite.
Gartner’s 2009 Magic Quadrant is a publication that can be used to assess the relative strengths of various BPMS’s. The Gartner analysis includes BPMS products from the top 22 vendors that account for most spending in the BPMS market. See Figure 10 for Gartner’s 2009 Magic Quadrant.
Although most clinical systems today have a rules engine to assist with managing workflow, few clinical systems have an embedded workflow engine. Siemens Soarian® Clinicals is an exception. Hospitals can use the workflow engine to create new workflows specific to their needs. These workflows help coordinate patient care. Alerts can also be sent to a text pager or cell phone. Using Soarian® Clinicals, any deviation from a hospital’s established workflow can be seamlessly notified via on-screen notification or by text messaging the authorized personnel’s pager or cell phone. This solution provides a safety net for physicians, staff and patients, helping to promote a higher standard of care for everyone at the hospital.
SUMMARY

This first part of this toolkit has defined workflow improvement concepts, theories and components. It has introduced software that could be used to support a workflow redesign endeavor. In addition, it has provided a basis for how an organization could begin to formulate and execute a plan to change the way work is done. This redesign, in turn, would allow for the use of information technology to enable the process of improved patient care and organizational performance. The remainder of this toolkit will focus on healthcare organizations that have used these tools to transform patient care within their organizations. By conveying their stories, the EHR Adoption Task Force hopes to demonstrate how such a journey can allow for improvement in any organization that chooses to embark on process improvement and workflow redesign using the proven concepts outlined in this toolkit. The organizations we interviewed focused on three important aspects of workflow redesign. These aspects are people, process and technology. Based on their focus area, we have divided the interviews into these three categories.
Case Studies

KEY AREAS OF FOCUS

PEOPLE
Lucile Packard Children’s Hospital at Stanford

Lucile Packard Children’s Hospital at Stanford (LPCH) is located in Palo Alto, CA. Its mission is devoted entirely to the care of infants, children, adolescents and expectant mothers. It is an academic medical center on the campus of Stanford University and is made up of more than 650 physicians and 4,750 staff and volunteers. Many of its physicians serve on the faculty of the Stanford University School of Medicine. LPCH opened its doors in 1991. It was listed as one of the top 10 pediatric hospitals by U.S. News & World Report in 200861. Forty percent of the patients treated at LPCH are critical-care patients. It has 280 active beds and a number of highly active clinics. We spoke with LPCH about how they addressed the people aspects of their clinical transformation and system implementation.

Clinical Transformation and the Organization

In 2006, LPCH executive leadership recognized that the organization needed to enhance their approach to change management, so Dr. Jerald M. Jellison author of Managing the Dynamics of Change34 was brought in to lecture at the hospital and administrative leadership on change and the “J curve of transformation.” Multiple leadership sessions, including lectures and small group sessions, were conducted for approximately 300 people. The focus of these sessions was: change in general, managing change and anticipating change. The sessions were received very well by the leadership staff and were considered universally helpful. The sessions were conducted in late 2006, approximately a year prior to the CPOE activation in November 2007. The principles taught by Dr. Jellison were adopted for the clinical transformation project.

The clinical transformation project consisted of computerized provider order entry (CPOE) and clinical documentation. LPCH wanted the benefits of an online system quickly, so they went with an acuity-based activation strategy with a big bang for 90 percent of hospital beds rather than a phased-in approach. They wanted the order entry to drive the tasks as well as the orders. That was a challenge to the hospital in that nurses and providers went live at the same time. Unlike the phased-in approach, where nurses and providers could be supportive of each other during their individual implementations, going big bang caused an upheaval as well as an impact to workflows all at one time.

Even with all the change, the project was considered highly successful, with CPOE rates at 97 percent average orders the first month. Job descriptions for some positions were modified as a result of the implementation. After 12 to 18 months, based on internal surveys taken, the general feeling was that no one wanted to return to life prior to CPOE.

To ensure a successful project the following strategies were adopted:

- The scope was clarified from a laundry list of things to accomplish to items that could be validated and measured. The overall structure of the project was built around how to achieve the outcomes that had been defined for the project. The outcomes were the focus of the whole project and created the visibility around making sure the project was a success. These desired outcomes set the stage for change management.
- A budget was created to include not only hardware and software, but huge operational resources from all clinical areas so that it reflected the “total” needs of the project.
• Appropriate resources were allocated and involved. In addition to the Medical Director of Clinical Informatics, key individuals involved in the project included the Chief Medical Informatics Officer (CMIO); the Chief of Staff, who was the medical sponsor for the project; the Chief Operating Officer, who was the operations sponsor; and the Chief Information Officer, who was the IS sponsor. The Medical Director of Clinical Informatics helped plan the project, participated in the kickoff meeting and conducted one-on-one sessions. Since leadership buy-in was important, the board and executive leadership were brought into the project during the initiation phase. The board functioned as champions and provided directives. Physician champions, representing key areas such as obstetrics, critical care, general surgery and oncology, were appointed for the entire project. Physician super-users were appointed toward the end of the project. During the actual implementation, the physician super-users provided go-live support for three to four weeks. In addition, financial incentives were given to some of the executive leadership team. Director-level positions were aligned with the various project goals.

• A Project Management Office was created that consisted of key senior leaders from areas such as nursing, pharmacy and laboratory, that were responsible for getting people to the table. These key senior leaders had ownership over the project.

• An “adoption team” was created early on in the transformation consisting of nurses and physicians who were responsible for defining a good adoption and measuring success. This group was responsible for communication and change management.

• An evidence-based outcomes dashboard, with 32 different indicators, was developed for board-level oversight, with a subset of those goals translated into individual incentive plans. It included parameters that were agreed upon and provided a clear message as to where things stood with the project and its ability to be successful. The dashboard was updated monthly and used as a communication vehicle.

• The system was designed and built based on evidence-based lessons learned by other organizations. Members of the leadership staff did actual site visits to other organizations around the country who had implemented CPOE and clinical documentation, to gain insight into their lessons learned. In addition, literature on CPOE implementations was read and conferences were attended. The organizational goal of this effort was to be in a position to build best practices and not to make the mistakes that other organizations had made.

• Provider training was conducted by physicians, and clinician training was conducted by registered nurses and others. In addition, provider training was actually done in a classroom setting. All this activity of colleagues training each other helped build support for adoption.

• LPCH understood that people were more likely to adapt to the change if it improved their job and optimized workflows. They knew that it was important to the success of the project, that the staff understand the benefits and that those benefits be communicated clearly to them. Communication was done using multiple venues, including print and in person through meetings and one-on-ones. The CMIO and Medical Director of Clinical Informatics attended physician meetings for all disciplines at least twice during the project. Communication was vertical in that you had the Chief Executive Officer (CEO) providing updates to the appropriate staff as well as communication being given to the frontline.

• The project was considered to be about quality improvement with emphasis on its safety benefits and efficiencies in clinical care. It was not about technology, hence the title “clinical transformation.” Other drivers for the project included operational efficiencies, regulatory compliance, ability to mine data for research, financial, quality outcomes such as turnaround times, and regulatory compliance with The Joint Commission, government
agencies and others. CPOE and clinical documentation were seen as tools that could assist in meeting the burden to display regulatory compliance.

The clinical transformation project was the largest change management initiative to date for LPCH. See Figure 11 to identify how LPCH organized its staff around this project. This initiative created dramatic change for the organization. Some keys to its success included:

- Mutual respect among leadership.
- Visibility of leadership.
- Clinical staff input.
- Frequent communication at all levels of the organization.
- Understanding that process changes need to occur with technical implementations.
- Heightened awareness of information technology as a tool for clinical care.
- Better appreciation of individual roles within the organization.
- Raising conflict resolution to an integrated, multi-disciplinary effort that always has the patient at the center of focus.
- Learning that automation ties together parallel and independent functions which results in closer connection between workflows.

Figure 11: LPCH’s Clinical Transformation Governance and Management Organization
Lessons Learned
Throughout this clinical transformation process, LPCH has learned:

- Have an outstanding physician leader who is active, respected by peers, has clout and has some accountability for the overall success of the project. Be sure that the CEO and others understand the importance of this role.
- Have a strong nursing leader that supports the vision and can communicate to others the need to change.
- Start educating individuals early that the project is going to be difficult and educate them on the phases of change so that they know what to expect during the project phases.
- Have the project driven by senior leaders through active participation and accountability. The project should be pushed from inside with a high level of commitment.
- When possible, have clear and measurable outcomes to focus the project on. This acts as a driver that can be used to maintain focus and minimize scope creep.
Medical University of South Carolina

The Medical University of South Carolina (MUSC) is located in Charleston, SC. Its mission is to serve all South Carolinians through education, research and patient care. It has 709 licensed beds and 776,000 ambulatory care visits a year. It has an extremely active emergency department. MUSC has 705 affiliated physicians, 545 residents and 11 hospitalists on staff. MUSC has been listed as one of America’s Best Hospitals by U.S. News & World Report61 for various categories over the past 13 years. We spoke with MUSC about how they handled the people aspect of their workflow redesign and system implementation projects.

Workflow Redesign with a Focus on People

When computer system problems or questions arose at MUSC, nurses did not feel they were sufficiently supported, primarily due to a lack of resources. The Help Desk did not have clinically trained resources and after-hours support was handled by operations, leaving staff to rely on clinical IT staff who were on-call and at home, to troubleshoot and problem solve. Nurses were rarely asked to participate in implementations, and staff felt that they were poorly trained in how to use the systems or how to incorporate them into their workflows. To address this problem, approximately three years ago, the Office of the Chief Information Officer (CIO) began a large-scale core clinical information system project, which included executive sponsors and project leaders from the clinical areas, as well as IT project managers to improve collaboration. The teams worked on core areas, such as CPOE and clinical documentation, and assisted with the implementation of tasks specific to the system implementations. The project leads were paired up with department leads on projects and shared overall project responsibilities. In addition, based on input from users and nursing leadership, five specialist/training positions were created and a new department of nursing informatics was instituted within the organization.

As rollouts for the new applications were planned, key support resources were missing and it was noted that the same implementation project team would not be able to provide the type of on-unit support and assistance that the clinical staff would need. In response, the clinical services organization created a group of five nursing informatics specialist positions. These positions were to report to the nursing informatics manager, who was already in place. The specialists participated in application training and provided a liaison for the clinical staff in incorporating workflow discussions, policy and procedure revisions, as well as elbow-to-elbow support during the implementation rollout. In addition, additional staff members were hired onto the team to help support clinicians during off-hours and on weekends.

Overall, there is no formal implementation methodology at the Medical University of South Carolina, but there is a strong IT governance structure, which includes key senior clinical and administrative leaders from each major area. The implementation oversight committees were formed, which reported to the overall project steering committee. These committee members are generally involved in the oversight groups as a result of their job functions and there are no special incentives for their participation. Engaging staff members and residents to participate and provide feedback to project initiatives can sometimes be challenging. The team found that occasional incentives such as pizza lunches, ice cream socials and special badge holders were helpful to show their appreciation for participation and feedback from these individuals. See Figure 12 which identifies the governance structure at MUSC.

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To gain physician involvement in the project, the executive medical director identified four physicians and allocated 25 percent of each of their time to serve in an advisory capacity to the projects. This was helpful, but input from residents was still difficult to obtain. This lack of input caused problems during implementation since the house staff were to be the primary users of the CPOE system. In addition, both house staff and attendings had to learn to use the system a little differently based on their workflow and established policy. For instance, attendings had to learn to use the system in order to sign certain orders and nurse managers were charged with making sure that all providers sign their orders.

Several key lessons learned from this project included:

- The impact of CPOE is totally underestimated. There are many things that nurses have historically taken care of out of habit, but now fall to the provider or others to handle. Do not underestimate how much workflow changes and how much reluctance there is to give up control.
- Do not try to do it all yourself. Ask for external help that can help challenge the vendor and the organization. Talk to other organizations and find out what worked for them and their key lessons learned.
- Review your workflows beforehand. Otherwise, you carry over dysfunctional processes and poor workflows. Look to standardize workflows especially between units.
• Be sure devices are tested and will work everywhere. If there are issues, resolve them before rolling out to additional units. Do not add to the chaos.
• Be sure to have executive sponsorship, adequate funding, appropriate resources as well as a broad level of input.
Case Studies

PROCESS
Fox Chase Cancer Center

The Fox Chase Cancer Center (Fox Chase) is located in Philadelphia, and is the only hospital in the region devoted solely to cancer treatment. It is a 100-bed hospital focusing on patient care, cancer research and cancer prevention. Fox Chase recently celebrated its 100th birthday. It has consistently been ranked as one of the top cancer hospitals within the United States by *U.S. News & World Report*. It also has been honored for its nursing excellence, holding Magnet status from the American Nurses Credentialing Center; and two Fox Chase scientists have won the Nobel Prize for their work in the oncology arena. Its staff is recognized nationally and internationally.

**Addressing Coding Workflow Issues**

Fox Chase has implemented an automated workflow for the coding of patient charts related to hospital inpatient, professional surgery, endoscopy, clinic procedures, radiology, pathology, radiation therapy and hospital outpatient care. This process was automated to resolve issues Fox Chase was having in the assignment of work to individual coders. Many of the Fox Chase coders work from home and the hospital was looking for a solution that would automate case finding. Prior to the implementation of an automated process, Fox Chase had a single list that would update weekly and a staff person would assign charts to the coders based on the list for the processing of their outpatient charts. Working from a single list, and using remote coders to work the list, created overlap causing coders to duplicate efforts. In addition, the staff could never actually get to the bottom of a list and the manual process created frustration and confusion for all concerned. After analyzing the problem, it was determined that Fox Chase would implement the QuadraMed Quantum Workflow application to resolve case assignment issues. Fox Chase began its implementation of the workflow tool in 2006 and completed the implementation in 2007.

**Creating a Solution**

Working with the coders, a workflow analysis of each area was conducted prior to creating the individual coder work lists. The workflow analysis revealed strengths and areas of weakness for each coding area. Since the majority of staff work from home, case finding was the most significant weakness identified. Fox Chase then designed the work lists that would best suit each functional area. The coding staff was involved in the testing of each work list and adjustments were made if problems were identified during the testing phase. Once each work list was installed, management continued to monitor the staff’s satisfaction and productivity.

The coders who coded the physicians’ professional services were the first group to go live on workflow. Fox Chase saw a slight improvement in daily productivity. However, the work was organized on one list per coder, accessible to assigned coders, sorted by payor, date, name, etc., and at any point in time; the employee’s supervisor could easily identify how many cases were in the queue and determine if additional resources were needed. Management no longer had to fax daily work lists to coders since the list was available online within the workflow application.

The most significant improvement was seen when Fox Chase went live with the hospital outpatient work list. In January 2007, the hospital had $15 million in unbilled outpatient accounts before the hospital outpatient work list was installed. This work list was installed in February 2007, and by the end of March of the same year, the unbilled outpatient accounts...
toted $4 million. During the same period, the number of outstanding accounts went from 8,300 in January to 2,800 at the end of March. Fox Chase has continued to maintain these numbers. In addition to a daily work list for the hospital coders, Fox Chase also created an exception queue. When a case cannot be completed, it is moved to the exception queue. This allows the coders easy access to new work. They no longer review the same report from the billing application over and over again. With the sheer volume of hospital outpatient cases, approximately 12,000 per month, workflow has allowed Fox Chase to present the coders with new work daily. This workflow process has eliminated the need to use the billing report for case finding. The exception work list has allowed the hospital to remove cases from the active work list, hold the case until the problem is resolved, and return the case to the active work list when it is ready to be coded.

Fox Chase started to develop standard work list templates for the professional accounts in early 2006. The need for six work lists was identified. This development, coupled with testing the work lists, making changes, and finalizing the work lists was completed in two months when these work lists were then put into production. The inpatient work list was completed in three to four weeks. The hospital outpatient work list was the most difficult to implement. Fox Chase spent six months working on different rules and work lists until it finally settled on the work list rules it uses today for outpatient charts. Once the rules were set, it took another two to three months before the hospital was ready to go live. The live event for hospital outpatient work lists occurred in February 2007. The Health Information Management (HIM) department worked with the QuadraMed implementation team to create flow charts with decision trees. Most of the analysis of the workflow application was done by Fox Chase’s system support specialist. The QuadraMed team developed the diagrams and the maps.

Fox Chase’s system support specialist led the HIM team throughout pre- and post-implementation. The team included the operations manager for hospital and physician services as well as several of the more computer-savvy coders. The team determined the rules to be built into the system with the help of the QuadraMed team. The QuadraMed team took the hospital’s rules and built them into the workflow application. Fox Chase believes that it involved the right staff for this project. The managers determined the rules to be built as well as the set up for the work list displays. The majority of the coding staff became involved once the system was ready to be tested. At that point, the coders focused on the rules and the actual displays they would use to find their cases.

At this point, the reports created by the application are simple, but highly useful and organized based on the templates. Fox Chase would like to create similar reports for its other QuadraMed applications. The hospital is also interested in making enhancements to the coder work lists now that they are operational and creating additional work lists, where needed, using the templates available. The HIM department believes that Fox Chase has an excellent IT team that can address enhancements without engaging QuadraMed. HIM also believes the internal team can handle any interface changes.
Identifying the Benefits

Fox Chase believes that turnaround time is important in coding because it impacts the hospital’s cash flow. The HIM department experienced a definite improvement in turnaround time across all functional areas. The rules built within the workflow application have allowed management to prioritize accounts by date order, payor and high-dollar amounts. Coders no longer have to search for cases. Cases are presented to them, which has saved the coders time and has allowed them to focus on coding rather than case finding and chart selection. Although the hospital never did a specific time study on coder productivity, the significant improvement in the outpatient unbilled accounts demonstrates a productivity improvement using the system. Using workflow tools, hospital outpatient cases are now coded within two days of posting. Prior to the use of this application, there was a 10 to 15 day turnaround time for outpatient records.

Workflow has become a very important part of HIM operations. This application has facilitated the use of remote coders, created a paperless environment, significantly reduced hospital outpatient unbilled accounts, eliminated frustration and confusion and increased productivity. In addition, managers can now readily identify areas of backlog and assign additional resources, as needed. This solution proved a valuable investment for Fox Chase in terms of improved cash flow and coder productivity.
Loma Linda University Medical Center

An outgrowth of the original Sanitarium on the hill in 1905, the present 11-story Loma Linda University Medical Center (LLUMC) opened on July 9, 1967. With the completion of the Loma Linda University Children's Hospital (LLUCH) in 1993, nearly 900 beds are available for patient care, including those at Loma Linda University Medical Center East Campus and Loma Linda University Behavioral Medicine Center (LLUBMC). Loma Linda University Health Care (LLUHC), a management service organization (MSO), supports the many programs and services provided by 400+ faculty physicians. LLUMC operates some of the largest clinical programs in the United States in areas such as neonatal care and outpatient surgery, and is recognized as the international leader in infant heart transplantation and proton treatments for cancer. Each year, the institution admits more than 33,000 inpatients and serves roughly half a million outpatients. LLUMC is the only level one regional trauma center for Inyo, Mono, Riverside and San Bernardino counties in California. We spoke with LLUMC about workflow redesign for two of its clinical implementations.

Information Systems in Use

LLUMC using the enterprise-wide and departmental systems noted below.

Enterprise-wide Systems:


Departmental Systems:

GE Medical – (Fetal, MacLab/GenLab, Viewpoint), McKesson (HPF, PFM, PMM, HSM, PHS), DocuSys, EndoSoft, MUSE, Phillips Echo (Excelera), Computrition, Winstrat/CHARMS, 3M DRG/GRP Grouper, MD Audit, Medstorm, Gajema, Qmatic, Galvanon, UDSPRO, HUGS, AcuDose, Intellishelf, MagView, Talkteck, MDEverwhere, PatientKeeper,, MS0w, OQ Measures, Premise Bed Management, RALS, TOROL, Transunion, CareMedic, Emdeon, Stockamp (TRAC).

Workflow Redesign in Support of System Implementation

The projects focused on implementation of a clinical documentation system, including an electronic medication administration record (e-MAR) within the inpatient environment and implementation of an electronic medical record (EMR) system for ambulatory care. LLUMC was solely responsible for the inpatient implementation. LLUMC worked with LLUHC, the MSO to the faculty practice, for implementation of the ambulatory EMR.
Inpatient Clinical Documentation System and e-MAR Implementation

The roll-out strategy for this project was to implement computerized clinical nursing documentation one inpatient unit at a time. The process for workflow redesign follows:

1. The paper forms that were used for documentation were first inventoried; duplication of information and variations in nomenclature were identified.
2. A multidisciplinary team was established. This team was responsible for designing the electronic forms for documentation. The approach that this team followed was to examine existing forms, identify form elements that were the same concept, but were represented in various ways, e.g., breath sounds. The design approach was to harmonize these various representations so that the electronic forms had one term for each concept.
3. Current and future state process flows were documented and approved by designated patient care teams. Future state processes were included in education and training prior to go-live.
4. Weekly updates and status reports were provided to the executive team. This was beneficial in that the executive team provided significant project support along the way and also gave meaningful recognition to each unit during go-live.
5. During go-live at each nursing unit, the nurses were educated about how documentation would be done electronically, while comparing this process to the former process of paper documentation.
6. Each unit manager championed a unit go-live theme with designated super-users around the clock for a two-week period. Going live with a small population of end-users provided opportunity for cohesive change management.
7. Staff debriefings were held at the end of each shift to maintain open and transparent communication. It also provided an opportunity for quick turn-around for issue resolution and/or to make needed changes to the system.

Lessons Learned
1. Expectations about electronic documentation could have been framed better. Electronic documentation alone does not necessarily improve the process of documentation or make it easier to complete.
2. Implementation unit-by-unit fragmented patient information flow when a patient transferred from a paper documentation unit to an electronic documentation unit and vice-versa.
3. Floating of all categories of clinical staff between paper documentation units and electronic documentation units could have been better planned and implemented.

Ambulatory EMR Implementation
LLUMC has clinics for all major specialties for both the adult and children populations. LLUMC treats more than half a million ambulatory patients a year. The key activities associated with workflow redesign in the ambulatory information system implementation included:

1. A multidisciplinary group of individuals were identified. This group was characterized by personnel familiar with the processes in the ambulatory setting, including front office, back office, nursing, office visits and health information management.
2. End-to-end process flows were documented for current state as well as future state. The future state process flows included any paper that would still be used and IT data capture points.

A representative project timeline for an example clinic is depicted in Figure 13.

**Figure 13: LLUMC Ambulatory Clinic Project Timeline**

As noted by the dates in the timeline, this implementation is ongoing at this time. What follows are the lessons LLUMC and LLUHC have learned thus far regarding this implementation which supports their physicians in ambulatory care.
Lessons Learned

1. Physician involvement is key to success.
2. Physicians must invest in training opportunities. Relying solely on on-the-job training at go live will not result in a positive outcome.
3. Workflow within the clinics cannot be “business as usual”. Workflow processes must be re-engineered, which includes addressing clinic policies and procedures; job descriptions; and scheduling and billing workflows.
4. Clinic management must be actively involved.
5. In a large academic medical center where there are several different operating companies, decisions around who will cover the cost of purchasing and maintaining hardware and software must be reconciled at the inception of the project.
6. Clinic visits will be immediately impacted after go-live. Plan accordingly and invest up front.
7. Advanced users play a critical role in project success.
8. Determine who will be responsible for yearly resident training and support.
9. Allow for onsite technical support for at least two weeks after go-live.
10. Dispel the myth that an EMR will make physicians work faster. This is not true. An organization must look at the total benefits, not just the number of patients seen. Benefits realization must be incorporated into this type of project.
11. Physicians must deal with the cultural change which this type of project imposes upon them. The five stages of cultural change that physicians must deal with are excitement, frustration, anger, bargaining and acceptance.

LLUMC has documented benefits realization for its ambulatory EMR implementation. Figure 14 identifies how this organization measures each clinic implementation after a go-live event.
**Figure 14: LLUMC Benefits Realization Measurement Tool**

Loma Linda University Health Care  
EMR Adoption - Post Implementation Evaluation Worksheet

<table>
<thead>
<tr>
<th>Implementation Date:</th>
<th>Evaluation Date:</th>
<th>Clinic: Possible Score</th>
<th>Comments</th>
</tr>
</thead>
</table>

### Cost Reduction
- **Reduced Transcription Costs** 2.00
- **Reduced Labor Costs** 2.00
- **Reduced Internal/External Copying Costs** 2.00

### Revenue Enhancement
- **Improve Completeness of Documentations** 2.00
- **Accuracy of Coding** 2.00
- **Increase Number of Visits per Day** 2.00
- **Disease Management** 2.00
- **P4P and Other Payor Incentive Programs** 2.00

### Improved Administrative Efficiency
- **Fewer Chart Pulls and Lesser Filing** 2.00
- **Universal Access to the Chart (by more than one person)** 2.00
- **Less Searching for Lost Chart.** 2.00
- **Reduction in Phony Tag.** 2.00
- **Improve Internal Office Communication** 2.00
- **Fewer Call Backs from Pharmacies** 2.00
- **Easier Compliance with Chart Requests and Chart Audits** 2.00

### Improved Clinical Efficiency, Patient Care, and Service
- **Higher Quality Documentation (Legible, Organized, Complete)** 2.00
- **Built-in Protocols and Reminders (Health Maintenance)** 2.00
- **Speeds Responses to Patients** 2.00
- **Provides Diagnosis Support and Patient Education** 2.00
- **Improved Medication Management** 2.00
- **More Efficient Signing of Charts** 2.00

### Reduce Medical Errors
- **Medication Management** 2.00
- **Prescribing Errors** 2.00
- **Recalled Medication** 2.00
- **Discharge Management** 2.00
- **Laboratory Results Management** 2.00
- **Errors of Omission** 2.00
- **Documentation of Patient Communication** 2.00

**TOTAL** 0.00 52.00

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MCGHealth Inc.

Based in Augusta, GA, MCGHealth Inc. (MCGHealth) is a world-class healthcare network, offering the most comprehensive primary, specialty and subspecialty care in the region. MCGHealth provides skilled, compassionate care to its patients, conducts leading-edge clinical research, and fosters the medical education and training of tomorrow’s healthcare practitioners. MCGHealth is a not-for-profit corporation that manages the clinical operations. MCGHealth’s facilities include the 478-bed MCGHealth Medical Center, the Ambulatory Care Center with more than 80 outpatient practice sites in one convenient setting, the Specialized Care Center housing a 13-county regional trauma center and the 154-bed MCGHealth Children’s Medical Center. The health system also includes a variety of centers and units, such as the MCGHealth Sports Medicine Center. The EHR Adoption Task Force spoke with MCGHealth about how it supports the EMR from a process perspective.

Clinical Transformation Process
MCGHealth and the Cerner Corporation entered into an agreement to deploy integrated clinical solutions in December 2002. Phases one through four of the MCGHealth project focused on Cerner Radiology, Clinical Laboratory, Pharmacy and Powerchart Office for the ambulatory clinics, including the medical profile history, prescription writing and prescription printing. These four phases were completed over a three-year period, from 2004 to 2007. In 2007 and 2008, MCGHealth focused on nursing documentation, which covered initial nursing assessment through documentation for discharge of the patient. During this same period, MCGHealth also implemented an eMAR and CPOE in its children and adult medical centers. Today, MCGHealth uses PowerNotes for psychiatry with some voice-recognition of notes in a few of the ambulatory clinics. In addition, they have implemented APACHE in the ICU Specialized Care Center.

MCGHealth recognized that in order for this project to be successful, the project had to focus first on clinical transformation, followed by the implementation of technology to support that transformation.

As such, MCGHealth created a clinical transformation team at the inception of the project to address the workflow redesign that would be needed. This team looked at the current, paper process and then designed the future state with input from other project teams. This future state has been continuously rolled out since 2004.

Early on, a consulting firm was used to assist in outlining a process for clinical transformation and for the development of a communication plan. It was understood that the consulting firm would provide a knowledge transfer so that MCGHealth could continue this process independently.

This knowledge transfer was completed in the early stages of the transformation initiative. The transformation took approximately three years to complete. During this period, senior executives met weekly to review the status of the project. The project manager was included in these meetings. Leadership was involved from the beginning, with the chief executive officer committing the leadership team’s involvement and oversight in the transformation. Senior officers were aware of and committed to meeting project deadlines and budgets. Grounded in realism, the project managers never underestimated the cost of training, support and
consultant fees for go-live events. This allowed the projects to stay within the budget allocated for each phase of the project. The executive team, which included the chief information officer, the chief medical information officer, the chief medical officer, the chief nursing officer and senior vice presidents, functioned as the primary decision-makers on all key decisions. Figure 15 defines the governance structure that was put in place at MCG Health. Figure 16 demonstrates how all major clinical areas participated in the clinical transformation and provided input into how future workflows would function.

**Figure 15: Project Governance**

![Project Governance Diagram](image)

Figure 15: Project Governance

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As depicted in Figure 16, stakeholders were deeply involved in the workflow redesign process and all clinical areas were invited to participate. Nurses and six residents were given incentives to develop clinical content and to assist with workflow. This group eventually became MCGHealth’s super users who designed, tested, and trained end-users. There were also four paid physicians on the Executive Team who covered different services. A phased approach was used for implementation. The super users did a lot of one-on-one training, especially for physicians. Some resistance was encountered from users who did not want to let go of the old workflow. MCGHealth used presentations which compared the timing for paper workflow to the
electronic workflow to eliminate resistance. In addition, a custom application was used for change management. The steps that were used for clinical transformation were as follows:

1. Designed workflow
2. Prepared users
3. Facilitate organizational change
4. Supplied facility-specific data
5. Drove, verified and signed off on decisions
6. Localized documentation, policies and procedures
7. Built solutions
8. Validated systems
9. Created test scripts
10. Customized training material

CPOE was the most challenging workflow redesign and implementation for MCGHealth. The CPOE implementation took longer than expected and had the most impact on operations. One of the barriers faced with physicians was the development of clinical content for order sets. When the organization tried to introduce evidence-based order set content from a third party to ease the redesign of orders, the physicians resisted the use of outside content. In the end, the physicians developed their own content for orders. Figure 17 identifies how MCGHealth organized its CPOE team.
To facilitate order entry by physicians and other providers, MCGHealth used computer on wheels (COW), touch books and tablets for its implementation and this type of hardware is still used at this time. The organization is currently testing the use of net books.

### Lessons Learned

1. Put patient safety first.
2. Communicate, communicate and communicate.
3. Stick to your plan and pre-established dates.
4. Use tools to assist in prioritizing project tasks.
5. Invest in your information technology infrastructure so that you can adequately support operations.
6. Set expectations for downtime, planned and unplanned.
7. Develop a partnership with operations, which will increase understanding on both sides.
8. Develop a plan to manage change and stick with it.
9. Once a phase is completed, move on to the next phase. Success builds upon success.
10. Do not underestimate the costs associated with this type of endeavor.

MCGHealth is extremely proud of the successes it has achieved since 2004. Because of the organization’s hard work and dedication, it has built an infrastructure that supports patient safety and it has improved on the efficiency and effectiveness of its operations. In addition, it
has created a culture that fosters involvement by all levels of the organization to carry its mission of patient care, research and education.
Seattle Children’s Hospital

Seattle Children’s Hospital (Children’s) is passionate about its mission to prevent, treat and eliminate pediatric disease. In 2009, Children’s was ranked as one of the nation’s top children’s hospitals for the 17th consecutive year by *U.S. News and World Report*. As a tertiary hospital with 250 beds, and in collaboration with physicians providing care in nearly 60 pediatric subspecialties, they provide inpatient, outpatient, diagnostic, surgical, rehabilitative, behavioral, emergency and outreach services. Children’s is affiliated with the University of Washington and is the primary teaching, clinical and research site for the Department of Pediatrics at the University of Washington School of Medicine.

*Continuous Performance Improvement*

Children’s adopted a philosophy and management system called Continuous Performance Improvement (CPI) nearly 10 years ago as a means to transform healthcare. The methodology draws from Toyota Production System principles to support a culture that puts patients and families first, engages staff and faculty as partners in improvement and takes a long-term view. Children’s is making improvements in quality, cost, delivery, safety, and engagement for the benefit of patients and families. The core goal is to remove waste from processes as a way to create more value for its patients while also reducing barriers for its people.

Children’s staff applies CPI to improvement efforts across the hospital, to make improvements in everything from patient rounding, staff handoffs in care, documentation, lab test processing and more. The hospital has also applied this approach to address workflow redesign in information systems implementations, such as their recent Epic Revenue Cycle system implementation.

The need to replace their obsolete system was well known, but the challenge was to leverage the new technology to enable process redesign rather than to recreate existing processes that included work-arounds and wasted effort. They accomplished this goal by applying several fundamental CPI principles:

- Involve the people that do the work; engage staff to clearly differentiate actual requirements from perceived and test/validate future state workflows.
- Standardize processes and tools whenever possible; eliminate variation to yield more predictable results and support problem-solving.
- Error-proof processes; eliminate hand-offs and identify/fix errors when they occur to prevent them from flowing downstream.
- Maintain focus on the customer; assess new processes with the impact to the patient in mind.
- Always ask why; understand the root cause of problems to ensure new processes are effective and requirements clearly understood.

In this CPI philosophy, technology is no longer seen as the “answer,” but as an enabler of sound underlying work processes. The focus on gaining a deep understanding of current processes and customer requirements before applying technology is a difficult culture change, but essential for successful system improvements.

*Examples of Tools Used*
- **Assessment and Planning Tools**: used to understand current state, scope of improvement efforts and targets of improvement efforts.
- **Cultural Assessment Tool**: used to assess readiness of a work group for anticipated change and countermeasures that may need to be applied for an improvement effort to be successful.
- **Rapid Improvement Workshops**: Three- to five-day improvement events including participants from all key roles involved in a process.

Each improvement project has a sponsor who drives the vision forward and removes barriers for the improvement team, a process owner who is responsible for the process, and five to 12 team members. Children’s also has a Management Guidance team for each project that includes leaders of the concerned areas involved in the process.

Children’s CPI philosophy and commitment is the engine that drives innovation and change across the organization. The organization is using CPI to optimize processes in support of quality care for patients and creating workflow plans that support its people.

<table>
<thead>
<tr>
<th>Lessons Learned</th>
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<tbody>
<tr>
<td>1. Culture eats strategy for lunch.</td>
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<tr>
<td>2. Technology is an enabler, not the answer.</td>
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<tr>
<td>3. Involve stakeholders from the beginning.</td>
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<td>4. Commitment to engaging staff in improvements that impact their work.</td>
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**University of Kansas Hospital**

The University of Kansas Hospital is a 550-bed and 24-bassinet tertiary and quaternary care hospital located in Kansas City, MO. The hospital provides a full continuum of inpatient and outpatient care which includes, but is not limited to, the following services: medical and surgical; organ transplantation; critical care; neurological care; pulmonary care; cardiac care; women’s and children’s care including a level 3 nursery; psychiatric care; rehabilitation; family medicine and primary care; a 24-hour emergency department; a nationally recognized level 1 trauma center, along with a burn center; and a cancer center.

The hospital is fully accredited by The Joint Commission. In addition, national and/or specialty groups certify several of the hospital’s programs. Rehabilitation services is certified by The Commission on Accreditation of Rehabilitation Facilities (CARF); the level 1 trauma center is certified by the American College of Surgeons; the stroke program receives accreditation from the Joint Commission as a primary stroke center; the cancer program received approval from the Commission on Cancer of the American College of Surgeons; and the clinical laboratories are accredited through the College of American Pathologists. In 2006, the hospital received Magnet status recognition for nursing through the American Nurses Credentialing Center.

**Selecting an Electronic Health Record**

The guiding principles for implementation of the electronic health record (EHR) included:

- Enhancing patient safety and confidentiality.
- Creating a patient-centered workflow.
- Supporting a “one record” experience.
- Allowing patients to be partners in their care.

For the clinicians and physicians it is a system that supports one-time, error-free data entry, limits the need to “toggle” between systems, and is supported by timely and complete training and tools.

The process of implementing an EHR began more than five years ago with executive involvement and support for the project as a top priority. It was important that the hospital’s mission and goals be incorporated into the guiding principles of the project. Both the Chief Operating Officer (COO) and the Chief Executive Officer (CEO) participated in product selection. The hospital selected key people with process knowledge who could assist the IT department with the implementation of the EHR. These people formed a team called Advanced Clinical Information Systems (ACIS). The project was named O2 for Optimal Outcomes and is used as a brand name for the system.

During product selection, the choice was the Epic System from Epic Systems Corporation in Madison, WI. Clinicians wanted a truly clinical solution supported by IT, but not an IT product forced onto clinicians. About 100 clinicians provided input into the system selection process to assure a democratic and clinically-driven vision with heavy nursing involvement.

The change management process was started very early. During the implementation, an executive steering committee resolved issues, planned strategically for product rollout and reviewed performance. The clinical transformation team was responsible for design of the
solutions and optimization of the software. All decisions and considerations regarding design of systems were made with the patient in mind. A physician was subsequently appointed as the Chief Medical Information Officer and he led the creation of an organizational structure and process that had broad clinical input. An external consultant was also engaged to moderate the process.

**The Process for Workflow Design**

Concerned that the project would not move forward at a rapid enough pace, the hospital decided that the goal was not to totally redesign the clinical process to a state of perfection and then model the EHR after that process. Rather, a design process was developed to facilitate creation of standard processes and move away from the diversity of practices throughout the hospital. It was decided that design and build should occur concurrently. Similar recommendations had been made in some the literature searches done on EMR implementation during the planning phase and the University of Kansas Hospital chose to use this approach. It was felt that designing strictly on paper would not convey as much information for participants to evaluate workflow, content and usability, as would actual screens and screen sequences.

Configuration of the commercial off-the-shelf product started with the ACIS project team who traveled to Madison to complete Epic software training and education on the design-build-validate (DBV) process. The ACIS team developed a list of processes that would be facilitated by the implementation. The team determined what elements from the model system would be useful and appropriate for use in the hospital. The team elicited input from end-users and stakeholders and documented the changes required to be made to the model system. Ineffective processes and policies were concurrently reviewed and reworked to eliminate the possibility of automating them. The team used Visio workflow diagrams to document current and future-state processes at the hospital. A number of examples of tools used by the project team to facilitate the project, with an explanation of the tool, follow after this section.

A core physician group comprised physicians from various specialties, such as internal medicine, the ambulatory clinics, surgery and others involved in workflow redesign helped to correct problems with workflows and assist in the optimization of workflows. This group still meets weekly and helps the ACIS team with the prioritization of improvement activities. The group obtains input from the general physician population through opinions and feedback.
This is a multi-swimlane diagram that illustrates the events in and integration between outpatient, peri-operative and inpatient transitions during patient care. The critical activities by role were validated with stakeholders. This example illustrates the order reconciliation process.
Once a determination was made on changes to the model system, the proof of concept was built in a test environment and validated by the users. These builds provided demonstrations of the build and the workflow. The results of these validations were documented using an Excel spreadsheet tool called a Stoplight Evaluation Summary.
Excel was a tool used for build tracking, testing script writing, and testing tracking. This is a sample template used by application team members to test a workflow scenario during each phase of testing including system, integrated, and regression testing.
Microsoft SharePoint was the main ACIS and O2 project repository. This is a screen-print which identifies how hyperlinks are used to get to full project workspaces on SharePoint - a quick portal for project teams to navigate across projects.

Information Systems in Use
The implementation of the EHR at the hospital has been a phased, ongoing process that began with implementation of limited nursing documentation and pharmacy orders. Further implementation is ongoing. This necessitates a melding of several legacy systems with the new O2 system and it means that some departments are not fully operational with O2.

To date, the following O2 systems have been implemented:
- Emergency department clinicians are using triage documentation and this department has replaced its Lynx system with the Tracking Board.
- Pharmacy has replaced Worx and has implemented medication orders for pharmacists.
- ChartMaxx Document Imaging, a conversion process for paper documents, was put into place when clinical documentation went online.
• Nursing’s clinical documentation includes patient profile, flowsheets, intake and output, vital signs, shift assessments and social work documentation. Nursing is using the Phillips monitor. There is ventilator and hemodynamic monitoring through device interfaces.
• A clerk order entry system, Siemens (Net), was replaced with O2.
• Ancillary care clinicians document in O2 for inpatients receiving physical, occupational and speech therapy.
• Respiratory therapists document on the medication administration record (MAR), and document ventilator parameters and treatments on a flowsheet.
• Physicians create clinical documentation using HIM applications, discharge orders and discharge documentation.
• Three ambulatory clinics are fully automated.
• The cancer center’s clinician documentation in exam, procedure and treatments areas is currently in process and will replace Centricity.
• File conversions have been completed for the master patient index file, allergies and all results from the Siemens system for a four-year period previous to the initial go-live.
• O2 was recently upgraded to a new version, Spring ’08.
• Over 40 interfaces have been incorporated into the project. A new interface engine was implemented and old interfaces converted. Inbound interfaces include ADT from Siemens, IDX and Athena; results from laboratory, radiology, gastrointestinal and cardiopulmonary Centricity; ChartMaxx; and others. Outbound interfaces include charges, attending doctor and infections.

Other projects on the horizon for 2010 and beyond include cardiology, computerized provider order management, care planning, patient education, oncology, chemotherapy order management, revenue cycle, operating room, radiology, blood administration, specimen collection and medication administration, taking into account the five rights of patient safety.
Lessons Learned

Positive lessons:
1. Utilizing people who were already a part of the organization and were familiar with processes was very beneficial.
2. Developing and educating clinical personnel to understand the DBV process. The project team was given the time to learn the system and this equipped them with the knowledge to present and discuss options for building the future state.
3. Cross-training of the ACIS application teams has improved resource efficiency and given the University of Kansas Hospital the ability to move resources when project work is prioritized. The DBV sessions brought diverse departments together to design future processes and were an effective way to gain end-user and stakeholder support. End-users were trained by hospital staff members who understood the culture and workflows.

Negative, yet valuable lessons:
1. End-users and stakeholders did not always possess the knowledge needed to make informed decisions. Access to the model system and preparation for the discussion would have led to more informed design discussions. Frustration occurred when key organization members could not make decisions quickly enough for processes that spanned inpatient and outpatient issues.

2. Technology issues. For example, Epic software that was not appropriate for use at the University of Kansas Hospital was not able to be easily deleted from the system. In addition, redundant requests for improvements to the system from clinicians bogged down ACIS team members until the process was changed to allow clinicians to act as filters to determine the appropriateness of such requests and help prioritize them. Lastly, issue tracking databases were updated from Microsoft SharePoint to one supplied by the vendor to facilitate this process within IT. This provided a more optimal solution for IT.
**Blessing Hospital**

**Introduction**
Blessing Hospital (Blessing), located in west central Illinois, serves 23 counties in northeast Missouri, western Illinois and southeast Iowa. It is a 310-bed community hospital with 2,100 employees and 250 physicians. Operating as one hospital from two campuses and an ambulatory surgery center, Blessing is the largest and most sophisticated center in a 100-mile radius, with nearly 14,000 inpatients and 377,000 outpatient encounters annually. In addition to providing a full menu of acute-care services, Blessing operates a Community Outreach Clinic, providing free care to the uninsured; and sponsors a college of nursing, and schools of radiologic technology and medical laboratory technicians.

Blessing Hospital is a member of Blessing Health System. Other system affiliates include Blessing Physician Services, a multi-specialty group practice; Illini Community Hospital, a critical access hospital; Denman Medical Equipment & Supply; Denman Biomedical; Denman Linen; and Adaptive Mobility Systems.

**Information Systems in Use**
Blessing uses the Eclipsys Sunrise Clinical Manager system for its EMR applications, which is built on the Eclipsys XA technology platform. In addition, the health system uses the Eclipsys Sunrise ED Tracking Board, Medication Management, Enterprise Person Identifier, Knowledge-Based Charting for clinical documentation, clinical analytics and CPOE. CPOE has been implemented on the Behavioral Health Unit, Rehabilitation Unit, Obstetrics and Nursery Units, and within the Emergency Department.

Plans are to rollout CPOE to all units. McKesson’s Healthquest system is used for patient management, patient accounting and medical records. The pharmacy is supported by a McKesson robot and McKesson’s AcuDose automated dispensing devices. McKesson’s Pathways Healthcare Scheduling and Compliance Advisor are used for scheduling purposes. McKesson’s Horizon Surgical Manager is used in surgery and the Horizon Healthcare Advanced Clinicals is used to support homecare and hospice. Future plans are to migrate registration, patient accounting and medical records systems from McKesson to Eclipsys. Other ancillary systems in use include:
- ScImage Enterprise Imaging Solution for Picture Archiving and Communication system (PAC’s) within Radiology.
- Sunquest Laboratory Information system and CoPathPlus Anatomic Pathology system to support the Laboratory.
- Phillips EKG and Apollo Cardiology systems for Cardiology care.
- AtStaff Staff Scheduling for employee scheduling.
- Allscripts Ambulatory for documenting ambulatory care.

Blessing uses the Cloverleaf Interface Engine to manage interfaces between systems. The health system also subscribes to the Healthcare Advisory Board’s Compass products in order to benchmark itself against peer organizations.
Technology

Citrix provides remote access of the EMR from home and office. Wireless technology is available throughout the hospital, supporting laptops, tablets and carts. Touch pens and screens are available, although use is low. It is anticipated that utilization will increase when CPOE is fully deployed. Eighteen servers are structured in clusters and have fail-over ability. They are set in an active/passive cluster so that only one server is active at a time. It takes one to two minutes to move from one server to another. The monitoring of servers is handled through alerts from the network and the alerts are received by the technical team. Adequate downtime policies, processes and procedures are in place to deal with scheduled and unscheduled downtimes.

Development is done internally by IT with vendor support and end-user involvement. IT has a staff of approximately 50 people. In addition, there are seven clinical informaticists who reside in Care Delivery Redesign (CDR); three laboratory employees who support the laboratory systems; two radiology employees supporting the radiology systems; and one pharmacy employee supporting the pharmacy systems. The clinical IT staff, CDR and the ancillary support staff make up the Clinical Information Systems (CIS) team.

The Administrative Director of Clinical Information Technology and the IT Supervisor of Clinical Systems provide oversight and direction on the development of the clinical information systems and the EMR. The Director of Health Information Management also is involved, which has allowed Blessing to address the development of the EMR from patient care, legal and compliance perspectives. The clinical informaticist team reports to the Administrative Director, who works very closely with IT. The clinical informaticists focus on process redesign, system design, change management and physician training. This group was trained by an outside firm on process redesign and change management during their first EMR project. After the first project, the clinical informaticists managed internally without further outside help.

Detailed test plans are prepared for unit, integrated, and user acceptance testing. The CIS team is heavily involved in all aspects of system testing to assure data integrity and system reliability. Blessing maintains four environments including testing, training, development, and production. Every time an upgrade is installed, the production system is copied back to the other three environments to keep everything in synch. In addition, a copy of the production and training systems is done every evening. When testing, Blessing also conducts tests on process flows to assure that the envisioned process will meet the needs of care delivery and that the technology to be used will support the process. LEAN Six Sigma is the methodology used to support process redesign at Blessing.

Change management is governed by a Clinical Design Team that meets monthly to approve requested optimizations for the enterprise clinical systems. The change management process was developed using tools from LEAN Six Sigma in order to provide a structured approach to managing changes. The Clinical Design Team has the final say on what changes will be instituted. Approved changes are documented on Excel. Department-specific changes do not require approval by the Clinical Design Team unless the change to a department system will have impact on the enterprise system. Physician requests are handled through a Physician Informatics Committee, which follows the same approval process as the Clinical Design Team. Membership on the Physician Informatics Committee is voluntary. The Clinical Design Team is interdisciplinary and membership is selected or appointed by directors who work with the Chief
Nursing Officer on selection of the team. Ancillary teams are created internally within their respective departments and work in tandem with the IT Department, Clinical Design Team, and Physician Informatics Committee. Some members of the Clinical Design Team have stayed with this team since its inception.

The Project Management Office (PMO) is responsible for management of all organizational projects. The LEAN Six Sigma process is incorporated into projects and black belts are assigned to serve on project teams. IT manages its own projects, but works with the PMO when technology is used to support a process. IT meets with the PMO office every other week. IT tracks the time spent on PMO projects and will work with the PMO to resolve any type of resource issues.

The clinical staff was initially provided eight hours of training, with additional training provided based on role or specialty. When an upgrade is implemented, four to eight hours of additional training is required to assure an understanding of new functionality. Physicians are trained in pairs of two. The physician training is provided over the course of an hour. Just-in-time training as well as computer-based training is used to augment classroom training. A 30-day follow-up session is scheduled with physicians to ensure they are comfortable using the system. New residents are provided three two-hour sessions. Most of the educators are registered nurses. One unit secretary trains other secretaries. The super users also serve as additional trainers, as necessary.

New access requests come through Human Resources (HR) following definition by an employee’s manager on what access is needed. Security is such that caregivers can only access patients on their floor and work station. Physicians can only see patients on which they are providing care.

An over-ride function is available for consultants. When a consult is written, the consulting physician is automatically added to the record as an additional provider. If a physician or other clinician needs access to a record for which they are not providing care, there is a break the glass function in place where a reason for access must be documented before the record becomes available to the requestor. Physicians must request security for their office staff.

Remote users are provided a questionnaire every six months to renew access. If the questionnaire is not answered, access is terminated. The same process is followed for employees and physicians, but on an annual basis. Medical and nursing students may only sign up for access one semester at a time, and they have to re-apply each semester. Their access is limited to assigned patients. There is a higher level of security for psychiatric patients. When an employee terminates, IT relies on HR to provide information on terminations. If an employee is terminated for cause, access is immediately withdrawn. The Compliance Department performs random audits to assure that users are only viewing records on a need-to-know basis. There is an audit tool that tracks compliance based on specific criteria.

The EMR implementation process began in 2003. For each part of the EMR that has been rolled out, it has taken 12 to 18 months to complete. Implementation of CPOE is in process. Blessing believes that it will take 18 months to two years to complete the CPOE implementation process. House-wide CPOE is planned for the spring of 2010. Future IT plans include:
• Replacing their mainframe systems with client-server technology,
• Addressing ARRA’s meaningful use.
• Planning technology for their critical access hospital.
• Implementing closed loop medication administration.
• Implementing medication reconciliation and e-prescribing.
• Developing methods for electronic physician documentation.
• Acquiring document imaging for any remaining paper.
• Implementing the Eclipsys Clinical Analytics.
• Replacing surgery system with a system that will also support operating room documentation.
• Developing and implementing a patient portal.

Additionally, Blessing is in the planning phases for development of a platform to share data with external organizations. Their six-county Medical Trading Area (MTA) just obtained a health information exchange (HIE) grant to establish community-wide data sharing. At this time, Blessing sends electronic data to the Healthcare Advisory Board’s Compass products. This data capture and reporting is also supported by the Eclipsys financial decision support system.

Blessing Hospital has carried out systematic studies to measure the benefits from various implementations. Important outcomes are:

1. Outcomes related to their Emergency Department (ED) project:
   • Assured that 100 percent of the orders placed by physicians in the ED are electronic.
   • Decreased overall ED length of stay by 20 minutes within the first week of go-live.
   • Decreased the triage time by 60 percent using new documentation tools.
   • Increased regulatory compliance by using Medical Logic Modules (MLM) or rules-based functionality to mandate documentation compliance.
   • Customized dashboard reporting, which provides historical trending for management decision support.
   • Implemented a comprehensive, integrated ED solution to improve physician satisfaction, streamlines workflows and improve throughput.

2. Outcomes related to Sunrise Medication Management/Electronic Medication Administration Record (eMAR) implementation include:
   • A 7.1-percent increase in nurses who agreed that they have the information to safely administer medications.
   • A 6-percent increase in knowing what medications patients are to receive.
   • A 6.9-percent increase in knowing when patients are to receive medications.
   Of those surveyed:
   • 80.4 percent agreed that first doses are easier with buffer times.
   • 87 percent believed that order messaging is helpful when communicating with Pharmacy.

Other benefits have included:
• Pharmacy turn-around time decreased by 24 percent.
• CPOE order modification decreased from 5.8 percent to 0.6 percent due to Smart Select.
• CPOE increased from 5.8 percent to 20 percent due to an ability to type in a dose.
• Eliminating eight hours of a registered nurse’s time weekly for medication charge entry in surgery due to implementation of a charge interface.

3. Outcomes related to EMR hardware upgrade have included:
   • Performance related calls decreased by 75 percent.
   • Hourglass occurrences decreased by more than 90 percent.
   • The new storage area network (SAN) reduced 75 percent of disk thrashing.
   • Disk utilization was reduced by 65 percent with SQL-stored procedure optimization.
   • Custom SQL-stored procedures were improved by 60 percent.

4. Outcomes related to nursing documentation have included:
   • The Joint Commission survey eight months post-clinical documentation go-live demonstrated excellent results. We received no deficiencies in documentation for the first time in 20 years.
   • 100 percent compliance with The Joint Commission’s mandatory admission assessment criteria through the use of mandatory fields on the patient profile.

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<thead>
<tr>
<th>Lessons Learned</th>
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<tr>
<td>1. Measurable outcomes further promote technology investments. The organization’s documentation compliance with new Joint Commission requirements was at 100 percent after eight months, when consistently measured. Other areas of growth have included reducing wait time in ED, core measure compliance and cost savings from eliminating the printing of results.</td>
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<td>2. Perform pre- and post-assessment to measure outcomes and IT value.</td>
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<td>3. Review device/equipment procedures and attach laminated cards to carts to remind end-users to charge devices.</td>
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<td>4. Standardize downtime communication. Use templates with a color-coded status designation.</td>
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<td>5. Recognize that printing is a challenge on a wireless foundation with laptop printing based on patient location.</td>
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<td>6. Assure knowledge transfer when using consultants and develop appropriate policies for transition.</td>
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<tr>
<td>7. Use technology such as document imaging to assure that all patient data can be housed in an electronic format. It is difficult for clinicians to live in two worlds – paper and electronic.</td>
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DENVER HEALTH

Denver Health is the primary safety net hospital for Colorado. In the last ten years, Denver Health has provided more than $2.1 billion in care to the uninsured. Twenty-five percent of the residents of Denver receive their care at Denver Health. Denver Health comprises:

- 500-bed hospital;
- 911 medical response system for the City and County of Denver;
- Denver Public Health Department;
- Eight community-based Family Health Centers;
- Twelve school-based health centers in Denver public schools;
- Rocky Mountain Poison and Drug Center;
- NurseLine which provides 24/7 coverage to the community;
- Program for substance abuse with community detoxification services;
- Correctional care;
- Denver Health Medical Plan Inc.

Denver Health is home to the Denver Health Paramedic School; the Rocky Mountain Center for Medical Response to Terrorism, Mass Casualties, and Epidemics; The Rita Bass Trauma and EMS Education Institute; the Colorado Biological, Nuclear, Incendiary, Chemical, and Explosive (BNICE) Training Center, a statewide initiative to educate Colorado’s healthcare and public safety work force on the principles of preparing for, and responding to, a weapons of mass destruction event. As an academic medical center, Denver Health provides clinical training programs for medical residents and allied health professionals in various specialties.

Denver Health’s motto is “to provide level one care for all.” This organization is extremely proud of the care it provides to both insured patients as well as those who are uninsured, disenfranchised and in need of health services. Denver Health and its Chief Executive Officer (CEO) Patricia A. Gabow, MD, have received numerous awards. Most recently, it received a University Health System Consortium (UHC) Rising Star in safety and quality award for significant improvements in the UHC’s 2009 rankings for quality and patient safety.

Information Systems in Use

The major information systems in use at Denver Health include Siemens INVISION Patient, Management, Patient Accounting and CPOE. Siemens Pharmacy and Med Administration Check are used to support pharmacy operations and for closed loop medication administration. The Siemens Soarian suite of applications, including Enterprise Document Management, Scheduling, Clinical Access, Clinical Team and Critical Care, are used for scheduling, maintenance of a clinical repository and electronic documentation for nursing and the ancillary departments. The Siemens Radiology Information system is used to support radiology operations. For professional billing, the Siemens Signature system is used. Other systems used to support clinical care include:

- Philips Apollo Cardiology Suite.
- Sunquest Laboratory system.
- McKesson ORSOS which supports perioperative care.
- Amicas (formerly Emageon) Picture Archiving and Communication System (PACS) for radiology images.

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• 3M for managing health information management operations.
• Med Assets suite for managing organizational assets.
• Lawson Procurement, Human Resources, Material Management and Financial Suite for operational support.

Technology
Denver Health has a very robust infrastructure to support its business operations. Cisco is used for the basic infrastructure network. The network primarily runs on a one gigabyte backbone. It is fully distributed throughout the hospital. The on-campus clinics have a SONET ring, which runs 10 megabytes to the ambulatory healthcare centers. Denver Health supports various connections through the Internet, direct connections and through its core network, which also goes to the school-based clinics.

There are two data centers at Denver Health. Both are fully-provisioned with redundant power and redundant cooling. The data centers are well-maintained. The servers are standardized on Dell as the base hardware, with a highly virtualized operation. Out of 504 servers, 250 are virtualized. Denver Health runs a geographically tolerant storage database, fully-replicated across the data centers. Thus, if Denver Health were to lose servers or power at one of the data centers, services would still be available from an alternative site. This ensures close to 99.9 percent overall availability.

At Denver Health, a zero-client PC environment system is maintained with Citrix as the back-end. This allows for persistent mobile sessions to the healthcare provider. With this configuration, anyone in the organization can be linked through the clients and log into a session within a second or so. Touch screen monitors or tablets are not currently used. Denver Health uses smart cards to access the thin client so there is always two-factor authentication. It has been found that it is better to deploy thin clients in the patient rooms so that the nurses and doctors have access to patient information at bedside. They also have thin clients outside the patient rooms for placing orders, reviewing charts and for rounding. The zero client is a Sun Ray and any personal computers are typically Dell. With standardization, the hardware has been easier and more cost-effective to maintain.

For monitoring the server systems, Denver Health uses the Microsoft Service Center Operating Manager (SCOM). For monitoring the network, SolarWinds is the primary monitoring tool, supplemented with NetScout and AirMagnet. For Citrix, EdgeSight is used for monitoring. These monitoring systems work in concert to ensure high availability of infrastructure components in this critical care environment. The monitoring systems send alerts to support staff if any infrastructure components begin having problems.

For Denver Health’s most recent application development work on the Siemens Soarian system, the hospital has primarily used internal resources augmented by a few consultants. The nursing staff has played an integral part in all stages of application development and testing, including a pilot go-live event.

The testing approach for the Soarian system is based on the Toyota Production System’s LEAN concept. The Denver Health IT Department utilizes the LEAN approach to project management, including vertical value stream assessments (VVSA) and rapid improvement events to identify
current, ideal and future state. These quality improvement processes lend themselves to rapid development of applications through the iterative cycles of design-develop-test in rapid, sprint-like bursts. The end-users and IT staff work together to eliminate the rework that is traditionally associated with application development and implementation. This has vastly reduced Denver Health’s development time by up to 50 percent and implementation costs by 30 percent.

System training is started early in the process and includes hands-on, Web-based and at-the-elbow training for end-users. Practitioners are involved in training development and are available to train co-workers on products where they participated in development.

Over a period of time, the change management process has matured at Denver Health. The organization is continuously making enhancements to its existing systems and processes. Enhancements are managed by IT analysts for their respective products and are thoroughly reviewed and prioritized. Routine meetings are held to go through the proposed enhancements. The IT staff work closely with vendor partners to provide enhanced products and services on aggressive timelines.

Siemens is contracted to provide Help Desk and support services at Denver Health. For any questions or issues, users are routed directly to the outsourced Siemens Help Desk.

### Lessons Learned
Denver Health began a strategic focus on IT to support financial and clinical applications back in 1997. At that time, the hospital had only about a dozen integrated systems. Now Denver Health supports well over 200 interfaces and 400 applications. Denver Health has learned a great deal over the past 12 years. The bulleted points below summarize Denver Health’s maturation in IT and process improvement to support hospital operations.

1. Ensure executive sponsorship. Without this, major IT projects are doomed to fail. At Denver Health, IT has the full support of the hospital’s board as well as the CEO, who served as the catalyst for the adoption of the enterprise-wide LEAN methodology at Denver Health.

2. Streamlined project governance is critical to project speed and cost reduction. IT cannot govern projects alone. Projects governance must include key stakeholders and vendor partners and both must be involved from the beginning. Without this governance structure, the organization cannot get the buy-in from end-users that it needs to be successful.

3. Projects need to be managed by a dedicated project manager and proven project management methodologies need to be adopted and practiced. In a large organization, such as Denver Health, a Project Management Office is a necessity.
4. Consider merging health information management (HIM) operations with IT. This merger has successfully taken place at Denver Health with HIM management taking over key operational aspects of software development, implementation and maintenance of clinical systems while retaining traditional HIM functions. This has allowed IT to focus on IT technology, infrastructure, disaster recovery, security and other key IT functions, while transitioning HIM from a paper-based department to an electronic records management department, fully-integrated with IT.

5. Focus first on workflow and then technology. When focusing on workflow, use methodologies that have proved successful in other organizations and other industries. Denver Health uses LEAN. With LEAN, Denver Health has used various tools to document current, ideal and future state. A sample workflow is provided in Figure 22. In addition to workflow benefits, this methodology has allowed Denver Health to significantly reduce its implementation timeframe. It took Denver Health seven years to fully implement CPOE. With LEAN, it is implementing four Soarian applications that address clinical documentation within an 18-month timeframe. The vendor’s estimated implementation timeline was 36 months for these applications. Although this implementation is equally complex, the LEAN methodology, prior experience with implementing clinical systems and use of integrated tools has improved the speed to go-live and improved the quality of the process as well as quality of care at Denver Health.

6. Involve clinicians in the implementation of clinical systems. With the Soarian project, the hospital has 50 nurses engaged in rapid improvement events and in design, testing and quality assurance review of the software. All major decisions, with the exception of those relating to scope, cost and resources, are made by a delta team of three people to promote rapid development and deployment. When Denver Health implemented CPOE, it relied heavily on the Chief Medical Information Officer and it paid residents to develop clinical content for the orders used within the system. In addition, the various medical directors were involved during implementation of CPOE within their respective departments. End-user involvement is a prerequisite to success.

7. Develop objective measures to demonstrate value for the investments being made in IT. Denver Health did not initially do this, but learned that this is critical since it can take years to fully-realize return on investment or improvement in clinical processes, especially with clinical projects that have a long implementation timeline. Once metrics were established and measured, the outcomes both positive and negative were surprising. An example of what Denver Health was able to demonstrate includes:
   a. With CPOE, an 83-percent reduction in turn-around time for medication orders from 80 minutes to 7.3 minutes from time of order to time of medication availability.
   b. Medication risk avoidance of approximately 300 doses per month using Med Administration Check.
   c. A 100-percent improvement in order legibility.
   d. An annual reduction of 400,000 pharmacy call-backs to clarify physician orders.
   e. Refinements to the clinical decision support system to better meet the needs of physicians and ensure a safe environment for patients, resulting in data mining that improves quality of care and helps to manage chronic diseases in patients such as diabetes, asthma and hypertension.
   f. A 37.5-percent reduction in consulting costs for outside consultants using on IT projects.
As Soarian is being developed, Denver Health is building measures within Soarian so that the system will be able to automatically collect measures of performance as clinicians document care. Denver Health believes this will completely eliminate the need to manually abstract records to compile results.

Where possible, deploy software that leverages a workflow engine. Denver Health has been able to do this within their HIM area and, with Soarian, they will be able to provide near real-time complex reviews of patient status or process flow adherence. Workflow engines will also support operational and administrative workflows. In HIM, the workflow engine supports such functions as distributing medical transcription and other documents to physicians for signature and work listing for distribution of records to coders, some who work remotely from the hospital. With Soarian, Denver Health plans to build and introduce five new workflows monthly. Examples include ventilator withdrawal, pacemaker placement, IV antibiotic administration for surgical patients, physician documentation and professional billing. These workflows will have escalation points so that if a process reaches predefined boundaries, caregivers are alerted and can bring the process back into control before an adverse event occurs. The goal is to reduce patient risk and enhance oversight, while providing, the safest, highest quality care possible with no disparity based on race, gender or ethnicity.

**Future Plans**
Based on the HIMSS Analytics EMR Adoption Model, Denver Health is functioning as a Stage 5 hospital. However, because their inpatient physician documentation is not automated at this time, it is preventing Denver Health from moving to the highest level seven status. Denver Health’s goal is to migrate to this level. Future plans include:

- Continue rollout of electronic charting within nursing.
- Develop and implement automated physician documentation for the inpatient population using Soarian.
- Replace the existing ambulatory system, which is not certified, with a certified ambulatory system for ambulatory charting to ensure economic stimulus funding for the hospital.
- Leverage the Siemens Workflow Engine to support advanced care processes, engaging physicians at the right time in the care process, thereby further improving patient safety and care quality.
- Remove the physician’s need to mine data to practice medicine using advanced push technology to route data when and where needed.
- Develop patient communication systems to manage chronic diseases outside the normal care environment.
- Further integrate LEAN tools and methodologies into the department to continue to drive down implementation and support costs.
- Plan for implementation of ICD-10.
- Position the organization to be successful when undergoing RAC audits.
Figure 22: Sample Denver Health Future State
**MCGHealth Inc.**

*Introduction*
Based in Augusta, GA, MCGHealth Inc. (MCGHealth) is a world-class healthcare network, offering the most comprehensive primary, specialty and subspecialty care in the region. MCGHealth provides skilled, compassionate care to its patients, conducts leading-edge clinical research, and fosters the medical education and training of tomorrow’s healthcare practitioners. MCGHealth is a not-for-profit corporation that manages the clinical operations. MCGHealth’s facilities include the 478-bed MCGHealth Medical Center; the Ambulatory Care Center with more than 80 outpatient practice sites in one convenient setting; the Specialized Care Center housing a 13-county regional trauma center; and the 154-bed MCGHealth Children’s Medical Center. The health system also includes a variety of centers and units, such as the MCGHealth Sports Medicine Center. The EHR Adoption Task Force spoke with MCGHealth about how it supports the EMR from a technology perspective.

*Information Systems in Use*
MCGHealth uses the GE Healthcare Centricity system for scheduling and patient registration; McKesson products such as HealthQuest for patient accounting and pathways for financials; and the Cerner Millennium system for its clinical applications. MCGHealth has fully implemented Cerner laboratory, radiology, pharmacy and nursing documentation, the electronic medication administration record, computerized provider order entry and physician progress notes in both the adult and children’s hospitals. Imaging solutions consist of numerous departmental modalities such as Siemens for picture archiving and communication system (PACS) and a Kodak (Carestream) Web browser to view images within the clinical information system. The Cerner Provision system is a document imaging solution fully-integrated into Cerner Millennium, which contains images of hard-copy patient records dating back to the mid-90s. The Cerner Profile application is used in the health information management (HIM) department to support HIM operations, including chart completion and deficiencies. Cerner’s PowerChart Office product is used in ambulatory care with the ability to print out prescriptions in all of its clinics. The Cerner clinical suite of products has allowed MCGHealth to be fully automated, with very little to no paper chart in use at this time.

*Technology*
Being an academic medical center involved in patient care, education and research, MCGHealth differs from community hospitals. Because it is an academic environment with residents, interns and medical students who are willing to accept innovative IT solutions that improve workflow, MCGHealth has experienced unprecedented success with its EMR implementation. In addition to physicians, MCGHealth has a hospital staff that has been open to change and willing to transform the way care is provided in their organization.

The infrastructure at MCGHealth is quite robust with clustered servers and high availability fail-over capabilities. Most of the servers are either IBM 570 AIX servers for mid-range applications, such as the Clinical Information System, Windows-based IBM Blade servers for Windows and Citrix based applications and a mainframe to run the enterprise patient accounting and patient management systems. The databases are predominantly Oracle. The data center is located about quarter of a mile from the hospital and the technical staff is in the process of building a disaster recovery system of the Cerner Clinical Information system for clinical continuity and potential sharing of information with our rural healthcare affiliates. Public and private wireless networks are available throughout the enterprise. In both the hospital and the clinics, the clinicians use handhelds and blackberry devices. Some physicians
have asked to use their personal laptops. This is allowed once the laptop has been inspected and approved for use by the IT department. MCGHealth has bedside workstations in the majority of patient rooms. Nursing also uses computers on wheels (COW) to facilitate bedside charting. The organization has added LoJack to identify laptops and minimize theft of its mobile devices. Bar-coding is used in the laboratory. The organization has been highly successful with single sign-on. Smart cards and biometrics have been tested, but not implemented yet.

To support the infrastructure operations on a 24/7 basis, monitoring of the infrastructure is continuously done. To resolve any issues, the organization has an on-call system with well-defined procedures for issue reporting and escalation. Help Desk services are located in the hospital, with technicians’ onsite to support the end-users as well as in the data center. Issues are recorded and reported on 24/7.

IT partners with operational departments to bring systems live. To manage the project, a project manager is assisted by an IT project lead and an operational project lead. For example, if a pharmacy implementation or upgrade is being undertaken, the Clinical Executive Team assigns a member of pharmacy management as a project lead. In this way, the design is done according to the needs of the end-user department.

Most application development is done internally with MCGHealth’s IT resources. Very few consultants are used with the exception of their use for go-live events where a small staff of consultants is retained for training and additional coverage. The clinical application team is small, consisting of 11 full-time equivalents, lean and productive—with projects completed on time and under budget. When possible this team uses technology to replace the need for manual labor with build and testing. For example, IT uses tools such as LoadRunner software for keystroking simulation during the quality assurance and testing steps.

From a system testing perspective, all of MCGHealth’s testing resources are drawn from a group called the clinical transformation team. This team is multi-disciplinary in nature, drawing from areas such as nursing, social work, physicians, clinical laboratories and other clinical disciplines. From basic unit testing to integrated testing and pre-go-live dress rehearsals, members of this team conduct all the testing. The team has created standard test plans including integrated test plans. MCGHealth also has a strong group of physicians that work with testing. These physicians are known as super docs. There are 15 super docs who test physician functionality for MCGHealth’s two hospitals. For CPOE testing, they actively assist in order entry from a physician standpoint. They also train physicians on the use of CPOE.

The implementation of the various clinical systems has gone relatively smooth with the exception of CPOE, which presented challenges. MCGHealth found that CPOE took the longest to implement and it was also the most demanding of all their clinical implementations. The development of clinical content for orders presented the challenge. First, MCGHealth engaged a third-party to provide clinical content, but the medical staff would not buy-in to its use. Secondly, the organization obtained clinical content from other organizations that had implemented CPOE, but still could not obtain the necessary buy-in.

The final strategy, which worked, was to convey that this was a go-forward strategy for the organization, not negotiable and that the medical staff was responsible for providing the clinical content for their orders. With this directive, the physicians provided the necessary content, and in return, IT continues to work diligently to provide its physicians with service-specific “quick views” to facilitate system navigation and to streamline work. To aid the capture of progress notes and other physician
documentation, MCGHealth uses DragonSpeak voice-recognition software with a small group of internal medicine practitioners.

For ongoing end-user support, there is a clinical response team (RN), available 24/7, for any physician that needs help with entering orders or documenting care. The response team goes online with the end-user or assists them physically at the physician location. This group does the new resident training each year. Residents are trained during their first week of residency and before they begin working on their assigned clinical service. The training is provided over two eight-hour days. Nursing has its own group of trainers for system education. Ancillary personnel are trained by super users within each department.

To address software enhancements, MCGHealth uses submitted enhancement requests and compares them to what is in the next software release from Cerner or their other vendor partners in order to identify what enhancements can be resolved through ongoing software development by the vendor. If a requested enhancement is not addressed through vendor software development, then physician executive teams, representing each service, as well as impacted hospital departments, identify, prioritize and recommend enhancements for their respective areas. Once this prioritization is done, a senior executive group makes the final decision on all enhancements to the various systems used at MCGHealth.

For scheduled as well as unscheduled downtime, proper policies, procedures and communication protocols are in place. A downtime group meets monthly and plans for scheduled/planned downtime. This group comprises representatives from hospital operations and IT. Each department is required to have a downtime procedure. In addition, there are enterprise procedures that apply organizationally. For planned downtime a number of communication methods are used to convey that systems will be going down. These include:
- The downtime group that meets one week prior to scheduled downtime to discuss the process and ensure all are on board with the objectives of the downtime.
- The use of paging groups.
- Displaying a banner on the Web site.
- Calling 24/7 departments before the system goes down.
- Calling 24/7 departments when bringing the system back up.

In the event of unscheduled downtime, a 30-minute window is used. If the downtime goes beyond 30 minutes, departments are contacted and downtime procedures are instituted.

Along with documented processes for downtime, MCGHealth has created several Web applications that assist users when the clinical or registration systems are down. MCGHealth uses a Web-based order communication system which allows individuals, during downtime, to communicate a written order, consultation or registration electronically to the necessary hospital departments, and the system documents the status of orders back to nursing.

MCGHealth has a Web-based downtime reporting system for both the electronic medication administration record and CPOE orders. On regularly scheduled intervals, the Web application grabs an extract of patient orders and medication administration information from the clinical information system and pushes a “downtime feed” to downtime designated workstations. With this application, patient orders and medication administration information are always available at the nursing unit to be printed and used as a downtime tool enabling the nurses to manually chart their medications and other critical patient information. Orders from the downtime workstation are printed so that nurses know the
latest orders entered prior to the downtime and are available even if network connectivity is lost. Finally, MCGHealth has developed a Web-based application that extracts the patient problem list, allergy list and medication records for those who have future, scheduled appointments in the clinics. This application is used to provide a custom report for the patient to assist in medication reconciliation and it is also available in the event the clinical system goes down. Currently, MCGHealth is finishing up its disaster-recovery project, which when completed, will provide a fully redundant clinical information system that mirrors the primary production system near real time.

MCGHealth has affiliated with hospitals in the surrounding area and it also has an agreement with the East Georgia Healthcare Cooperative. This cooperative is working toward providing an exchange of information with member hospitals and health centers. Funding has been made possible through ARRA. By partnering with their neighboring county for an alternative data site for information exchange, the ultimate vision is to become a regional center for patient information sharing. Plans are to exchange information both to and from MCGHealth.

Being an academic medical center, MCGHealth exchanges information with many agencies. The following information is conveyed in an electronic manner at this time:

- Regional immunization data.
- University Health System Consortium data.
- Georgia Hospital Association data.
- Healthcare Advisory Board’s Quality Compass data.
- Infection control data.
- Medication usage data.
- The Joint Commission core measures data.
- Tumor registry data.
- Trauma registry data.
- Bio-repository data for research purposes.

### Lessons Learned

1. Development of an EMR is a journey and each implementation paves the way for the next destination on the journey.
2. Successful implementation requires strong leadership.
3. Each participating group needs to be held accountable for their contribution to the overall success of the endeavor.
4. Success requires negotiation, consensus-building and a willingness to accept trade-offs.
5. Use of an EMR requires a partnership between IT and the operational departments.
6. When implementing systems, stick to the design to assure intended outcomes.
7. Put patients first. When necessary, develop a work-around in order to preserve the organization’s responsibility for quality and safe patient care.
8. Monitor performance to assure desired results and to demonstrate the value derived from an investment in IT systems.

Due to the many benefits derived from its IT efforts, technology has helped MCGHealth to be acknowledged as one of the top 100 Hospitals in the U.S. by Thomson Reuters in 2007®. To achieve this recognition, hospitals are objectively assessed on their leadership effectiveness, organizational improvement strategies and impact of executive decisions. Through a wise investment in IT, MCGHealth
has demonstrated leadership in the top 100. MCGHealth is also extremely proud of the inroads it has made toward its use of an electronic record.
Case Studies

ACHIEVING EXCELLENCE
Eastern Maine Medical Center

Introduction
According to Eastern Maine Medical Center (EMMC), an electronic health record (EHR) implementation is not about installing information technology; it is about clinical transformation. This attitude is one reason why EMMC has made their healthcare IT implementations so successful, and in 2008 the organization was recognized for their EHR with the Nicholas E. Davies Award for Organizational Excellence. EMMC is a 411-bed tertiary care medical center located in Bangor, ME. It has served the central, eastern and northern communities of Maine for more than 115 years. EMMC has a reputation of being a high-quality, progressive organization having received the Exemplary Service Overall Best Performer Award from Avatar International Inc. for six years running. This award recognizes healthcare service quality. The organization also won a 2007 Project Management Project of the Year award from the Project Management Institute (PMI). EMMC has been recognized as a Top 100 Most Wired winner in 2008 and 2009.

EMMC’s 400 providers and 3,000 clinical and support staff provide both inpatient and outpatient services to a large geographic area. Its parent organization is Eastern Maine Healthcare Systems (EMHS), which provides for the information technology needs of EMMC. In addition, EMMC participates in, and is a founding member of, the Maine HealthInfoNet Project, which functions as a health information exchange for hospitals, providers, pharmacies, and other healthcare-related organizations within the state of Maine. EMMC serves as the hub referral hospital for 21 hospitals in rural Maine. Twelve of these 21 hospitals function as critical access hospitals and rely heavily on EMMC for continuing care of their patients.

The achievement of an EHR at EMMC was guided by an EMHS vision that all EMHS providers would be able to treat a patient using one shared electronic record system regardless of where in EMHS the patient sought care. This vision coupled with EMMC goals to improve patient safety and quality of care; improve provider and staff satisfaction; increase volume and market share; and improve financial results allowed the idea of the EHR to germinate and take root. It was recognized from the beginning that this undertaking could not be viewed as a technology project, but rather as a transformation of care project that would be supported by the use of technology. During their recent CPOE implementation, more than 100 workflows were analyzed and optimized by committees of subject matter experts.

The entire system was designed using physician and nurse input led by a Clinical Coordinating Committee of the medical staff. The organization developed methods to share best practices, and metrics were established to measure progress towards the overarching goals of an improvement in patient safety, quality, satisfaction and financial performance. A baseline was taken before the project began so that EMMC could measure improvement over time. Once the baseline was established, the metrics were measured throughout the life of the project and reported on until the project was complete.
To further support the project, EMMC performed an internal readiness assessment to gauge whether or not the existing technology within the organization could support their desired future state. This assessment identified that technology needed to be upgraded and a 10-year EHR Roadmap was created to guide the process. An initial step was to upgrade EMMC’s inpatient information technology system to the latest version of Cerner Millennium, which was achieved early on in the implementation of their roadmap. This allowed EMMC to focus on higher level goals such as workflow redesign, quality improvement and user acceptance. EMMC measured its progress towards achieving a fully-functional EHR using the levels outlined in the HIMSS Analytics EMR Adoption ModelSM.

The CPOE implementation was so successful that EMMC was able to achieve Stage 4 status, and now EMHS is ready to deploy the technology across the entire delivery network. With a plan to achieve Stage 7 by 2011, the EMHS is well on its way to leveraging the full power of a health information technology system and realizing workflow efficiencies that can be gained from a carefully planned implementation.

EMMC successfully navigated the road to improved patient safety, quality and satisfaction using an electronic health record and workflow redesign, and it achieved an honor few organizations achieve. The following sections include an overview of how EMMC successfully addressed the challenges it faced around people, process and technology.

**Information Systems in Use**

The EHR used at EMMC resides on the Cerner Millennium system used in conjunction with the GE Healthcare Centricity EMR. In addition, Cerner systems are used to support critical care, emergency, laboratory, patient registration, pharmacy, radiology, scheduling, and clinical decision support. Siemens INVISION is used for patient accounting. Associated systems which support patient care include:

- Logicare—Patient discharge instructions;
- Cardinal Health—Pyxis medication dispensing devices;
- AGFA—PACS system for radiology images; and
- Zynx Health Information—Evidence-based clinical content for physician orders.

**People**

Since the EMMC EHR implementation was an organization-wide strategy, the redesign project was governed by a defined structure, accountable to the hospital board. An EMMC Board Team oversaw the project with the Medical Executive Committee, Project Steering Committee, and Executive Team reporting to the board on the project. The Project Management Office supported these three bodies and provided leadership for the three very important committees. These committees addressed:

- Transformation of care.
- Transformation of culture.
- Technology improvement.

In addition, the project had an additional reporting relationship to the EMHS Information Services (IS) Governance Committee. This committee focuses on IS strategies related to current and future direction,
system capabilities, and resource allocations. This body is also responsible for reviewing the EHR roadmap on an annual basis to identify accomplishments, determine next steps and document total annual investment in the electronic record.

To involve day-to-day staff, a number of stakeholder workgroups were created. Members were selected by the leadership and team leads. The work groups focused on orders, documentation, workflow and technology. Physicians were also actively involved focusing on:

- Disease-specific order sets and clinical decision support;
- Specialty-specific views;
- Regional oncology record;
- Updating progress at section and service meetings;
- Participating in provider surveys; and
- Voting on necessary medical staff bylaw changes to support the use of CPOE.

The physicians were led by a CMO and CMIO who whole-heartedly supported the project. They titled the project the “Patient First Initiative,” and their goal was to achieve zero avoidable errors. This leadership served as the catalyst needed for the majority of the medical staff to buy-in to CPOE and to the use of an electronic record.

Although most groups at EMMC did support the EHR and CPOE implementation, not all groups saw the value during the initial stages. As EMMC discovered, failure to engage all key stakeholders can lead to problems after go-live. In the EMMC case, the cardiology department decided not to participate during the development phase of the project. The project team worked around them and built what they thought would suffice to support this service. However, when the service went live, the cardiology process broke down entirely. What they found was that most of the current cardiology processes were not documented and because of this, many aspects of their workflow were not taken into consideration during the design and build stages of the project.

The Chief Medical Information Officer called a meeting of the entire department following their live event to discuss whether they should abandon this project and revert to paper in the short term or continue on the path to an electronic record and electronic orders. The department voted to continue with this initiative despite the failure and to invest the time needed to do it correctly. It took six months, but the cardiology service established a standardized, safe, efficient process for patient care that is now used for cardiology care at EMMC.

Hospital staff was also heavily utilized during workflow redesign and EHR implementation. To make the project successful, EMMC used subject matter experts rather than managers to design new processes. The intent was to have people who are closest to the process focus on the redesign. The various hospital and physician teams addressed well over 100 detailed process changes over the life of the project.
During analysis, these processes were broken down and all sub-processes, dependencies, and other key factors were dissected. Once a build was complete, the teams did walkthroughs to ensure that the newly designed process would meet the needs of a given service. This involvement, coupled with timely and consistent communication helped to assure the success of the project.

EMMC’s communication strategy focused on awareness, understanding, acceptance, alignment and commitment. EMMC recognized that if their project was to be successful, they had to have commitment from all levels of the organization to sustain their workflow redesign and projected foreseeable gains. Various methods were used for communication including face-to-face meetings, newsletters, videos, the sharing of prototypes and system demonstrations. Most importantly, EMMC focused this project on the patient. The goal was to create an environment where they could demonstrate an improvement in patient care and safety. This goal was supported by the use of technology in the form of an EHR.

**Process**

EMHS has a Project Management Office which assigns project managers to IS projects. These project managers follow the practices established by the PMI for the management of their assigned projects. These practices were used to guide the implementation of technology in support of EMMC’s workflow redesign project.

The technology was implemented using a phased approach. The first step in the process was to upgrade to Cerner Millennium so that a foundation for the EHR could be established. Once that was completed, EMMC used the HIMSS Analytics EMR Adoption ModelSM to guide its implementation of functionality needed to achieve an EHR. implementation followed the implementation process outlined in Figure 23:

**Figure 23: EMMC Implementation Process**
A project implementation team was created to assist with the rollout of applications. The team members comprised Cerner and EMMC staff. EMMC was represented by IS, super users and other key stakeholders. This team established a structure so that it could ensure:

- Oversight and escalation;
- Command Center functions;
- Assessment and resolution of issues;
- Education and communication;
- Response and resolution at go-live; and
- Solutions development.

EMMC used the LEAN methodology to refine their manual processes. This methodology was also used during their conceptual design sessions. The goal was to eliminate waste and non-value added work. End-users, subject matter experts and providers of care were utilized during major phases of the redesign to gain commitment on the changes that would be deployed. In addition, a certain tolerance for deviation was initially endured after the go-live in an effort to allow the end-users to adjust to new methods.

Patient First Care Coordinator (PFCC) positions were established to aid providers in their use of the electronic record. Four registered nurses were assigned to this role. These coordinators assisted during the go live and EMMC has retained these nurses in this role. Part of their responsibility is to round with providers on a regular basis and answer questions on the EHR.

EMMC introduced a change management program during the implementation of the EHR and it embedded a change management plan in each implementation project. The program focused on communication, resistance to change, and optimal education so that all end-users would be comfortable with their new processes and technology.

At EMMC, all the clinical staff are required to attend training on the EHR and demonstrate competency. This training is required before system access is granted. In addition, training is required when system upgrades are instituted on a quarterly basis. Training is provided twice a week on a regular basis for new employees and others who might need additional training. Classes are supplemented with rounding where education is provided on an individual basis. EMMC has also created tutorials which can be taken online and publishes material to keep all users informed of planned upgrades and tips for system use. EMMC’s goals with process have been to assure efficient and effective patient care and system competency with the use of the EHR.
Technology

From a technology perspective, EMMC strives to be as transparent as possible. System issues are submitted online and end-users can see the status of tickets at all times through an online view. End-users also are free to send comments to IS on what they may not like about the system. IS, in turn, will respond to these comments and if the comments are deemed to be system issues, IS will address these items and keep the end-users informed of the status.

To gain buy-in during implementation, end-users select the devices they will use once their system is implemented. For the EHR, the nursing staff chose computers on wheels (COW) and the physicians chose multi-purpose workstations. At go-live, the physicians chose to dictate all their documentation, but are currently in the process of developing structured documentation and voice recognition.

Physicians are also provided accurate, complete real-time data that reports how they are doing from a quality and cost perspective. This data has produced positive benefits in the form of improved outcomes and lower cost of care because the physicians can see how their protocols directly impact quality and cost. EMMC has found that the sharing of data is changing behavior for the better.

Lessons Learned

1. To assure success, secure medical staff and executive leadership for support of the project.
2. Engage in extensive planning for the EHR future state and solicit the participation of subject matter experts and providers of care.
3. Ensure that the technology design fully supports clinical processes rather than having clinical processes support the technology design.
4. Mandate that all clinicians have EHR competency and mandate CPOE competency for all physicians.
5. Modify medical staff bylaws and rules and regulations to support the use of CPOE.
6. Provide flexible training methods and just-in-time training when needed.
7. Mandate the use of paper order sets with evidence-based content prior to migrating to CPOE.
8. Implement decision support at the point of care, but be selective in its use so that it serves as an aid to providers and not an annoyance.
9. Limit alerts to avoid alert fatigue.
10. Involve clinicians in providing end-user support to other clinicians and their peers.
11. Provide 24/7 support on the floor during go-live events. Provide assistance “at-the-elbow.”
12. Provide quick resolution to issues at go live and monitor the implementation process to assure success.
13. Use structured, proven project management methodologies over the life of the project.
14. Use structured, proven workflow redesign methodologies to transform the process of care.
Although EMMC experienced many positive outcomes, like all organizations, they did encounter issues that were unanticipated. For example, they did not anticipate that providers would select the wrong encounter when placing orders or documenting care. This pointed out that more training was needed on the encounter selection process to avoid back-end cLEAN up of this type of mishap. Another area where they experienced difficulty was during the registration of patients. This process delayed the initiation of orders and highlighted how process redesign should focus on all aspects of the continuum of care. In general, EMMC found that errors or workarounds that existed in their manual environment became more pronounced when the process was automated. Thus, they discovered that all aspects of a process should be taken into consideration during redesign in order to assure a better outcome with the change. This includes those processes that are documented as well as those that are undocumented, but practiced in the day-to-day operations of a healthcare organization.

Looking Toward the Future
Although EMMC won the Nicholas E. Davies Award for Organizational Excellence, the organization still has many technology goals yet to achieve. When EMMC’s Chief Information Officer (CIO) first proposed that EMMC apply for the Nicholas E. Davies award, some hospital staff were unsure if their hospital could achieve this distinction. However, as the team worked through the application process, documenting the many milestones EMMC had achieved, the exercise forced them to take a step back and appreciate how far they had come. The staff involved in the application processes felt that even if they had not won the award, they still had gained a great deal from the process itself.

Today, EMMC is focused on:
- Assisting other hospitals within the EMHS system in adopting the technology used at EMMC.
- ARRA’s “meaningful use” to assure reimbursement to fund additional technology.
- Bar-coding medications in an effort to implement closed loop medication administration.
- Structured documentation and voice recognition for physicians.
- Moving from Stage 4 to Stage 7 on the HIMSS Analytics EMR Adoption ModelSM. The goal is to have EMMC as well as all EMHS hospitals at Stage 7 by 2015.

In summary, EMMC achieved its EHR goals by focusing on the patient, which in turn provided the catalyst for the transformation of clinical care. The technology itself served as an enabler to improved care processes. By using this approach, EMMC was able to garner the support needed from its board, medical staff, hospital leadership and hospital staff to make a difference in the way care is delivered. This has been a seven-year journey for EMMC. However, the journey has demonstrated a decrease in medication errors, an improvement in overall efficiency and a reduction in the cost of providing care to the communities it serves. Might this be a journey on which your organization should consider embarking?
APPENDIX

**Pareto Chart**
The Pareto principle suggests that most effects come from relatively few causes. In quantitative terms: 80 percent of the problems come from 20 percent of the causes (machines, raw materials, people, etc.). Therefore, effort aimed at the right 20 percent can solve 80 percent of the problems. General use: To decide where to apply initial effort for maximum effect. See Figure 24 for an example of a Pareto Chart.

**Figure 24: Pareto Chart**

<table>
<thead>
<tr>
<th>Reject Causes</th>
<th>% Rejects</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>45%</td>
</tr>
<tr>
<td>B</td>
<td>17%</td>
</tr>
<tr>
<td>C</td>
<td>16%</td>
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<tr>
<td>D</td>
<td>13%</td>
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<tr>
<td>E</td>
<td>5%</td>
</tr>
<tr>
<td>F</td>
<td>4%</td>
</tr>
</tbody>
</table>

**Control Charts**
Control charts are tools to enable the control of distribution of variation rather than attempting to control each individual variation. Upper and lower control and tolerance limits are calculated for a process and sampled measures are regularly plotted about a central line between the two sets of limits. The plotted line corresponds to the stability/trend of the process. Action can be taken based on trend rather than on individual variation. See Figure 25 for an example of a Control Chart.

**Figure 25: Control Chart**

Variation is considered significant when any of the following conditions are met:
• Ten out of 11 consecutive points on one side of the center line.
• Twelve out of 14 consecutive points on one side of the center line.
• Fourteen out of 17 consecutive points on one side of the center line.
• Sixteen out of 20 consecutive points on one side of the center line.

To catch additional sequences that may indicate out-of-control situations, draw one additional horizontal line two standard deviations away from either side of the central line (these occur at two-thirds of the way toward the control limits. These lines are called the Upper Warning Limit (UWL) and the Lower Warning Limit (LWL). Additional sequences that may now indicate out-of-control situations include:
• Two out of three consecutive points are between a warning limit and the corresponding control limit.
• Three out of seven consecutive points are between a warning limit and the corresponding control limit.
• Five or more points which are all increasing or decreasing (a trend) and which cross a warning limit.

Cause-and-Effect (a.k.a. Fishbone or Ishikawa) Diagram
The cause-and-effect diagram is used to depict problem causes and effects. They are excellent for capturing team brainstorming output and for filling in from the "big picture". They help organize and relate factors, providing a sequential view. See Figure 26 for an example of a Cause-and-Effect Diagram.

Figure 26: Cause-and-Effect Diagram

Flow Charts
Pictures, symbols or text coupled with lines, and arrows on lines show direction of flow. Flow charts enable modeling of processes; problems/opportunities; and decision points, etc. They are helpful for developing a common understanding of a process by those involved. See Figure 27 for an example of a Flow Chart.
**Six Sigma (DMAIC)**

There are five high-level steps in the application of Six Sigma tactics. Within each of these steps, there are sub-steps called toll gates. Each toll gate indicates specific work steps that a project team must complete as they progress through each of the high-level steps.

<table>
<thead>
<tr>
<th>Define</th>
<th>Measure</th>
<th>Analyze</th>
<th>Improve</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose – to have the team and its sponsor reach agreement on the scope, goals, and financial and performance targets for the project.</td>
<td>Purpose – to understand the current state of the process &amp; collect reliable data on process speed, quality and costs.</td>
<td>Purpose – to pinpoint and verify causes affecting the key input and output variables.</td>
<td>Purpose – to learn from pilots of the selected solution and execute a full-scale implementation.</td>
<td>Purpose – to complete project work and hand off improved process to process owner with procedures for maintaining goals.</td>
</tr>
</tbody>
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<table>
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<tr>
<th>Tollgates</th>
<th>Tollgates</th>
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<th>Tollgates</th>
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</thead>
</table>
| • Create the project charter.  
• Identify and validate customer needs and requirements.  
• Create a high-level picture of the process targeted for improvement. | • Create a data collection plan.  
• Implement plan and return with baseline performance measured in Sigma language. | • Examine data.  
• Watch the process.  
• Determine root causes. | • Generate solutions.  
• Select solutions.  
• Implement solutions. | • Pick the right control method.  
• Document the response plan. |

The tools commonly used for Six Sigma are defined in Figure 28, which follows.
Figure 28: Tools Commonly Used for Six Sigma

Define Phase Tools
- Project Charter
- Stakeholder Analysis
- SIPOC Process Map
- Voice of the Customer
- Affinity Diagram
- Kano Model
- Critical to Quality (CTQ) Tree

Measure Phase Tools
- Prioritization Matrix
- Time Value Analysis
- Pareto Charts
- Histograms
- Control Charts
- Run Charts
- Failure Mode and Effect Analysis
- Cause and Effect Diagrams

Analyze Phase Tools
- Brainstorming
- 5 Whys Analysis
- Cause and Effect Diagrams
- Control Charts
- Pie Charts
- Design of experiments
- Flow Charts
- Pareto Charts
- Regression Analysis
- Scatter Plots
- Failure Mode and Effect Analysis

Improve Phase Tools
- Brainstorming
- Stakeholder Analysis
- Kaizen

Control Phase Tools
- Control Charts
- Quality Control Process Charts
- Flow Charts
- Before & After Charts
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SOFTWARE APPLICATION COMPANY RESOURCES

73. ITIL (web resource), Information Technology Infrastructure Library, http://www.itil‐officialsite.com/home/home.asp
82. Smart Draw, Smart Draw Flowcharting, www.smartdraw.com
Resource Link by Topic

Planning and Scheduling:
AHIMA: [http://www.ahima.org/e-him/](http://www.ahima.org/e-him/)

AHIMA Joint Work Force Task Force:

AHIMA Best Practice in Electronic Health Records:
[http://library.ahima.org/xpedio/groups/public/documents/ahima/bok1_032055.pdf#page%3D2](http://library.ahima.org/xpedio/groups/public/documents/ahima/bok1_032055.pdf#page%3D2)

The Common Wealth Fund:

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Business Process Management (BPM):
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Business Process Management, by John Jeston, Johan Nelis:

Business Process Automation (BPA):
Modernizing IT: Strategies for Improving Service Quality and Reducing IT Costs:

Automating IT Process to Ensure Virtualization Success, a half-hour recorded Webinar with a process overview and a case study:

Business Process Modeling:
The Business Process Model UML Tutorials, a whitepaper provided by Sparx Systems:

Essential Business Process Modeling by Michael Havey:

Business Process Modeling with ARIS: A Practical Guide by Rob Davis:
Business Driven Development:

Transforming IT – The CIO as Clinical Transformation Champion:
http://www.himss.org/content/files/08_column_Leadership.pdf

http://books.google.com/books?id=1FUOirKeevUC&pg=PP1&dq=Revenue+Cycle+Management#v=onepage&q=&f=false

Change Management:
A tutorial providing a summary of each of the main areas for change management based on Prosci’s research with more than 900 organizations in the last 7 years:

A comprehensive overview of change management principle and guidelines:
http://www.businessballs.com/changemanagement.htm

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Continuous Quality Improvement in Healthcare, By Curties P. McLaughlin, Arnold Kalunzy
http://books.google.com/books?id=aVXmoTKNeSU&printsec=frontcover&dq=Continuous+Quality+Improvement+in+healthcare&lr=#v=onepage&q=&f=false

Quality Management in Healthcare, By Donald F. Lighter, Douglas C. Fair
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Flowchart Software Support:
FlowChartX control - Visit homepage of FlowChartX control
FlowBreeze - Visit homepage of FlowBreeze Standard Flowchart Software
FlowChart.NET - Visit homepage of FlowChart.NET
SmartDraw – Visit homepage of www.SmartDraw.com
EDraw - Visit homepage of EDraw Flowchart Software

Workflow Modeling :
Open Source Modeling Tools: Intalio BPM community edition

**Other Commercial Tools**: Listing of software tools
http://bpm-directory.omg.org/vendor/list.htm
CONTRIBUTING ORGANIZATIONS

The HIMSS EHR Adoption Task Force would like to thank the follow individuals and organizations for their contributions to this toolkit.

**Blessing Hospital**
Jeanne Anderson, Systems/Application Analyst, Information Technology
Peggy Plummer, RN, Clinical Informaticist, Care Delivery Redesign
Ariel Mears, Supervisor Clinical Systems, Information Technology

**Denver Health**
Gregg Veltri, Chief Information Officer
Jeffrey Pelot, Chief Technology Officer
Amy Richardson, RHIA, Director Health Information Management & EMR Applications

**Eastern Maine Medical Center**
Cathy Bruno, Chief Information Officer, Eastern Maine Health Systems
Eric Hartz, MD, Chief Medical Information Officer, Eastern Maine Medical Center
Zen Thomas, Project Manager, Eastern Maine Medical Center

**Fox Chase Cancer Center**
Jackie DeSiato, Director, Coding Services

**Loma Linda University Medical Center**
Mark Zirkelbach, Chief Information Officer
Steve Corbett, MD, Chief Medical Information Officer
Padmini Davamony, Ambulatory Executive Director, Information Services & Decision Support Services
Norma Oros, Solutions Architect
Jeanne Messinger, Executive Director, Patient Care Services
Janet Munu, Director, Clinical Informatics

**Lucile Packard Children’s Hospital at Stanford**
Chris Longhurst, MD, MS, FAAP, Medical Director, Clinical Informatics
Robert Schwyn, Consultant, Technology Leadership Partners (served as Director, Clinical Transformation for this project)

**MCGHealth, Inc**
Harold Scott, Vice President of Information Systems and Chief Information Officer
Dwain Shaw, Director Information Services, Technical Support
Marlene Sides, RN, MHSA, Director Information Services, Client Services
Kathleen Herald, Director Information Services, Applications

**Medical University of South Carolina**
Janice Hazy, RN, Nursing Informatics
Bonnie Foulois, RN, Manager, Nursing Informatics
Melissa Forinash, RN, Director, Patient Care Systems
Seattle Children’s Hospital
Cara Bailey, Vice President, Continuous Performance Improvement
Christine Kessler, Director, Corporate Services, Continuous Performance Improvement

University of Kansas Hospital
Gregory A. Ator, MD, FACS, Chief Medical Information Officer
Mendy Dee RT, MMIS, Orders Team Lead, Advanced Clinical Information Systems
Doug Erich, Director, Advanced Clinical Information Systems
Kay Grasso, Director, Clinical Information Systems
Brad House, RD, LD, MSE, Beacon Team Lead, Advanced Clinical Information Systems
Terry Rusconi, Senior Director, Quality Improvement
C. Anne Sass, RN, MN, Assistant Director, Inpatient & Emergency Department Clinical Applications,
Advanced Clinical Information Systems
Shelly Sawatsky, RN, BSN, Clinical Documentation Team Lead, Advanced Clinical Information Systems
Shirley Weber, MHI, MHA, MT (ASCP), Director, Laboratory Services
CONTRIBUTING AUTHORS

**EHR Adoption Task Force Chair**
Cecilia Backman, MBA, RHIA, CPHQ, Associate Director, Health Information Management, Parkland Health & Hospital System

**EHR Adoption Task Force Members**
Vinod Aggarwal, MD, MS, MSHI, Health Informatics Consultant
Joan Barlow, Senior Consultant, Hayes Management Consulting
Paul Blumfelder, MBA, RHIA, Senior Consultant, ECG Management Consultants, Inc.
Alane Combs, RHIA, Senior Information Systems Consultant, Coastal Healthcare Consulting, Inc.
Douglas Eastman, PhD, Executive Director, Technology Adoption & Organizational Capability, Kaiser Permanente
Darice Grzybowski, MA, RHIA, FAHIMA, President, HIMentors, LLC
Adena Handly, FHIIMSS, CPHIMS, Director, Healthcare Marketing, AT&T
Lee Herrmann, MSE, PMP, CPHIMS, Owner/Principal, Pinch HIT Consulting
Elaine King, MHS, RHIA, CHP, CHDA, Product Manager, QuadraMed Corporation
Elaine Lips, RHIA, President & CEO, ELIPSe, Inc.
Claire McCarthy, MA, Director, Organizational Effectiveness, Kaiser Permanente
Scott A. Murphy, President, General Health Solutions
Michael Quintero
Marijo Rugh, MT, (ASCP), CPHIMS, Clinical Process Improvement Specialist, Poudre Valley Health System
Kelly Sager, Marketing Manager, eHealth Solutions, GE Healthcare
Adrish Sannyasi, MBA, PMP, Manager, Deloitte Consulting
C. Anne Sass, RN, MN, Assistant Director, Inpatient & ED Clinical Applications, University of Kansas Hospital
Soni Singal, MSHI, Memorial Hermann Healthcare System
Vivek Varma, PhD, Senior Director, Technology, Ultimo Software Solutions, Inc.
Laura Wentz, MPA, RN, BC, McKesson MPT, Liberty Health

Edna Boone, MA, CPHIMS, Senior Director HIMSS, Staff Liaison EHR Adoption Task Force
Juanita Threat, Coordinator HIMSS, Staff Liaison EHR Adoption Task Force