

# Workflow Opportunities and Challenges in Healthcare

Jonathan Emanuele and Laura Koetter,  
Siemens Medical Solutions USA, Inc., United States

[www.usa.siemens.com/medical](http://www.usa.siemens.com/medical)

**SIEMENS**  
medical

# Workflow Opportunities and Challenges in Healthcare

by Jonathan Emanuele and Laura Koetter,  
Siemens Medical Solutions USA, Inc., United States

## Abstract

Workflow technology has expanded substantially into the healthcare industry over the last year. Hospitals are embracing this technology as a means to improve operational efficiency, achieve patient safety goals, and positively influence the quality of care. This paper will explore the opportunities Business Process Management (BPM) and workflow technology have to make a profound impact on patient care while examining the challenges that are present in the healthcare arena.

## Introduction

Hospitals today face a constant challenge to find ways to improve the quality of care, while at the same time reduce costs and increase revenue. Concepts such as process optimization, throughput, and efficiency are gaining attention within the healthcare community as a means to achieve operational goals. Hospitals are increasingly asked to tackle the problem of doing more with less. For example, as the number of patient visits continues to rise, the number of beds is not,<sup>1</sup> and hospitals need to make better use of their assets. At the same time, the focus must remain on clinical excellence and quality of patient care.

Most emergency departments are at or over capacity.<sup>2</sup> The majority of hospitals lose money when treating Medicare/Medicaid patients: more than \$25 billion in 2005.<sup>3</sup> Staffing shortages exist across healthcare job types, causing emergency department overcrowding, diversion of emergency patients to other facilities, reduced number of staffed beds to serve patients, delayed discharge and increased length of stay for patients, and decreased staff and patient satisfaction.<sup>4</sup>

These challenges do not change the fact that patients deserve and demand safe and top quality care. Patients put their trust in hospitals to treat them according to best practices, to ensure they receive the appropriate tests, medications, and interventions for their conditions. Delayed care delivery, unnecessary tests, medication errors, or preventable complications due to an omitted step in a plan of care increases the likelihood of poor patient outcomes. Workflow technology and BPM concepts, designed to help hospitals deliver the right work to the right people at the right time, are ideally positioned to serve the needs of the patient.

Other industries have used BPM concepts to automate and improve processes with success. Opportunities exist to bring BPM

concepts to the healthcare industry; however there are significant challenges to address for successful utilization of these concepts. The healthcare industry has been slow to adopt BPM practices and workflow tools. This is due, in part, to technology constraints. Only recently have we seen the increased use of SOA-based healthcare information systems or electronic medical records by which we can collect the data necessary to leverage the possibilities of business process management. But even with growing data availability, there is a perception that healthcare is a much more complex environment than other industries that employ BPM, and that BPM is simply not ready for that level of complexity.

For the healthcare industry to fully support the investment in BPM concepts and workflow technology, the tools and technology must handle the complex conditions and challenges of a healthcare environment, from physical and financial resource constraints to utilizing technology for clinical decisions to variations in patient conditions and treatments. BPM in hospitals can apply to administrative and operational as well as clinical processes. Human lives will be affected by these tools. There are opportunities for BPM to improve patient care and operational processes and potentially achieve significant financial savings and ROI for the healthcare industry. In order for this to happen, BPM must take into account the unique challenges of managing a care process for healthcare providers and patients with workflow technology. Ideally, a fully optimized healthcare information system would allow patients to receive the best care, in the least amount of time, for the least cost, and with increased profit margin for the hospital.

BPM is gaining traction in the healthcare setting. As it continues to meet the challenges and concerns of the industry, healthcare BPM as a movement will grow. Healthcare BPM is the vision for the future of healthcare.

## Technology

BPM has many tools at its disposal for handling the life-cycle of a business process. Rules engines and workflow engines handle run-time execution, while modeling, simulation, and analytical tools exist for offline optimizations. This section will discuss the run-time applications that can be embedded into healthcare information systems.

Clinical Decision Support (CDS) is a well-established area in medical informatics. This field assists the clinician in making medical decisions, by providing access to the data necessary to make an informed choice. It is especially targeted at enhancing patient care and reducing errors. Typically, CDS systems involve a rules engine, with the majority of these based on the HL7 standard Arden syntax.<sup>5</sup> These systems function primarily by receiving triggers from an electronic patient record when data on a patient is entered, updated, or about to be updated. The rules engine then gathers data from the database and performs logic to respond with reminders or alert messages to the clinical staff. As an example, during the physician order entry process, if the doctor is ordering a drug that has potentially negative interactions with another drug already listed as an active drug the patient is taking, a rule can alert the doctor to that interaction and suggest alternative drugs that would avoid the potential problem. These rules are typically immediate decisions or scheduled recurring decisions. They are usually limited to clinical decision-making and do not take into account the notion of state management and the need to adjust recommendations over time as the process unfolds.

A workflow engine is a step beyond a rules engine. Workflow engines specialize in the execution of business processes, not just decisions made at a discrete point in time. Workflow engines are beginning to be utilized in the healthcare industry, which can draw on the strong knowledge base in workflow available from many other industries. The healthcare processes these engines handle can deal with all aspects of running a hospital, including clinical,

financial, administrative, and operational processes. These tools often make use of graphical flow-diagram interfaces, which try to make an executable workflow look as close to a process diagram as possible. These tools can greatly assist in clinical decision-making by not only presenting clinicians with alerts and reminders, like a rules engine, but also by handling the teamwork aspect of clinical decisions, the time management and task allocation aspects of process delivery, state changes in patient or operational conditions, and behind-the-scenes automation of process steps.

Workflow processes can be designed, built, modified, and maintained by a hospital. The workflows a hospital chooses to implement are tailored to that hospital's unique needs and problem areas. Hospitals can let their process experts design their workflows, such as a team of physicians and nurses working together to design a clinical workflow. All of this customization can be accomplished at the content level, without requiring custom code to be developed or delivered by a hospital's HIS vendor. This allows for a large degree of flexibility, and sites may constantly update and adapt their workflows well after their initial implementations. Additionally, workflows, or the ideas behind the

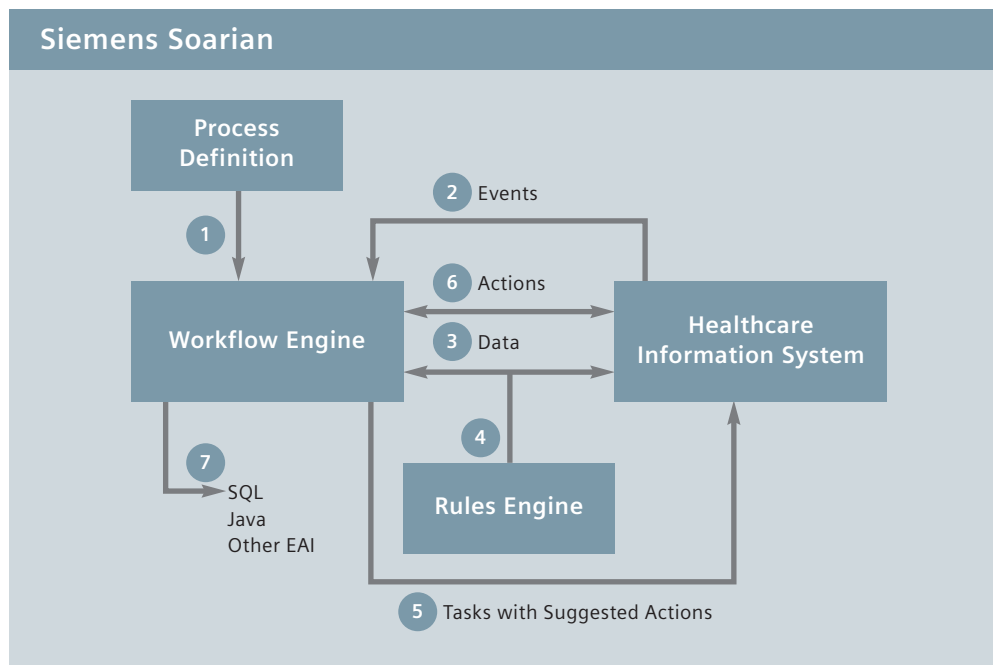
workflows, can be shared and exchanged between hospitals if desired.

According to Gartner, Inc., a key component of the fourth generation of a computer-based patient record is workflow. Gartner states that "workflow capability will be an integral part of these [healthcare information] systems."<sup>6</sup> Workflow offers potential to aide in clinical decisions, reduce medical errors, and even save human lives. Workflow technology makes the vision of healthcare BPM possible.

## Architecture

The following diagram represents an example of the architecture of a workflow engine integrated with a healthcare information system (HIS). The integration between the two is usually highly customized for optimal performance, but key to the integration is a strong service-oriented architecture. The three main components of a healthcare workflow are: the input of a process model, integration with the HIS system, and integration to any additional systems the hospital may have.

The process definition (Step 1) is provided by the healthcare provider organization or hospital. Process definitions can initially be done on whiteboards, in tools like



Microsoft® Visio, or in specialized modeling software. In order for the model to be importable, it must, at some point, be converted to a language that the engine can understand, such as XPDL. These process definitions define the process that a hospital wants to follow. They usually have a “happy-path” to ensure that what is supposed to happen is being done. These definitions also include what actions to take when the process deviates from the happy-path, such as notifying supervisors. The processes are not performed as a one-time transaction, like a rule in a rules engine. Rather, they span time, such as a patient’s entire visit or the length of a patient’s care at one facility.

In order for these processes to be kicked off and for the state within the workflow to be updated, it is important that the HIS system notify the workflow engine when major events happen (Step 2). A patient being admitted to the hospital, an order being placed, and an assessment being valued are all examples of events in the HIS that need to be pushed to the workflow engine. A typical patient encounter workflow will start on an admission, monitor updates to the patient record throughout the stay, and terminate when the patient leaves the hospital.

There are many times the workflow process needs to make a decision among multiple options in a process definition. The system will usually query the HIS to look up additional information (Step 3). If there is a need for complex queries or complex decision logic, the workflow engine can call a rules engine (Step 4). For example, suppose an order to discharge the patient was received and the engine needs to decide which tasks need to be completed before the patient is sent home. In order to do so, the engine will query the HIS and identify pending orders, labs, discharge summaries, and other steps that need to be completed.

When incomplete activities are identified, it is necessary for the workflow engine to push a task to hospital staff (Step 5). Perhaps it is to remind a nurse to complete an assessment that is overdue, or to notify housekeeping that a bed needs to be

cleaned. There are many modes of communication that come into play here, including messages inside the HIS and messages through external devices such as pagers, phones, and email. When orchestrating care, it is critical that the engine has access to hospital staff and clinicians, and can assign tasks to them and alert the next human in the escalation chain if a response is not documented in the patient record.

The workflow engine is also capable of performing actions directly in the HIS without human intervention, helping to get work done (Step 6). These actions may mirror actions available to end users of the HIS, such as an order, saving an assessment, or adding a patient to a staff census. Automation of services without human intervention is based upon hospital agreement that some services do not require human input.

The final point to bear in mind when applying a workflow engine-enabled HIS is that there may be other sources of data, other applications in the hospital, and new devices that should be integrated in the process. The ability of the workflow engine to provide a rich set of programming interfaces enables a hospital IT department to fully leverage the tool (Step 7). For example, a hospital may have a historical database of infectious disease data that needs to be queried when a patient arrives. The ability to interface with external data sources allows the workflow engine to leverage any electronic data or system the hospital may have.

## Opportunities for Healthcare BPM

At any point in time, hospitals are managing several hundred processes across a myriad of departments and clinicians. Every patient passing through the emergency department or staying in a bed has a unique and evolving plan of care, requiring treatment from multiple clinicians, departments and offsite facilities. Processes are in place to support care and keep the hospital running. Patients must be transported, dietary trays delivered, blood

drawn, vital signs monitored, results entered into information systems, beds cleaned, bills tracked, and so on. The number of processes and patients in play for any single member of the healthcare team can be very significant.

The opportunities for BPM in healthcare abound. BPM and workflow technology can have an impact by automating steps, integrating the team, pushing information when and where it's needed, managing communication points, and making decisions. Automating healthcare business processes can positively impact the time and resources necessary to provide patient care. In an industry plagued by staffing shortages and high costs, better utilization of human and physical resources enables the team to focus on patient care and results in a better bottom line for the hospital. Workflows automate aspects of the healthcare delivery process to improve compliance with policies and standards of care, eliminate communication breakdowns, and bring the interdisciplinary team in sync to deliver an integrated plan of care.

A clinical care environment is hectic, multidisciplinary and ever-changing. Treatment plans must be reactive to unique patient conditions and physician decisions for care. Processes must be adaptive. Workflows can respond quickly to changes in patient status, alerting clinicians of minor issues before they become more serious and costly conditions. Healthcare workflows allow for variations in patient care decisions, accommodating the needs of a people-driven industry.

### **Healthcare BPM Process Opportunities: Clinical, Operational, Financial, and Administrative**

Where are the process opportunities in healthcare? As it has in other industries, BPM can improve operational, financial, and administrative processes. But unique to healthcare, BPM can also be implemented to improve clinical processes. In fact, as hospitals adopt workflow engines, the processes prioritized at the top of the list are most often clinical care improvement initiatives.

**Clinical processes** focus on patient care. Processes may address patient safety goals, such as reducing patient falls or preventing pressure ulcers. National directives, such as The Joint Commission's annual National Patient Safety Goals,<sup>7</sup> provide guidelines to potential patient safety initiatives. Keeping patients safe reduces the risk of patient suffering and more expensive treatments.

Improved patient care may stem from following evidence-based standards of care. Standards of care are treatment guidelines for patients with certain diagnoses. Guidelines are ever-changing and are updated whenever new information on a given treatment comes to light. Managing standards of care with healthcare BPM allows for quick changes to processes and reduces the need to reeducate the team after each change — team members can rely on the workflow engine to manage guideline recommendations.

Clinical process improvements can be designed to respond to trends in healthcare. For instance, MRSA (Methicillin-resistant *Staphylococcus Aureus*), a type of bacteria resistant to certain antibiotics, is on the rise in healthcare settings. MRSA infections accounted for two percent of the total number of staph infections in 1974 and 63% in 2004.<sup>8</sup> MRSA patients are more likely to die, have longer hospital stays, and have higher treatment costs.<sup>9</sup> Implementing process improvements to help prevent infection and to identify and treat patients who have been infected can help improve patient safety and reduce costs.

Clinical processes are about providing the best care for patients to decrease their distress and improve their health. Workflow makes better care possible.

**Operational process** opportunities work to improve efficiencies, reduce costs, and improve patient throughput resulting in the ability to treat more patients at reduced cost. Workflows can help to enhance communication channels, eliminate unnecessary phone calls, and allow clinicians to focus their time on direct patient care. Patient throughput is a major operational process that impacts a hospital's bottom line. Efficiently managing

the process of getting a patient into and out of a bed results in more patients receiving timely care and fewer patients diverted to other facilities.

**Financial process** improvement opportunities are critical. With tight margins and underpayment for services rendered, hospitals must maintain strict control of finances to be able to continue providing care to the community. A radiology appointment missed may mean an extra day in the hospital while the appointment is rescheduled — a day that Medicare doesn't cover. A dietary tray delivered to a discharged patient is waste. The longer a patient's length of stay, the greater the cost of care. There are ample opportunities to use BPM to improve returns.

**Administrative process** opportunities improve documentation compliance. Administrative processes focus on documentation and assessment completion, signing of charts, processing of consent forms, etc. Incomplete documentation has a direct impact on patient care; if the documentation is not done, the information is not available for clinical decision-making. Lack of documentation may also impact the bottom line. Insurers will not reimburse for care that may have been delivered, but was not documented.

### **Application of Healthcare BPM: JCAHO/CMS Acute Myocardial Infarction National Hospital Quality Measure**

The Joint Commission and Centers for Medicare & Medicaid Services (JCAHO/CMS) put out quality measure guidelines for the treatment of Acute Myocardial Infarction (AMI).<sup>10</sup> These guidelines outline evidence-based measures of care suggested for the treatment of patients with AMI. Following standards of care contributes to improved health outcomes for patients presenting with this condition.

While evidence-based guidelines are an accepted industry standard, the actual adoption of guidelines by clinicians is difficult to achieve. It takes an average of five years for guidelines to be adopted into

routine practice.<sup>11</sup> As an example, JCAHO/CMS quality measures recommend patients diagnosed with AMI receive a beta blocker within 24 hours of arrival at the hospital. Approximately 50% of eligible patients do not receive beta blockers after an acute myocardial infarction.<sup>12</sup>

The costs of non-compliance with JCAHO/CMS AMI quality measures include increased mortality, increased patient health issues, more expensive treatments, future readmissions, and extended lengths of stay.

Healthcare BPM can contribute to the management of the Acute Myocardial Infarction care process. Utilizing a workflow engine and interacting with the interdisciplinary care team, BPM can have an impact on patient health and outcomes.

A workflow engine can gather real-time and historic patient information – results, assessments, orders, problems, diagnoses – to identify AMI patients as soon as possible. Once identified, the workflow starts monitoring for the measures of care. If a measure of care, such as aspirin administration within 24 hours of arrival, is not fulfilled, the workflow engine notifies the appropriate roles in the care team to make a decision. A suggestion is made to consider placing an order. For other measures of care, suggestions might include the request of a procedure or patient education. In all cases, the clinician has an option to follow the suggestion or document a reason he/she chose an alternative. The workflow engine continues to listen to responses, escalating issues not addressed or progressing to other steps in the process as the patient receives care. Throughout the process, role-based users interact with the information systems, sending new information to the workflow engine, affecting process decisions.

In addition to patient identification and monitoring of measures of care, the workflow engine can be utilized to collect compliance data for reporting to the JCAHO and CMS organizations. Data is collected throughout the patient visit, highlighting missing information or incomplete care. This data can be utilized internally by a

hospital for quality and process improvement purposes, offering the hospital an opportunity to identify ways to improve patient health and rates of compliance.<sup>13</sup>

### **Application of Healthcare BPM: Bed Management**

One of the pressing problems in hospitals is achieving efficiency in the bed turnover rate, or the ability for the hospital to get one patient out of the hospital bed and the next person into that bed as quickly as possible. In an average hospital, a single bed is turned 53 times per year. In a hospital operating in the 75th percentile, a bed is turned 61 times per year. The increased bed turnover equates to a revenue gain of more than \$7 million.<sup>14</sup> The pieces in play include transportation, housekeeping, facility maintenance, and a bed inventory system. The workflow engine allows a system to track, in real-time, when a patient exits his or her room upon discharge, to schedule all housekeeping and maintenance activities immediately, to track when those staff members leave the room, having completed their tasks, and mark the bed as available for a new patient. The state the workflow engine manages in this case isn't the state of the patient, but the state of the bed. By tracking beds that require cleaning, location of housekeeping personnel, time required to clean, and other statistics, you can more accurately manage the bed turnover in the hospital.

## **Challenges to Healthcare BPM**

The opportunities for healthcare BPM abound and the potential benefits to the healthcare industry are great. As with all BPM projects, however, healthcare BPM is not without significant challenges. Some challenges are similar across industries – access to data required, degree of automation, sending too many alerts and reminders. But healthcare has a very unique responsibility – patient health. If a workflow process dealing with a car accident claim fails, the effects are undesirable, but do not affect a human life. If a healthcare process fails, it has the

potential to cause patient harm. It is imperative to address the challenges and needs of healthcare BPM with great care and attention.

### **Lack of Access to Data Required**

Healthcare workflows utilize data from electronic information systems to make decisions. One of the greatest impediments to building workflow-based healthcare information systems is lack of access to all relevant data. Without available and updated information, it is virtually impossible to fully manage the state of a patient's care.

Several data access problems may exist. Data may be incomplete, as when new healthcare information systems are implemented and historic data from older systems is not ported forward. Or, data may continue to exist in inaccessible paper formats. There is wide variation in the level of automation among hospitals. The industry is in favor of an electronic patient record, with real-time data entry and interaction, but adoption varies widely. Some facilities still operate on a manual paper-based system. Many others exist in a middle ground, with some aspects of the charting process entered electronically and other aspects still communicated on paper.

The level of automation and data available at a hospital facility drives prioritization of which processes are candidates for improvement with workflow technology. The iterative nature of BPM allows for continuously changing workflows – start simple and add to the workflow process as new features are implemented at the hospital site.

### **Identifying Patient Populations with a Workflow Engine**

In a clinical environment, a workflow engine often must identify the population of patients to whom the workflow applies. For example, a workflow that monitors compliance with JCAHO/CMS Acute Myocardial Infarction quality measures must first identify patients with myocardial infarction. Information available to identify a patient with a specific condition is not

always complete. The workflow engine can be used to determine if a patient is a likely AMI patient, even if a diagnosis isn't entered into the system until the patient is discharged. We may instruct the workflow to check for elevated test results, often an indication of AMI. This identifies a patient, but there is still a margin of error — not all patients with elevated results have AMI and not all patients with AMI have elevated results. Therefore, our patient population data is not perfect. Data available to make a decision may be limited, out of date, or potentially inaccurate.

Workflows do not replace human interactions in planning and providing care. Processes must be built to include, not exclude, opportunities for human intervention and feedback. In the case of identifying a patient population, such as AMI, the system can give clinicians the opportunity to inform the workflow that the patient is not an AMI patient and should be excluded from the population. In the case of a suggested order that is not appropriate for the patient, clinicians must have the opportunity to override the suggestion. Humans and automated process management working together are the ideal solution.

### **Technical Feasibility Opens Automation Questions**

An integrated workflow engine opens the door to numerous technically feasible possibilities for process management. The workflow engine can be called upon to perform actions behind the scenes, such as automatically updating the patient record or automatically placing orders.

A balance must be determined between what a hospital is comfortable having the workflow engine do automatically, without user intervention, and which steps require human interaction. A workflow may seek clinician input at specific points in the workflow. Medication orders will always require human confirmation before activation. A dosage change must flag a pharmacist to review the request. While many functions are technically feasible, care and concern must be taken to evaluate how decisions might affect patient safety.

At the end of the day, the hospital, not the workflow engine, remains responsible for patient care.

### **Physicians Choose Different Treatment Options**

Physicians make different decisions when treating patients with similar conditions. The healthcare industry gives physicians the discretion to determine the care their patients need. This makes healthcare unique; it is unrealistic to force a single standard when developing clinical treatment processes. Even when evidence-based standards of care are encouraged, physicians have the opportunity to choose alternate treatment plans and every patient's condition, or combination of conditions, drive different clinical decisions.

Healthcare BPM must be flexible. While a workflow may suggest best practices according to hospital or national guidelines, workflows must offer the ability to deviate from the suggested action. If a medication is suggested for a patient, along with the option to place the order, the physician needs to be offered the options to order an alternate drug, decline placing the order, or find more information about the disease, drug, or guideline evidence. Clinical workflows require built-in flexibility to accommodate human discretion.

### **Communicating with Team Members**

Throughout a workflow process, it may be necessary to give information to or request decisions and actions from members of the team. In a clinical environment, it is imperative that the team members receive these messages in a timely manner. How the information is delivered is important. If the only method for communicating with team members is on a stationary computer screen in an office or nurse station, then there is the potential that team members will not log in often enough to receive new information. Options must exist to support communication via additional devices, such as PDAs, pagers, and phones. These options bring their own issues, such as security concerns or limited reception in all areas of the facility. In workflow building, it is

important to identify the appropriate device for communication for each team member and time of day, sometimes utilizing multiple communication methods.

When pushing action requests and alerts to team members, care must be taken to avoid overloading the person with too many messages. If a doctor is being paged every time a lab result posts, he or she will quickly start to ignore the pages entirely. It is important to consider the number of interactions that may be requested of a single person across workflows. A balance between optimizing processes and sending too many alerts to team members should be considered. The workflow engine can be used to track not only the state of the patient, but also the state of the messages being sent to the clinical staff. If staff members are receiving too many alerts, a workflow might consolidate messages or utilize an alternate communication method.

## Conclusion

Healthcare is a complex environment with opportunities for BPM and workflow technology to improve patient care and operational efficiencies. Healthcare BPM faces technical, clinical, and cultural challenges. Despite these challenges, BPM is powerful and possible in healthcare. This paper has demonstrated that workflow can be applied in healthcare environments. Healthcare BPM is a movement and vision for the future of healthcare.

The architecture presented in this paper describes at a high level the Soarian® product of Siemens Medical Solutions USA, Inc. and the workflow opportunities and examples discussed are processes currently implemented or in development, using the Soarian® HIS, at hospitals around the globe.

- <sup>1</sup> The Advisory Board Co. (2007, January 17). *Leveraging IT to Optimize Hospital Throughput: An Improved Approach to Managing Capacity*. Presented at Maryland HIMSS conference.
- <sup>2</sup> American Hospital Association. (April 2006). *The State of America's Hospitals – Taking the Pulse: Findings from the 2006 AHA Survey of Hospital Leaders*. Retrieved Jan 18, 2007, from <http://www.aha.org/aha/research-and-trends/health-and-hospital-trends/2006.html>
- <sup>3</sup> American Hospital Association. (Oct 2006). *Underpayment by Medicare and Medicaid Fact Sheet*. Retrieved Jan 18, 2007, from: <http://www.aha.org/aha/content/2006/pdf/underpaymentfs2006.pdf>
- <sup>4</sup> American Hospital Association. (April 2006). *The State of America's Hospitals – Taking the Pulse: Findings from the 2006 AHA Survey of Hospital Leaders*. Retrieved Jan 18, 2007, from: <http://www.aha.org/aha/research-and-trends/health-and-hospital-trends/2006.html>
- <sup>5</sup> The Arden Syntax for Medical Logic Systems. (updated July 21, 2006). Retrieved January 29, 2007, from: <http://cslxinfmtcs.csmc.edu/hl7/arden/>
- <sup>6</sup> IMIA Yearbook 2003. (Feb 2003). *Leveraging IT to Improve Patient Safety*. Pg. 8. Retrieved January 23, 2007, from: <http://www.himss.org/content/files/whitepapers/PatientSafetyWhitePaper122602.pdf>
- <sup>7</sup> The Joint Commission. (2007). *National Patient Safety Goals*. Retrieved January 18, 2007, from: <http://www.jointcommission.org/PatientSafety/NationalPatientSafetyGoals/>
- <sup>8</sup> Centers for Disease Control and Prevention. (updated Oct 6, 2006). *MRSA in Healthcare Settings*. Retrieved Dec 11, 2006, from: [http://www.cdc.gov/ncidod/dhqp/ar\\_MRSA\\_spotlight\\_2006.html](http://www.cdc.gov/ncidod/dhqp/ar_MRSA_spotlight_2006.html)
- <sup>9</sup> Pennsylvania Health Care Cost Containment Council. (August 2006). MRSA in Pennsylvania Hospitals. *PHC4 Research Brief*, 10, 1–4.
- <sup>10</sup> Centers for Medicare & Medicaid Services (CMS) and the Joint Commission on Accreditation of Healthcare Organizations (JCAHO). (June 2006). *The Specifications Manual for National Hospital Quality Measures*, Version 2.0. Retrieved July 2006, from: <http://www.jointcommission.org/PerformanceMeasurement/PerformanceMeasurement/Current+NHQM+Manual.htm>
- <sup>11</sup> Lomas J, Sisk JE, Stocking B. (1993). From evidence to practice in the United States, the United Kingdom, and Canada. *Milbank Q*, 71, 405–410.
- <sup>12</sup> Bradford WD, Chen J, Krumholz HM. (1999). Under-utilisation of beta-blockers after acute myocardial infarction. Pharmacoeconomic implications. *Pharmacoeconomics*, 15, 257–268.
- <sup>13</sup> Portions of the subject matter disclosed herein are the subject of pending patent applications.
- <sup>14</sup> The Advisory Board Co. (2007, January 17). *Leveraging IT to Optimize Hospital Throughput: An Improved Approach to Managing Capacity*. Presented at Maryland HIMSS conference.

On account of certain regional limitations of sales rights and service availability, we cannot guarantee that all products included in this brochure are available through the Siemens sales organization worldwide. Availability and packaging may vary by country and is subject to change without prior notice. Some/All of the features and products described herein may not be available in the United States.

The information in this document contains general technical descriptions of specifications and options as well as standard and optional features which do not always have to be present in individual cases.

Siemens reserves the right to modify the design, packaging, specifications and options described herein without prior notice. Please contact your local Siemens sales representative for the most current information.

Note: Any technical data contained in this document may vary within defined tolerances. Original images always lose a certain amount of detail when reproduced.

© 2007 Siemens Medical Solutions USA, Inc.  
Order No. A9133-71250-C1-4A00  
Printed in USA 07-2007  
All rights reserved

**Contact Address**

Siemens Medical Solutions  
Health Services  
51 Valley Stream Parkway  
Malvern, PA 19355-1406  
USA  
Telephone: +1-888-826-9702  
[www.usa.siemens.com/medical](http://www.usa.siemens.com/medical)

**Headquarters**

Siemens Medical Solutions USA  
51 Valley Stream Parkway  
Malvern, PA 19355-1406  
USA  
Telephone: +1-888-826-9702