Discover, Interact, and Optimize for Smarter Healthcare with BPM Powered by Smart SOA

Redguides for Business Leaders

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- Using complex event processing with BPM to optimize healthcare
- Improving provider organization healthcare delivery with BPM
- Enabling personalized, preventive, and predictive healthcare with BPM

Executive overview

This IBM® Redguide™ describes one of the most significant challenges in healthcare today: the need for healthcare providers to effect patient care positively and proactively in the face of increasing patient load and information overload. However, the healthcare industry has been slow to embrace information technology (IT) solutions that can optimize clinical and administrative processes and, therefore, maximize the cost-effectiveness of care. The sluggish healthcare industry adoption of IT is attributable in large measure to the unavailability or inadequacy of IT tools for use at the point of care (POC). Such tools can enable user-friendly, complete, accurate, and timely clinical decision support, inherent in which is the real-time contribution to the medical common body of knowledge (CBOK).

IBM WebSphere® business process management (BPM) powered by smart service-oriented architecture (SOA), or *BPM powered by Smart SOA*, has the potential to maintain the increasing CBOK. It also makes critical, current data available to practitioners in a manner that is consistent with the evidence-based, event-driven environment to which healthcare aspires. BPM powered by Smart SOA can also automate healthcare provider administrative and care delivery processes to optimize enterprise operations and to maximize the safety and success of patient care.

A plethora of problematic processes

"*Employment in the United States healthcare sector jumped again in July [2010], increasing by approximately 26,600 jobs. The industry has gained 231,000 jobs over the past year, although hospitals lost jobs for the third straight month ... [but] the biggest healthcare job gains continued to be in ambulatory care services, where 23,100 jobs were added...*"[1]

"*A new study estimates that measurable medical errors cost the United States economy USD19.5 billion in 2008 ... Of the approximately USD80 billion in costs associated with medical injuries, around 25 percent were found to be the result of avoidable medical errors.*"[2]

[1] "Ambulatory care jobs rose in July, but hospitals continued downward trend" by Richard Pizzi in Healthcare Finance News, August 9, 2010, found at:
http://www.healthcarefinancenews.com/news/ambulatory-care-jobs-rose-july-hospitals-continued-downward-trend

[2] "Study: Medical errors cost U.S. economy almost $20 billion in '08" by Chelsey Ledue in Healthcare Finance News, August 9, 2010, found at:
http://www.healthcarefinancenews.com/news/study-medical-errors-cost-us-economy-almost-20-billion-08

"Chronic disease accounts for about 75 percent of the costs of United States healthcare; yet, much of the system remains oriented to providing acute care."[3]

"It is estimated that 56 percent of the chronically ill are not receiving appropriate preventive services."[4]

As these quotations demonstrate, healthcare worldwide is plagued by fragmented and complex administrative procedures, wasted resources, and a lack of scientific knowledge and methods at the POC[5].

These deficiencies in the delivery of healthcare lead to avoidable medical errors and unacceptable levels of patient morbidity and mortality in all societies. In technologically advanced nations, such as the United States, these deficiencies are inexcusable. IBM WebSphere BPM powered by Smart SOA software and professional services mitigate this situation by enabling clinicians and other healthcare and life sciences participants and stakeholders to realize these benefits:

- Discovery of insights that enable process innovation
- Interaction of clinical, heuristic, administrative, research, and teaching processes
- Optimization of productivity, resource allocation, and clinical outcomes

The most consequential healthcare-related decisions, those decisions that have a direct impact on patient care and treatment, generally are those decisions that must be made quickly; therefore, the immediate availability of relevant data is imperative. Other data-intensive industries with real-time or just-in-time processing requirements, such as banking and finance, responded long ago to their competition and customers by implementing IT innovations, such as automated teller machines (ATMs). These industries have progressed from staff-centric, batch-oriented, and time-driven or request-driven processing to system-centric, transaction-oriented, and a high degree of event-driven processing. The result has been genuine business performance transformation, as evidenced by much-improved process agility, productivity, accessibility, stakeholder satisfaction, and overall cost-effectiveness.

Healthcare will not be optimally cost-effective until the problems of system fragmentation, resource waste, and the inadequate application of science at the POC are resolved. Evidence abounds that the inadequate application of science contributes exponentially to the severity of the other two problems. IT can mitigate all of these factors. But for IT to be effective in healthcare, it must be implemented as a paradigm shift similar to IT-enabled banking. In this new paradigm, the information must be accessible to providers, patients, and other authorized healthcare stakeholders through generally available, easy-to-use, and affordable methods of delivery, such as cloud computing and software-as-a-service (SaaS).

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[3] *The power of prevention: Reducing the health and economic burden of chronic disease*, United States Department of Health and Human Services, Centers for Disease Control and Prevention, 2003, found at: http://www.welcoa.org/freeresources/pdf/power_of_prevention.pdf

[4] *Potential Savings Under the AdvaMed Plan Associated with Health Reforms Focusing on Chronic Care Management, Prevention and Health Information Technology* by Kenneth E. Thorpe, Ph.D, Emory University Rollins School of Public Health, found at: http://www.advamed.org/NR/rdonlyres/03AE0ADD-3472-4F29-BC58-32EC0575AB67/0/healthreformsavingsthorpeFINAL.pdf

[5] *IT-enabled Personalized Healthcare* by Jim E. Adams, Edgar L. Mounib, and Amnon Shabo, IBM Institute for Business Value - Global Business Services® 2010 Executive Report, page 1, found at: http://www-935.ibm.com/services/us/gbs/bus/html/ibv-it-enabled-personalized-healthcare.html

Regardless of the delivery method, although the delivery method is key to minimizing the cost and complexity of an IT solution, event-driven, real-time, and transaction-oriented IT can support healthcare in two ways: 1) chronically or continually, focused on individuals and 2) emergent or episodically, focused on healthcare providers. In this Redguide, we refer to these IT implementations as *IT-enabled personalized healthcare* (IT-PHC) and *IT-enabled organizational healthcare* (IT-OHC). Both IT implementations are manifestations of a common IT-enabling approach: BPM with complex event processing, which is referred to as *BPMcep* in this Redguide.

Presenting problem: Inadequate information technology

> *"Estimates suggest that as much as USD700 billion a year in healthcare costs do not improve health outcomes. It occurs because we pay for more care rather than better care. We need to be moving towards a system in which doctors and hospitals have incentives to provide the care that makes you better, rather than the care that just results in more tests and more days in [the] hospital."*
>
> Peter Orszag, Director of the White House Office of Management, "Budget Chief: For Healthcare, More Is Not Better," National Public Radio interview, April 16, 2009: http://www.npr.org/templates/story/story.php?storyId=103153156

The science of healthcare and the scope of the healthcare and life sciences ecosystem have expanded to the point that efficient, effective, and economical healthcare delivery is thwarted at every turn. Patients are exhorted by the media and their healthcare providers to live healthy lifestyles and adhere to best practices for maintaining wellness. However, so much information is available and so many guidelines abound that health and wellness management has exceeded the time and knowledge limits of the typical person.

The delivery of high-quality healthcare remains founded upon a face-to-face encounter between the healthcare provider and patient. Problematic are the limitations of short time frames for office visits (often 15 minutes) in the typical medical practice, coupled with multiple regulatory constraints and a flood of new pharmaceuticals, therapies, and available knowledge. These factors minimize the probability of determining a complete and accurate differential diagnosis and, therefore, an effective treatment plan. These factors might also lead to unintentional but nonetheless consequential iatrogenic (physician-induced) illness.

For a typical medical or surgical hospitalization, cost-effective patient management throughout the hospital stay relies on a carefully orchestrated confluence of staff, systems, equipment, and supplies to convene at time-critical locations to provide care and treatment. Attendant process-related problems, though, can lead to nosocomial (hospital-acquired) infection, medical errors resulting in protracted illness or death, or the occurrence of so-called "*never events*," such as the surgical removal of a healthy organ or limb. To mitigate or eliminate these problems, the support of robust and feature-rich process automation is required.

The required process automation must be able to compensate for the paucity of scientific information and IT tools that lead to the delivery of unwarranted care, costing an estimated USD250 to USD300 billion annually in the United States[6] (see Figure 1). Of the conditions that plague the healthcare industry at large, such as fragmented and complex processes, waste of resources, and lack of scientific knowledge at the POC, evidence abounds that inadequate science contributes substantially to increasing the severity of the other two conditions.[7] This deficiency is exacerbated by the shortage of complete, accurate, and timely information because of inadequate IT tools at the POC.

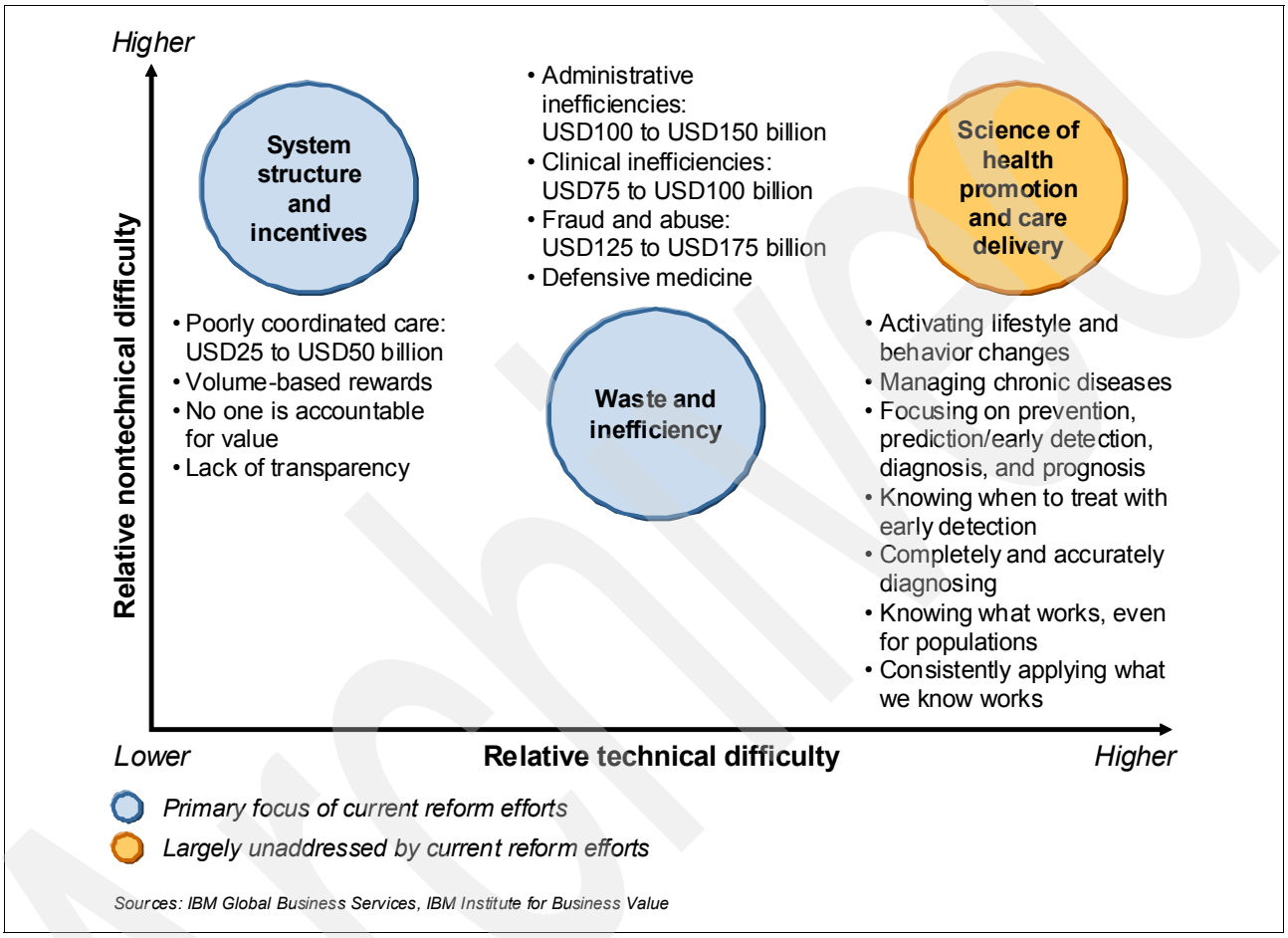

Figure 1 Areas of healthcare deficiency

IBM healthcare vision

Challenges in the current healthcare environment suggest a remedy founded upon information that is constantly refreshed by events and is readily accessible at the POC, as needed. Clearly, a creative, comprehensive, and capable IT solution is required. IBM has a vision for how to improve the way that the world works, how every person, business, organization, government, natural system, and manufactured system function and interact. IBM calls this vision *Smarter Planet*™.

[6] "Where can $700 billion in waste be cut annually from the United States healthcare system?" by Robert Kelley, Thomson Reuters, October 2009

[7] *IT-enabled Personalized Healthcare* by Jim E. Adams, Edgar L. Mounib, and Amnon Shabo, IBM Institute for Business Value - Global Business Services 2010 Executive Report, page 1, found at: http://www-935.ibm.com/services/us/gbs/bus/html/ibv-it-enabled-personalized-healthcare.html

The Smarter Planet vision recognizes an infusion of intelligence into the systems and processes that are used in the world, which enables the following results:

- Physical goods to be developed, manufactured, bought, and sold
- Services to be delivered
- Everything from people and money to oil, water, and electrons to move
- Billions of people to work and live

These systems and processes demonstrate the following characteristics:

- The world is becoming *instrumented*. By 2010, there will be one billion transistors per human being, each one costing one ten-millionth of a cent.
- The world is becoming *interconnected*. With a trillion networked things, such as cars, roadways, pipelines, appliances, pharmaceuticals, and even livestock, the amount of information that is created by those interactions grows exponentially.
- All things are becoming *intelligent*. Algorithms and powerful systems can analyze and turn those mountains of data into actual decisions and actions that make the world work better and smarter.

The IBM Smarter Planet vision, as applied to the aggregate of participants and processes that is referred to as the *global healthcare and life sciences ecosystem*, is called *Smarter Healthcare™* (see Figure 2 on page 6). IBM describes Smarter Healthcare in terms of the following transformational tenets:

- Patient-physician relationship: From doing things to patients to doing things with patients, from the experience of one physician determining care to the experience of many physicians determining care, and from a focus on physician needs to a focus on multidisciplinary teams serving patient needs
- Innovation: From the latest medical technologies for heroic intervention to patient health maintenance, and from a slow adoption of research to the rapid adoption of new knowledge and techniques
- Culture: From provider and facility-centric to patient-centric and team-oriented collaborative care; and from change resistance to continuous improvement
- Process: From manual methods to computerized technologies and techniques, and from department and facility-oriented optimization to integrated care optimization
- Information management: From paper-based and nonstandard processes to electronic and standardized processes, and from anecdotal and provider-specific experiences to evidence-based and collective experiences

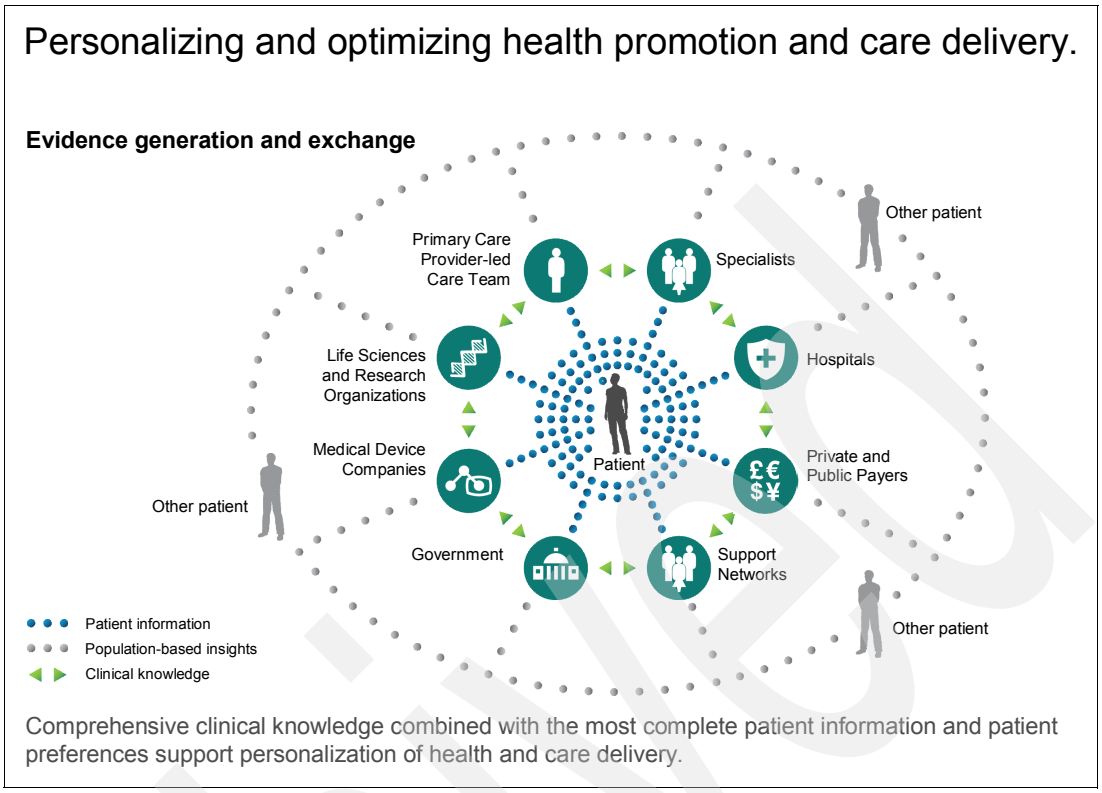

Figure 2 The IBM vision for smarter collaborative healthcare

Plan for treatment: Agile processes

> *"When appropriately applied to an individual with a disease, PHC can significantly improve the ability to assess risks and understand events that initiate a disease, detect those events molecularly (perhaps long before clinical detection is possible), and tailor treatments specifically for that individual. This approach can improve the likelihood of preventing or reversing the disease, thereby reducing overall costs associated with the disease."*
>
> *IT-enabled Personalized Healthcare* by Jim E. Adams, Edgar L. Mounib, and Amnon Shabo, IBM Global Business Services, IBM Institute for Business Value 2010 Executive Report, page 9, found at:
> http://www-935.ibm.com/services/us/gbs/bus/html/ibv-it-enabled-personalized-healthcare.html

To obtain the transformation that is embodied in the IBM Smarter Healthcare vision, the transformation must be realized in both chronic and critical healthcare circumstances:

- *Chronic*: Continuous care, with a focus on the individual patient, for the management of illness and wellness during that person's lifetime (from conception through death and autopsy, if authorized). Chronic status includes an individual's normal medical status, whether it is completely healthy or includes a degree of disability, but the individual's normal or typical condition, nonetheless.
- *Critical*: Episode-based care, with a focus on healthcare providers, for the management of ambulatory and inpatient care. Providers can be individual physicians or organizations (for example, general hospitals, behavioral health clinics, outpatient surgery centers, or private practice physicians). The primary objective of episodic care is to resolve or stabilize a specific medical problem and, concurrently, to optimize processes that are related to clinical, heuristic, administrative, research, and teaching (CHART) needs.

Information technology is necessary to answer today's toughest questions about healthcare[8]:

- *How can individuals be motivated to make better health and healthcare choices?*
- *What can be done to better manage the growing number of people with chronic diseases?*
- *What can be done to promote a greater focus on and effectiveness of prevention and prediction/early detection both in individuals and throughout the healthcare system?*
- *As early detection capabilities improve with tools, such as advanced imaging, how do you learn more about which factors that are detected require treatment or ongoing monitoring and which do not?*
- *How can doctors ensure complete and accurate diagnoses?*
- *What can be done to increase knowledge about which diagnostic and therapeutic approaches work in real-world settings?*
- *What can be done to more consistently apply what is known to work?*

To attain maximum benefit, it is imperative that IT support patients at both levels of care (chronic and critical care) in two venues (healthcare provider facility and patient home or other non-provider location).

IT-enabled personalized healthcare (IT-PHC)

The purpose of IT-PHC is to provide automated support for the management of illness and wellness of individuals, referred to herein as *chronic* care. The longitudinal scope of this support is from conception through death and autopsy. IT-PHC provides continuous accessibility to and analysis of medical information. Also, it prompts the patient or provider organization to take recommended actions based on a request, an event, or even a point in time. Hypothetical examples include an annual physical exam for an adult of either gender over the age of 25. Similarly, a female is contacted at age 35 to inform her that mammography is needed, with follow-ups every five years through the age of 60, and then every two years thereafter. Based on this schedule, prompts are communicated to the patient or provider throughout the patient's life, at the appropriate times. Events, such as changes in subjective (for example, medical history or symptoms) and objective (for example, physical examination or signs) data, are analyzed and archived when received for potentially immediate reuse in diagnosis or treatment of this patient or another patient.

[8] *Ibid*, pages 4 - 5

Unlike the electronic medical records (EMRs) and personal health records (PHRs) that are currently available, IT-PHC renders a host of information (including archival) that is interoperable with agile and dynamic business processes that are designed to be responsive to complex events on demand. These dynamic processes might include communication, collaboration, event detection, decision making, content management, and retrospective and prospective analyses.

The automated activity of IT-PHC stands in stark contrast to the current condition of healthcare information management, in which copious knowledge has been archived, but not in readily accessible form. As a result, the information is not available to providers at the POC to aid in accurate diagnoses and cost-effective treatment plans. Stated another way, the "*bridge from bench to bedside*" is too long and narrow to be of practical use.

Even assuming the ready accessibility of data, information, and knowledge that are appropriate for clinical decision support, complete and correct understanding by the healthcare practitioner typically is limited by the practitioner's cognitive ability and clinical experience: the "*clinical cognitive conundrum*." Healthcare providers are only human beings, and they lack the cognitive ability to assimilate all the relevant data to infer the required information from which to draw the correct clinical conclusions in real time. Therefore, healthcare providers are limited in their ability to determine correct diagnoses and treatment plans.

Without adequate IT to assist the medical profession, timely access to the required information and, therefore, optimal intervention are limited. Furthermore, the typical earliest clinical detection cannot be advanced in time sufficiently to preclude the expression of full-blown pathology and the consequent need for medical intervention (see Figure 3).

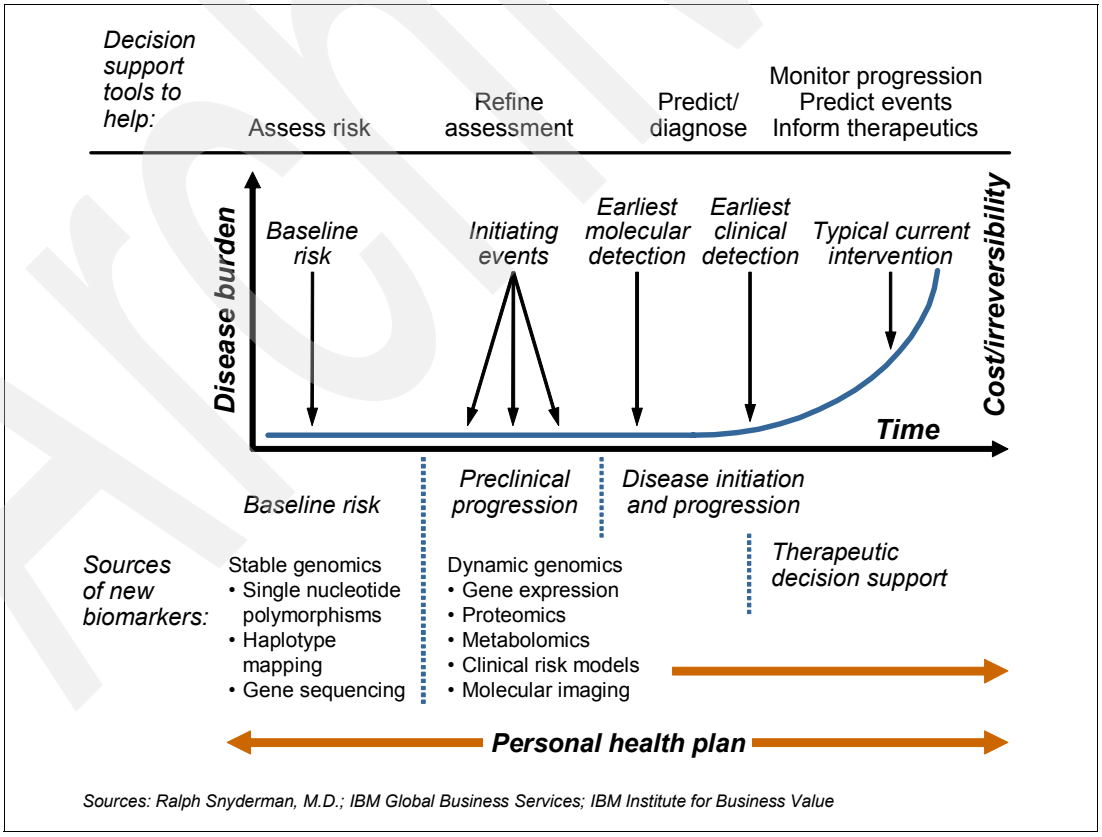

Figure 3 Cost-benefit of advancing disease detection and diagnosis

IT-enabled organizational healthcare (IT-OHC)

The purpose of IT-OHC is to provide automated, real-time, and complex event-driven IT support for episodes of emergent and planned care managed by healthcare organizations, referred to in this Redguide as *critical care*. The scope of this IT support also includes the business operations (for example, financial and administrative) of the organization. The purpose of IT-OHC is to provide real-time and automatic responses to request-driven, time-driven, and complex event-driven detection. These responses include supplying reports, reactions, and recommendations in response to real-time events (for example, presentation of a differential diagnosis after recording patient admission workup data, or ordering sterile supplies or pharmaceuticals when amounts on-hand fall under refill thresholds). Real-time feedback loops also are included (for example, updating medical record databases and clinical data warehouses with clinician-confirmed diagnoses, treatment, and outcome data). This information provides the basis for differential diagnoses and treatment for patients who present similarly in the future.

An additional purpose of IT-OHC is to effect cost containment or decrease, together with improved clinical outcomes and increased return on investment (ROI). Worldwide healthcare organizations must comply with a host of accreditation standards, professional certification requirements, and legislated regulations. In the United States, the foremost organization for accreditation standards is the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), and there are regulatory equivalents in many other countries. In fact, JCAHO standards manuals are issued for most forms of care delivery organizations (for example, hospitals, skilled nursing facilities, and behavioral health organizations). Accreditation is an eligibility requirement for Medicare reimbursement, which constitutes at least one-half of most United States hospitals' revenue streams. IT-OHC can contribute significantly to accreditation compliance with minimal human effort (for example, reducing frequent review committee meetings and process monitoring by typically overworked staff) by applying the standard business process management capabilities of modeling, monitoring, and modifying.

Prescription: Business process management with complex event processing (BPMcep)

> *"In large organizations, tens of millions of events occur every day, but not all events or event occurrences are of equal importance. Providing insight requires the ability to determine when a pattern of related or seemingly unrelated events from one or more sources has occurred and then to coordinate the execution of the responses to that pattern of events. Recognizing the complexity, excessive time and cost that would be required to write custom code for such a solution, a software technology emerged specifically designed to address these requirements: Complex Event Processing (CEP)."*
>
> IBM white paper, *Empowering the business to sense and respond; Delivering Business Event Processing with IBM WebSphere Business Events*, July 2008, WSW14031-USEN-00, found at:
> http://www.ibm.com/search/csass/search?q=WBE+complex+event+processing&co=us&lo=any&ibm-submit=&sn=mh&lang=en&cc=US&en=utf&hpp=

To bring about the needed transformation in healthcare from trial-and-error to personalized and preventive (and even predictive), the medical care continuum must be managed in both its chronic and critical states (see Figure 4 on page 10).

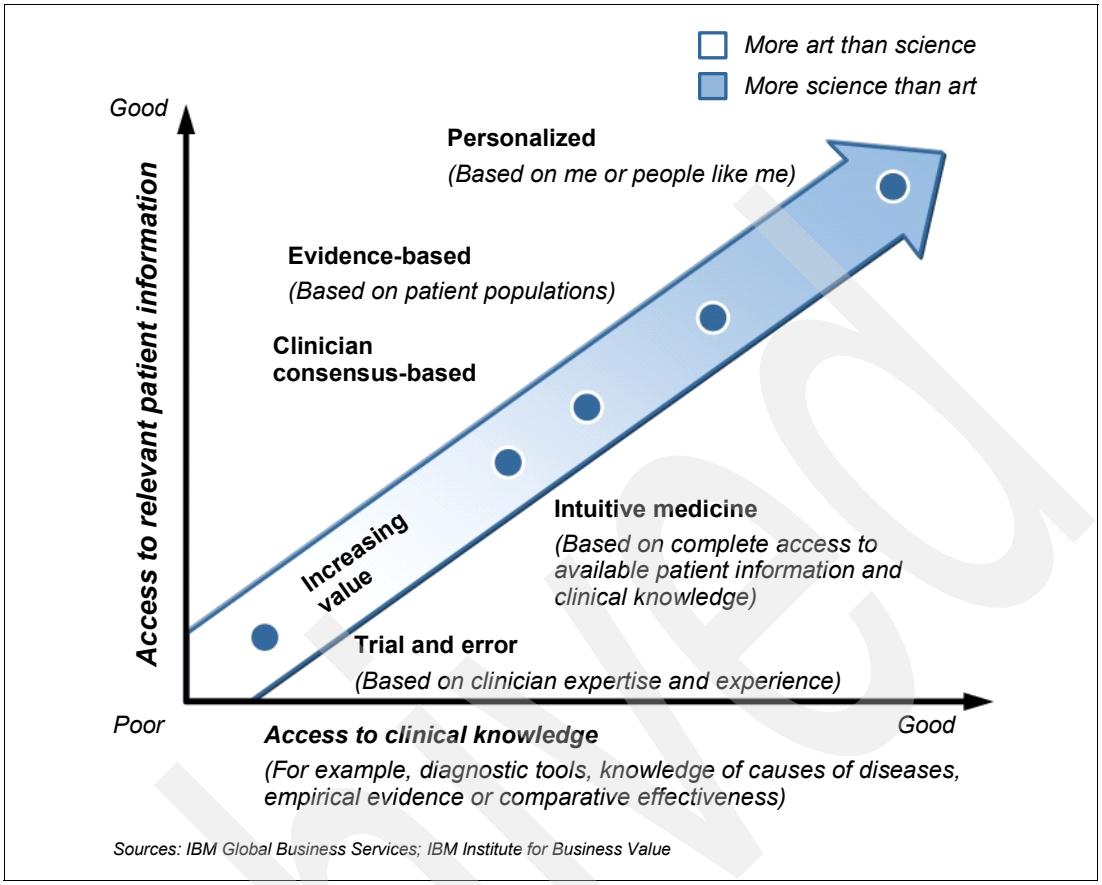

Figure 4 Progression to personalized care

To accomplish this transformation, IT must be implemented to enable a similarly significant paradigm shift: from principally request-driven and batch-oriented processing to principally complex event-driven and transaction-oriented processing, which is made accessible to participating providers and their patients using modern methods of communication and user collaboration through the web or cloud. Thereby, the clinical cognitive conundrum previously described can be mitigated in a cost-effective manner by BPMcep. As the body of clinical knowledge and relevant patient information grows, BPMcep is needed to enable the medical care value progression.

Business process management (BPM)

The IT discipline of BPM incorporates software and best practices, which, in tandem, improve the performance, visibility, and agility of business processes and facilitate innovation. In healthcare, business processes include an array of functions represented by the CHART acronym: clinical, heuristic, administrative, research, teaching. The purpose of IT-OHC is provide real-time and automatic responses to request-driven, time-driven, and complex event-driven detection (*chart*). We use this acronym not only as a convenient shorthand to describe the scope of healthcare processes, but also to keep our focus on the patient, as reflected by the medical record or chart.

BPM powered by Smart SOA can incorporate rigid and typically *siloed IT applications*[9] with human-centric, document-centric, or content-centric tasks to define newly choreographed processes. These processes also can include new software services that are coded from scratch or parsed from existing hospital information system (HIS) modules and ancillary or departmental applications. This *"wrap and reuse"* approach, including the intelligent interoperability that is obtained by BPM choreography, is the key value proposition of BPM powered by Smart SOA (see Figure 5).

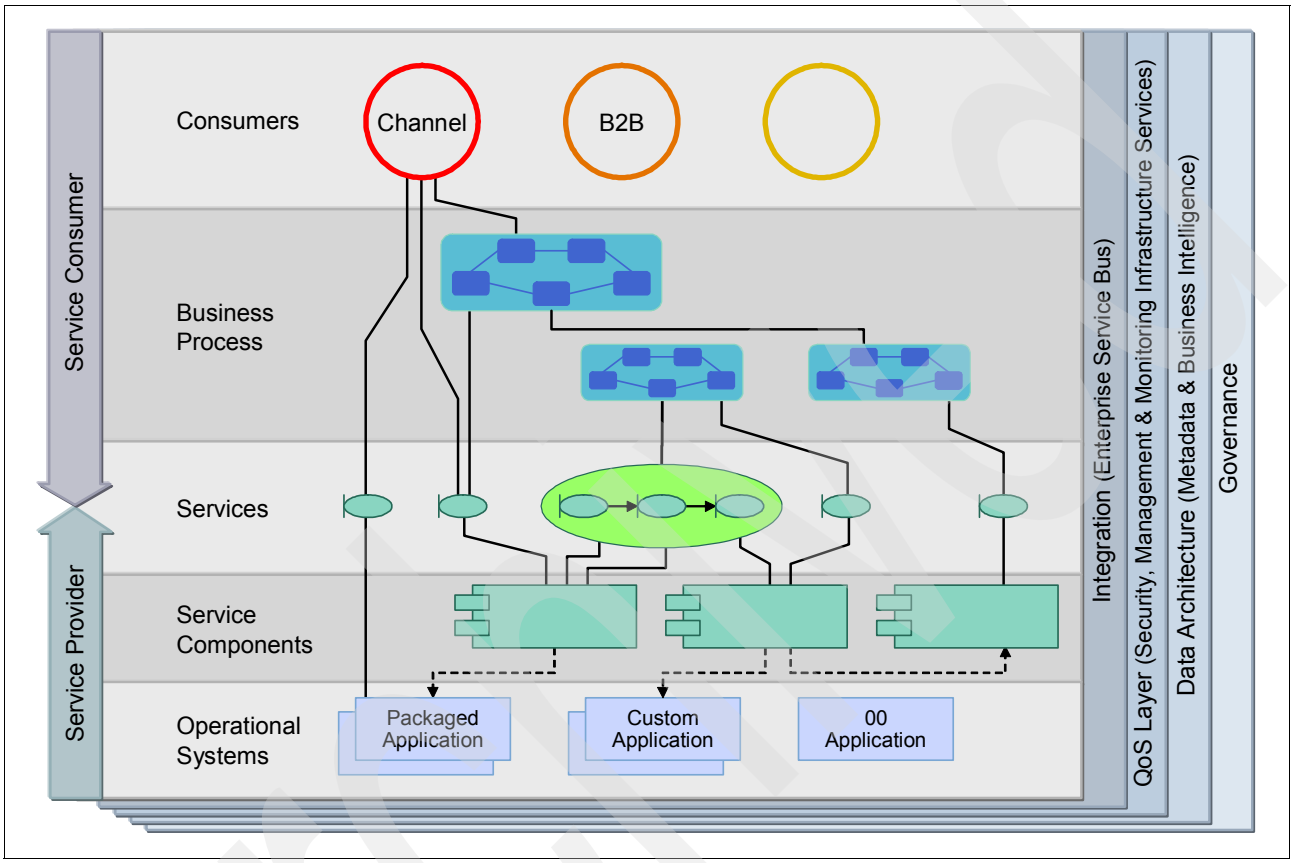

Figure 5 Choreography of BPM powered by Smart SOA services and processes

IBM's BPM powered by Smart SOA is the BPM software and services global market leader and is used by over 5,000 clients in over 30 countries. It is commercially available in three customizable foundational offerings (see Table 1).

Table 1 BPM powered by Smart SOA foundational offerings

Offering name	Purpose and orientation
WebSphere Dynamic Process Edition	Highly scalable, fault-tolerant dynamic process integration and automation within and among enterprises
WebSphere Lombardi Edition	Rapid process implementation, with a focus on project team collaboration, in the enterprise or in a cloud
FileNet® Business Process Manager	Content and document management, workflow, and collaboration among departments and between enterprises

[9] The term "siloed IT applications" refers to software that operates in isolation or, at best, with data exchange interfaces to other such applications or software systems.

BPM powered by Smart SOA uses, through interoperability, a globally renowned array of components and capabilities, including ILOG® rules management and optimization, Cognos® retrospective analytics, and Statistical Package for the Social Sciences (SPSS) prospective analytics. In addition, BPM powered by Smart SOA executes in the WebSphere software stack, which can run on virtually any proprietary or open source operating system. It provides connectivity for the enterprise (including Message Broker, which is compliant with Health Level 7 (HL7) standards) and the web (including aJAX capabilities of asynchronous Java™ 2 Platform, Enterprise Edition (J2EE) and XML). And, BPM powered by Smart SOA is compatible with Lotus® portal and collaboration capabilities (see Figure 6).

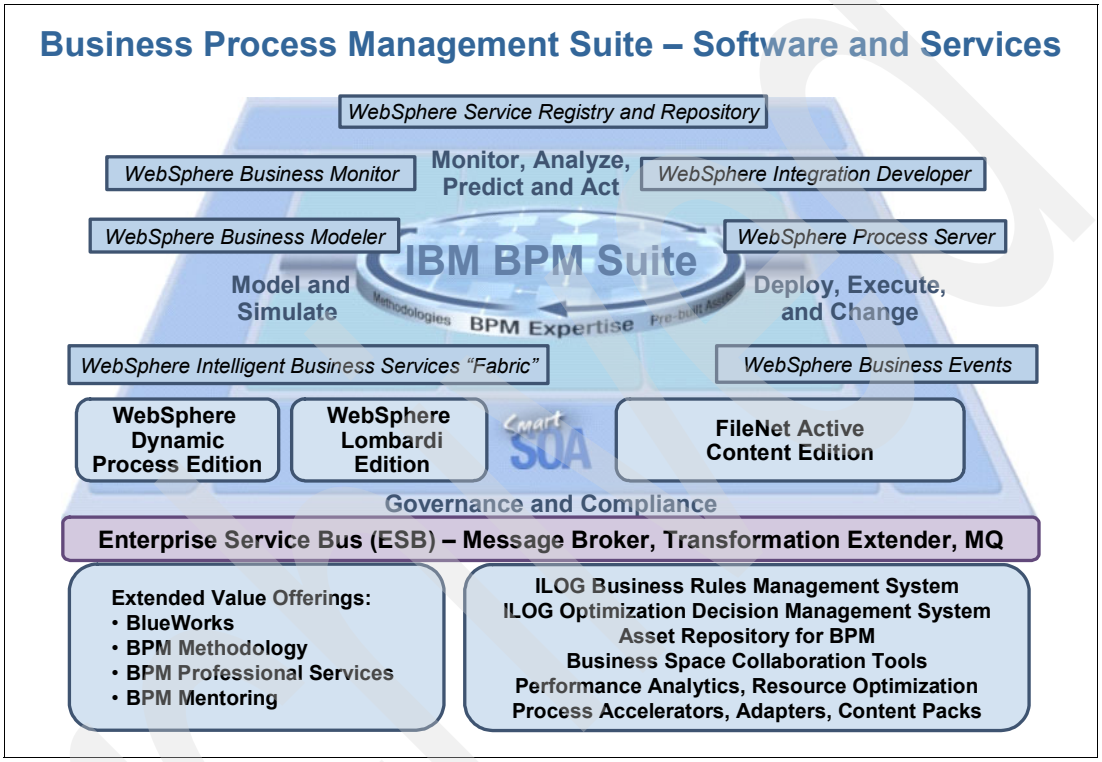

Figure 6 IBM BPM powered by Smart SOA software and services

Furthermore, BPM powered by Smart SOA includes state management capabilities, which enable tasks to be held in abeyance for long periods of time and then executed on a time-driven or event-driven basis. For example, we mentioned the female who, 35 years from birth, is notified through her personal digital assistant (PDA) that a mammogram is needed. Similarly, digital test procedures can be automatically initiated based on electronically archived maintenance schedules, and results can be reported for all electrical and electro-mechanical devices that are accessible through an organizational provider's local area network. These scenarios are examples of IT-PHC and IT-OHC at their best. In addition, the IBM Health Integration Framework (HIF) defines the array of interoperable software platforms, standards, accelerators, and globally renowned independent software vendor (ISV) IBM Business Partner client-facing applications (for example, Initiate Systems® Enterprise Master Person Index) for deploying healthcare solutions. These resources reduce time to value (TTV) while containing total cost of ownership (TCO) and maximizing ROI.

Events and complex event processing (cep)

In this Redguide, we define an *event* as an occurrence, for example, something that happens or does not happen, during a prescribed period of time or at a confluence of circumstances. The event can occur in the real world (for example, a patient's condition has or has not deteriorated since a specific prior event or time, or relative to another defined situation), in the digital world (for example, an application that is designed to generate a report about hospital census at midnight has failed to function as expected), or not at all. Event processing, therefore, is critical to the implementation of cep, without which actionable events cannot be detected, nor cep executed.

Cep is an elaboration of event processing, which includes the processing of a distinct event (or event object) in three phases: event capture, analysis, and response.[10] The three phases might be represented by one or more of the following functions:

- Monitoring
- Detecting
- Recording
- Filtering
- Organizing
- Analyzing (statistically or in another algorithmic manner)
- Actuating (a digital consumer, such as a processor or other electronic device)
- Reporting data, information (the analytic confluence of data), or even knowledge (a new understanding or concept derived from accrued data and information)

For cep to have its maximum beneficial effect, each defined event must be detected in a timely manner (ideally, in real time), and its significance understood in the context of existing data, information, and knowledge by means of rapid analysis and interpretation.

Event-driven architecture (EDA)

Event-driven architecture (EDA) is an architectural style of organizing and utilizing distributed IT capabilities and components in processes, sources, and data sessions, as needed, to support simple or complex event processing (see Figure 7 on page 14).

By definition, an EDA system implements the following five principles:

- Individuality: Each event is transmitted individually. The event producer does not allow a batch of events to accumulate before sending the first batch.
- Push: Notifications are transmitted by the event producer, not queried or called by the event consumer. Therefore, the event producer decides when it will send a notification. This approach minimizes the time lag between the real-world event and sending the notification message. By contrast, a pull, or request-driven system, always has delay or latency, because the consumer does not know when to look for the event data, so the message must wait for a period of time.
- Immediacy: The consumer software component does something in response immediately after it receives the notification. (This approach is always true in a simple event processing system, although the consumer's response in a cep system sometimes is merely saving the event data for later use.)
- One-way: In an EDA, notification is a *"fire-and-forget"* type of communication. The producer emits the notification and goes on to do other work, or it can end processing and shut down. It does not get a reply or any other return message from the event consumer.

[10] K. Mani Chandy and W. Roy Schulte, from IBM-commissioned special edition mini-book *Event Processing: Designing IT System for Agile Companies,* 2010, McGraw-Hill, New York, ISBN 978-0-07-163711-4

- Free of commands: A notification, such as a customer order, is a news report, not a specific request or command. It does not prescribe the action that the event consumer will perform. The consumer contains the logic that determines how it will respond.[11]

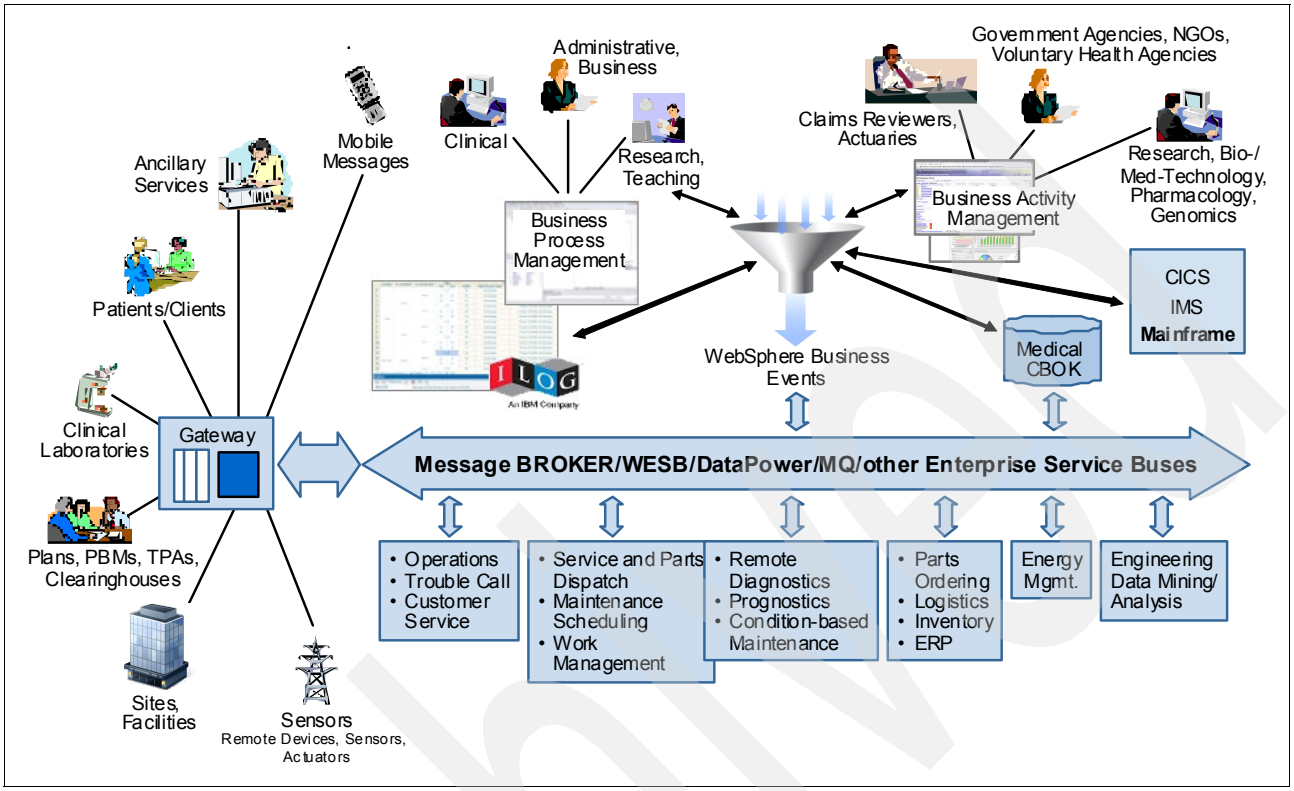

Figure 7 IBM event-driven architecture for cep

The key beneficial characteristic of EDA in healthcare is that it can support cep in an *always on* state, as opposed to request-driven or time-driven implementations, which require initiation at specific times or by specific agents (human or IT). EDA requires only a complex event-driven action to initiate the *event object* (meaning anything digitally described, ranging from a single command to an entire business process). EDA does not specify the actions to be taken, by which agents, at what times, and so forth. Therefore, it is open-ended (meaning that it is not linked inextricably to any other architectural component through logic coupling, but only by the fire and forget method). An event object in an EDA is not only open-ended and, therefore, operable by many other agents in the EDA environment; it also is conditional on the occurrence of any or all other event attributes, individually or in combination. Generally, the inclusion of BPM, which is interoperable with a complex event processor, and an enterprise service bus (ESB)[12] collectively constitute an EDA. EDA, therefore, is the key enabler for BPM with complex event processing (BPMcep).

[11] *Ibid*, p. 10

[12] The term “enterprise service bus” refers to a software communication capability that can connect to all other architectural components that are electronically accessible.

Business process management with complex event processing (BPMcep)

The BPM component of the EDA that is described and depicted in Figure 7 on page 14 is an interoperable combination of significant BPM components (see Figure 8).

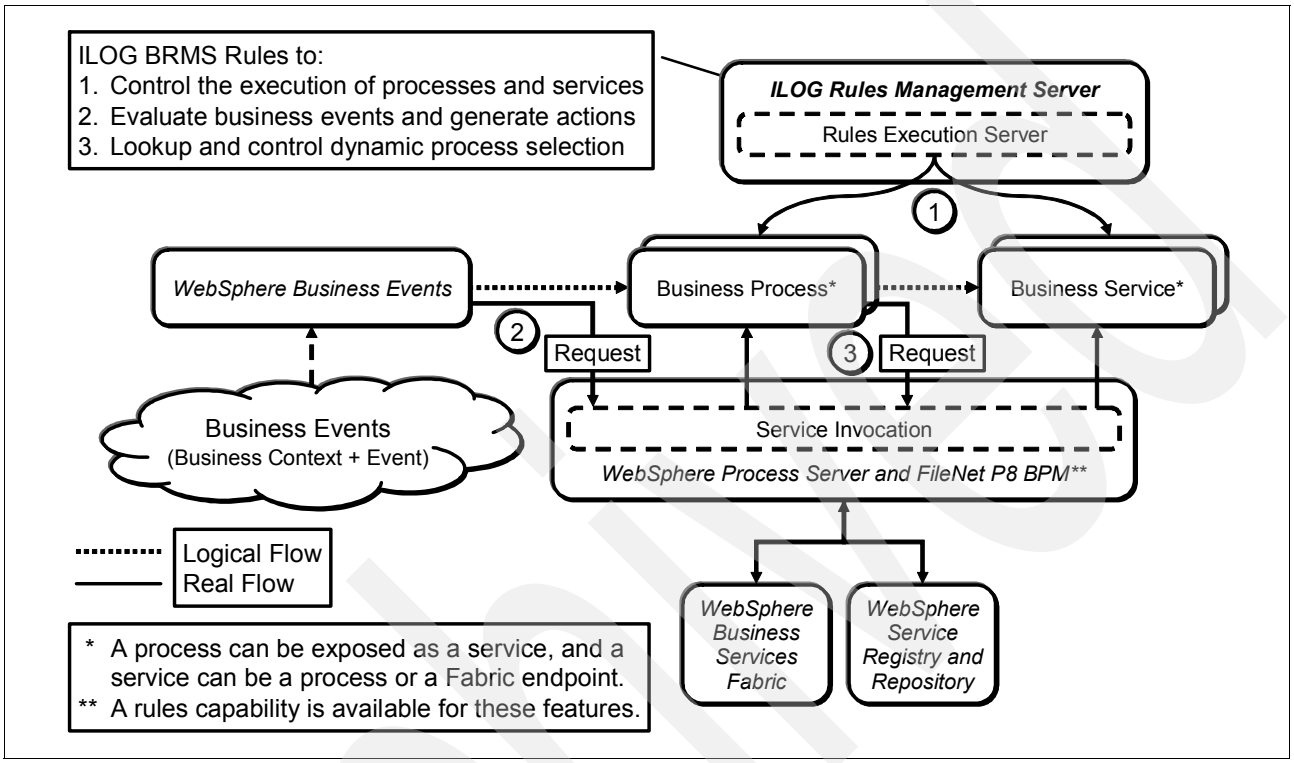

Figure 8 IBM EDA BPM component interoperability

The EDA architecture, enabling the union of cep and BPM in a common design-time model and runtime instance, creates the following complex event-driven process opportunities[13]:

- *"A single event can trigger a new process instance [WebSphere Business Events].*
- *A business process monitor [WebSphere Business Activity Monitor] can use complex events to track and report the health of a process and its individual instances.*
- *A single event can trigger a new activity or sub-process within a process [WebSphere Business Services Fabric].*
- *The runtime orchestration or workflow engine [WebSphere Process Server] can make decisions on process flow based on the (non)occurrence of complex events.*
- *An activity can emit a new event notification [WebSphere Business Events and ILOG JRules Business Rules Management System] to trigger another process or activity.*
- *Complex event management software can identify a threat or opportunity situation that triggers a new business process instance.*"

[13] Chandy and Schulte, op. cit., page 51, Figure 6-1

The implications of these capabilities for IT-PHC and IT-OHC are virtually endless, and they are awe-inspiring in the context of the current healthcare system problems:

- The impediments of the clinical cognitive conundrum
- The increasing accreditation, regulatory compliance, and process complexity
- The accelerating magnitude and complexity of the medical CBOK
- The reduction of resource quality and quantity available for healthcare practice development and care delivery

Prognosis: A cost-effective outcome

"The appropriate exchange of health information across our system through health information technology can improve coordination of care and facilitate a collaborative approach to keeping patients healthier. But we need to do more. The public and private sectors need to put the necessary focus on building the electronic healthcare platform of the future. Doctors and patients need these solutions now; the faster we build the health information highway, the sooner quality of care will improve for all of us."

Dr. Lonnie Reisman, Chief Medical Officer, Aetna Life & Casualty Company, announcing Collaborative Care in the Cloud with IBM: "In Push to Digitize Patient Insurance Technology Records, Aetna Humana Partner to Kick-start Electronic Health Records", by Tracey E. Schelmetic in TMCNet Healthcare Technology, August 10, 2010, found at: http://healthcare.tmcnet.com/topics/healthcare/articles/94780-push-digitize-patient-insurance-technology-records-aetna-humana.htm

IT-PHC and IT-OHC enabled by BPMcep

Unlike the EMRs and PHRs currently available, IT-PHC and IT-OHC combine data, information, and knowledge archives with agile and dynamic business processes. These instantiations of BPMcep run perpetually to execute both patient healthcare and provider operations processes using event detection, analysis, and response; decision making; content management; and analytic and predictive capabilities.

The scope of IT-PHC includes automated, real-time BPMcep support for patients in their chronic care states (see Figure 9 on page 17). This support is an elaboration on the medical concept of "*the bridge from bench to bedside*." The *bridge* can be infinitely widened and shortened with the instantiation of BPMcep-enabled IT-PHC at the POC, including feedback to and from the medical CBOK in real time. The principal result to be expected from such an implementation is twofold: maximum wellness maintenance for each individual in the chronic care mode, and minimum duration with maximum cost-effectiveness in the critical care mode (meaning an episode of illness or hospitalization).

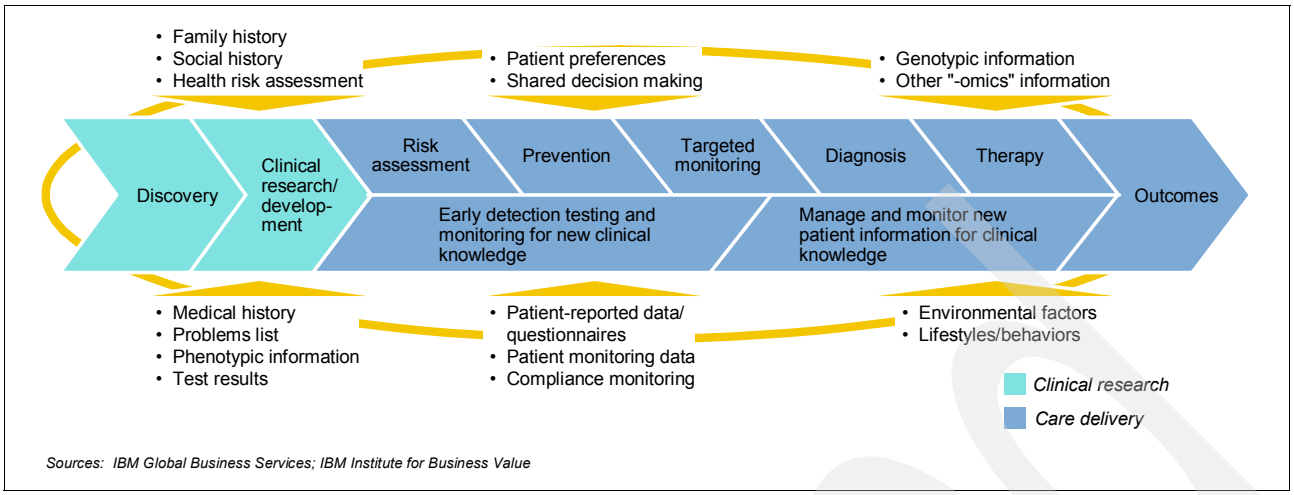

Figure 9 The scope of personalized healthcare (PHC)

The scope of IT-OHC includes automated, real-time BPMcep support for patients requiring critical care and also organizational support for care and treatment management and for supporting administrative, research, and teaching processes.

Table 2 describes examples of technically feasible BPMcep implementations that meet selected JCAHO accreditation standards, which are the JCAHO equivalent of service-level agreements (SLAs).

Table 2 Selected JCAHO hospital standards and BPMcep implementation

JCAHO 2009 accreditation standard type and number	**Category, chapter, and standard name**	**Typical BPMcep clinical or administrative process functionality and components**
National Patient Safety Goals (NPSG): Hospital-specific goals	A version is available from the JCAHO for each care delivery organization type.	
NPSG.01.01.01	Improve the accuracy of patient identification.	Executes during patient admission process and invokes master person index to validate patient ID.
NPSG.02.01.01	Improve the effectiveness of communication among caregivers.	Notifies each staff member with a patient-specific assignment (for example, hospitalist, nurse, or therapist) of the patient status, location, or orders change at the time of the change.
NPSG.03.03.01	Improve the safety of using medications.	Checks at the time of the order and reports to caregiver and pharmacist regarding adequacy, efficacy, and contraindications.
Universal Protocol (UP)	This standard applies to all care delivery organizations types.	
UP.01.01.01	Conduct a preprocedure verification process.	An instance of IT-OHC automates the "*never event*" prevention process that is designed by hospital management.

UP.01.02.01	Mark the procedure site.	A human task, including user-identified confirmation, requires verification that the site has been marked for the process to continue.
UP.01.03.01	A timeout is performed immediately prior to starting procedures.	A smart form task requires the completion of a checklist previously customized for the surgical procedure underway, without which electrical power to the operating table lighting or another indispensable facility is interrupted.

Case studies

The following case studies describe IT-PHC and IT-OHC implementations, as enabled by BPM powered by Smart SOA components. Each case study defines the challenge, solution, and benefits that are relative to the purpose and scope of the implementation. The first case study is hypothetical. The other case studies are implementations by IBM clients.

Case study 1: Chronic obstructive pulmonary disease (COPD) status monitoring

This case study, although hypothetical, has been implemented by IBM in demonstration format depicting IT-PHC and IT-OHC operating in tandem. It depicts the “handing off” of patient medical management from the provider organization (in this case, a hospital) to the patient, with ongoing participation as needed by the patient’s physician.

Challenge

At a typical hospital, per JCAHO accreditation standards, continuing care instructions are provided to patients at discharge. However, patient noncompliance owing to lack of will or understanding might result in the deterioration of medical condition and, often, readmission. In this case, the patient being discharged has been treated for chronic obstructive pulmonary disease (COPD) and is instructed to measure vital signs on a specified schedule. The patient’s physician will begin proactive monitoring if problematic trends are noted in the patient’s condition. How, then, can the probability of patient compliance be maximized with minimal but effective provider participation?

Solution

An instance of IT-OHC has been providing medical management support of this patient’s course in treatment for COPD. The instance of IT-OHC detects that discharge is underway, and it produces a smart form to drive and record the following dialogue and activity series:

- The physician asks the patient if that person is an active smoker:
  - If not, the physician proceeds with the discharge.
  - If so, the case manager is alerted to schedule a smoking cessation interview:
    - If the interview is not scheduled in the allotted time frame, IT-OHC sends an alert to the patient’s case manager and the case manager’s supervisor.
    - If the interview is scheduled in the allotted time, the discharge process continues.
- If the patient is an active smoker and has been interviewed, the patient is given a home health monitoring device from which vital signs will be reported to the patient’s IT-OHC and IT-PHC instances.

- After the patient's discharge, the monitoring device forwards vital sign readings to a data analysis server that is monitored by both IT-PHC and IT-OHC. The data is constantly evaluated and correlated using cep to determine if the vital signs are outside of acceptable ranges.

Solution event patterns:

- Event pattern 1

  Vital statistic readings indicate the patient might be smoking, as determined by the patient's IT-PHC instance. The instance communicates this finding to the patient's IT-OHC instance for comparison with other relevant inpatient findings that indicate continued smoking. The IT-OHC determines that the patient's readings in comparison with other findings do not indicate continued smoking, so the finding is noted in the chart for optional review by the physician, and no further action is taken.

- Event pattern 2

  A similar pattern is noted within a predefined period. Vital sign measurements are recorded, as are variables, such as medications, that the patient takes that might cause false positives. Based on these findings, it is confirmed that the patient is smoking. Complete vital statistics are relayed to the patient's physician with a recommendation for therapeutic intervention.

Benefits

The combined implementation of IT-OHC and IT-PHC for a specific patient benefits both the patient and the physician in three ways:

- The physician is kept aware of the patient's behavior and physiological data, resulting in the opportunity to intervene proactively with counseling, medication, or other means.
- The patient's condition is monitored automatically without the expense of a hospital stay or professional time and expense.
- Continuous, automated monitoring and timely, professional intervention when needed minimize the likelihood of physical deterioration and readmission.

Case study 2: University College London Hospitals (UCLH) patient tracking

UCLH is one of the largest National Health Service (NHS) trusts in the U.K. It offers first-class, acute, and specialist services in a state-of-the-art facility. UCLH experienced considerable challenges that have been overcome by this partial example of IT-OHC implementation.[14]

Challenge

UCLH handles the needs of approximately 500,000 patients every year who are referred to the Trust from general practitioners (GPs) and other NHS hospitals. In 2004, the U.K. government stated that patients must start treatment within 18 weeks of referral from a GP (also known as *18 week Referral To Treatment* or *18wkRTT*). All healthcare trusts within the U.K. had to adhere to these challenging requirements by December 2008.

[14] *University College London Hospitals (UCLH)*, found at:
http://www-01.ibm.com/software/success/cssdb.nsf/CS/VCHN-8869FP?OpenDocument&Site=default&cty=en_us

To meet the new targets, UCLH needed to implement a complex management system to meet the following challenges:

- Handle high volumes of data.
- Pull information from 270 disparate clinical IT systems.
- Model patient treatment pathways.
- Provide crucial real-time notifications and alerts. For example, the system provides alerts about patients in danger of breaching the 18-week target, so that resources can be proactively directed to ensure that clinical services are delivered on time.

Solution

UCLH used Lombardi Blueprint for a series of process discovery sessions, which led to a mapping of the administrative processes. Although highly complex, it was found that approximately two-thirds of the documented processes were identical and that the variations concerned how various therapy and care services needed to be handled. The Lombardi Teamworks-based patient tracking system (PTS) enabled UCLH to model and implement processes to manage various patient pathways. It also linked directly to those core IT systems that hold information about patients (appointments, diagnostic tests, and treatment) so that when treatment is first administered, whether therapeutic or for a period of advised observation, this treatment is noted and managed.

Benefits

Previously, each appointment list was managed individually by the department concerned, with no awareness of where a patient had to wait in the pathway or for how long. As an automated process, appointment list management is much more efficient and allows much earlier rectification of issues.

> *"As an illustration of the magnitude of the task, our Trust cancer team previously tracked every one of its cancer patients, about 270 yearly, manually, through their treatment pathway from outpatient, through diagnostics and therapy. There is a target of 62 days for the treatment of cancer patients, and the management of this process took a team of seven full-time people. If we extrapolate that, then we are talking about the Trust needing to employ an extra 800 - 900 people to manage the treatment of our 500,000 patients annually ... The new ... PTS not only enables us to better manage our clinical pathways and resources, but also helps us improve the patient experience by reducing uncertainty in the scheduling of treatments,"* explains James Thomas, IT Director of University College London Hospitals NHS Foundation Trust.[15]

Case study 3: Mayo Clinic medical imaging workflow

Mayo Clinic, an internationally-regarded group medical practice, is known for the dynamics of speed and efficiency in performing medical tests and specialist consultations for all patients. Continually identifying and implementing new methods to further improve quality and timely patient care is deeply embedded into the culture of Mayo Clinic.

Challenge

Medical imaging is one example of advanced technology that requires the intervention of human expertise to realize its full clinical potential. Imaging technologies such as computed tomography (CT) scanning and magnetic resonance imaging (MRI) have revolutionized medicine by providing ultra-detailed - and non-invasive - tools to detect and diagnose internal abnormalities. In many chronic diseases, this is generally done by comparing scans from two or more time periods to detect changes in either the size or location of an abnormal mass or condition. While these comparisons would not be possible without advanced imaging technologies, the sheer magnitude of information that is generated poses a challenge to the radiologists who analyze it. Most CT and MR examinations consist of hundreds to thousands

[15] Ibid

of images that must be compared. Facing this challenge, Mayo Clinic saw imaging informatics as a way to transform its medical imaging processes.

Solution

Mayo Clinic collaborated with IBM in an effort to target the especially complex and manual process of identifying brain aneurysms, the abnormal bulging outward of arteries in the brain. To maximize clinical effectiveness, Mayo Clinic and IBM needed to weave this automatic “read” seamlessly into radiology workflows. Using IBM WebSphere® Process Server to model and orchestrate the process flow, IBM worked with Mayo Clinic radiologists to design a medical imaging workflow that enables radiologists to review results of detection algorithms in the course of their typical activities using standard image review workstations. Although Mayo Clinic selected Magnetic Resonance Angiography (MRA), which produces pictures of blood vessels in the brain, the solution was designed to be configured easily to any type of imaging technology. When MRA images are acquired, they are routed automatically to the servers, algorithms developed and commercialized by Mayo Clinic for use on any technology platform analyze them to find and visually mark potential aneurysms. Results of the detection algorithm can then be routed to the Mayo Clinic Picture Archiving and Communications System, where they are viewable on the radiologist’s workstation.

Emblematic of the SOA approach that IBM followed, the solution employs a library of reusable Web Services that perform specific functions. The workflows at the heart of the solution, orchestrated by IBM WebSphere Process Server, invoke these services as needed. (See Figure 10.)

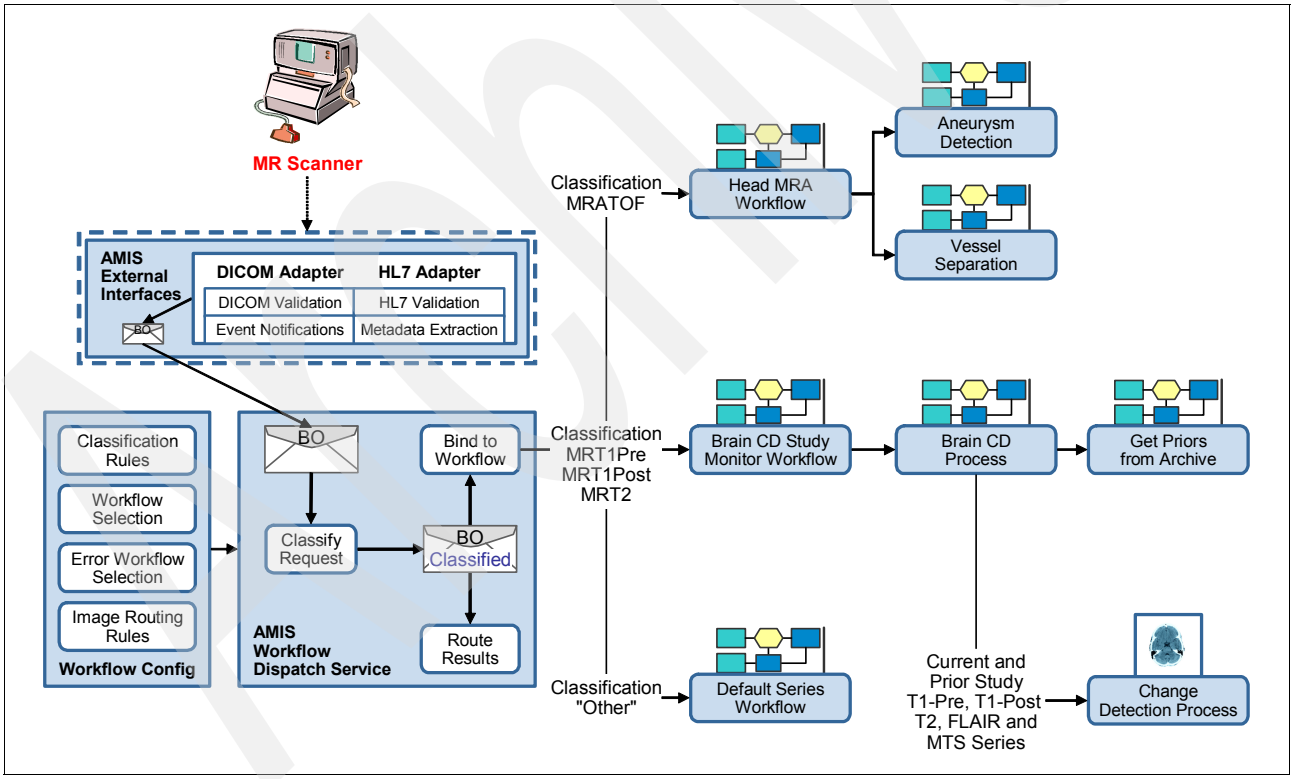

Figure 10 EDA of Advanced Medical Imaging System (AMIS)

Benefit

The impact of the new algorithm combined with a workflow engine is that Mayo Clinic radiologists have access to new tools to aid in interpretation of MRA images in a timely and efficient manner. For Mayo Clinic, the benefit has been much more than time and cost savings. Mayo Clinic now has the enhanced ability to more accurately diagnose aneurysms,

and improve the quality of patient care offered through this new imaging workflow. In addition, Mayo Clinic has the opportunity to license its aneurysm detection technology to other medical centers for the benefit of patients worldwide.

The reliance of the solution on reusable assets will make it much easier for Mayo Clinic to extend this service model to other radiological processes. Bradley Erickson, M.D., Ph.D., head of Mayo Clinic's Radiology Informatics Lab and Medical Imaging Informatics Innovation Center co-director, sees Mayo Clinic's medical imaging initiatives as reinforcing its constant emphasis on improving patient care. "*Our imaging and radiology work will help provide faster and better information for our physicians and improved treatments for our patients,*" says Erickson.[16]

Case study 4: Hannover Medical School patient tracking and prioritizing

Founded in 1965, Medizinische Hochschule Hannover (MHH), or Hannover Medical School, is one of the world's leading university medical centers. The school's world-class research and patient care help set national and international standards. With so many patients in various stages of medical treatment, MHH needed IT to improve its ability to provide care at the POC.

Challenge

MHH wanted to enhance patient safety, improve the quality of its treatment services, reduce patient waiting time, optimize its processes, and better support its special operating conditions. However, the school lacked an IT solution to facilitate tracking the patient from admission through discharge in order to ultimately optimize the treatment process. Typically, patient information was entered into the hospital information system (HIS) after the patient arrived, but after that, IT support ended. Patients were ordered into the treatment area according to the sequence of arrival, and there was no system in place to track admissions by medical priority.

MHH wanted to optimize its patient treatment process by prioritizing and tracking patients from admission to discharge, based on medical priority and treatment. It needed to deploy a tracking solution to not only integrate with the existing HIS, but also automatically gather and record data about patient treatment throughout the hospital stay, including details regarding waiting times and patient location. MHH wanted to use its existing wireless local area network (WLAN) for this tracking solution. In addition, the solution needed to be scalable and able to include other enterprise-wide capabilities, such as helping MHH locate and track medical devices. This configuration reduced the need for investment in new technology each time that the hospital deployed a new tracking solution, while optimizing the patient care process by locating devices and other medical assets faster.

Solution

MHH engaged IBM Global Services (Global Business Services, IBM Global Technology Services, and Integrated Technology Services) to create a comprehensive tracking solution. The Global Business Services team designed and implemented the solution architecture using an SOA. The solution uses radio frequency identification (RFID) technology to track and record each patient or device automatically. The information is uploaded to a portal server, providing an easy-to-use user interface (UI) for doctors and medical staff to track patient location, treatment information, and wait times.

The tracking solution uses a cep engine to aggregate location changes and other events automatically into process-relevant information, resulting in data, such as "patient waiting for doctor in room *x*," ultimately improving service to patients during their stay in the hospital. The solution is adaptable and scalable, enabling the hospital to deploy other tracking solutions for

[16] *Mayo Clinic helps radiologists pinpoint potential problems*, found at: https://www-01.ibm.com/software/success/cssdb.nsf/CS/JSTS-7WNNFY?OpenDocument&Site=default&cty=en_us

medical devices and assets without investing in new hardware or system architecture to support such solutions. The solution is currently being piloted within the hospital's trauma surgery department.

Benefits

SOA makes the current solution highly scalable and adaptable so that it ultimately can become the basis for a fully integrated enterprise-wide tracking solution. The solution will improve overall patient care by helping doctors locate and prioritize patients from the moment they enter the hospital until the time they are discharged. "*The tracking solution, built using state-of-the-art technologies like RFID, along with an open source approach, provides the medical school with an inexpensive entry-level tracking solution that we can build on for the future*," says Timo Stübig, Physician and Project Manager at MHH.[17]

Case study 5: University of Pittsburgh Medical Center Smart Room

University of Pittsburgh Medical Center (UPMC), which is located in Pittsburgh, Pennsylvania, U.S., and IBM decided to build on their shared vision of the future of healthcare by forming a unique and far-reaching partnership that is aimed at developing and commercializing new clinical solutions. One of UPMC's defining qualities as an organization is a pervasive entrepreneurial culture that is driven by an intense commitment to improving patient care through clinical innovation. The IBM partnership with UPMC uses this quality and demonstrates how a shared vision of healthcare innovation can produce real results.

Challenge

As the current national discussion around healthcare reform has shown, the battle to improve healthcare delivery to make it safer, more efficient, and more cost-effective has many fronts. One of the most important fronts is the inpatient nursing unit environment within hospitals, which in many ways represents the backbone or the front line of the healthcare delivery system. As the point of most intensive contact between caregivers and patients, nursing units are the scene of a constant choreography of activities, the majority of which are routine and predictable. Patients are monitored and tested, administered medications, and, if necessary, repositioned while in their beds to avoid pressure ulcers, all in strict accordance with guidelines for timing, frequency, and dosage.

Within this core framework of tasks, nursing staff are required to respond to sudden situations that routinely pull them away from their more structured regimens. These situations can include consulting with attending physicians, handling emergency situations, answering questions from a patient's family, and above all, providing compassionate care at the patient's bedside. These situations also include the kind of critical thinking that is required to spot and solve problems. In addition, the nursing staff must transition seamlessly from one shift to the next shift to ensure the continuity of care and also ensure that clinical warnings are not missed in the transition.

Solution

Within this task mix, UPMC saw the opportunity to improve the quality of care and timeliness of completed tasks by structuring parts of the nursing unit workflow, where practical. UPMC also provided the nursing staff with information support, enabling nurses to focus less on remembering their complex task list and, when a task is complete, helping them easily chart the task as completed at the POC. Using its own clinical expertise and IT staff, UPMC

[17] *Medizinische Hochschule Hannover deploys an RFID patient tracking system that improves care and reduces wait times*, found at: https://www-304.ibm.com/jct01003c/software/success/cssdb.nsf/CS/CPOR-7UGJFU?OpenDocument&Site=default&cty=en_us

designed and implemented a workflow module that is known as *Smart Room*, which uses interactive, in-room screens to present nurse or nursing support personnel with a prioritized sequence of tasks to perform for a given patient (in that patient's room), and a suggestion regarding which room to visit next and which patient to care for.

UPMC's Smart Room solution is supported by real-time linkages to key clinical systems, such as pharmacy and lab services. At any given time, the underlying workflow module compiles a list of required tasks from various back-end systems, using algorithms that are derived from UPMC nursing staff activities that indicate the order in which tasks must be performed. To control access to this information, Smart Room employs indoor positioning technology from IBM Business Partner, Sonitor Technologies, which uses in-room ultrasound sensing devices to identify the nurse, or any other hospital staff member, entering the room. When authenticated, the nurse calls up the task list on the screen within the room. After performing the task, the nurse can easily confirm on the touch screen that the task was completed, which triggers the automatic update of the appropriate electronic records. The nurse can also view additional clinical information on the screen in the room with the patient's permission.

This rules-based and intelligence-based adaptability ensures that UPMC patients receive the right treatment at the right time. Even though technology enables this intelligence in the form of algorithms, the logic that guides it comes directly from the clinical knowledge of UPMC nurses and physicians. Rather than trying to industrialize nursing or deploy a new gadget, this technology is making routine tasks easier, allowing nurses more time to do what they are trained for: critical thinking and spending time with patients at the bedside.

Using IBM WebSphere Message Broker to create an ESB between the solution and its clinical systems, UPMC was able to redesign the solution using an SOA with open interfaces. In addition to making it easier to deploy the Smart Room solution more broadly within UPMC, this SOA-centric approach also facilitates the UPMC and IBM joint strategy of offering innovative clinical solutions, such as Smart Room, to other healthcare providers as commercial offerings. Moreover, UPMC can deploy solutions on its existing virtualized infrastructure that is powered by IBM hardware and software, which helps guarantee the high levels of availability that all clinical applications require.

Benefits

"*Improving patient care is the fundamental driver behind all of UPMC's clinical innovations and represents the primary benefit of the Smart Room initiative*," explains David Sharbaugh, Senior Director of UPMC's Center for Quality Improvement and Innovation. "*Smart Room improves the quality of care by providing information directly to the bedside—where it's needed most—not to a computer in the hallway or to a workstation at the nursing desk*," says Sharbaugh. "*The less nurses have to focus on mundane, predictable tasks, the more they can focus on the human, compassionate side of patient care*."[18] The same dynamic holds true for the time spent documenting completed tasks.

By sharply reducing this part of the nursing workload (the reduction was 57% in the initial 22-bed evaluation unit), Smart Room enables nursing staff to spend more time at the bedside and less time walking to and from a computer terminal. Finally, Smart Room is also expected to improve patient safety by providing nursing staff with bedside access to detailed, up-to-the-minute information about not only prescriptions and doses, but also allergies and risk factors, such as patient falls, all of which give caregivers the tools that they need to make the right clinical decisions.

Chief Quality Officer, Tami Minnier, RN, sees the Smart Room project as embodying the vision that guides UPMC's innovation efforts. "*Our aim is to provide the right care, at the right*

[18] *UPMC reshapes the nursing unit with SmartRoom*, found at: https://www-304.ibm.com/jct01003c/software/success/cssdb.nsf/CS/GMMY-86MLVJ?OpenDocument&Site=default&cty=en_us

time, all the time," says Minnier. "*Smart Room is an example of how our partnership with IBM is helping us meet that goal*."[19]

Summary

Clearly, BPMcep is the much-needed and long-overdue IT approach for IT-PHC and IT-OHC. IBM BPM powered by Smart SOA can implement BPMcep in a manner that healthcare providers can use to discover, interact, and optimize for continuous process improvement, thereby attaining quantum improvements in medical management, operational cost-benefit, and clinical outcomes.

Why IBM is the best choice

Why IBM? The IBM interest in and commitment to global healthcare and life sciences IT is not only as a purveyor but also as an innovator. IBM participates in fundamental and applied healthcare research, typically in joint ventures with globally recognized organizations. These efforts have resulted in over 600 patents in life sciences, healthcare, and medical devices that have been granted to IBM. In addition, IBM is an active and influential corporate citizen, interested in national healthcare policy and development initiatives (for example, the Patient-Centered Medical Home). Healthcare benefits for its over 450,000 employees worldwide cost IBM over USD1.3 billion annually.

The IBM commitment to healthcare has been demonstrated over time. As a thought leader, IBM was the first corporation in the United States to formalize the policy that its employees' personal medical information be prohibited from use in human resource and corporate benefit management activities. Also, IBM is a founder and corporate participant in the Patient Centered Primary Care Collaborative, which is a not-for-profit voluntary health organization headquartered in Washington, D.C., that advocates for the development and implementation of cost-effective medical care.

Why BPM powered by Smart SOA? The answer is threefold. The IBM BPM powered by Smart SOA software suite provides these benefits:

- *Comprehensive capability*: Built-in capabilities, such as a modeler with simulation, monitoring of key performance indicators (KPIs), interoperability complete with user interfaces for non-technical design and content generation tasks (for example, rules definition, long-running tasks, and orchestration of human, content, and IT tasks).
- *Strength of the stack*: Because BPM powered by Smart SOA is situated in the WebSphere stack, it includes IBM-designed, crucial connectivity for the enterprise (ESB, WebSphere Transformation Extender, and WebSphere Message Broker), the web (aJAX), and also IBM portal technology.
- *Intelligent interoperability*: Including world-class components, such as ILOG JRULES and CPLEX®, FileNet, Cognos, SPSS, Lotus collaboration, and Tivoli® system and platform management capabilities.

Today, advanced analytics can lead to earlier diagnosis and intervention, while accelerating the growth of the medical CBOK. Raw data from clinical use can be converted into evidence and actionable information for clinicians and patients. With the amount of patient information that is amassed over time, it is critical that doctors have direct access to IT tools that integrate and analyze data from multiple sources. To maximize the cost-effectiveness of care and minimize medical errors that can lead to iatrogenic disabilities or loss of life, these IT tools

[19] Ibid

must be capable of automatic operation as a function of current clinical and administrative events that call for immediate intervention. IT-PHC and IT-OHC based on BPMcep can realize these critical capabilities for any healthcare provider that understands the value proposition and will act to benefit from it.

Realizing the BPMcep-enabled IT-PHC/IT-OHC vision with IBM

The five case studies previously presented show that IBM has successfully assisted clients in implementing the vision of IT-PHC and IT-OHC based on BPMcep technologies and the WebSphere application and integration middleware software stack. IBM and its Business Partners continually collaborate on a variety of efforts to bring a more evidence-based approach to healthcare. IBM's commitment is demonstrated by the following successful implementations from around the world:

- Computer scientists are working with cardiologists to create a system that helps identify difficult-to-see patterns in symptoms and characteristics across a patient set that gives better insight into diagnoses and the comparative effectiveness of various treatments and outcomes.
- Researchers are working with the European HYPERGENES consortium to understand the interrelationships of genomic, clinical, and environmental factors underlying essential hypertension (EH). They are also helping to improve diagnostic accuracy and introduce new strategies for early detection, prevention, and therapy for individuals who suffer from EH. Through attempting to build a comprehensive EH disease model that is based on biological pathways, these researchers hope to identify new genetic variations that contribute to EH and the associated organ damage.
- Persons with chronic disease (those individuals around the globe who are aging and taking multiple medications) present additional challenges to the healthcare system. Scientists and mathematicians across IBM are using data mining, information management, and advanced analytics to build a system that can help us to better address adverse drug reactions and interactions, and provide insights for improved treatment plans.
- In China, IBM and the Peking University People's Hospital are building an evidence-based clinical care solution that focuses on chronic disease management. It integrates a comprehensive view of a patient's health data, best practices from previous diagnoses, treatment, research, and more to provide doctors with clinical decision support at the POC. The solution also incorporates a mobile platform that will enable doctors and nurses to provide remote care and monitoring services.
- Scientists are also combining their expertise in nanotechnology and biology to develop new applications for personalized medicine. Scientists have begun to develop the medical diagnostic tests of the future that can quickly and accurately analyze biological samples and test for a variety of diseases. IBM is also collaborating with Hoffmann-La Roche Inc to develop a nanopore-based technology that is expected to read and sequence human DNA quickly and efficiently for more personalized diagnosis and treatment.

Next steps for forward-thinking providers

You can realize the full potential of IT-PHC and IT-OHC with BPMcep.

Implementing BPMcep is practicable, and the results are predictable using IBM's BPM powered by Smart SOA software, services, and best practices (see Figure 11). Thousands of IBM clients in healthcare and virtually all other industries worldwide have demonstrated the power of implementing BPM capabilities using cep.

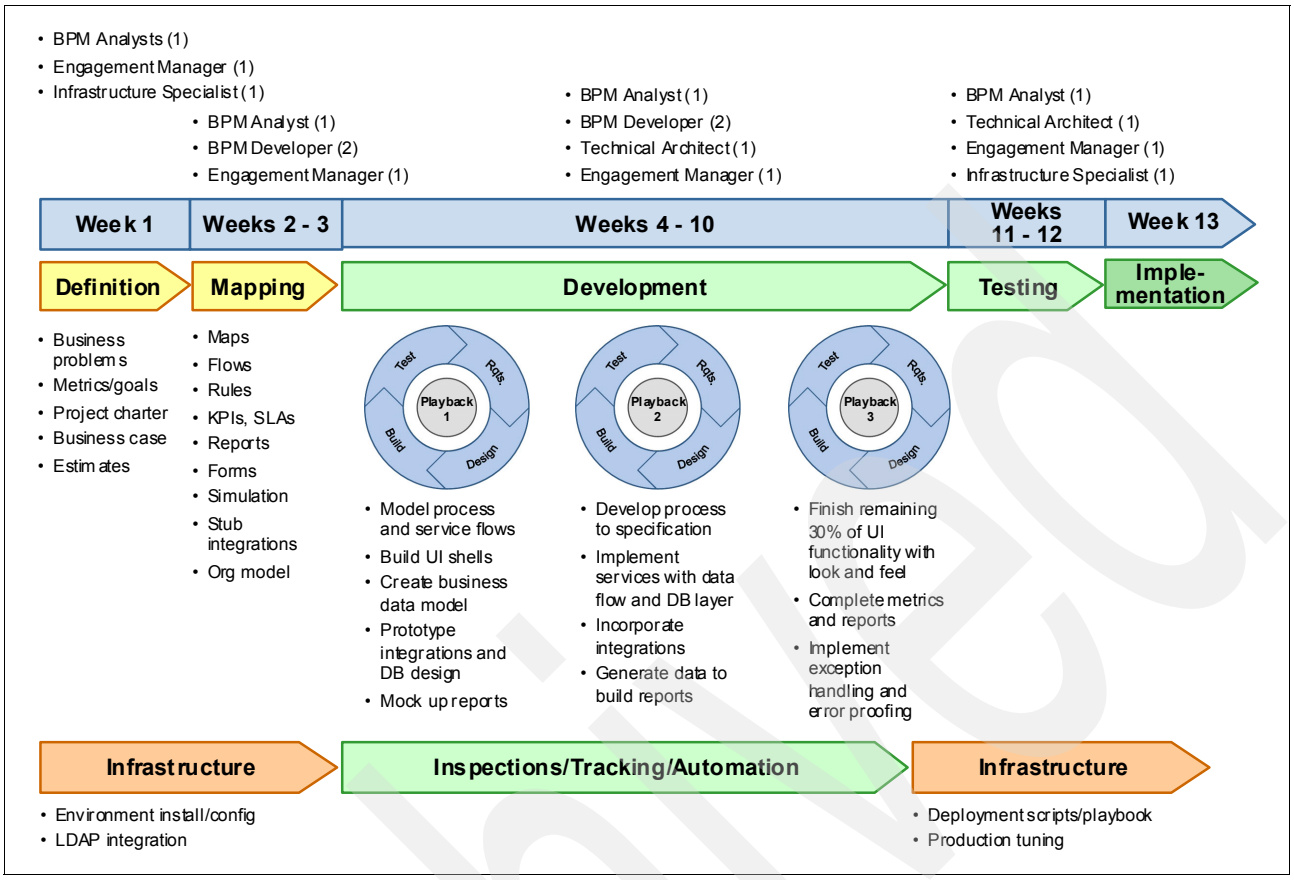

Figure 11 Ninety day IT-PHC/IT-OHC implementation plan

To learn more about how IBM can help you transform your healthcare provider and patient care processes, or for information about any IBM products mentioned in this Redguide, contact your IBM sales representative or IBM Business Partner today.

Other resources for more information

For further information, see the following resources:

- "Ambulatory care jobs rose in July, but hospitals continued downward trend" by Richard Pizzi in Healthcare Finance News, August 9, 2010, found at: http://www.healthcarefinancenews.com/news/ambulatory-care-jobs-rose-july-hospitals-continued-downward-trend
- "Study: Medical errors cost U.S. economy almost $20 billion in '08" by Chelsey Ledue in Healthcare Finance News, August 9, 2010, found at: http://www.healthcarefinancenews.com/news/study-medical-errors-cost-us-economy-almost-20-billion-08
- *The power of prevention: Reducing the health and economic burden of chronic disease*, United States Department of Health and Human Services, Centers for Disease Control and Prevention, 2003, found at: http://www.welcoa.org/freeresources/pdf/power_of_prevention.pdf

- *Potential Savings Under the AdvaMed Plan Associated with Health Reforms Focusing on Chronic Care Management, Prevention and Health Information Technology* by Kenneth E. Thorpe, Ph.D, Emory University Rollins School of Public Health, found at: http://www.advamed.org/NR/rdonlyres/03AE0ADD-3472-4F29-BC58-32EC0575AB67/0/healthreformsavingsthorpeFINAL.pdf
- *IT-enabled Personalized Healthcare* by Jim E. Adams, Edgar L. Mounib, and Amnon Shabo, IBM Institute for Business Value - Global Business Services 2010 Executive Report, page 1, found at: http://www-935.ibm.com/services/us/gbs/bus/html/ibv-it-enabled-personalized-healthcare.html
- Peter Orszag, Director of the White House Office of Management; "Budget Chief: For Healthcare, More Is Not Better," National Public Radio interview. April 16, 2009: http://www.npr.org/templates/story/story.php?storyId=103153156
- "Where can $700 billion in waste be cut annually from the United States healthcare system?" by Robert Kelley, Thomson Reuters, October 2009
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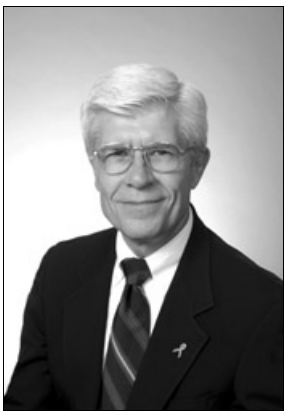

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