



Reactive to Adaptive Transforming Hospitals with Digital Technology*

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Transforming Hospitals with Digital Technology

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■ Industry Perspectives

During preparation of this report, we benefited from discussions with the following executives:

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Brad Bjornstad, MD, Chief Medical Officer; University Community Hospital

Siegfried Bocionek, Chief Operating Officer, Health Services Division; Siemens Medical Solutions

Phil Buttell, Chief Operating Officer; Centennial Medical Center

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Brandon Savage, MD, General Manager, Enterprise Solutions; GE Healthcare

Brigitte Shaw, Chief Executive Officer; Pepin Heart Hospital and Research Institute

Cindy Slaydon, RN, MSN, CHE, Chief Nursing Officer; Centennial Medical Center

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Philip Strong, MD, IT Physician Liaison; El Camino Hospital

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Mark Zielazinski, Chief Information Officer; El Camino Hospital



Executive Summary

Hospitals are widely criticized for not adopting information technologies more quickly. Many have taken a reactive posture, skeptically deferring the expensive purchases of technologies that can improve patient care and efficiency. PricewaterhouseCoopers believes that healthcare organizations in the reactive mode will fall behind the growing wave of digital hospitals, or adaptive organizations that are ready to surpass their competition by leveraging technologies that integrate information sent from laboratories, patient beds, pharmacies, physician offices, and even patients themselves. These digital hospitals are compressing processes, adapting to market forces, generating the quality data that payers increasingly demand, updating the clinical data that physicians and patients expect, and preparing for reimbursement changes that inevitably will occur.

PricewaterhouseCoopers researched digital hospitals to examine their ability to provide patient care and be competitive in the market, the barriers that keep hospitals from becoming more digitally advanced, and the lessons that other hospitals can learn from the pioneers. In developing this report, we analyzed previous research on the topic and data from public and private sources, including the following: the American Hospital Association, the Centers for Medicare and Medicaid Services, and Solucient. We supplemented data analysis with interviews of hospital and physician leaders, consultants, payers, policy makers, and healthcare IT vendors.

PricewaterhouseCoopers also teamed with HIMSS Analytics to explore the benefits of being digitally advanced. PricewaterhouseCoopers and HIMSS Analytics identified a group of 36 digitally advanced hospitals, chosen on the basis of their reputation in the industry for implementing advanced clinical systems. This digitally advanced group had implemented 70 percent of the clinical and advanced clinical systems surveyed by HIMSS Analytics. This compares with 50 percent implementation by all HIMSS Analytics–surveyed hospitals. This research found that digitally advanced hospitals generally tend to have reduced length of stay, increased quality of care, and increased revenues. However, benefits may take years to realize and usually require significant investment.



PricewaterhouseCoopers defines a digital hospital as follows:

The digital hospital relies on technology as an integral and fundamental part of its business strategy. It enables organizations to fully realize a hospital's latent potential for delivering higher quality care in increasingly efficient ways through the use of information technology and process redesign.

The digital hospital goes beyond advanced clinical systems and includes significant additional integration between information technologies and medical technologies—such as patient beds, surgical equipment, nurse call and communications systems, pagers, and medical imaging technologies. A digital hospital strategy is not restricted to new-build or specialty facilities, but can also apply to general hospitals.

Modern healthcare delivery is increasingly recognized as an information business as well as a people business, but many healthcare delivery organizations seem significantly under-provisioned in modern information management capabilities.

■ **Introduction**

The ideal healthcare system of the future—under any funding model—is typically described as being more flexible, responsive, and adaptive. Such a system comprises organizations that can integrate care across care settings and organizational boundaries, and that can adjust quickly to changing patient needs, to improving standards in clinical practice, and to new market conditions. Healthcare system executives, federal officials, employer organizations, and technology vendors all increasingly perceive information technology as a necessary element of this adaptive, flexible, and responsive health system. Hospitals—a more than \$500 billion industry in 2003, according to the Centers for Medicare and Medicaid Services (CMS)—represent the largest slice of the U.S. healthcare spending pie and thus the key to this more flexible system.

Executives at healthcare delivery organizations continue to face complex and ever-shifting strategic and tactical challenges when transitioning to this new model. Payers, employers, and government agencies are increasingly vocal in their demands for improved quality and reduced costs. Payment is beginning to be linked to performance, which is gradually being expressed in clinical terms. Patients demand personalized care. New technologies portend further cost pressures on hospitals. A continuing emphasis on ambulatory, community, and even home care further affects hospitals. Moreover, in their core markets, hospitals continue to confront competitive pressures such as the recent growth in specialty hospitals, even though a temporary moratorium on the expansion of such physician-owned facilities has been imposed by federal law and may be extended.

One response to all of these pressures is hospitals positioning themselves as health systems, extending the boundaries of hospitals. Such organizations have used referral arrangements, strategic alliances, mergers and acquisitions, or—in a smaller number of organizations—technology as the basis for breaching organizational walls. This positioning reflects the growing awareness—highlighted in various reports, including the Institute of Medicine's *Crossing the Quality Chasm*—that healthcare should be more integrated to enable patients to receive the best possible care.

A key element of this response is information technology. Hospitals provide time-sensitive and usually resource-intensive interventions, and this vital function is a highly information-rich and information-dependent undertaking. Modern healthcare delivery is increasingly recognized as an information business as well as a people business, but many healthcare delivery organizations seem significantly under-provisioned in modern information management capabilities.

In fact, expenditure of time and money is a major indicator of how serious a hospital or hospital system is about this change. On average, today's hospitals spend approximately 2.5 percent of their operating budgets on technology, while hospitals investing in more advanced clinical information systems spend 3 to 5 percent or more. Although automation is not a panacea—information technology is not likely

to change the number of people in the United States without health insurance, for example—it is foundational to many strategies that hospitals can use to respond to current business challenges. As a result, hospitals have made major investments in information technology. Some organizations, still a minority, have adopted the digital hospital concept as part of their response. The term digital hospital has typically been used to refer to new-build (greenfield site) hospitals, usually specialty care facilities. PricewaterhouseCoopers believes that the concept has far broader relevance and that general hospitals—whether new-build or not—can benefit from a well-implemented digital hospital strategy.

“When I think about organizations that spend 1 and 2 percent of their operating budgets on information technology, that’s not going to cut it. If you really want to do this, then you need to find another 3 percent of your operating budget somewhere, because that’s what you’re going to need to deploy this strategy,” asserts Mark Zielazinski, chief information officer of El Camino Hospital, a not-for-profit community hospital in Mountain View, California that has implemented significant IT in its current facility and is also building a new, digitally advanced hospital.

Hospital spending fuels overall healthcare spending, and increasing average IT spending to levels of 3 to 5 percent across the industry would add approximately \$5 billion to hospital IT spending in 2005. Yet compared to other industries’ investments in technology, healthcare is perceived as lagging. Many observers now ask whether this increased investment in technology will bring the same productivity gains that IT has provided other industries. For example, airlines have begun to deploy self-check-in kiosks or enable home check-in over the Internet. Manufacturers rely on automated inventory management. Bank customers expect ATMs and Internet account access, and these tools have reduced customer service costs.

“When I think about organizations that spend 1 and 2 percent of their operating budgets on information technology, that’s not going to cut it. If you really want to do this, then you need to find another 3 percent of your operating budget somewhere, because that’s what you’re going to need to deploy this strategy.”

***Mark Zielazinski,
El Camino Hospital***

KEY FINDINGS AND RECOMMENDATIONS

The following is a summary of our findings and recommendations for healthcare delivery organizations. This report is based upon original and third-party research, including PricewaterhouseCoopers interviews with executives at healthcare delivery organizations, healthcare IT vendors, government officials, and other industry experts.

KEY FINDINGS

■ **Information technology and automation are important elements of an overall strategy of service quality and business improvement in a healthcare delivery organization.** Opportunities exist to enhance patient safety, improve clinical outcomes, and streamline overall hospital operations through digitization. PricewaterhouseCoopers' research indicates that digitally advanced hospitals have reduced length of stay, increased revenues, and are more compliant with processes that lead to higher quality. Hospitals that succeed in implementing digital solutions say they enjoy market advantages.

■ **The fully digital hospital remains rare, and is typically a specialty cardiac hospital.** Many hospitals have made significant progress in foundational automation, and several have adopted advanced clinical information systems such as computerized physician order entry (CPOE) and clinical decision support systems (CDSS). The digital hospital, however, goes beyond advanced clinical systems and includes significant additional integration between several medical and information technologies that have historically been beyond the scope of a hospital's information technology strategy.

■ **Outside forces, such as pay-for-performance, consumerism, and government reporting on quality, are pressuring hospitals to analyze and present their clinical data.** As hospitals begin benchmarking their clinical outcomes, they will assess the processes that lead to those outcomes. Effective analysis and presentation of clinical data will depend upon substantial automation and information capture. Responding to pay-for-performance and consumerism will require

increased technology investment and associated organizational transformation.

■ **Significant benefits require more investment than has typically been made.** The healthcare industry has often been described as under-investing in technology. On average, today's hospitals spend 2.5 percent of their operating budgets on technology, while hospitals in the process of digitization spend 3 to 5 percent. Hospitals will spend an estimated \$14 billion on IT in 2005. Digitally advanced healthcare delivery organizations demonstrate a range of qualitative and cost-reduction benefits. Payers and patients also benefit significantly.

■ **Organizations making sufficient progress toward deep and broad automation may realize unexpected benefits.** Such benefits arise through enhanced organizational responsiveness, adaptiveness, and innovation. Examples include improved patient experiences, more rapid adoption of new clinical practice guidelines, better ability to secure research grant funding, or greater capacity to manage workflows. These benefits are not direct consequences of automation, but rather secondary effects that flow from enabling the organization to respond in new ways.

■ **Deep interconnectedness of technologies implemented is important but difficult.** A digital hospital cannot be purchased off the shelf. Implementing the digital hospital concept requires the integration of many subsystems. The burden of this integration falls not only on software vendors, but on hospital executives as well, who must assume significant process design responsibilities. Integration engines, Extensible Markup Language (XML), and the various information exchange standards such as HL7 Version 3.0 that are gradually stabilizing can all help, but they do not magically make the challenge disappear.

■ **Business strategy must determine technology strategy.** Business goals and models must determine technology choices. This does not mean that vendors can, or should, be forced to rewrite their products for

each customer. Rather, business decisions can create a need to select a product for multiple departments that might not have been the first choice of every department involved. Maintaining this business priority is an important task for senior staff leadership.

■ **Technology acquisition and systems integration efforts are not enough; organizational transformation is needed.** Technology implementation techniques have emphasized mapping and automating processes to make them go faster. Now the goal is eliminating process components to realize benefits—potentially completely rethinking the manner in which a process is undertaken. Such redesign is fundamental to digitization and requires major investments in organizational development and cultural change. For transformational efforts to be successful—which is necessary for benefits to be fully realized—it is important that the functional or operational divisions are fully engaged in the technology implementation process. Otherwise, an organization may fail to achieve essential process redesign and thus fail to generate the expected benefits.

■ **Physicians, once barriers to clinical information systems implementations, are becoming supporters.** Such support follows from factors such as the age of the physicians and where they were trained (young physicians trained at academic medical centers using CPOE expect to work in a more digital environment), whether or not they have financial incentives to do so, how involved they are in the planning, and whether they are employees of the hospital. Information garnered from clinical systems may also assist in developing and managing new compensation models that tie physician pay to clinical quality.

■ **Implementing a digital hospital is not a one-time event or a singular goal.** Instead, it is a process of continuous renewal. Hospitals will uncover new areas for process redesign and automation during initial efforts to which they will return later. Staff will incorporate continuous quality improvement as part of their jobs.

New clinical technologies will become requirements from a competitive perspective—and may disrupt clinical care paths that were perhaps relatively newly deployed. Hospitals that fully adopt the concept of being a learning organization reap the highest returns on their investments.

RECOMMENDATIONS

■ **Start with strategic business planning and engage the hospital board when adopting the digital hospital concept.** Such a project entails a full appraisal of the organization's competitive position, internal capabilities, and future strategy. The magnitude of the organizational transformation—and the associated business risks—is such that the board needs to be involved in the decision and provide explicit support.

■ **Involve the physicians—whether staff or not.** Physicians play a central role in the successful deployment of many technologies that compose the digital hospital. Some technologies will require changes in physicians' work, and frequently, physicians do not benefit from this disruption. Hospital management may need to find new ways to work with physicians to ensure project success. For example, management might offer new medical staff positions or financial incentives to participate in the project.

■ **Interweave process and organizational design and technology acquisition and implementation.** Implementing a digital hospital entails the deployment and integration of a complex, connected series of technologies to create a smoothly running system that fully exploits the technology and empowers clinicians and other hospital staff to more effectively fulfill their responsibilities. To achieve this goal, organizations must balance technology capabilities and clinical processes and be prepared to make tradeoffs. A clearly articulated technology strategy is central to ensuring this balance can be well managed. Trying to make a specific product or technology support processes for which it was not designed is rarely successful.

KEY FINDINGS AND RECOMMENDATIONS (CONTINUED)

■ **Recognize that substantial benefits may not appear until a sufficient level of automation has been reached (a tipping point).** This tipping point is a function of both investment and sufficient process change having occurred. Hospitals should plan for this and for the fact that benefits may take several years to realize—especially when process change efforts have been neglected. Some organizations also choose to undertake a basic technology implementation prior to undertaking process redesign.

■ **Maintain productive hospital-vendor relationships.** While caveat emptor must be kept in mind when contracting, projects are rarely successful without full and deep engagement by vendors. Cultivate good relationships with senior staff at vendor organizations. Emphasize effective shared project management. Remember that responsibility for a successful implementation remains with the hospital—even if some financial risk is transferred to the vendor. Whether the project is a strategic imperative or motivated purely by the search for a return on investment (ROI), project failure or delay will probably adversely affect the hospital more than the vendor.

■ **Pick your system boundaries carefully.** No vendor has a complete solution to all technology needs, let alone an integrated delivery system encompassing cross-continuum care responsibilities. Multiple vendors' products will need to be integrated. When determining overall system design, organizations should note the difficulties of particular boundary layers between technology components. For example, some commentators suggest that CPOE, clinical data repositories (CDRs), nursing documentation, controlled medical vocabulary solutions, CDSS, and pharmacy solutions must be an integrated solution from one vendor to function smoothly. Interfaces between lab and other ancillary systems and other vendors' CDRs are more commonplace.

■ **Engage patients and payers when planning the project.** Patients bring a unique and crucial perspective to the design of healthcare processes. Patients are

becoming more knowledgeable of technology that supports clinical care, and they want their providers to use the latest equipment. At the same time, payers are becoming more open to offering hospitals financial incentives for improvements to safety and effectiveness through technology investments. As part of their planning process, hospitals should initiate the conversations with payers and seek potential benefits from technology investments, such as financial incentives and greater patient awareness of the hospital's commitment to safety. Additionally, bringing patients into certain technology planning and process design environments may be beneficial: They have the best perspective on what constitutes a good patient experience.

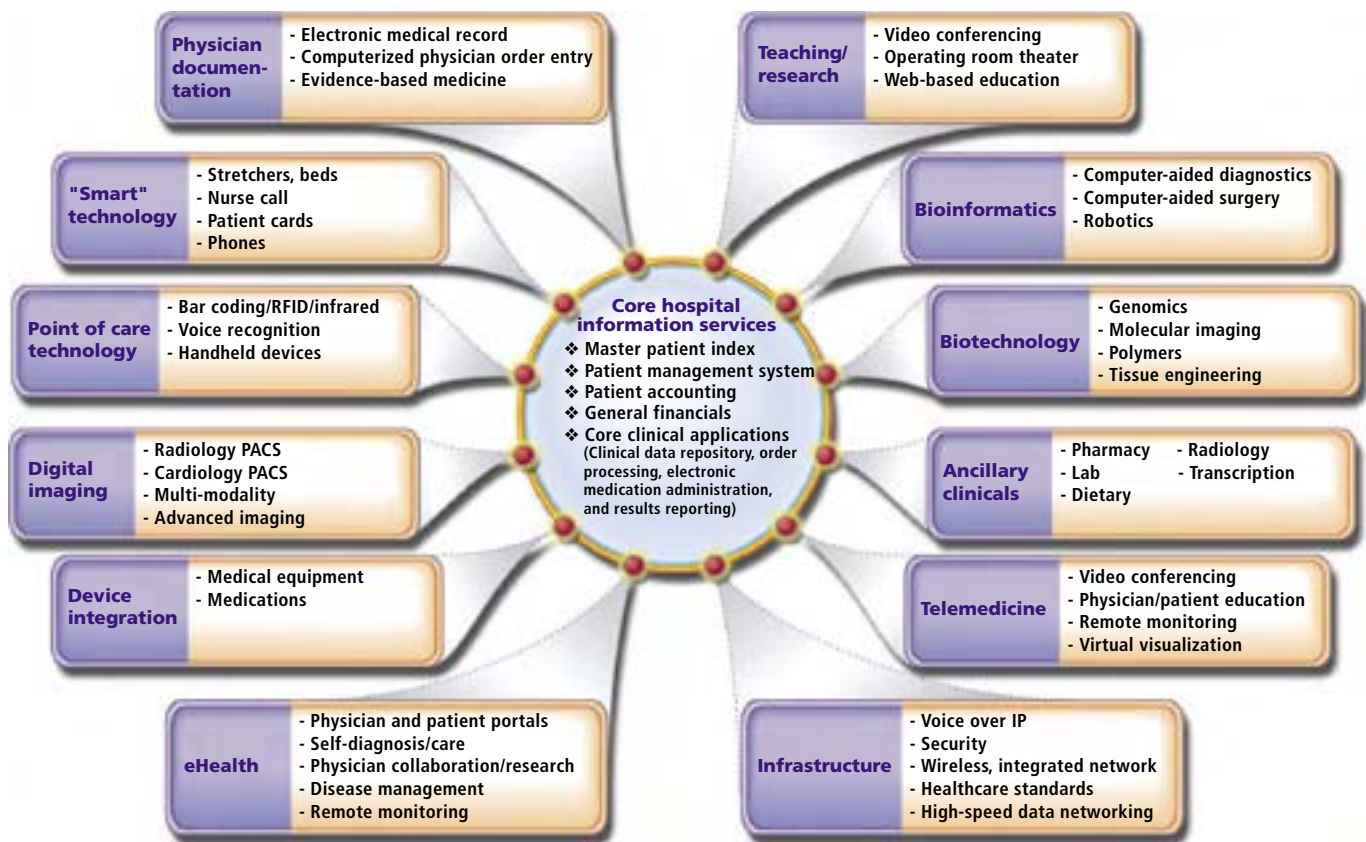
■ **Support the development of new roles and skills.** Be prepared that new roles and skills will be needed. Hospitals should support the training, accreditation, professional development, and other human resources implications of these roles. For example, hospitals may need to create new nursing and pharmacy positions, and enable physicians and other clinical staff to participate in formal academic training in informatics and related disciplines.

■ **Change the information services department as needed.** Most physicians will not rely on a traditional technology help desk during day-to-day clinical practice. Clinically credible and technology-savvy staff will be needed on the floors. Policies and procedures may need to be revised to reflect the truly mission-critical nature of more advanced clinical systems. Hospitals may need to consider the integration of technology planning and support functions typically operated separately in departments such as radiology, cardiology, or biophysics. Many hospitals will need to upgrade their technology infrastructure through acquisition of redundant networking technology, fault-tolerant hardware platforms, and enhanced business continuation plans, for example. ■

■ Defining The Digital Hospital

The digital hospital comprises a completely automated and deeply integrated set of health information services capabilities that fulfill clinical, financial, and administrative requirements. Core technologies in a digital hospital include digital radiological image management solutions (picture archiving and communications systems, or PACS), medical devices, patient and equipment tracking solutions, and other technologies. (See Figure 1.) Although the precise definition of a digital hospital lacks consensus, core technologies and automated processes are common elements of the definition. Table 1 on page 9 shows interpretations of the digital hospital concept from executives at healthcare delivery organizations, healthcare IT vendors, and other industry experts.

FIGURE 1: DIGITAL HOSPITAL APPLICATIONS AND TECHNOLOGIES



The digital hospital relies on technology as an integral and fundamental part of its business strategy. Technology is applied to every facet of clinical and business operations—integrating people, process, technology, and cultural elements. Technology is defined more broadly than is typical in the healthcare industry. The digital hospital goes beyond advanced clinical systems and includes significant additional integration between information technologies and medical technologies, such as patient beds, surgical equipment, nurse call and communications systems, hospital lighting systems, mobile phones, personal digital assistants (PDAs), pagers, and heating, ventilating, and air conditioning (HVAC) systems—devices that act as both

“A fully digital hospital would not produce or use paper records. It would have digital imaging, order transmission, clinical notes, and other aspects of the electronic health record. It would have integrated supply chain management and integrated revenue cycle management.”

***David Brailer,
U.S. Department of
Health and Human
Services***

input and output instruments. Modality inputs and outputs, to the extent possible with current technology, are “digitized,” residing on the organization’s single data network, and are integrated into a patient’s longitudinal electronic medical record (EMR). Industry standards and legislation (such as the Health Insurance Portability and Accountability Act [HIPAA], Clinical Context Object Workgroup [CCOW], and others) are leveraged to enhance connectivity with stakeholders and business partners outside the walls of the hospital.

Occasionally a term comes into common use that signals the beginning of a new era. The World Wide Web is one such term, defining not so much a specific technology or application, but a broad set of architectural and organizational principles that has reshaped how people think about computers, information, work processes, and even social interaction. PricewaterhouseCoopers believes that “digital hospital” may have an impact analogous to the World Wide Web, within the context of the hospital industry. Much as e-business is no longer debated but largely expected, PricewaterhouseCoopers anticipates that becoming a digital hospital will be an inevitable part of a hospital’s business strategy.

The digital hospital concept will come to represent a rallying point and architectural goal for deploying and linking information systems and medical devices. Using such systems and devices in accordance with a clearly articulated information technology strategy holds the promise of reshaping how people think about hospitals and their services, as well as the roles and responsibilities of clinical staff, administrators, and even patients and clients. As such, the digital hospital represents the massive potential that remains latent in hospitals for delivering higher quality care in increasingly efficient ways through the use of information technology and process redesign.

The digital hospital entails a broader array of technologies than traditional IT strategies, and the technologies are implemented in a more integrated manner. The traditional model includes enterprise administrative systems, financial systems, and clinical systems—usually with modest data-sharing capabilities. For example, PACS is infrequently integrated with the EMR. As organizations aspire to become digital, the vision broadens to encompass almost all information processing, information tracking, and workflow management functions. This broader vision may involve technologies sometimes implemented under the traditional model, but in a more coordinated and integrated fashion. Common functions are defined as services, which are used within many processes to reduce development and maintenance costs.

Few real-world examples of digital hospitals exist, although several large, general hospitals are well along the way toward becoming digital. The organizations described as digital hospitals tend to be standalone, new-build (or greenfield), specialty hospitals that were conceived of as advanced, highly automated facilities. The value of being digital was assumed in the earliest planning stages of such facilities. However, the principles that inform the transition to a digital hospital are derived mostly from successful healthcare automation experiences in other environments.

TABLE 1: SURVEY OF DIGITAL HOSPITAL DEFINITIONS BY INDUSTRY EXPERTS

<p>"A fully digital hospital would not produce or use paper records. It would have digital imaging, order transmission, clinical notes, and other aspects of the electronic health record. It would have integrated supply chain management and integrated revenue cycle management."</p>	<p>David Brailer, MD, PhD, National Health Information Technology Coordinator; U.S. Department of Health and Human Services</p>
<p>"Don't focus on a technical or engineered vision; this process is not comparable to constructing a dam or a building. It can't be context free—how do you define success? You must build a vision with the technology. The digital hospital must have a care vision and a process vision."</p>	<p>John Glaser, MD, PhD, VP and CIO; Partners HealthCare System</p>
<p>"A digital hospital means all digital, with EMR, CPOE, PACS, and labs that dump into EMR. A digital hospital should be as paperless and wireless as you can make it."</p>	<p>Brad Bjornstad, MD, CMO; University Community Hospital</p>
<p>"A digital hospital needs to be defined in chunks because healthcare is a grouping of so many different businesses. Typically, you try to automate systems from a patient-experience point of view. The digital hospital could be paperless, but many will still have some paper and some film. Either way, it is an iterative process."</p>	<p>Lauren O'Brien, Regional CIO; Providence Health System</p>
<p>"The digital hospital is an effort, a spectrum, and a concept. It is a process of managing more by computer and less by manual processes."</p>	<p>Dick Gibson, MD, PhD, CMIO; Providence Health System</p>
<p>"A digital hospital is the use of electronic information beyond administrative and billing purposes—really integrating electronic information into the clinical aspects of the delivery of care. A digital hospital makes use of electronic information to provide the highest quality status and most efficient care possible."</p>	<p>Suzanne Delbanco, PhD, CEO; The Leapfrog Group</p>
<p>"A digital hospital uses digital technology for communications, tracking, and information flow."</p>	<p>Cindy Slaydon, RN, MSN, CHE, CNO; Centennial Medical Center</p>
<p>"A digital hospital that is just digital technology is simply a technology advancement, and the organization will advance at the rate the technology advances. The digital <i>integrated</i> hospital is what healthcare executives should aim for. With a commitment to that direction they would not purchase a telecommunications system without accounting for its full integration into the system. With a 30-year investment, the operational impacts are dramatic."</p>	<p>Jon Trigg, National Director, Healthcare; Siemens One</p>
<p>"For a hospital to be digital, most people would agree that the key administrative and clinical systems must be computerized and communicate with each other. So clearly, you have both a quantitative aspect—that is, a number of systems that are digital—and a qualitative aspect of interoperability."</p>	<p>Michael L. Millenson, Independent Consultant</p>
<p>"A lot of folks are trying to talk about the digital hospital. I think no one knows what it means. If you ask a hundred different people who haven't been exposed to it, you would get a hundred different variations on some sense of what it means to be a leading-edge technology hospital."</p>	<p>Philip Strong, MD, IT Physician Liaison; El Camino Hospital</p>
<p>"In a digital hospital, all information about patients and about health choices is digital and is available everywhere it's needed. That information can be retrieved, processed, sorted, and prioritized using information technologies. No paper, in other words."</p>	<p>Mark Leavitt, MD, PhD, FHIMSS, Medical Director; Healthcare Information and Management Systems Society</p>

During PricewaterhouseCoopers interviews with healthcare executives, vendors, payers, and experts, participants were asked to define the digital hospital. The table highlights a representative sampling of these responses and illustrates the wide-ranging interpretation of the concept.

The goal of being digital is merely a stepping stone on a path to a more complete vision for the future. Few sites have begun a significant program of investment in information technology unencumbered by previous technology procurements. Instead, most organizations inherited a more complex starting-point at the time of the decision to proceed. Hospitals usually have at least basic automation of patient registration, scheduling, and billing; and most have some automation within laboratories, radiology, and pharmacy departments.

“You should really shape the focus of the digital hospital to focus on process change. There is no inherent value in a paperless or digital system.”

*John Glaser,
Partners HealthCare
System*

THE DIGITAL HEALTH SYSTEM CONTINUUM

The digital hospital is a point of a continuum as healthcare delivery organizations incrementally automate their core processes. Rather than a final goal, the digital hospital is a milestone on the path to becoming an organization that has ever more effective capabilities in how it exploits technology for the benefit of patients and the staff that care for them. The final goal—which inevitably evolves over time—is a fully automated, highly responsive organization that smoothly plays its role in the broader Digital Health Community. Thus, there is a continuum of increasing digitization. At one end is an organization that remains highly reliant on manual and paper-based processes occurring in poorly connected silos of care. At the other is an organization that functions in an effectively paper-free fashion, where practically all aspects of healthcare planning and care delivery use modern information technology extensively to make all relevant information consistently available at all times, in all places of care including links to other organizations participating in the Digital Health Community. (See Figure 2.)

FIGURE 2: THE DIGITAL HEALTH SYSTEM CONTINUUM



Several characteristics help to explain why healthcare delivery organizations have difficulty traversing the digital hospital continuum. The digital hospital does not encompass a well-defined set of technologies, nor is it limited to a technological continuum—for example, the degree of process change undertaken also influences an organization’s progress. The digital hospital also requires the integration of its many components, and such integration is not easily achieved, in part due to the limitations of current products. The digital health continuum is neither linear nor uni-dimensional, which adds complexity.

A Conceptual Construct

The digital hospital is more a conceptual construct than a well-defined set of technologies; it represents an architectural concept. An information systems architecture can be defined as a strategic framework for the tactical deployment of solutions. Similarly, the digital hospital should be seen as an architecture. Little is fundamentally new in the notion of a digital hospital. Most of the conceptual breakthroughs that define a digital hospital are more than 20 years old. Only recently have sufficiently powerful technologies (high-speed networks, wide-area networks, and inexpensive PCs, for example) and mature software products become readily available enough to make the digital hospital appear as a mainstream concept. Some commentators even question whether being digital is important, choosing instead to focus on clinical process redesign supported by digital technology.

To gain the most benefits from any significant information systems project, an organization must focus its attention on process redesign. Healthcare is no exception. Healthcare, however, may represent an extreme case of the importance of this principal.

“You should really shape the focus of the digital hospital to focus on process change. There is no inherent value in a paperless or digital system,” explains John Glaser, vice president and chief information officer of Harvard-affiliated healthcare delivery system Partners HealthCare System.

Additionally, the project must be large enough to command sufficient management focus and provide a suitably powerful organizational catalyst for the significant process changes that are necessary. Although projects must be motivated primarily by business objectives, technological realities must also be kept in mind in project planning and implementation.

Technology Challenges

The digital hospital is still at the edge of technical feasibility. The products available today are not always as robust as both their vendors and customers would like. A significant need persists for difficult and expensive implementation efforts in what is a complex environment in which to effect change. In the absence of mature standards for interoperability, the challenges of integrating multiple systems and technologies (almost inevitably from different vendors) remain daunting.

In addition to these challenges, healthcare may be attempting to use IT in ways that are substantially in advance of other industries. The following hypothetical examples illustrate the challenges for IT. A lawyer in a courtroom accesses an online legal research service and receives automatic suggestions of case-law and supporting arguments to counter opposing counsel’s arguments—in real time—using speech-recognition and text-searching technology. A teacher assesses a student’s educational needs and designs a program of instruction to assist the student in the context of the student’s learning preferences, career direction, and access to funding to pay for certain schools. Currently, neither the legal industry nor the educational world has access to technology with such knowledge support capabilities. By analogy, these are precisely the kinds of problems that advanced clinical information systems seek to solve. Some aspects of the digital hospital vision may be stretching modern IT beyond the capabilities applied in any other industry.

“It is clear that healthcare is pushing the envelope of what automation can provide. The functional requirements for adequate automation support of clinical healthcare activities far exceed those of any other industry. Fortunately, it appears that each of the key technologies needed to make serious progress against this goal has now reached at least a minimal level of functionality. As a result, automation solutions are demonstrating accelerated progress toward the goal of effective support for clinical activities,” says Barry Hieb, research director at Gartner.

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***Barry Hieb,
Gartner***

Unique features of the healthcare industry also make implementation of digital solutions especially challenging. Few other industries face an equivalent need to maintain 24 hour, 7 days a week, 365 days a year service with absolutely no tolerance of downtime. Shutting down the hospital for a weekend for training or a system upgrade is effectively impossible. Additional challenges also apply: a user population comprising staff and non-staff, significant regulatory complexity, and unusually complicated transactions. In addition, transactions—in the usual sense of the term—represent a smaller proportion of the information processing that occurs in a digital hospital than in other industries, which is another reason implementing digital solutions in hospitals is difficult.

A Nonlinear Continuum

Unless a hospital chooses to automate almost all processes in a single big-bang strategy (which usually occurs only in a facility being built on a greenfield site, before opening the hospital doors to patients), significant areas of hospital function will still need attention later. Incremental progress toward the goal of becoming digital will require several steps. These steps vary in size and complexity, making the continuum far from smooth to traverse.

For example, implementing a departmental PACS such that a digital reading room is established in a radiological department may substantially aid the workflow in that department. Developing this solution as a service—with standards-based methods to call the service—provides the capability to distribute radiological images to other devices and applications. Integrating that PACS into a hospital-wide radiological image distribution network represents a step-change in the manner in which radiological images are processed. It becomes possible to almost eliminate the production of film. This elimination of film may enable entire clinical processes to be redesigned on the assumption that images are available everywhere and may transform the speed at which diagnostic decisions can be achieved and care paths actualized.

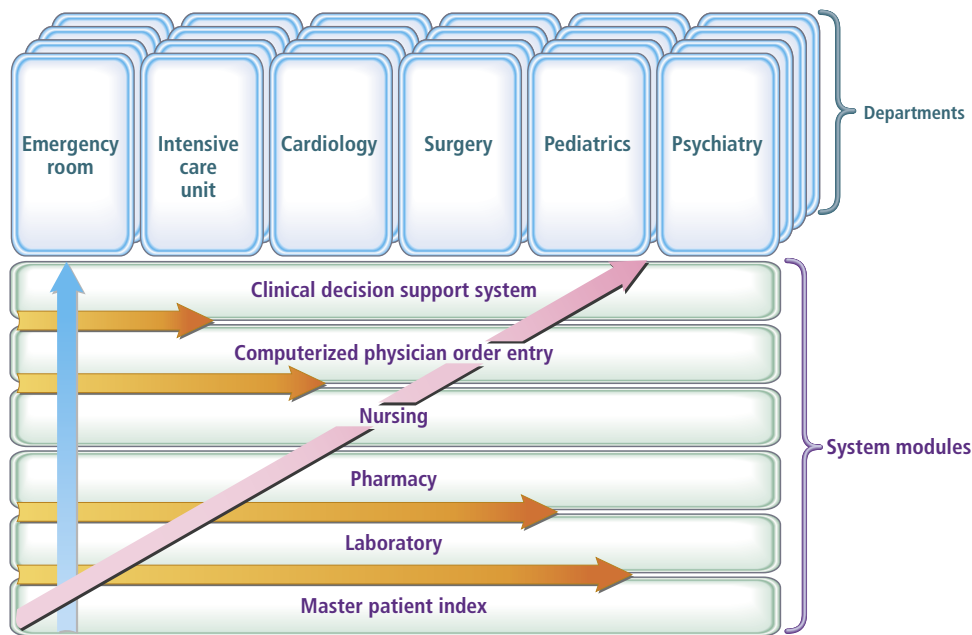


For an example of the challenges of novel technology deployment in healthcare, see the sidebar, “RFID,” on page 14.

A Multidimensional Continuum

In the digital hospital, several converging and overlapping paths of automation may be considered, each representing different aspects of the core processes of a healthcare organization. Organizations close to being digital have typically followed one or more of the paths outlined in Figure 3 on page 13, making progress in implementing some of the key elements, such as PACS, nursing automation, clinical knowledge management, physician office integration, community outreach, patient engagement, and computerized physician order entry (CPOE). (Alternatively, CPOE is sometimes defined as computerized practitioner order entry, since physicians are not the only clinical users.) These elements are not independent, however. Effective clinical knowledge management is almost impossible without CPOE. But unless pharmacy automation and nursing process automation are fairly entrenched in the organization, CPOE is unlikely to succeed. Similarly, some industry experts believe that a sophisticated EMR is an essential prerequisite to achieving a successful CPOE installation.

FIGURE 3: THE CHALLENGE OF BECOMING DIGITAL



Hospitals in pursuit of becoming digital can approach the goal gradually by broad incremental deployment of systems or components (orange arrows), or by projects providing more complete, deep automation of entire departments or functions such as an ER or a cardiology department (blue arrow). Organizations also can attempt incremental progress across both axes (pink arrow). The latter entails working through difficult integration problems, while the other approaches defer this additional, but necessary, task.

Specialty hospitals benefit from the simplifying fact that they focus on only one service line, typically cardiology. Having one clinical specialty makes process standardization easier to implement. Developing standard processes across the wider range of service lines in a general hospital is a barrier to success in healthcare information technology projects in those organizations. A further consideration is that technological interdependence between multiple processes being automated is an even greater challenge to navigate if interdependencies need to be resolved across multiple service lines simultaneously, such as the development and maintenance of formularies or order sets.

To offset this complexity, a services-oriented architecture (SOA) that identifies standards for information exchange, for process definition, and for common subprocesses should be defined. An SOA does not require complete definitions of all processes, but can be developed incrementally. Data standards and message standards based on industry norms are required to start.

THE DIGITAL HEALTH COMMUNITY IS THE GOAL

The digital hospital is not necessarily the ultimate goal. Instead, the Digital Health Community is. (See Figure 4 on page 15.) The Digital Health Community describes the incremental automation and interconnectivity of the broader collection of organizations that take part in healthcare in any given locale. Hospitals do not exist in isolation. From patients’ perspectives, hospitals play a very important—though not the only—part in their overall care, especially for chronic conditions. Hospitals should enable smooth integration of care processes with other organizations engaged in the care of patients. Moreover, referring physicians, payers, reference laboratories, tertiary care centers, rehabilitation centers—the myriad participants in the healthcare economy—all represent potential opportunities for connectivity to improve the healthcare process. This is one of the motivations of the Regional



A services-oriented architecture (SOA) is the broad set of architecture principles, concepts, and standards-based constructs that enables components to be provided and consumed as services.



For details on the National Health Information Network initiative, see the sidebar, “National Health Information Infrastructure,” on page 17.

Health Information Organization concept, which is seen as a key element of efforts to implement a National Health Information Network in the United States.

“If we could fully monitor patients in a way that is safe, a lot of reasons people get admitted to hospitals wouldn’t happen. We would just monitor them at home and have them come back if something happens,” says David Brailer, chosen by President George W. Bush in May 2004 to be the first national coordinator for health information technology in the U.S. Department of Health and Human Services.

Healthcare takes place outside hospitals considerably more than inside them. The challenge for the healthcare industry is to disentangle the complex array of misaligned incentives and legislative barriers that appear to impede effective progress toward the greater degree of information sharing that many observers believe is missing from the healthcare industry.

Says Philip Strong, IT physician liaison at El Camino Hospital, “Even though I’m a hospitalist and hospital-based, the bulk of medical care goes on outside the hospital. I think the truly digital hospital has a role in extending its basic IT capabilities beyond its four walls. The question is how and who pays.”

RFID: THE POTENTIAL AND CHALLENGES OF INNOVATION IN HEALTHCARE

Radio frequency identification (RFID) tags store identifying information about the physical objects to which they are attached, enabling the monitoring of a device’s location through remote sensors. RFID tags are either passive or active. Passive tags have no battery; they acquire energy from the radio signals used to read them. Active tags have a built-in power supply, enabling them to be read from longer distances. RFID tags are appearing in several retail and industrial settings, and some companies have deployed them to help manage inventory more effectively than previously possible. Target and Wal-Mart, for example, are beginning to require passive RFID tags on pallets of some electronics products.

Although the use of RFID in healthcare lags the retail setting, RFID seems to hold much promise for healthcare and some pioneering implementations have begun. The Regional Medical Center in Memphis, Tennessee, for instance, has used readers in its trauma center to track patients who have RFID tags attached to their ankles. Similarly, the U.S. Navy has used RFID to track wounded personnel at its Pensacola Fleet Hospital in Iraq, according to RFID wristband supplier Precision Dynamics.

Tags that store abbreviated versions of patient records are part of a patient tracking system in trials at Mt. Ascutney Hospital in Windsor, Vermont. The trial uses Extravera Technology’s eShepherd RFID system, which allows wireless local area networking equipment made to the IEEE 802.11 standard to be used in place of readers.

Most commonly discussed is the possibility of using RFID in pharmacy inventory management. The growing threat of counterfeit drugs to patient safety has further motivated the pharmaceutical industry to use RFID. To help authenticate its products, Pfizer announced in November 2004 that it would tag its shipments of Viagra by the

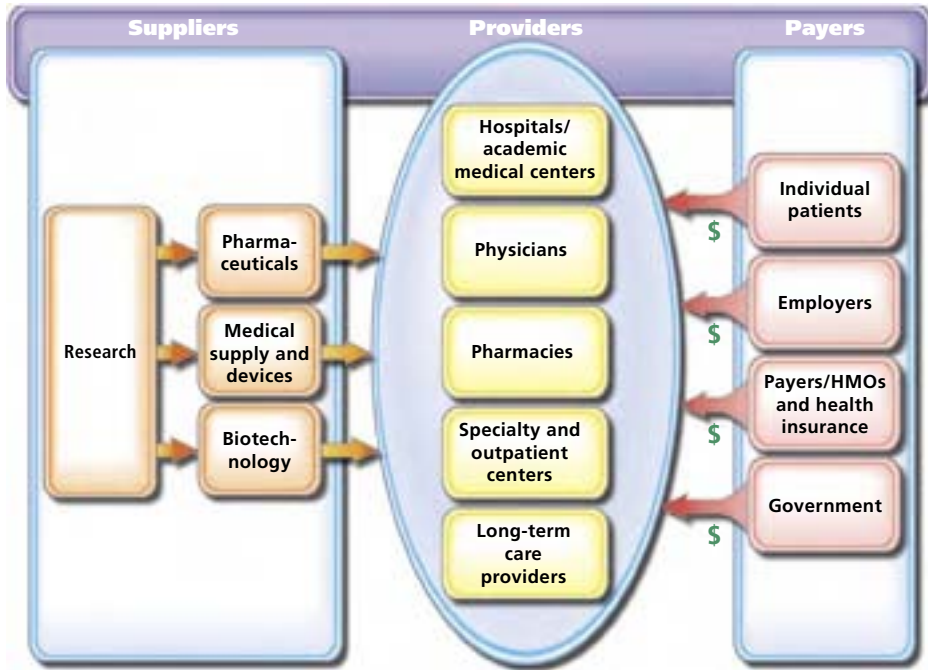
end of 2005. Other companies such as GlaxoSmithKline and Purdue Pharma plan similar measures. These companies have all offered to participate in the U.S. Food and Drug Administration (FDA) Counterfeit Drug Task Force plan to use RFID to reduce counterfeiting by 2007.

Despite the promising outlook for RFID in healthcare, RFID remains far from the healthcare mainstream. Some commentators have suggested that RFID may be a distraction from more pressing patient-safety efforts, such as bar-code-supported medication administration solutions. Bar codes have been used for decades and offer proven methods of identification and tracking, but the healthcare industry has been slow to adopt their use. In 2002, when the FDA proposed requiring a bar code for pharmaceuticals, industry trade groups noted that use-of-unit packages for medicines—the kind most often used in hospitals—did not have bar codes on them, one reason that many hospitals had not invested in bar code readers and software. Bar code requirements for drug and biological products were not issued by the FDA until February 2004.

Whether for patient, equipment, pharmaceutical, or other supply tracking, RFID systems in use at hospitals are based on proprietary protocols and coding methods. Standards necessary for broader adoption by the industry will likely be slow to develop. A final caution for organizations contemplating RFID technology is to consider whether vendors indemnify users against possible breaches of intellectual-property rights in equipment or software. This caution concerns Generation 2 RFID technology, which may still be subject to patent claims.

RFID holds sufficient promise for healthcare delivery organizations to begin considering it as part of a comprehensive digital hospital strategy. ■

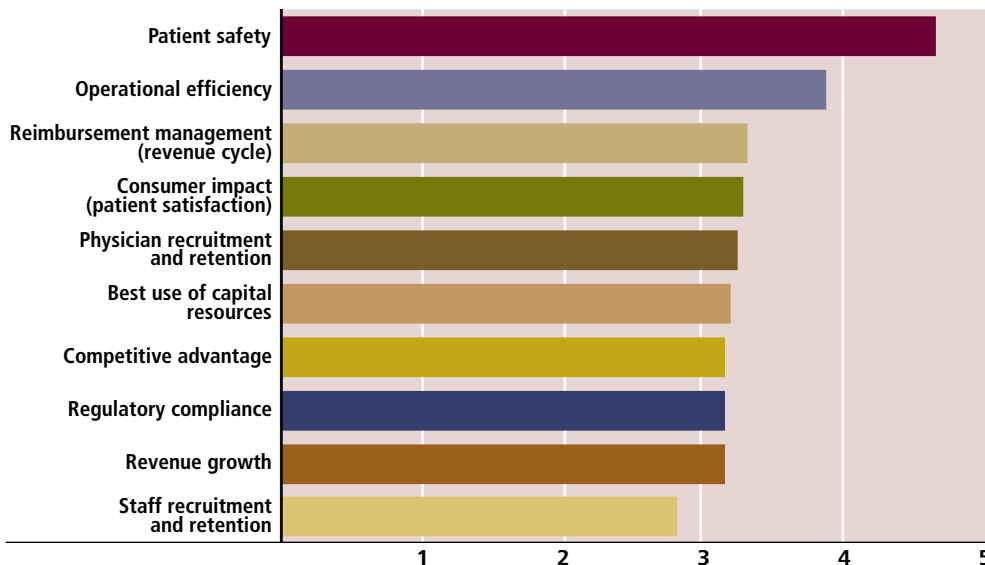
FIGURE 4: DIGITAL HEALTH COMMUNITY



Digital Hospital Benefits

Although few hospitals are fully digital facilities, many healthcare organizations, vendors, and industry experts agree that significant benefits can be realized through the effective automation of healthcare processes. Some benefits can accrue along the entire continuum of digitization, enabling a return on investment. Examples and evidence exist in several studies discussed in this paper. Figure 5 provides an overview of perceived digital hospital benefits. PricewaterhouseCoopers’ research indicated that the benefit of patient safety ranked highest among hospital executives interviewed for this paper.

FIGURE 5: BENEFITS OF THE DIGITAL HOSPITAL CONCEPT



When asked to rate the most compelling benefits of digitization for a healthcare delivery organization (on a scale of 1 to 5, with 5 having the greatest impact), more than two dozen hospital executives, healthcare IT vendors, and other industry experts cited improvements in patient safety as the most likely benefit. Respondents also look to the digital hospital to provide gains in operational efficiency.



For more information about the PricewaterhouseCoopers and HIMSS Analytics study, see the sidebar, “Operational and Clinical Characteristics of Digitally Advanced Hospitals,” on page 22.

To further explore the benefits of digital hospitals, PricewaterhouseCoopers teamed with HIMSS Analytics to review operational, financial, and quality metrics of a study group of 36 digitally advanced hospitals.

DISCRETE BENEFITS

Examples of the benefits of automation abound in the healthcare industry. Some examples are simple, single-institutional case studies, such as a radiology department that has reduced transcriptionist full-time equivalents (FTEs) through the use of speech-recognition software. Others are more academically robust studies of benefits, such as fewer prescribing errors after implementation of CPOE systems. Table 2 on page 18 shows a sampling of anecdotal benefits cited in an October 2003 study by the U.S. General Accounting Office (GAO) on the benefits realized through information technology. The following discussion examines the most widely cited benefits.

Patient Safety

CPOE—a key component of any digital health strategy—plays a significant role in patient safety programs. Results from several studies, such as many cited in the President’s Information Technology Advisory Committee’s June 2004 report *Revolutionizing Health Care Through Information Technology*, have validated this claim. CPOE improves patient safety by reducing order transcription errors and by improving legibility of orders. The integration of CPOE with decision support technology further contributes to patient safety because alerts and reminders can intercept potential errors, such as dosing errors, medication conflicts, and allergies.

“Advanced clinical information systems improve safety and quality in my mind, because caregivers are doing the real work of providing good patient care, and physicians are spending meaningful time with patients. Instead of searching for radiology or laboratory results in a chart, caregivers have the information on a handheld or on a screen where it’s easily accessible,” explains Richard Miller, president and chief executive officer of Virtua Health, a multi-hospital healthcare system in New Jersey.

Improving the availability of patient information by eliminating paper charts and replacing them with a widely and continuously available EMR contributes to patient safety. According to the Center for Information Technology Leadership (CITL), approximately one-fifth of medical errors are due to inadequate availability of patient information.

“The ability to deliver care with great knowledge about the patient’s history, the medications the patient is on, the problems the patient has, and so forth, is enabling us to change and improve forever the process, quality, and accuracy of the care we deliver. Anytime, anywhere access is key,” says Dave Printz, chief information officer of Central DuPage Hospital, a 360-bed acute care hospital located in Winfield, Illinois.

Another important element of a digital hospital strategy is clinical knowledge management. In most hospitals, technology rarely plays a significant role in the direct support of clinical best practice. The selection of ideal investigation strategies or pharmacological remedies is typically a purely human undertaking, relying almost exclusively on professional judgment. Technology can help. Recent automation in healthcare has focused on patient safety through the avoidance of errors of commission—prescribing errors being the most significant example. However, evidence indicates that errors of omission are much more frequent—and more difficult to identify. Errors of omission might include missing vaccination opportunities or failing to follow specific therapeutic recommendations based on clinical practice guidelines. Only through the use of advanced clinical decision support will many errors of omission be addressable for the first time. Information systems are necessary but not sufficient for such improvements, however. Increased automation must be accompanied by organizational change, such as the formation of a medical informatics board to evaluate new proposed care management protocols.

NATIONAL HEALTH INFORMATION INFRASTRUCTURE

As the automation of healthcare gathers momentum within hospitals and integrated healthcare delivery systems, the need for cooperative information interchange between different healthcare organizations becomes increasingly clear if the industry is to reap the broader benefits of automation. Hospitals are adopting information technology primarily to improve clinical quality and to improve their cost profile—typically motivated by internal considerations. To support the broader health information milieu known as the Digital Health Community, several countries have begun to plan a national health information infrastructure (NHII).

An NHII typically focuses on key aspects of health information management:

- **Individual health records**—Individuals would create and have possession of their own personal health records. A health record could include an individual's health history, health conditions, medication history, and health insurance information.
- **Healthcare delivery**—Healthcare providers would have access to data from individuals' personal health records, physician's notes, and any other clinical information. They would also have access to tools like digital prescription applications.
- **Population and public health**—By accumulating individual health data, trends or patterns in larger populations or specific demographics can be observed. These findings can be used to better manage national health, identify what costs are being incurred by all users, and conduct further research.

In the United States, the NHII concept is being approached as the National Health Information Network (NHIN), with oversight from the Office of the National Coordinator for Health Information Technology (ONCHIT). Encompassing interoperable technologies and standards, the NHIN would be an information and knowledge-sharing network rather than a central database of patient records. Several challenges must be overcome before the NHIN can become a reality in the United States. Fragmentation of healthcare delivery represents a key barrier to the development, implementation, and maintenance of

the NHIN. Such an initiative involves a wide range of stakeholders, including various healthcare organizations, payers, consumers, and private and government agencies. The question of who will pay for the NHIN and all of its components within the United States remains largely unanswered.

Other challenges include the lack of national standards and concerns over privacy. Interoperable technologies are not yet available to be implemented on a country-wide scale. Participation in the NHIN will almost certainly be voluntary, and the private sector may choose not to share information—creating a major roadblock for the NHIN. Perhaps the implementation of an NHII in the United States will occur only after more experience has been gained with regional information interchange through the Regional Health Information Organization (RHIO) concept.

Approaches to NHII vary significantly internationally. Other countries have approached the concept differently from the United States. Probably the boldest venture is that of the United Kingdom. The U.K. National Health Service is investing significant sums to make an NHII a reality through the National Programme for IT (NpIT). The highly centralized implementation of this infrastructure spans primary, acute, and tertiary care as well as mental health and community care.

In Canada, the federal government has taken an active role and provided funding for the Health Infrastructure initiative. The government has appointed Canada Health Infoway, a not-for-profit organization, to oversee the development of interoperable technologies and their deployment across the country.

Interest in the NHII concept is growing around the world and as successes are demonstrated, countries may be able to learn from each other. It may be decades, however, before comparisons between such large-scale deployments lead to significant new learning, and in the interim most countries will feel their way gradually toward improvement of national healthcare information management. ■

TABLE 2: EXAMPLES OF DISCRETE BENEFITS REALIZED BY HOSPITAL IT INVESTMENT

Hospital description	IT initiative	Benefit realized
350-bed, private, not-for-profit community hospital	Medical administration application	<ul style="list-style-type: none"> Prevented 1,241 wrong drugs or dosages, amounting to a \$732,909 value in prevented errors Prevented 1,968 early or extra doses, amounting to a \$116,226 value in prevented errors 50% decrease in phone calls to the pharmacy per day
437-bed, private, not-for-profit integrated healthcare system	Electronic medical record system	<ul style="list-style-type: none"> 372,000 fewer laboratory and radiology reports printed and filed annually About \$1,000 in savings per year per physician due to improved formulary compliance 50% or greater decrease in transcription costs in some medical departments 9–25% increase in productivity in five clinical services during a one-year period 100% ICD-9 coding of all orders by the provider, improving the accuracy of billing Chart pulls reduced by 105,000 annually
Private, not-for-profit integrated healthcare delivery system serving an urban population of 440,000 members	Electronic medical record system	<ul style="list-style-type: none"> 76% decrease in phone calls to obtain lab results during four-year period More than 90% decrease in chart pulls for quality review 2,000 fewer daily chart pulls overall, eliminating 16 FTEs and saving and avoiding about \$5.7 million on medical record unit FTE costs 7.5% decrease in laboratory test ordering—attributable to reliable and efficient access to test results—reducing redundant tests 10% decrease in outpatient visits per member per year over three years, reversing previous increases Decrease in average number of lab tests per member from nearly 17.5 to less than 16 per year
1,951-bed, private, not-for-profit teaching hospital serving urban, rural, and international populations	Clinical information system	<ul style="list-style-type: none"> \$2,906,000 annual savings resulting from reduction in staff needed to route paper medical records, from clinical notes technology, and from automation of correspondence \$2,850,000 annual savings resulting from electronic access to all laboratory results and reports compared with the previous manual process for handling medical records \$8,630,000 annual savings resulting from the elimination of paper medical charts during outpatient encounters \$7,000,000 annual savings resulting from a reduction in unbillable tests and the ability to bill patients directly
927-bed, academic medical center serving an urban population	Automated billing, admissions, discharges, pharmacy, laboratory, radiology, and other functions	<ul style="list-style-type: none"> \$1,167,317 saved in transcription costs in one year 40% reduction in paper faxes as they are intercepted and imported into the system 28 FTEs eliminated as a result of automatic scanning, problem lists, and EMR, saving \$704,000

Source: Information Technology: Benefits Realized for Selected Health Care Functions, U.S. General Accounting Office, October 2003

A study by the U.S. General Accounting Office (GAO) illustrated some of the typical benefits that healthcare organizations have derived from investments in IT.

Operational Efficiency

Healthcare automation enables organizations to gain significant operational efficiencies. According to the CITL, approximately 90 percent of the more than 30 billion point-to-point healthcare communications that occur in the United States each year are conducted by fax, paper mail, or phone. A digital hospital adopts direct information interchange through interoperable information technology for many of its transactions, making communication less expensive, faster, and more accurate.

Several studies, including the Institute of Medicine's *The Computer-Based Patient Record: An Essential Technology for Health Care*, have documented the amount of time staff spend looking for clinical information. Effective deployment of EMRs dramatically improves this situation. Case reviews may be undertaken without extensive, manual searching. Nursing handovers may be shortened significantly. Scheduling systems can enable reductions in wait times, for patients and staff alike: Next steps in processes can be scheduled automatically, and when a test must be canceled, associated orders can be automatically cancelled also.

"In every hospital I've been at, the most common complaint of doctors is that they don't have radiology and lab results. Here they can never say that, as they can view the results in their office or at home before they come in," says Lynn Mergen, chief executive officer of Centennial Medical Center, an 118-bed acute care hospital that opened in 2004 in Frisco, Texas.

Centennial also realizes increased efficiency through other technology investments: "We have digital mammography. With this technology, your throughput is higher, thus making the hospital much more efficient," Mergen explains.

The Indiana Heart Hospital, an Indianapolis-based cardiac care hospital, also measured a number of benefits from its investment in a fully digital hospital, including: increased market share by 15 percent in the first fiscal year, reduction in medication errors by 85 percent, reduction in inappropriate denials and delays with respective payers by 65 percent, reduction of chart management costs from \$15 to \$3 per chart, reduction in medical transcription and dictation costs by 45 percent, reduction in coding and abstraction workload by 15 percent, and reduction in physician chart completion activities by 30 percent. These comparisons were made between new-build Indiana Heart and previous cardiac facilities elsewhere in the hospital system.

The digital hospital is also more flexible and adaptive. Technologies may enable the disaggregation of healthcare practices and recombination into new approaches so that healthcare enterprises can assemble processes of care that are more efficient and effective. Moreover, as implementation and integration deepen, the highly automated enterprise becomes more capable of effective strategic and tactical reactions to market shifts.

"In every hospital I've been at, the most common complaint of doctors is that they don't have radiology and lab results. Here they can never say that, as they can view the results in their office or at home before they come in."

***Lynn Mergen,
Centennial Medical
Center***

“If you don’t have an electronic medical record with CPOE in the next five years, you’re going to be like the bank without ATMs. The patient will demand it. And you are going to have a really tough time recruiting residents. They’ve trained with these tools—just try to get them back to paper.”

***Jack Wolf,
Montefiore Medical
Center***

Other Benefits

An important benefit realized through technology investment is increased patient satisfaction. If patient records are electronic, healthcare staff are less likely to ask the same questions repeatedly. Patients report a reassuring sense that the physicians and nurses know more about their case when all their information is clearly in one place.

Organizations can also gain a competitive advantage through technology. Physicians and nurses are increasingly attracted to the smooth and efficient operational environment that effective automation can offer. At Indiana Heart, for example, employee satisfaction increased and employee turnover decreased significantly, from 11 percent turnover at the old facility to slightly more than 1 percent at the new hospital.

“If you don’t have an electronic medical record with CPOE in the next five years, you’re going to be like the bank without ATMs. The patient will demand it. And you are going to have a really tough time recruiting residents. They’ve trained with these tools—just try to get them back to paper,” asserts Jack Wolf, vice president and chief information officer of Montefiore Medical Center.

In Portland, Oregon, where physician wages lag the national average, Providence Health System, a not-for-profit healthcare delivery organization, improved its physician recruitment and retention by offering clinical IT. Dick Gibson, chief medical information officer, says that PACS is a real “doctor pleaser” because it consolidates imaging from all three of the network’s hospitals. “For many docs who are high admitters, it can save as much as 30 minutes a day,” Gibson says.

Digital hospitals also enjoy more effective reimbursement management through online eligibility checking prior to providing treatment. Clinically driven revenue cycle management reduces charge-entry efforts and enables billing to become more of a by-product of the clinical process. Charge capture is thus more rapid and accurate, which can reduce the amount of rework that often plagues billing functions.

HOW BENEFITS ARE REALIZED

From the earliest days of healthcare process automation, the topic of benefits realization has challenged the industry. Some benefits are immediate and easy to identify—such as the reduction in cost of paper forms upon implementing CPOE. These benefits, however, are the rarest. Healthcare automation—whether standalone departmental information systems or complete enterprise-wide digital health system projects—requires careful management attention to ensure that the benefits are realized. And they may take several years to come to fruition.

“PACS really shows high value and most of the doctors really like it. But you must completely eliminate film to get the full ROI. The same holds true for document imaging. We purchased a document imaging system, but continued to keep a paper medical record for several years. This increased our costs instead of decreasing costs due to dual processes. We had to change processes and eliminate the paper record entirely before we realized the savings of automation,” explains Lauren O’Brien, regional chief information officer of Providence.

The digital hospital—through the completeness of its vision—also enables incorporation of many technologies that may otherwise be implemented without reference to a central information technology strategy. This organization-wide coordination of technology planning and investment provides opportunities for economies of scale, better project management, and better prioritization of capital expenditure; and enables explicit planning for integration of otherwise disparate technologies into a coherent organization-wide information architecture. Examples of such technologies may include patient tracking, radiological information management technologies (such as PACS), laboratory information management solutions, and external connectivity and outreach programs.

“There is clearly a value from these technologies and that value can be significant. However, it’s difficult to quantify. The value of technology and process redesign is multifaceted and can be hard to capture. Some benefits such as the reduction of medical errors may benefit patients and employers more than hospitals due to current incentives,” asserts Partners’ Glaser.

Incremental Benefits

The benefits of individual components of healthcare process automation are now reasonably well established. Greater automation appears to lead to more benefits—but slowly. As further anecdotal and more rigorously statistically analyzed evidence emerges about the benefits of individual technologies (such as CPOE or automated generation of reminders), some research studies have attempted to compile data from multiple institutions to determine whether incremental automation leads to significant additional benefit.

A 2002 study by the Federal Reserve System, *Measuring the Cost Impact of Hospital Information Systems: 1987-1994*, explored relationships between technology investments and operational metrics in 3,000 hospitals over a seven-year period. The study found that the most thoroughly automated hospitals experience a significant decline in costs three to five years after adoption of technologies. Declining costs were associated especially with more modern technologies, described as those designed for cost management, for the administration of managed care contracts, and for clinical and financial decision support. Stronger associations may be anticipated in future studies because more clinical systems have been implemented during the past 10 years, and as additional investment in clinical process automation occurs.

Network Effects

Organizations may accrue benefits throughout the digitization continuum. Usually, benefits are documented as case studies of singular functions: CPOE, nursing documentation, PACS. However, the relationship between investment in healthcare automation and benefits of it appear not to be linear. PricewaterhouseCoopers’ research indicates that as technology penetrates an ever greater degree of the enterprise, the degree of benefit the organization enjoys rises more significantly. Healthcare enterprises appear to move past a threshold and become significantly more adaptive, responsive, and organizationally transparent. (See Figure 6 on page 24.)

“We purchased a document imaging system, but continued to keep a paper medical record for several years. This increased our costs instead of decreasing costs due to dual processes. We had to change processes and eliminate the paper record entirely before we realized the savings of automation.”

***Lauren O’Brien,
Providence Health
System***

OPERATIONAL AND CLINICAL CHARACTERISTICS OF DIGITALLY ADVANCED HOSPITALS

PricewaterhouseCoopers teamed with HIMSS Analytics (a wholly owned subsidiary of the Healthcare Information and Management Systems Society) to identify a group of 36 digitally advanced hospitals. PricewaterhouseCoopers and HIMSS Analytics selected this group of hospitals on the basis of their reputation in the industry for implementing clinical information systems.

The 49 different applications described in the HIMSS Analytics DatabaseSM were categorized into three application types: administrative, back office, and general clinical. The clinical category was further broken down into clinical and advanced clinical.

The sample group was significantly more digital than the full set of hospitals in the HIMSS Analytics Database. The digitally advanced sample group showed 76 percent implementation of general clinical applications, 62 percent implementation of advanced clinical applications, and 70 percent overall. At the same time, the average implementation levels for all of the hospitals in the database were 60 percent general clinicals, 37 percent advanced clinicals, and 50 percent overall. (See Figure A.)

Of the digitally advanced group, none had a big-bang beginning; they added IT systematically and slowly. Few hospitals can afford the capital or disruption of becoming a completely digital enterprise in a single year. As systems such as computerized physician order entry (CPOE) became available, hospitals began to implement them.

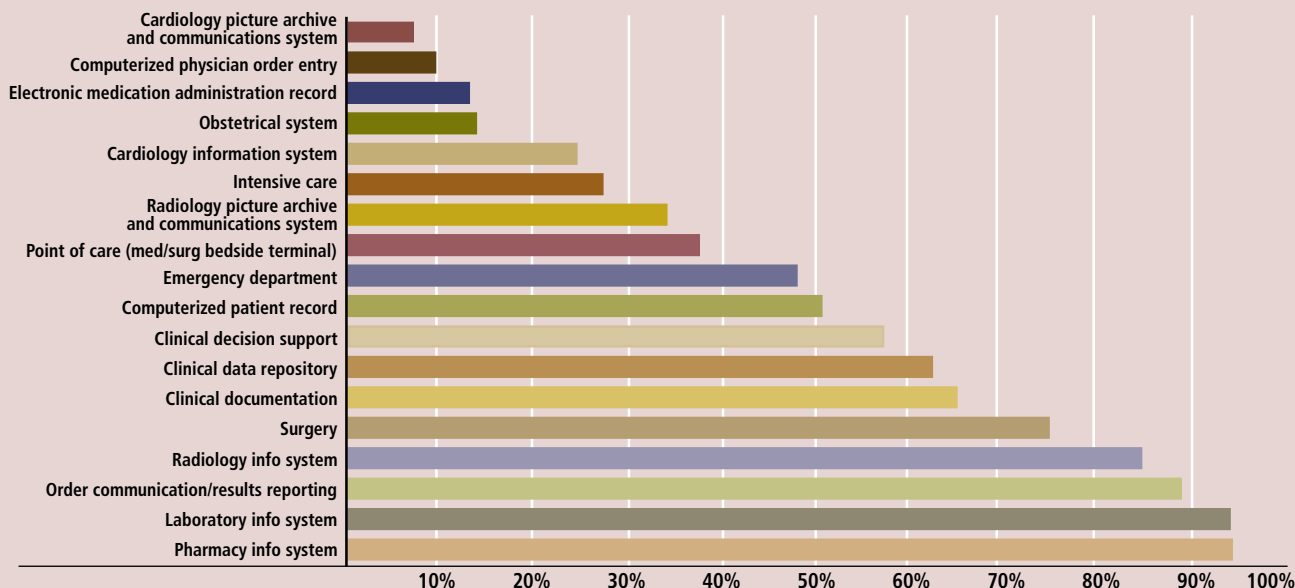
The data also shows that the digitally advanced hospitals tend to have certain similar characteristics. Many of them are academic hospitals. This characteristic is not surprising; such hospitals are often larger than average and often the most advanced medically. Further, larger hospitals in general, and healthcare systems in particular, are more likely to be digital. Not only can such organizations realize economies of scale, but hospitals with multiple facilities also are generally accustomed to electronic communication and collaboration. The data also reveals that digitally advanced hospitals exist nationwide and are not limited to regions that are centers for high technology.

PricewaterhouseCoopers undertook additional comparative analysis of operational, financial, and quality metrics of the study group of hospitals. We compared the performance of the group of digitally advanced hospitals to national averages using medical data from the Centers for Medicare and Medicaid Services' (CMS') publicly available *Hospital Quality Alliance: Improving Care Through Information*, and financial data obtained from Solucient, for the digitally advanced hospitals and in aggregate.

Average length of stay (ALOS) is generally regarded as an indicator of efficiency, and the digitally advanced group of hospitals saw bigger drops in length of stay. Table A uses data from Solucient and the American Hospital Association (AHA) to compare the digitally advanced group to all hospitals.

Overall, the digitally advanced hospitals also reported a larger increase in revenues than all hospitals. (See Table B.)

FIGURE A: PENETRATION RATE OF VARIOUS TECHNOLOGIES FOR DIGITALLY ADVANCED HOSPITALS



Source: The HIMSS AnalyticsSM Database (formerly known as the Dorenfest IHDS+ DatabaseTM) ©2005 HIMSS Analytics (HIMSS Analytics collects and analyzes healthcare organization data relating to IT processes and environments, products, IS department composition and costs, IS department management metrics, healthcare delivery trends, and purchasing-related decisions.)

TABLE A: AVERAGE LENGTH OF STAY FOR DIGITALLY ADVANCED HOSPITALS COMPARED WITH ALL HOSPITALS

Year	ALOS for digitally advanced hospitals	% change	ALOS for all hospitals*	% change
1999	5.91		5.9	
2000	5.89	-0.20%	5.8	-1.69%
2001	5.89	-0.10%	5.7	-1.72%
2002	5.76	-2.10%	5.7	0.00%
2003	5.62	-2.40%	5.7	0.00%

Source: AHA Hospital Statistics, 2005 Edition; Solucient.

*Includes all non-federal short-term, general, and other specialty hospitals surveyed by the AHA

TABLE B: CHANGE IN OPERATING REVENUE FOR DIGITALLY ADVANCED HOSPITALS COMPARED WITH ALL HOSPITALS

Year	Digitally advanced hospitals	All hospitals*
2000	11.09%	6.32%
2001	5.05%	8.35%
2002	11.02%	9.69%
2003	8.02%	7.64%
Cumulative increase	40.18%	36.01%

Source: AHA Hospital Statistics, 2005 Edition; Solucient.

*Includes all non-federal short-term, general, and other specialty hospitals surveyed by the AHA

Cost savings from automation are neither immediate nor directly realized. The hospitals in the PricewaterhouseCoopers and HIMSS Analytics sample had a spike in applications implemented in 1998. This peak was followed by an increase in total expenses and full-time equivalents (FTEs) in the hospitals in 2001 and a decrease in later years. This trend speaks to the long-term vision needed to prioritize and complete such projects, as well as the need to commit substantial up-front funding to recognize long-term goals.

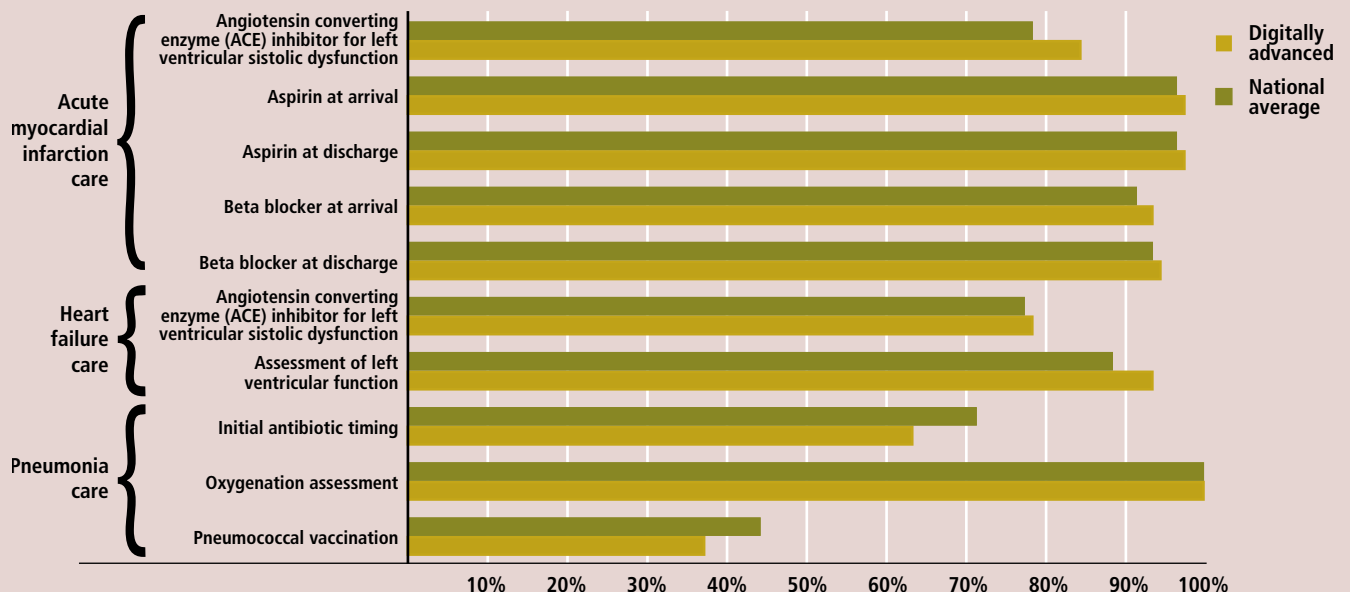
In addition to cost impact of digital technology investments, most organizations seek quality improvements. Measuring clinical quality usually involves assessment of process measures. Most quality metrics refer to processes that are thought to lead to quality. For

example, the CMS has asked hospitals to report on 10 measures that pertain to hospital care for three conditions: heart attack, heart failure, and pneumonia.

When the group of 36 digitally advanced hospitals was measured against all hospitals that had reported on the indicators, the digitally advanced hospitals ranked higher on 7 of the 10 indicators. (See Figure B.)

These results, while not necessarily of statistical significance, suggest a potential positive relationship between information technology investment and these metrics. It is not possible to conclude a causal relationship from these data; further research would be required. ■

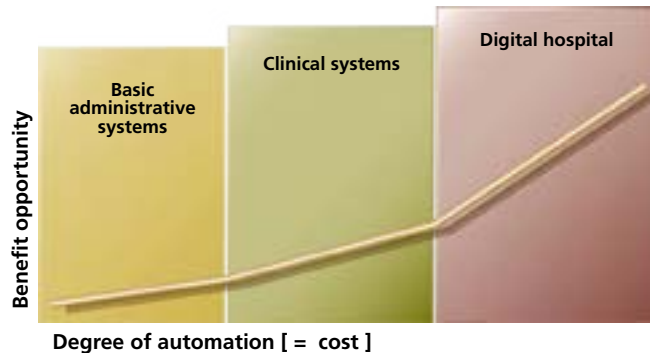
FIGURE B: COMPARISON OF COMPLIANCE WITH 10 QUALITY INDICATORS, DIGITALLY ADVANCED HOSPITALS AND ALL HOSPITALS



Source: Centers for Medicare and Medicaid Services, 2004

The opportunity for benefits, such as enhanced quality, reduced costs, and improved revenues, all increase as investment is made in increasing digitization. Such benefits do not flow readily to the organization's bottom line, however; significant emphasis on organizational transformation is needed to realize them.

FIGURE 6: RELATIONSHIP BETWEEN DEGREE OF AUTOMATION AND BENEFIT OPPORTUNITY



Explains Mark Leavitt, medical director of the Healthcare Information and Management Systems Society (HIMSS), “You have these breakthrough points. Let’s say you’re trying to gradually move into a digital environment. There’s a period when you invest and invest, and there’s no return—and then you crack through something and now you’ve got a return. You probably want to shoot for those milestones. It’s more expensive to go semi-digital because you’re still using paper. You actually make a workflow that’s worse.”

Two technology-adoption concepts appear to underpin the digital hospital continuum: network effects and the idea of a tipping point. The often cited example of a network effect is the fax machine. A single fax machine is of little value. Two fax machines can communicate, but the real value of owning a fax machine arises when the machines are commonplace and communicate through shared standards. Simplistically, at some point during the increasing adoption of fax machines, a point is reached at which ownership of one becomes a business necessity.

Similarly, for several years PCs did not include CD readers—they were optional. At some point, a tipping point occurred at which they effectively became a standard part of almost any new PC. When a sufficient level of CD-reader infrastructure could be assumed—from the reasonable presumption that any PC would have one—a further tipping point occurred: New ways of distributing software products became standard.

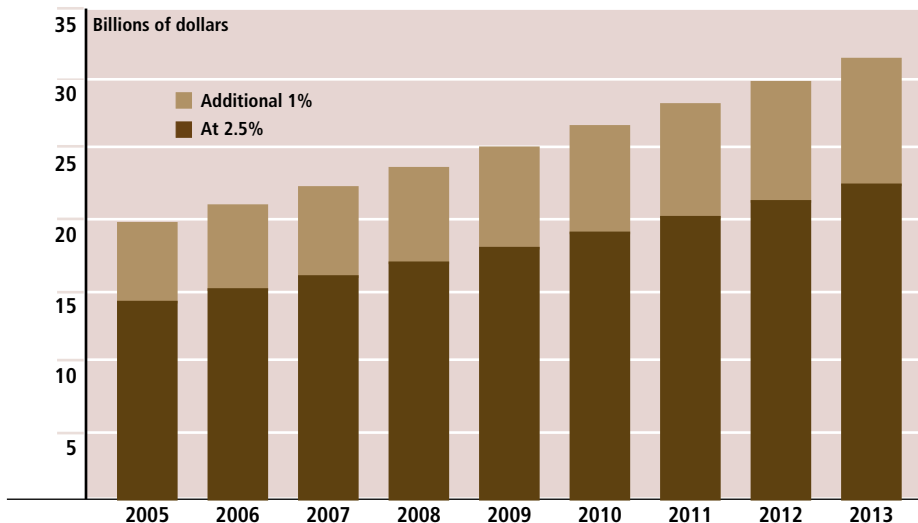
As information systems are incrementally deployed in various parts of the hospital, the necessity of all departments being similarly automated begins to become apparent. Demand rises for organizational transformation to better leverage the opportunities for enhanced information management and interchange between departments.

Thus network effects contribute to accelerating the adoption of information solutions within a healthcare delivery organization. As this adoption increases—with sufficient integration between systems and into the fabric of the enterprise—a tipping point seems to occur. The real payoff occurs as the level of automation, integration, and transformation each reach a threshold level. At that point, the interplay between various components of an organization’s technology infrastructure—if suitably integrated—enables a sea change in the way the organization is able to respond to novel strategic challenges. The organization can become an adaptive, responsive enterprise.

To reach this threshold at which more significant returns appear, hospitals will need to invest more than they do now. On average, hospitals spend approximately 2.5 percent of their operating budgets on IT, according to the February 2004 HIMSS Leadership Survey. However, PricewaterhouseCoopers' research indicates that organizations transitioning toward being digitally advanced are spending 3 to 5 percent.

Extrapolating these numbers by using the CMS hospital spending numbers, hospitals would spend \$14 billion on IT in 2005. However, by spending another 1 percent, hospital IT spending would add another \$5 billion in 2005, according to the CMS' Office of the Actuary. Figure 7 shows the level of IT spending at 2.5 percent, using the CMS projections for overall healthcare spending, as well as what the 1 percent in additional spending would contribute.

FIGURE 7: HOSPITAL IT SPENDING FORECASTS



Source: Centers for Medicare and Medicaid Services, PricewaterhouseCoopers, 2004

The network effect is especially clear when automation begins to occur beyond the boundaries of the hospital, between hospitals and other organizations with which hospitals interact. Then, the various participants in the healthcare economy depend on standards-based information interchange.

Most healthcare information management problems outside hospital boundaries pertain to the transfer of patient clinical and financial information between different organizations involved in a patient's care. Typically, these transactions are conducted through paper, fax, mail, or telephone. Significant opportunities for automation exist. The benefits of improving communication—usually considered to be a problem of institutional and technological interoperability—are both clinical and financial. For example, a parent enrolling his or her child at a new school needs an up-to-date cumulative immunization record. A family moving from Los Angeles to New York will typically wish to transfer their clinical records to their new care providers. A patient admitted unconscious to an emergency room would benefit from the emergency care team having access to the patient's primary care records.

“You have these breakthrough points. Let’s say you’re trying to gradually move into a digital environment. There’s a period when you invest and invest, and there’s no return—and then you crack through something and now you’ve got a return. You probably want to shoot for those milestones. It’s more expensive to go semi-digital because you’re still using paper. You actually make a workflow that’s worse.”

***Mark Leavitt,
Healthcare Information
and Management
Systems Society***

“Senior leadership of the health system should have a comprehensive understanding of the need for workflow redesign, intellectual capital focused on clinical informatics, and the commitment to training and education of the end-users. These are important components to ensure a successful implementation, as most vendor products and knowledge today are not as robust as they think are.”

***Brigitte Shaw,
Pepin Heart Hospital and
Research Institute***

The challenge of effecting such automation is not just one of automating hospitals. The majority of care settings to which these considerations apply (primary care settings, physician offices, public health organizations) are notably difficult to automate. The level of penetration of modern technology into the ambulatory practice setting is extremely low.

The CITL estimated significant benefits—cost savings and clinical quality improvements—through enhanced automation of the ambulatory healthcare environment, and through subsequent interoperability and information exchange. However, despite the impact of the network effect in accelerating the pace of benefits realization, the ambulatory healthcare environment is a singularly complex and difficult one in which to make progress. Policy and regulatory issues, financial barriers, organizational readiness for change, and perceived market failures (software solutions are said to be too expensive, but lower cost solutions do not survive the market) make rapid progress unlikely.

■ Digital Hospitals In Practice

In 2005, the number of fully digital hospitals in operation in the United States remains small. The majority of organizations that describe themselves as digital hospitals, whether operating now or planning to open in the future, are specialty institutions. Additionally, they often are new-build facilities, such as Indiana Heart or the Pepin Heart Hospital and Research Institute, a specialty cardiac treatment and research center in West Central Florida that is currently under construction. They arguably benefit from the single service-line function of the facilities. However, the experiences of early leaders highlight some important factors that organizations must consider when planning, building, and operating an all-digital facility—whether it is an 80-bed heart center or a 1,500-bed general hospital.

Among acute care institutions, several more digital hospitals are in the planning stages, such as those facilities being built by El Camino, Memorial Hermann Healthcare System, and Virtua Health during the next several years. The work of these organizations illustrates the considerations that form the rationale for a digital hospital. Finally, even those institutions focused only on specific clinical IT initiatives (such as CPOE, EMR, or PACS) demonstrate the challenges, opportunities, and payoffs that accompany the pursuit of the digital hospital vision.

The key considerations are discussed in the following sections.

LEADERSHIP

An organization’s management and board leadership for a digital hospital project are imperative. A digital hospital project entails significant organizational risk. Such a project is likely to span many years and may cost several tens of millions of dollars. In the case of Indiana Heart, the project began more than six years before the facility opened and represented nearly 1.5 million hours of work in architectural design, construction, operational design, IT implementation, resource planning, and many other key initiatives.

The U.S. Department of Health and Human Services' Brailer says that capital spending on IT may be wasted if not invested for the right reasons. "When spending capital, the question is why are they doing it? If they're investing capital to improve their long-term sustainable operating condition, I don't think the benefit is very high because this is not a very good financial decision in today's market.... If it's net revenue driven, the benefit is [low]; if it is mission driven the benefit is [high], because it's the best way to achieve the [organization's] mission."

A clear vision of the project purpose and goal is essential to ensure that all stakeholders share a common view of the organization's direction.

Central DuPage's Printz highlights the importance of leadership. "You must have a management team, board of directors, and a medical staff who are all marching to the same drum and have the same vision of the future. In the final analysis, the vendors can produce, and the hardware and software tools that are needed exist. Where organizations have problems is in leadership and execution. It's that simple."

A digital hospital project entails major organizational transformations and substantial business risks. These risks include cost overages, failure to gain expected returns on the investment made, and even user refusal. Few other industries spend tens of millions of dollars on information technology while facing the risk that—upon go-live—a significant proportion of staff will refuse to use the system. Broad and deep healthcare process transformation through technology may have a powerful impact on the organization. The board needs to be involved in the decision and to provide explicit support for the project.

"The educational component for the board is important—getting them aside for a couple of days and having them go through this in excruciating detail. Let them ask the questions, because it's new to them, too," says Virtua's Richard Miller.

Hospital digitization requires significant and sometimes difficult systems integration efforts. No vendor has all the answers, and senior management attention is required to ensure that proper collaboration occurs between all parties involved in making multiple systems interoperate.

"Senior leadership of the health system should have a comprehensive understanding of the need for workflow redesign, intellectual capital focused on clinical informatics, and the commitment to training and education of the end-users. These are important components to ensure a successful implementation, as most vendor products and knowledge today are not as robust as they think are," says Brigitte Shaw, chief executive officer of Pepin Heart.

Organizational transformation efforts may encroach on workflow decisions typically made within a single department. Such integration issues require engagement and cooperation among all departments that constitute the hospital—potentially some that might not usually work together. Maintaining good progress and morale during these efforts requires a sustained leadership commitment to the success of the project.

"You must have a management team, board of directors, and a medical staff who are all marching to the same drum and have the same vision of the future. In the final analysis, the vendors can produce; the hardware and software tools that are needed exist. Where organizations have problems is in leadership and execution. It's that simple."

***Dave Printz,
Central DuPage Hospital***

“CEOs are daily balancing the delivery of quality clinical services against increased regulatory and fiscal pressures. This revolutionary concept goes further than a PACS. The end product will enhance the delivery of healthcare for both physicians and the clinical staff.”

***Norm Stein,
University Community
Health***

“CEOs are daily balancing the delivery of quality clinical services against increased regulatory and fiscal pressures. This revolutionary concept goes further than a PACS. The end product will enhance the delivery of healthcare for both physicians and the clinical staff. I believe the cost/benefits will more than justify the capital expenditure,” explains Norm Stein, chief executive officer of University Community Health, a Tampa-based not-for-profit health network, of which Pepin Heart is a part.

“If you’re prepared to look ahead far enough and you believe that your success depends on being an innovator, then you need to be looking at [digitization]. If you’re just looking at this quarter or this year, understandably you may want a more incremental approach to improving the areas where you have the most problems. But you still need to think about your long-term strategy and make sure that it supports your success and doesn’t take you to a dead end,” says HIMSS’s Leavitt.

PROCESS REDESIGN

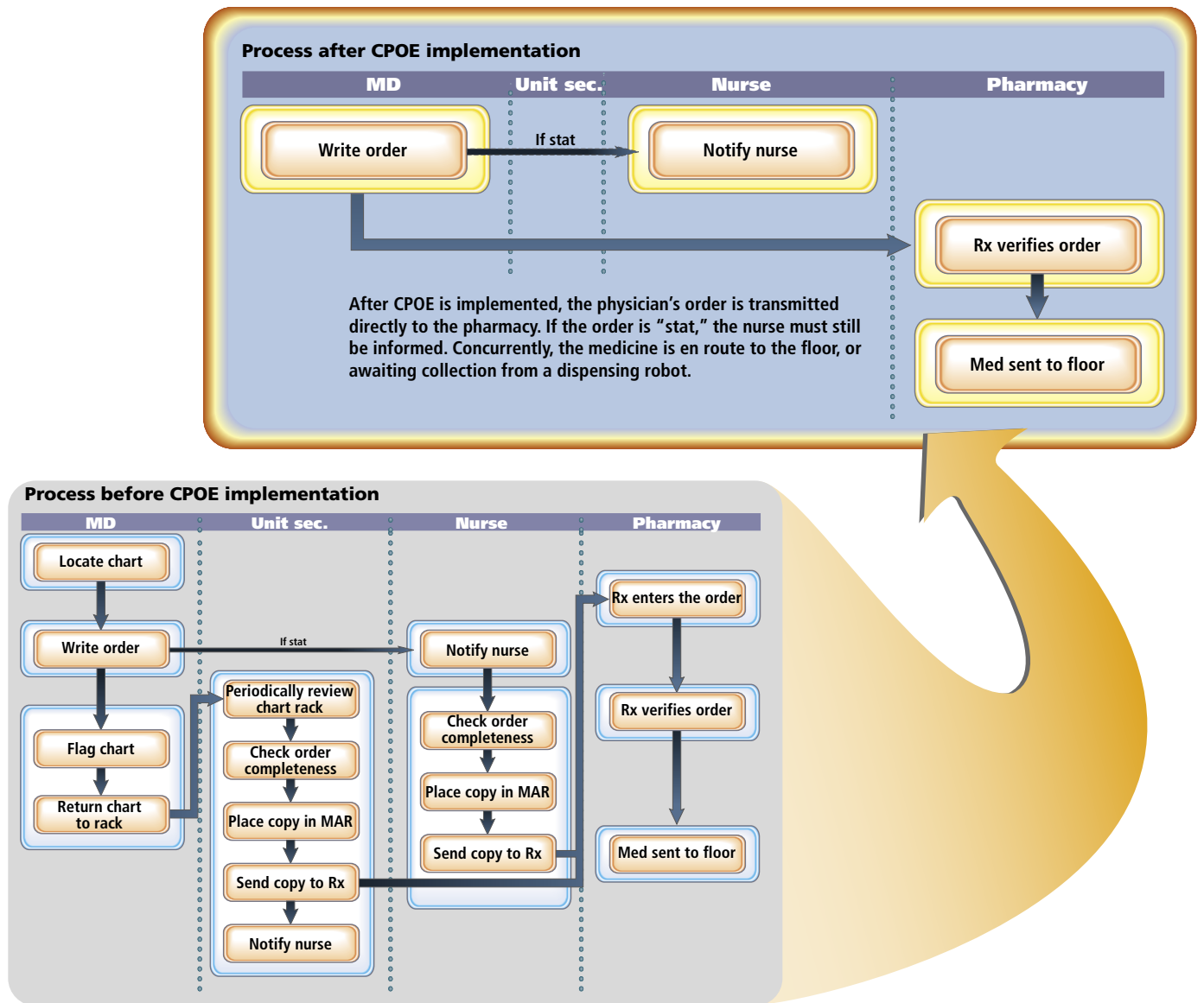
Process design and technology acquisition and implementation must be interwoven. Becoming digital is not a simple buy-and-install project. Implementing a digital hospital requires the deployment and integration of a complex, connected series of technologies to create a smoothly running system that fully exploits the technology and empowers clinicians and other hospital staff to more effectively fulfill their responsibilities. Work processes will need to change, requiring a careful interplay between process design and technology choices. Figure 8 illustrates the process redesign that was required at Montefiore Medical Center, the health system that is affiliated with the Albert Einstein College of Medicine, in Bronx, New York, which has fully implemented CPOE and other technologies. Montefiore has also established the Emerging Health Information Technology subsidiary, which provides healthcare information management solutions to other healthcare organizations.

Indiana Heart provides another example of process design. Indiana Heart’s stated goal was to build a hospital in which care was centered on the patient. The project’s initial design phase included the modeling of an ideal patient flow through the hospital. The model detailed what information was needed where, when, by whom, and in what format. The design process included physicians and other clinicians, as well as stakeholders from the Community Health Network of which Indiana Heart is one of five hospitals. Clinical IT specialists from vendor candidates also played an active role in workflow design—in advance of Indiana Heart’s final vendor selection for a technology provider.

The impact of organizational transformation is a significant factor in determining whether a project is ultimately judged as a success or a failure.

Providence’s Gibson concurs with the patient-centered approach. “The relationship between technology and process change should start with what is best for the patient. Patients don’t care if a hospital uses paper or is paperless,” he says.

FIGURE 8: EXAMPLE OF PROCESS REDESIGN IN A DIGITALLY ADVANCED HOSPITAL



Source: Montefiore Medical Center/Emerging Health Information Technology Inc.

Staff will need to change the way they work—possibly dropping older systems and adopting specific work processes designed to maximally exploit the capabilities of a given system.

“Process and technology are very interdependent. It’s a hand-in-glove thing—that’s kind of how I look at it. Technology can only be as good as the process is well defined,” says Ninfa Saunders, executive vice president of Health Services at Virtua Health.

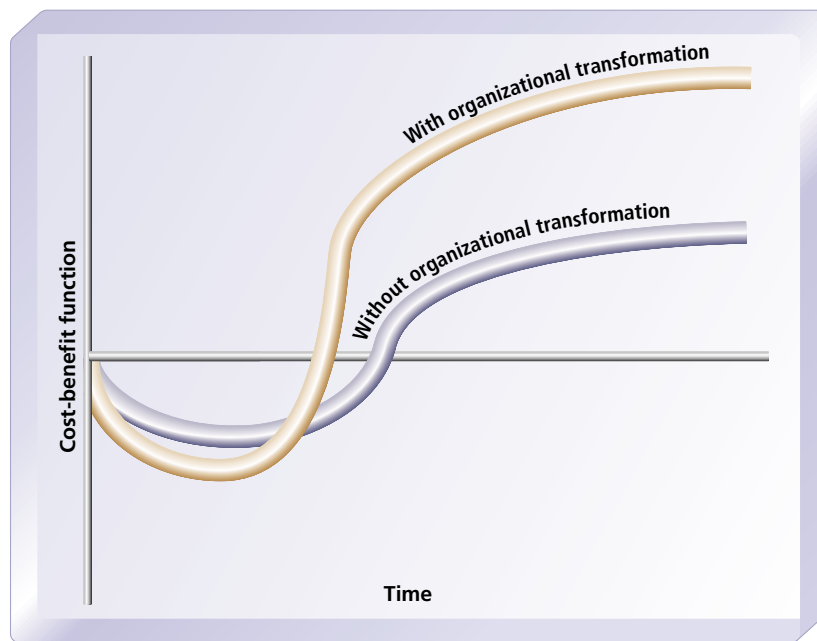
Montefiore Medical Center mapped the before and after workflows for the process of medication ordering, dispensing, and administration. The diagram shows process-step elimination, which contributed significant efficiency gains and financial benefits, in addition to the patient safety improvements that were demonstrated.

Technology implementation techniques have emphasized mapping and automating processes to make them go faster. Now the goal is to eliminate processes.

“We map work processes by department to see what the non-value-added processes are. The true value of clinical automation is in changing the business processes to change the way we do business. For our CPOE evaluation we brought in a PhD industrial engineer who worked with Nike on their order system to help us re-engineer our process before automating it,” explains Providence’s O’Brien.

With sufficiently integrated technology, organizational transformation can radically redesign clinical and other business processes, potentially eliminating significant components to realize process benefits. This process redesign is fundamental to the success of digitization, and requires major investments in organizational development and cultural change. Technology implementations without significant emphasis on process redesign appear not to generate the same levels of benefit. In fact, they are likely to add costs and overall frustration. The time taken for process design to become fully woven into hospitals’ operations may help to account for the lag typically seen between systems implementation and subsequent cost reduction, which is around three to five years. (See figure 9.)

FIGURE 9: IMPACT OF ORGANIZATIONAL TRANSFORMATION ON ROI CURVE FOR A WELL-MANAGED IT PROJECT



The realization of value of investment in hospital automation may be significantly delayed and substantially reduced if the implementation is not accompanied by effective organizational transformation efforts.

Moreover, trying to make technology support processes it was not designed to support is rarely successful. Although technology strategy should follow clinical strategy, software is not infinitely malleable, and all commercial clinical information systems require certain product-specific processes to be part of the overall clinical process.

Process analysis is crucial for technology selection. What Pepin Heart learned in extensive workflow design sessions helped the team assess where potential vendor

solutions fell short of meeting important productivity, patient safety, and revenue-generating workflow requirements. By identifying these gaps, Pepin Heart could work with vendors to commit to additional product development or customization to meet the hospital's needs.

TECHNOLOGY

Although technology strategy should be determined in order to support business strategy, it is important to pay close attention to what is currently technically feasible.

Indiana Heart developed a three-year strategic information systems plan in which technology was a fundamental part of the overall business strategy. The IT plan applied technology to every facet of clinical and business operations, integrating people, process, technology, and cultural elements. Indiana Heart expanded the definition of technology beyond core healthcare information and ancillary systems to include the comprehensive medical device spectrum, from patient beds and surgical equipment to lighting systems and pagers. Indiana Heart also defined its next-generation IT initiatives to ensure the products it selected were scalable and could remain compatible as the industry and standards evolved.

To better manage the implementation of unproven processes and supporting technology, both Indiana Heart and Pepin Heart created a simulated testing environment that enabled clinicians to learn systems and processes in a phased approach. The simulation increased the clinicians' comfort level and decreased the risk of them resisting change.

"The technology and physical design are really secondary to the employee culture. Improving processes is more important than developing a 'paperless' hospital. Cultural change is more important than digital change," asserts Michael Venturini, chief medical officer of Indiana Heart.

Indiana Heart created a 5,500-square foot replica of its new hospital. In this test environment, Indiana Heart's technology teams were able to implement the technology in parallel to existing operations; develop comprehensive testing and training programs to assure technology stability and staff comprehension; give clinicians and physicians the opportunity to model patient care activities; and set up a forum for immediate feedback not typically achieved until after technology is implemented.

Although few organizations are likely to be able to afford the time, space, or expense to undertake such an in-depth planning exercise, the experience was undoubtedly valuable for Indiana Heart and serves as an illustration of a particularly comprehensive and thorough approach to process design.

Organizations may benefit from workflow management technology, which enables them to develop explicit graphical representations of processes, which are then automatically implemented through the software by virtue of having been mapped graphically. Several healthcare software vendors are implementing workflow management technologies as components of their products. "If you already know what the next step is, you can trigger the step automatically," says Siegfried Bocionek, chief operating officer of the Health Services Division of Siemens Medical Solutions.

"The technology and physical design are really secondary to the employee culture. Improving processes is more important than developing a 'paperless' hospital. Cultural change is more important than digital change."

***Michael Venturini,
The Indiana
Heart Hospital***

“If I were to do it again, I would put financial penalties in the contract if the equipment didn’t integrate and work in a certain amount of time—all of the interfaces working. I would build in those back-end incentives. In two months, you pay this, in three months, you pay this.”

***Lynn Mergen,
Centennial Medical
Center***

Vendor Selection and Management

Selecting a core vendor—or set of vendors—is a decision that will have profound implications for many years. It is crucial to invest sufficient time and senior management attention in the selection process. Organizations should ensure that all key players are properly involved—not only technology advocates, but also key management staff from all disciplines that will be affected. Enough resources must be dedicated to the process of system review and selection.

Physicians, nurses, and other clinical staff must be engaged early and in a way that is respectful of their clinical commitments. Information technology staff should help to prepare staff for vendor review sessions. Product demonstrations are useless if they focus attention on minor aspects of system look and feel rather than system features and benefits.

Vendors ideally should be assessed for how their vision aligns with that of the hospital. Where do the vendors dedicate their development resources? Where have they demonstrated leadership and commitment to product development above and beyond the specific requests of their last new customer?

A significant consideration in system selection and contracting is systems integration. A digital hospital will require technologies from multiple vendors to be integrated.

“If I were to do it again, I would put financial penalties in the contract if the equipment didn’t integrate and work in a certain amount of time—with all of the interfaces working. I would build in those back-end incentives. In two months, you pay this, in three months, you pay this,” says Centennial’s Mergen.

Some organizations have chosen to contract with a single-source supplier as a prime vendor or super vendor who would carry the responsibility for effecting integration between participating vendors. For Indiana Heart, the selection of a so-called super vendor was seen as a way to save Indiana Heart leadership time and resources by having a single point of contact.

Providence, however, took the opposite approach. “You can really only afford to use the super vendor concept with a new hospital; you can’t do it with an existing hospital like Providence. In addition, the super vendors may not have good performance in all of the product lines and there is lots of vaporware out there. Besides, once you build it you have to constantly innovate so you might as well get used to integrating systems,” explains Providence’s Gibson.

Technology performance characteristics are also important in vendor selection. Response time and system availability characteristics may have a significant impact on user acceptance and substantial cost implications for a fully digital hospital.

Upon project commencement, hospitals that do not manage their vendors increase their risk of suffering a project failure—regardless of the vendor or technology chosen. Vendor management should include carefully monitoring the vendor’s necessary role in process redesign. Every vendor has success and failure experiences—no vendor can guarantee success. Yet vendors may be vital partners in ensuring a successful project.

Integration

A digital hospital is a hyper-connected hospital, fully integrated within its own walls and to the larger health community. This does not mean that all technology must be purchased from one vendor as a monolithic solution (such a solution is not available) but that real focus must be applied to systems integration efforts.

Irrespective of contractual responsibilities assigned to vendors as outlined in the previous section, integration cannot be just a vendor's responsibility. Integration always places significant process design and standardization responsibilities on the hospital. Modern technologies and approaches are a necessity. Integration engines, SOA, Extensible Markup Language (XML), and standards-based technologies are helpful and important, but they do not eliminate the challenge. They may, however, help hospitals with investment decisions that can reduce implementation risk.

CLINICAL ENGAGEMENT

Physicians have been seen as barriers to clinical information systems implementations. This is changing. Physicians are now perceived as facilitators of digital adoption—even advocates, with the right incentives. Nurses, pharmacists, and other clinical staff are also crucial groups to engage in the systems planning, selection, and implementation processes. Without such engagement, the probability of failure is high.

Hospitals must be prepared for resistance from some staff. “Out in front with me will be 10 percent of the people, going great guns. Another 10 to 15 percent are going to fight me every single step of the way. I’ve got to hear it and listen to it, but I don’t have to react to it. And then there’s the rest, the 70 percent who are going to follow. Unfortunately, that’s how it’s going to be, and I think that’s a real important thing to understand. It’s not going to be 100 percent,” says El Camino’s Zielazinski.

New job functions may attract some key clinical staff. For example, roles such as medical director of information systems, clinical informaticist, and clinical knowledge engineer have begun to emerge and can help ensure successful implementations.

“We have radiology information systems, laboratory information systems—we need people to maintain them. That’s a role that’s still developing. What type of role is a clinical IT person—is it a nurse? We don’t have a lot of nurses who want to do IT. That’s a blooming career path, but there’s not a lot of them now,” explains Cindy Slaydon, Centennial’s chief nursing officer.

Hospitals should support the training, accreditation, professional development, and other human resources implications of these roles. Hospitals may need to create new nursing and pharmacy positions, and enable physicians and other clinical staff to participate in formal academic training in informatics and related disciplines.

An added complexity is that physicians—a key user group—are often not employees of the hospital. Physicians play a central role in the successful deployment of many of the technologies constituting the digital hospital. Some technologies will disrupt physicians’ work—and frequently, physicians do not benefit from this

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***Mark Zielazinski,
El Camino Hospital***

The benefits gained are not always easily quantifiable, but nevertheless may be quantified. Benefits include significant quality improvements, operational efficiencies, cost savings, and improved revenues. A major strategic benefit, however, is the development of a responsive, adaptive, and learning organization.

disruption. Hospital management may need to find new ways to work with physicians to ensure project success. Prior to a clinical engagement program, particularly one that involves CPOE, a cultural readiness assessment is important. This assessment will help gauge the level of physician interest prior to program commencement, and assist the design of an organized program of physician engagement. Such a program may entail creating new staff positions, providing significant investment in new training (such as medical informatics study), or offering financial incentives to participate in the project.

“If you are creating a joint venture between physicians and hospitals, the role of a physician leader as a champion is critical. The physician should stay in his or her practice to be credible and to understand the clinical needs of the organization,” says Venturini of Indiana Heart.

Indiana Heart established clinician ownership for the EMR component of the project by selecting key clinical staff to design the part of the EMR that each would be interacting with. These so-called super users were released from clinical duties for six months to design the systems and to teach the new processes and systems to colleagues.

■ Conclusion

The digital hospital is real, and documented examples reveal the benefits of implementing such a strategy. Yet the challenge of making a hospital digital remains significant. New-build, or greenfield site, facilities find wholesale digitization easier than established facilities—changing processes to better exploit information technology seems to be more difficult than defining them that way to begin with. The healthcare industry has made significantly less investment in information technology than many other industries that rely, perhaps even less than healthcare, on information management. By combining findings from the small number of digital facilities that do exist with general lessons from healthcare automation, several conclusions are possible:

- To gain the much-vaunted and much-needed clinical, financial, and operational improvements from modern healthcare information technology, sufficient investment must be made.
- The investment must be made not only in technology but also in process transformation—especially in clinical settings. This transformation requires visionary, strong, and dedicated leadership.
- The benefits gained are not always easily quantifiable, but nevertheless may be quantified. Benefits include significant quality improvements, operational efficiencies, cost savings, and improved revenues. A major strategic benefit, however, is the development of a responsive, adaptive, and learning organization. This is much harder to quantify.

Such progress is not easy—it requires sustained investment and leadership. Moreover, significant political as well as financial capital will need to be invested in digitization projects. Current market solutions are imperfect and will remain so for several more years. The reality gap—the gap between vendors’ promotional claims and the experiences of their customers—is significant in this market, and quite different among vendors. Yet these are not reasons for inaction.

With the right investment, focus, and leadership, a growing number of organizations have already made demonstrable progress and reaped significant benefits. The newly built digital hospital will be outpaced by general hospitals that fully automate within five years. Significant, broad, and deep clinical process automation—which currently stands at less than 10 percent of institutions—will reach approximately 20 percent of organizations within those five years. Of all hospitals, PricewaterhouseCoopers expects an estimated 10 percent to undertake significant new construction or facility refurbishment during that time, of which more than 60 percent will invest significantly in becoming a digital facility. Moreover, as institutional interconnectedness accelerates, the benefits of being digital will accelerate further, creating ever more pressure on laggards.

■ Health Research Institute

PricewaterhouseCoopers Health Research Institute provides new intelligence, perspective, and analysis on trends affecting all health-related industries, including healthcare providers, pharmaceuticals, health and life sciences, and payers. The Institute helps executive decision-makers and stakeholders navigate change through a process of fact-based research and collaborative exchange that draws on a network of more than 4,000 professionals with day-to-day experience in the health industries. The Institute is part of PricewaterhouseCoopers larger initiative for the health-related industries that brings together expertise and allows collaboration across all sectors in the health continuum.

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