Curing Hospitals’ Ills:

Leveraging Information Technology to Transform People, Processes and Performance

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Abstract

This report details how a leading public health care institution, the University of Illinois Medical Center (UIMC), planned for, grappled with and ultimately overcame substantial challenges to a large-scale IT implementation. That effort, known as the Gemini project, fundamentally has changed processes at UIMC. The results are far greater operating efficiency and far higher cali- ber of information vital to safe, attentive patient care.

Gemini has helped UIMC transform not just its systems, but also the fundamental ways in which patients receive care. The effort's size and scope alone constitute a rare, remarkable public health-care story. Yet the UIMC transformation, while generally a success, has not been without challenges. These factors offer valuable insights into the issues, tensions and political maneuvers that underlie IT-enabled transformation efforts, as well as managerial strategies and tactics that can be highly effective in meeting them.
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Executive Summary

Hospitals unquestionably are among the public institutions with the greatest need for sophisticated information systems, both because of the vast amounts of data they handle and because of their literal life-and-death responsibilities. Yet implementing large scale IT systems in public health care institutions can be daunting. Several large American medical centers have failed in attempts to initiate major upgrades or overhaul processes entirely. Without careful planning, others may suffer the same costly, distracting fate.

This report details how one leading public health care institution, the University of Illinois Medical Center (UIMC), planned for, grappled with and ultimately overcame substantial challenges to a large-scale IT implementation. That effort, known as the Gemini project, fundamentally has changed processes at UIMC, resulting in far greater operating efficiency and caliber of information vital to safe, attentive patient care.

The authors present UIMC’s transformation journey over six years, beginning with the Gemini inception in 1996. They trace the technological, functional and organizational challenges faced by UIMC senior management, and the processes leadership used to overcome what seemed — at times — to be insurmountable challenges.

The resulting system, Gemini, is a highly sophisticated, comprehensive and integrated healthcare information repository. At its core is the electronic patient record (EPR), surrounded by more than 85 clinical and administrative hospital applications. Designed to cater to the needs of a wide range of health care professionals, Gemini dramatically has altered processes through which clinicians access, document, communicate and provide information critical to patient safety. Users include physicians, nurses, clinicians, specialists, pharmacists and other essential healthcare staff.

Gemini initially met with vastly divergent reactions from UIMC staff. To some users, the project held the promise of a more effective organization: improved workflow, vitally integrated information, well-informed decision-making and better patient care. To others, Gemini threatened established work practices and social hierarchies, while implying additional work with little added value. For still others, the entire effort seemed a waste of time and energy.

Prior to implementing Gemini, UIMC relied on outdated, isolated systems incapable of providing adequate technical and information support. When the medical center was hit with a financial crisis, the feasibility of a major systems and process overhaul suddenly was thrown into doubt. In fact, a consulting team recommended scrapping Gemini entirely and outsourcing its components instead.

Instead, UIMC’s vice chancellor and chief information officer together spearheaded a remarkable turnaround. As Gemini moved forward, however, numerous functional, organizational, technological and political challenges emerged. Along with technical challenges inherent in building an integrated, user-friendly and effective system, Gemini faced considerable resistance from many in the physician and clinician community. Resistance assumed numerous forms: non-compliance, circumventing procedures, political maneuvering and overtly or covertly questioning the system’s value. The heart of UIMC’s transformation story lies in how management structured the implementation, addressed issues as they arose, and ultimately succeeded in an enormous undertaking. This report highlights those processes and key lessons for leveraging information technology to transform public hospitals.

Today, Gemini contains medical data on more than two million patients. Patient demographics, insurance, medical histories, medication charting, nursing and physician notes, and lab reports are available from multiple access points, including remote access via the Internet. Caregivers can order diagnostic tests remotely and view results within minutes of their availability. Gemini also features decision support and knowledge management components, which alert clinicians to potential adverse drug events and reactions.

Gemini’s greatest value is deceptively simple: delivering all data about any patient to any doctor, anywhere, at any time. That capability in turn enables physicians, nurses and other staffers to provide the best possible patient care. Prior to the system’s implementation, patient health records were unavailable about 40% of the time. After implementation, records are accessible 100% of the time.

Physicians’ search time for medical charts has been reduced by over 30%. Doctors, nurses and other clinicians have redirected precious hours from inefficient, manual tasks to patient care. For instance, more than 5000 annual radiologist hours have been saved, and approximately $1.2 million of nurses’ time reallocated to patient care. Average time to receive laboratory and test results has dropped from three days to just seconds after availability. The stack of paper associated with each patient has decreased from about 300 pages to less than 75, and continues to drop every year.
Gemini has helped UIMC transform not just its systems, but also the fundamental ways in which patients receive care. In recognition of its ability to bring about organizational transformation, UIMC consistently has been rated as an IT leader by external agencies, business organizations and healthcare periodicals. Gemini also received the Nicholas E Davies award of excellence from Computer-based Patient Record Institute, and CIO Magazine’s coveted Enterprise Value Award.

The Gemini saga should serve as an inspiration to — as well as provide vital lessons for — other institutions undertaking ambitious, IT-enabled transformation projects.
Introduction

In recent years, the idea of leveraging information technology to transform hospitals organization-wide has gained significant momentum. Technological advancements in the form of enterprise resource planning applications, electronic patient records and newly capable clinical applications have spurred many health care executives to use information technology (IT) as an engine for institutional change.

Just as in other industries, however, hospitals often have been dismayed to find that these projects fail completely, fall short of expectations or don’t bring about desired organizational change. Studies show that as few as 20 to 30 percent of IT-enabled organizational change projects in all industries succeed — despite huge IT investments and organizational commitments.

The United States currently spends more per capita on healthcare than does any other country. Yet more than 98,000 individuals die in American hospitals every year due to preventable medical errors, according to a 2000 report by the Institute of Medicine. Such mistakes cost the country as much as $29 billion annually, to say nothing of the unquantifiable suffering of those who unexpectedly lose family or friends.

Many public-sector hospitals are in a quandary as never before. The electronic patient record (EPR), an online record that follows a patient’s hospital experience from admission to discharge, is fast becoming the order of the day. Moreover, the Department of Health and Human Services has mandated — through its privacy-oriented Health Insurance and Portability Act (HIPAA) — that hospitals adopt electronic ways to store, process and transmit patient care information.

Many public hospitals find themselves caught between technological imperatives and public policy on one hand, and internal resistance to change on the other. Some healthcare institutions that have undertaken massive, IT-driven transformation efforts are facing serious challenges, from technological hurdles to their own staff’s determination that patients, not processes, remain the foremost priority.

The Challenges of Change

What makes IT-driven change so difficult in public sector hospitals? To transform successfully, these institutions simultaneously must coordinate technology and business efforts, overcome internal political and cultural resistance, and continue providing high-caliber patient care. While most hospitals know what they want to achieve with IT-enabled transformation, they face problems in understanding how to carry out these initiatives – a crucial distinction that can spell the difference between near-term success and outright hostility to any future efforts.

Moreover, there seems to be little documented knowledge on how public sector hospitals have carried out large-scale, IT-driven organizational change projects. In this report, we document precisely that kind of effort at the University of Illinois Medical Center (UIMC), one of the nation’s leading health-care service providers. This case study explores the business and organizational challenges faced by UIMC senior management, and the processes they used to overcome what seemed, at times, to be insurmountable challenges.

The study focuses on an enterprise-wide IT initiative, called “the Gemini project,” from its 1996 conception to its completion in 2002. (This research excludes any subsequent upgrades or scope expansion). The report traces the technological, functional and organizational issues that UIMC executives tackled along the way.

We believe the Gemini project’s lessons are worthy of careful study for several reasons. First, UIMC overcame substantial challenges commonly faced by hospitals. By examining how its leadership confronted and overcame these challenges, the project provides a good source of learning for other hospitals attempting IT-enabled change. Second, the UIMC transformation, while generally a success, has not been without shortcomings. These factors can offer valuable insights into the issues, tensions and political maneuvers that underlie IT-enabled transformation efforts, as well as managerial tactics that can be highly effective in meeting them.

Third, the size and scope of the transformation is itself a rare, remarkable story in the public health-care sector. Fourth, the UIMC events, strategies and managerial mechanisms offer important lessons for other health care organizations:

(i) how to plan and execute an IT-driven transformation project,
(ii) how to win buy-in from varied organizational stakeholders,
(iii) how to sense and tackle challenges that may not be apparent at the outset,
(iv) how to manage political and cultural dynamics inherent in large scale IT-projects.
We conducted this study to understand critical factors that affect IT-based organizational change efforts in public hospitals. The primary data source was detailed interviews with key senior management executives, IT managers, and health-care personnel at UIMC. Interviews also were conducted across the organization with physicians, nurses and other healthcare professionals. Additional data was obtained from internal UIMC reports, physician surveys and archival records stemming from the Gemini project.
Implementing Information Technology in Public Health Care Organizations

For many decades, medical centers have sought to develop IT systems to improve work processes, reduce medication errors and enhance patient care. In the 1960s, hospitals primarily invested in financial systems – for billing, general ledger and payroll functions — that supported their financial accounting and reporting needs. The 1970s saw major projects by clinical departments, such as laboratories and pharmacies, to support their internal activities. In the 1980s, institutions shifted their focus from automating manual data processing tasks to generating cost-related data on doing business, including a rise in cost accounting and material management systems.

By the 1990s, hospitals had turned their focus to enterprise-wide clinical systems, which promised to integrate isolated, often redundant systems developed to support various departments and clinical facilities. This integration was especially important to increase quality of patient care. However, for several hospitals, these IT investments have produced low or nonexistent returns. Many institutions have created a hodgepodge of isolated systems that partially automate their back office operations, but are unable to communicate with one another. These systems tend to be largely proprietary and unable to integrate patient data with other pertinent health care information.

As in other industries, hospitals now are seeking more integrated systems capable of tracking a patient’s condition, treatment and physical location from admission to discharge. Such systems must process enormous amounts of patient information, including his or her medical history, results of various lab tests and other diagnostic procedures, data on medications ordered and dispensed, and other relevant information over a lengthy period of time. Only such integrated systems can support a longitudinal view of patients’ medical data, which is critical to providing quality patient care.

These electronic patient records can make patient data available wherever and wherever needed, across different health care units and systems, and accessible by a wide range of authorized health care providers. As the Institute of Medicine of the National Academies has said:

“Information technology must play a central role in the re-design of the health care system if a substantial improvement in quality is to be achieved over the coming decade .... re-organization and reform are urgently needed to fix what is now a disjointed and inefficient [health care] system.”

The primary objective of this quest is not a technology upgrade or an IT system enhancement, but an overall transformation in the health care process. Such transformation requires redesigning clinical processes, integrating and automating those processes through advanced IT systems, and encouraging essential cultural change throughout the organization.

When an enterprise-wide, integrated clinical system — including an EPR — is implemented successfully, physicians and clinicians can access patient information from labs, pharmacies, patient wards, patients’ bedsides, nurses’ stations, or physicians’ own office. Doctors can order tests or medications, review these results and confirm medication administration from their offices, stations within the hospital or via the Internet. Nurses are relieved from the tedium of collating patient charts, recopying physician orders, reconfirming prescriptions with doctors, and other administrative tasks that currently demand one-third to one-half of their time. Freed from those burdens, nurses can spend more time on their real priority: delivering quality patient care.

Huge Expenses, Minimal Gains

Many hospitals have invested millions of dollars to develop and implement EPR and clinical systems. Just as in many other industries, however, most hospitals have not succeeded in these efforts, and consequently have not realized expected efficiency gains and improvements in quality of services.

In part, these failures may be due to challenges that cut across virtually all industries: organizational, political, cultural and technological in successfully designing and implementing these systems. But such pressures are exacerbated in healthcare due to its urgent nature and intensive reliance on personal interaction. In fact, healthcare challenges and barriers tend to arise from human and cultural factors, rather than from technology per se.

For example, intended key users — physicians and other clinicians at the top of their fields — often refuse to learn and use the technology. They are especially resistant to changes to their work practices and organizational processes that often accompany the introduction of IT applications. Physicians tend to complain that information systems intrude into their ability to practice medicine.
Another major acceptance barrier is the threat to broader, institutionalized healthcare practices. Introducing new IT systems can require fundamental changes in the ways that physicians, nurses and other healthcare specialists create, share, and use patient information. Given many institutions’ deep-rooted allegiance to existing clinical processes and practices, such a fundamental overhaul is impossible unless physicians, caregivers and other stakeholders are willing to change their mindsets.

Health care organizations also face challenges unique to their extensive range of internal and external stakeholders. These individual and institutional influences cannot be underestimated. For example, public university hospitals such as UIMC are overseen by university officials, state legislatures, state funding agencies, federal authorities and various medical constituencies. Stakeholders’ differing — and often conflicting — objectives can lead to pronounced conflicts and increased desire for politically palatable solutions. By democratizing access to information, and thus the balance of power, wide-reaching information systems change can further compound ongoing institutional politics.
UIMC Background

Founded in 1882, UIMC is the largest state-funded hospital in Illinois and one of the nation’s busiest medical teaching institutions. The Center is a comprehensive health services facility that includes colleges of medicine, nursing, dentistry, applied health sciences and public health. UIMC operates a 450-bed hospital, an outpatient surgery center, a large non-surgical outpatient care center and eight satellite facilities. All are located within a 20-mile radius of the primary campus.

UIMC at a Glance
- Six health sciences colleges
- Eight satellite facilities
- 715 faculty physicians, 450 residents & 900 nurses
- 19,000 inpatient admissions annually
- 425,000 outpatient visits annually
- $316 million in annual revenues

A recent U.S News and World Report survey ranked UIMC in the top four percent of American hospitals in treatment of AIDS, cancer, cardiology, endocrinology, gastroenterology, geriatrics, gynecology, neurology, otolaryngology, ophthalmology, rheumatology and urology. As a tertiary site for many complex medical procedures, the Center supports major programs in neurosurgery, ophthalmology, oncology, cardiology, neonatology and obstetrics. Its mandate also encompasses extensive research and teaching activities.

UIMC generates revenues of about $316 million annually and employs over 2660 people, including about 715 primary care and specialist physicians, 450 residents and 900 nurses. The Center also provides education, support and clinical training to medical students and residents in multiple affiliated colleges. UIMC handles about 19,000 inpatient admissions and over 425,000 outpatient visits annually.
Gemini Overview

Gemini is a highly sophisticated, comprehensive and integrated healthcare information system that fundamentally has changed the way patient care is delivered at UIMC. By altering processes through which clinicians access, document, communicate about and provide information on patients, the system dramatically has increased patient safety. At its core is the EPR, surrounded by more than 85 other clinical and hospital administrative applications.

Gemini was launched with an investment of $10.3 million and has been funded at lower levels in subsequent years. The system now supports a network of 3,000 workstations used exclusively for Gemini applications and over 4,500 other personal computers onsite.

Currently, an average of 1,700 caregivers routinely access Gemini, contributing to, and drawing information from, more than 500,000 patient charts every month. Key users include physicians, nurses, physical and occupational therapists, clinical support staff, health science students, pharmacists and administrative staff.

In addition to providing instant access to a broad array of patient information, Gemini enables caregivers to order — and obtain results from — a wide range of clinical and diagnostic tests electronically. The system also features decision support and knowledge management components that guide caregivers in critical decisions. For example, Gemini automatically notifies physicians of contradictions in medication orders, such as a patient's allergy to a prescribed drug.

Gemini's greatest value is the ability to deliver all data about a patient to any doctor, anywhere, at any time, enabling all caregivers to provide the best patient care possible.

Several prominent agencies, industry associations and other business organizations have recognized UIMC’s efforts in IT-driven organizational transformation. In 2001, Gemini was awarded the Nicholas E. Davies Award of Excellence – one of the most prestigious awards in the healthcare industry – by the Health Care Information and Management Society (HIMSS). In 2002, Gemini won CIO Magazine’s coveted “Enterprise Value Award,” which recognizes exemplary uses of IT to fundamentally transform the organization and add value to the business. The Gemini project has also been featured in diverse publications, such as Healthcare Business, Modern Healthcare, Modern Physician, The Wall Street Journal, Healthcare Informatics, and The Economist.
UIMC’s Transformation Context

Like many other healthcare institutions, UIMC historically relied on dedicated, skilled medical professionals to deliver high-quality patient care. Great physicians and nurses — not great processes, management or technology — were seen as the primary drivers behind patient care process and overall business performance.

At the time UIMC embarked on its transformation journey in the mid-1990s, however, several developments had placed the entire medical center’s future in jeopardy. Medical technology advances and cost-control pressures over the past several years had shifted healthcare priorities from traditional, inpatient-oriented tertiary patient care to outpatient-oriented primary care. UIMC, which had focused principally on inpatient care for decades, was forced to focus equally on delivering inpatient and outpatient care.

UIMC also had expanded its physical facilities, specialties, research capabilities, and geographic reach considerably over the years. Critical considerations such as reorganizing management, adopting better management practices, and streamlining organizational processes lagged behind. Business processes emerged and proceeded with little systematic planning and design, resulting in considerable bottlenecks, inefficiencies and overhead. Operating costs meanwhile had escalated, and UIMC urgently needed to trim expenses while simultaneously increasing efficiency.

In terms of technology, UIMC relied on a set of mainframe applications for some back office operations and inpatient information. However, the isolated and mostly outdated applications offered limited functionality. All these problems significantly impacted healthcare delivery processes, ultimately affecting patient care.

The following quotes [from two of our interviewees] portray the context:

“We were in a complete mess then. We had a lot of redundant operations and processes throughout. Though we had patient records on paper, locating them was cumbersome, hard and time consuming…. Very often, a doctor had to wait for several days to get his hands on to a patient record. The patient had to wait for days before he could be attended to. This affected the fundamental purpose of our institution.”

“Our business was to deliver quality health care to patients. Information is crucial to giving quality health care to our patients. We often had problems with missing information, erroneous information, and sometimes there was no information at all…. For some patients, we would hide their medical charts under their beds so that we won’t lose information. We were facing so many problems just doing what we were supposed to do.”
Setting the Transformation Stage

In 1995, UIMC finalized a strategy to better position itself in patient care, clinical education and preparation of future physicians. This approach included a mission to centralize 28 facilities into a single, state-of-the-art site connected to all clinical services. UIMC also would strive to become a truly paperless enterprise. The objective was to implement a large-scale system that would have at its core a comprehensive, longitudinal EPR, accessible by caregivers across the UIMC healthcare continuum.

Planners understood that accomplishing this objective would require upgrading UIMC’s technology infrastructure and replacing legacy patient care information systems. Underlying objectives included:

- Providing caregivers access to a longitudinal electronic patient health record and improving access to clinical information across the enterprise.
- Increasing the efficiency and effectiveness of caregivers.
- Creating a technical infrastructure that allowed for deployment of open systems and provided flexibility for future growth.
- Replacing non-Y2K compliant, limited-function patient care systems.

UIMC’s IT department, working closely with clinical department leaders and physicians, spearheaded conceptual development of the EPR system that later came to be known as Gemini. Its overarching goals were:

- To improve quality of care dramatically by increasing connectivity along its entire continuum, and
- To achieve tangible financial savings through greater operating efficiencies.

Once a range of broad strategic and tactical objectives had been identified, UIMC’s leadership further refined those goals. Communications to key stakeholders occurred primarily through existing UIMC committees, which received monthly and quarterly updates. Information also was transmitted at annual organizational meetings, medical staff meetings, physician-hospital organization gatherings, and events associated with UIMC’s health sciences colleges.

Ultimately, UIMC’s leadership determined the following objectives for the new EPR:

- Combine inpatient and outpatient medical records for each patient.
- Focus on managing costs, outcomes, quality of care and interrelationships between these domains.
- Emphasize enterprise-wide data integrity.
- Support enterprise-wide operating process efficiencies.
- Support educational and teaching objectives.
- Use current open systems technologies to provide flexibility for future growth.
- Allow UIMC to monitor its performance internally and in comparison with external standards.

Gemini’s technology planning, selection and systems acquisition were driven by a central body of executive and clinical leaders. Called the Executive Management Systems Steering Committee (EMSSC), the committee reviewed and prioritized IT projects based on UIMC’s stated organizational objectives.

The key intent was to create a hub patient care system into which various legacy and new applications could be integrated. Collectively, system features would include “anytime-anywhere” access to medical records, increased availability and security, tracked and shared single records, improved physician-to-physician communication, duplicate order checking and medication interaction checking. Although no specific financial objectives were delineated at the outset, the new system was expected to produce significant, tangible benefits in three broad areas: patient safety, user satisfaction and cost reduction.

A Healthy Time Investment

To correctly identify the needs of clinicians, an IT analyst worked with key users to observe and understand their day-to-day activities and job routines. The analysts were required to view and study the processes from the perspective of the people carrying them out, work on ways to improve those processes, and design a system accordingly – not to design an “ideal” system that users might or might not ever be willing to adopt.

This tactic enabled key users and other stakeholders to understand how their jobs and work processes would change with the system. Each key user also was asked to prepare and prioritize a list of system attributes. “It’s the people, not the processes, that make up an organization,” explained UIMC chief information officer Joy Keeler. “If we use technology to help people better do their jobs, then the processes will automatically improve.”
Early in 1995, UIMC management sought approval from its Board of Trustees to implement the Gemini EPR system, then estimated at $10.3 million for hardware and software. The number of additional IT staff needed to implement and maintain the system was estimated to be 11. UIMC simultaneously requested a Certificate of Need from the Illinois Health Care Facilities Planning Board. The certificate, which is a state requirement for major facilities changes, would cover both UIMC’s new $100-million outpatient care center and the Gemini project.

Organizers envisioned these as joint cornerstones for building a state-of-the-art medical facility with tightly integrated inpatient and outpatient information — essential to delivering the highest quality care as efficiently as possible.

Though UIMC had a skilled IT team, senior management and the EMSSC understood their core competency was in medicine and health care delivery, not software development. They accordingly chose to customize a vendor-developed application rather than attempt to create their own custom applications from scratch. Customizing an existing solution also would save time, costs and effort while delivering more certain results.

After extensive vendor reviews, the Executive Management Systems Steering Committee chose the Millennium architecture from Cerner Corporation, a Kansas City, Missouri-based health-care systems provider and consultant. Among the system’s capabilities: creating a longitudinal record that included both inpatient and outpatient information; accessing information via the desktop in a variety of user-specific configurations; and supporting additional users and functionality in the future.
Planning and Pitfalls

At that point, the IT team and the institution faced numerous challenges. First, the Gemini project required several changes in the fundamental way that work was carried out at UIMC. Most critically, physicians would need to be open to a fundamental mindset shift to learn and use IT systems.

Second, nurses and technicians, who were not skilled in using computers, had been relying on IT staff to produce reports and schedules for their daily activities. They, too, would need to update their skills.

Third, the system required the physicians to spend time on data entry and updates, which could restrict the number of patients and cases to which they could attend. Yet the success of the EPR, and thus the entire project, hinged on physicians’ willingness to enter patient information directly.

To plan and execute implementation, the Gemini Executive Implementation Committee (GEIC) was formed. Management ensured strong physician involvement by designating a physician and information technology co-chair for every committee reporting to the GEIC.

In a stunning reversal, UIMC was hit with huge financial crisis in 1998. Cumulative losses from several preceding years—mounted to over $13 million, and the UIMC Board hired a group of external turnaround consultants for advice. Among other cost-saving recommendations, the consultants strongly advised disbanding the IT unit and outsourcing all its activities.

However, senior management realized Gemini’s strategic importance to the future of UIMC. The Vice Chancellor of Health Affairs (VC-HA) made two important decisions. First, shunning the consultants’ recommendations, he moved the entire IT group out of the hospital’s Operations department and into his own administrative department. Secondly, he re-aligned the organization so that Keeler directly reported to him, rather than to hospital administration. These decisions signaled the importance of IT, in particular, to all sections of UIMC.

Transformation Nugget: Top management in healthcare firms has to be the ambassador for IT. They have the onus of demonstrating and communicating the significance of strategic IT projects to the larger body of clinicians and caregivers.

It is not enough to merely approve the IT projects, or participate in the committee meetings. It is the active demonstration of the direct commitment of senior management that can make a significant difference to the project.
Transformation Tenets

Once the IT department’s future was secure, Gemini moved into full swing. Keeler and the GEIC devised a specific implementation philosophy, which became the critical foundation on which the rollout was based. Its central tenets:

**Practice incrementalism:**
To reduce staff and physician resistance, planners adopted an incremental application rollout strategy. Each user received one piece of functionality – such as a small application, module or feature — at a time, and everyone had the opportunity to learn and accept that piece before the next was presented.

*Transformation Nugget: Technology transformation can be big bang; but people transformation has to be incremental.*

**Though larger healthcare IT systems can be implemented overnight by a big-bang approach, it takes considerable time for clinicians, physicians and end-users to accept, adopt and use the system. Any healthcare IT system aimed at an organizational transformation needs to bear in mind that people-transformation is a slow and enduring process.**

**Drive change through value:**
Planners decided that implementation success would not be measured by whether software applications were running, but by whether clinicians were actually using them. The set of applications and rollout sequence were chosen carefully to ensure that applications with highest visible impact appeared first, demonstrating value immediately to skeptical users.

*Understand individual ‘tipping points’:* UIMC gave careful attention to distinct features, or ‘tipping points’, that create value for users. Planners sought to offer incremental value, along with incremental functionality, according to the differing needs of each medical specialty. By providing concrete, observable benefits, the design team hoped to generate small behavioral changes that would slowly lead to sustained, widespread Gemini usage and acceptance.

*Emphasize process, not product:* Gemini’s development and implementation consistently focused on improving fundamental health care delivery processes, not on delivering software capabilities. Even naming the system as “Gemini” helped remove associations with a particular product and focus attention on an effort to reinvent processes.

**Employ desktop metaphor:** Gemini was envisioned as a set of applications that could be accessed via a single entry point. An end user could reach a wide range of clinical, administrative and decision-support functions through a user-friendly, desktop-like interface. Gemini users now have a single entry point via a desktop “inbox” for all background information, reporting and treatment-related applications.


Encouraging Fresh Processes

One of Keeler’s first actions was to review applications that Cerner already had delivered to UIMC. She discovered that some applications had not been integrated thoroughly enough to perform UIMC’s diverse task load. Keeler realized that building a longitudinal EPR would be difficult given existing application constraints found in Cerner’s initial work.

She accordingly directed Cerner to provide a more robust, integrated solution better suited to the organization’s diverse needs. According to Keeler,

“We’re not implementing applications; we are trying to transform the process. That is why I went back to them and said, ‘I need a desktop. I need an inbox, seamlessly integrating all the discrete applications.’ … I didn’t shy away from going back to scratch. I would prefer to get things right before moving on.”

While Cerner was one of very few vendors in its class at the time, the development of a longitudinal EPR for UIMC was a significant undertaking. The result would be a leading-edge solution for both UIMC and the entire health care industry. Realizing the importance of communicating UIMC’s needs particularly in the early stages of the project, Keeler offered Cerner the chance to develop an integrated application suite cooperatively with UIMC. As a result, the two organizations moved from their previous customer-vendor relationship to a partnership model, which included forming joint teams to support knowledge sharing and transfer.

Transformation Nugget: It is wiser to ‘go back to scratch’ in the initial stages of a project than to face problems in later stages. Healthcare CIOs need to have adequate checks and balances in their IT development and implementation efforts. They should not be afraid to make tough and unpopular decisions. CIOs cannot effectively manage from a position of weakness.

At the tactical level, meanwhile, GEIC subcommittees oversaw the implementation process and applications rollout. Each subcommittee was co-chaired by an IT professional and a physician, handpicked by Keeler and the UIMC senior leadership, for his or her leadership skills and receptivity to new technology. Representatives from IT and relevant ancillary departments also sat on each sub-committee. In addition, key GEIC members conducted “town hall” meetings with the larger community of users to bridge knowledge gaps build an understanding of the potential value of the project, and identify potential allies in various departments.

While a few technologically savvy, enthusiastic physicians volunteered to serve on implementation committees, most doctors remained indifferent or opposed. Many resisted because they would be required to enter their own orders for treatments, diagnosis and medications, and felt that data entry was time-consuming or not their professional responsibility. A physician summed up that mindset as, “Our job is to provide healthcare, not to sit in front of the computers and enter data.”

Secondly, there was predictable resistance to Gemini from physicians who were inexperienced with technology, and who had little desire to spend time and energy learning the system. Thirdly, some doctors felt that Gemini would make their treatment methods, diagnostic practices, and medical judgments— including errors — more susceptible to external visibility and scrutiny.
Overcoming Resistance

Keeler and the GEIC accordingly enlisted another powerful constituency to help convert doctors: nurses. The GEIC spent considerable time cultivating nurses’ support and engaging them directly in system implementation. That task was made easier because doctors typically handed off maintenance, search and retrieval of paper-based medical records to on-duty nurses — many of whom already felt overloaded with other patient care.

A nurse described the situation as follows:
“Before Gemini, we were always running around for information. We couldn’t get lab results and other patient information on time. We used to be constantly on phone or physically moving around for information. The number of interruptions that we had to go through in carrying on our duty was pretty huge.”

In response, the GEIC designated a group of nurses — viewed as leaders by their peers — to be “power users” who would encourage and participate in Gemini implementation.

Transformation Nugget: Healthcare CIOs need to reach out to key stakeholders and users, such as physicians, clinical leaders and nurses and join hands with them at every opportunity.

According to the same nurse,
“When we [nurses] were asked to be a part of the Gemini design and implementation, it made us feel very important. We felt happy to be a part of the change process… We could see how this system would make our jobs much better… So we gave our best efforts to make it successful…..

What we didn’t want to do was just grab a piece of automation, put it in place and simply use it… We looked at our own jobs [and] work processes, [then] assessed how [they] could be done better and built a system accordingly. For the first time, we were in the conference rooms, drawing diagrams about our workflows and what we did…. It made us understand how we were, and what could possibly be done to improve ourselves.”

This selected group of nurses actively mobilized their colleagues’ support for Gemini. Another nurse explained:
“There was a lot of fear, as many nurses had not even touched a mouse before. Removing their fears and getting them to engage in the system was challenging. I would take my colleague’s hands, tap them on keyboard to show them that they couldn’t break it… We had to be very patient, and very friendly. We [nurses] cannot possibly tell the doctors how they ought to be working and change the way they worked, but we can definitely help another nurse understand and learn. For doctors, we cannot tell them, but show them”.

Keeler elaborated:
“I don’t believe in making people do things. I believe in creating an environment where people can do things by themselves. It is important for them to understand and appreciate the value technology is bringing to their work lives.”

Transformation Nugget: To win end-user acceptance of a system, it is important to develop personally relevant understanding of the value of system usage. An effective way to achieve this is to allow individuals to directly experience the value, rather than talking to them about it.

As it happened, the power users didn’t just train other nurses; they also influenced doctors’ acceptance of the system. When nurses started using the applications, physicians could see visible impact. A doctor explained:
“I said the same thing to the nurses after the system was installed that I did before it went in: ‘Get me the X-ray.’ Except I noticed that instead of 10 minutes, it took the nurse one minute to get it. After that happened again and again, I finally said, ‘How did you do that?’ “

Transformation Nugget: Transformation cannot be imposed from top – it should come from within. Organizational transformation starts with individual, self-driven transformation.

When physicians began seeing Gemini’s value, most reacted positively to its presence. Eventually, doctors learned to use the system themselves and started backing the project. Keeler encouraged participation early on by insisting that data be input in any format. Physicians could enter clinical notes and observations any way they chose, from typing into a standard form or writing unstructured notes to dictating information. While the process sacrificed discrete data points typically required to create a database or decision support system, the flexibility was essential to gain physician buy-in.
A physician who was a member of GEIC explained:

“We made a conscious decision at the beginning that we could not force people to use the system in a way that would make decision support easier down the road. If we had forced them to enter information in such a way that it would generate more discrete data, we would have never gotten everyone to use the system.”

This novel willingness to capture data in any form directly contradicts basic IT doctrine that requires data to be entered in a fixed format. Keeler said:

“This approach invites criticism from database specialists as this does not produce discrete data. The core focus is on getting the data, not its format. So it is OK to do away with forms. One can always use technology to convert data from one form to another.”

_Transformation Nugget: It’s the “data” that is important, not the form in which it is collected. Once the required data is collected, technology could be effectively deployed to change its form and nature._
Training for Transformation

The GEIC also paid considerable attention to how nurses, doctors and other users would be trained to use the system, in part because their IT “literacy” levels varied considerably. Rather than rely on classroom lectures and demonstrations, the team decided to follow a role-based approach. Training would provide customized guidance for different user groups, demonstrating how each application could be used in his or her specific job responsibilities, while also providing a larger picture of the application and its features.

A training team of power users, IT staff and Cerner learning specialists created different scenarios for varied constituencies of user groups, then translated those scenarios to online, computer-based training. All users — including physicians, nurses and technicians — were required to undergo training and clear certification tests before they could obtain formal access to the system. While most users accepted this approach, some physicians – most already opposed to Gemini – were among the resistors.

Opposition from these doctors and technicians continued despite efforts by Keeler, GEIC and the senior leadership to win complete user acceptance. While few people openly refused to use Gemini, some circumvented the system by passing off work to residents or nurses. Other groups lobbied through the Gemini committee and team structures to delay or block certain applications or features that they felt would affect their job or work responsibilities. A senior UIMC member said:

“Gemini had caused discomfort to some groups here - not just doctors, but other officers as well. Some saw it as a waste of time; some felt it was a threat to their freedom. They kept arguing, debating about it. They kept coming up with different reasons to oppose it. Some even started hating our IT group.”

Fortunately, Keeler and the GEIC had established informal channels of communication through which they were often tipped off about such political maneuvers. Keeler remarked:

“I share a good working relationship with many of the department heads, physicians and key users. I also made it a point to reach out to the user community at large, getting to know people at all levels – nurses, staff, physicians, technical staff. I would often chat informally with them to keep myself abreast of different events and happenings – most importantly of their perceptions and the perceptions of their peers. This helped me learn a lot about a number of issues. It also helped me understand the pockets of resistance, where they come from, and helped me formulate appropriate responses, and to develop solutions to their issues and concerns.”

Transformation Nugget: CIOs need to be attuned to organizational politics in large scale IT projects in health care firms. It is important to establish informal networks through which information can be gathered in order to formulate timely response strategies.

Project leaders also gathered feedback through formal channels. These included a user survey of system features, problems and areas of satisfaction and/or dissatisfaction. Responders then were categorized into ‘expert users’, ‘reluctant users’ and so on, which helped address specific problems pertaining to different user groups.
Clearing Final Hurdles

At this juncture, UIMC senior leadership made it clear that the EPR was a necessity. Strong believers in the user-driven change process, they even replaced some senior officers resistant to Gemini. This was an open message to non-complaint users to begin or complete training — and to start using the system.

The Vice Chancellor for Health Affairs explained:

“We had suffered some major problems because of hindrance from certain people. The head [of a division] did not make all the efforts he could have made to get this up and running. Another chief operating officer was also not interested and committed…. One of them retired and another one was replaced. And then, we moved on.”

Transformation Nugget: Decisive action by top executives in health care firms is essential for tackling organizational politics arising in large scale IT projects. CIO’s rapport with senior executive can go a long way to help mitigate politics in IT implementation

Presented with clear, decisive directive from senior leadership, most holdout physicians and other key individuals began using Gemini. A 2000 user survey revealed that, while about 20 percent of physicians were still ‘reluctant users’ who did not necessarily enter data directly, they nevertheless tapped the system for varied clinical information.
Under the Covers: Gemini’s Application Portfolio

Gemini’s more than 85 applications range from hospital administration and clinical specialties to knowledge management. As shown in Figure 1, its core is the longitudinal EPR that captures critical patient information. This EPR is surrounded by multiple layers of functionality: clinical applications, enterprise back-office systems, decision support and knowledge management applications, and other peripheral systems. The system simulates the look and feel of an email inbox to the end user, with the myriad applications hidden just under the surface. When the clinician logs on, s/he sees all reports, messages, and other information that needs attention in the inbox. This familiar metaphor helped speed acceptance among future users.

UIMC implemented systems by initially rolling out a few, high-impact applications. The application rollouts and corresponding transformation journey are depicted in Figure 2. A technical profile of the Gemini system appears in Appendix A.

Figure 1. Gemini - A snapshot of application portfolio
An automated clinical system called “Computerized Physician Order Entry” (CPOE) now enables doctors to enter orders for diagnosis, treatments and medications – all with greater accuracy and decision support ability than could traditional paper-based order entry methods. CPOE represents an important step in achieving UIMC’s “paperless enterprise” goal. Usage grew steadily as physicians, residents and nurses began using – and realizing the benefits of — CPOE for order entry, including medication, administration record and ancillary results retrieval.

Information reaches the core EPR through several channels and formats. Data capture methods include:

(i) Free-form notes, based on standard templates or custom created by clinicians.
(ii) PowerForms, which allow users to build forms that capture discrete data elements, but are stored in the central repository.
(iii) PowerNotes, which support a menu-driven approach via selection of discrete data, and in turn compose a textual document.
(iv) Transcription of doctor-dictated notes and reports that are subsequently interfaced with the system.

Figure 2. Application Rollout and Transformation Journey

![Application Rollout and Transformation Journey](image-url)
Document- and clinical-imaging applications help collect and manage EPR data in a central repository. Both of these flexible data capture tools have come to be known as ‘transformation toolsets’ at UIMC. Currently, physicians themselves enter more than half of the 15,000 clinical orders placed on a given day. The percentage of medication orders is much higher: 98 percent of the 2,000 orders placed daily are entered directly by prescribing doctors.

Traditionally, medication data entry occurred after the fact, forcing physicians to make medical decisions based solely on previous orders. The system was potentially hazardous given that a patient's condition, lab results and many other factors can change prior to medication delivery. Synchronization between orders and the “Medication Administration Record” (MAR) now improves accuracy and timeliness, enabling physicians to make care decisions based on what a patient actually has received — and ensuring the MAR's trustworthiness as a complete, timely decision-making tool.

The CPOE and EPR systems also paved the way for other, more sophisticated patient care applications. Discern Alerts notify doctors of any contradictions in orders, such as allergies to specific medications. The alerts also notify UIMC Nutritional Services staff when medication orders may react with a patient's diet, enabling the dieticians to make appropriate adjustments. Another application, “ADE Expert System,” utilizes an advanced expert system to further minimize the risk of negative medication combinations.

Discern Expert, a decision support solution, enables users to apply their own rules, and take appropriate actions, through if-then logic. These rules are developed and used throughout the care process, including physician orders, pharmacy, nursing, medication administration, and laboratory results reporting.

More broadly, the comprehensive information available through Gemini gives clinicians an up-to-date, complete snapshot of a patient's condition at all times. Gemini is accessible to every caregiver, on- and offsite, 24 hours a day, seven days a week. Users now access information at the point of care, be it the operating room, a specialty center, intensive care unit or an outpatient patient ward. From a simple data-driven solution, Gemini's capabilities have been enhanced to provide truly knowledge-driven care.
Strategic and Operational Impact

Today, UIMC utilizes a computer-based EPR system with medical data on more than two million patients. Users have instant access to demographic and insurance information, inpatient orders, medication charting, nursing documentation, personal and family medical history, lab, radiology and pathology report, physician notes, test results and outpatient visit records. Each is available with a click of a mouse from over 3000 ‘WinStations’ located across all UIMC facilities, or remotely via the Internet.

In addition, Gemini allows caregivers to order clinical and diagnostic tests, and to view those results as soon as they become available. Decision support and knowledge management components alert clinicians and pharmacists to potential adverse drug events and drug interactions, guiding physicians through the complete the patient-care processes. Further, Gemini seamlessly links the hospital, outpatient surgery center, outpatient care center, and eight satellite facilities — as well as academic centers, laboratories and any other location where a clinician may happen to be.

Primary benefits are:

- **Availability of Clinical Information:** The value of patient information availability—which can determine an individual's safety, ongoing health and very survival—cannot be overstated. A physician summed up his experience after Gemini was implemented this way: “[Now] everyone has the perception that people caring for patients know more than what they used to know. It’s a completely different world in terms of quality of care. I’m much happier with the care I’m providing.”

Prior to Gemini, UIMC estimated that a patient's health record was unavailable about 40 percent of the time. Today, those records are accessible electronically to clinicians at all times.

Improved record access dramatically has improved efficiency in several areas. Before Gemini, average turnaround time for laboratory and radiology reports was three days. With Gemini, test results are available within seconds of being verified. In addition, redundant orders — often triggered by delays in receiving test results — have been eliminated. Other tangible operating benefits are shown through the following.

### Operational, Tangible Benefits from Gemini

- Physician’s search time for medical charts reduced by over 30%
- More than 5000 annual radiologist hours redirected to patient care
- Physicians save 5 hours/week in review of resident orders
- No patients are seen without a medical record
- Approx. $1.2 million of nurse time reallocated away from manual documentation tasks
- Approx. $1.7 million in ambulatory clinic construction costs and $39,000 in annual maintenance saved
- Continuous, substantial improvements in physician satisfaction based on internal user satisfaction surveys
- Improved User Satisfaction: User satisfaction at UIMC has improved many times over. Nearly 90% of doctors believe communication and accessibility have improved since the conversion from solely paper-based processes, according to internal surveys. Both formal user satisfaction surveys and informal testimonials, such as those solicited for this study, point to Gemini’s impact.

Sample testimonials from physicians and nurses on how Gemini has affected their work lives are presented below:

### Physician Testimonials

“We used to call it ‘practicing in the dark’. What you knew was whatever the patient could tell you at the time. Fundamental medicine is taking a history from a patient, so the immediate interaction is unchanged. But now, with data available, we can find out more about them and ask more pointed, more useful and more efficient questions.” – **Dr. Bill Galanter, Associate Program Director, Department of Medicine**

“The key benefit of Gemini for us has been easy access to information we need to make decisions as physicians. Prior to Gemini, we had difficulty getting the information we needed to manage our patients. Now information access is easy. We don’t have to worry about lost records. Multiple physicians and other health care providers can access the same information simultaneously. The information is legible. It’s well organized. It saved us a tremendous amount of time tracking down results.” – **Dr. Daniel Hier, Professor, Department Head, Neurology and Rehabilitation**
“Gemini allows me to practice the way I want to practice. As a family doctor, I can focus on patient care and not paperwork. I can learn everything about my patients in a relatively short period of time, and I know immediately what is happening to any of my patients who receive care within our medical center. To me, that’s pretty powerful.” – Dr. Karl Kochendorfer, Resident, Department of Family Medicine

“Communication is facilitated. We’re all looking at the same information. That leaves us more time to speak to nurses, to consultants, to house staff about how and why decisions have been made. Tracking the data is so much easier.” – Dr. Linda Lesky, Vice Head, Medical Education, Department of Medicine

- Improved Communication: Gemini functionality is designed specifically to enhance communication and teamwork between caregivers. For example, the “physician inbox” and several applications support both workflow and clinician-to-clinician contact. Physicians cite Gemini’s communications structure as one of its most valuable features. Documents automatically post to clinicians’ inboxes through several methods, including a transcription interface, another caregiver, phone messages or new consult orders. Each time physicians log on, they find that their inboxes already include folders with documents to sign or review, phone messages and consult orders.

In short, communication with other caregivers is a direct result of Gemini’s structure, not something that requires extra steps solely for that purpose.

- Improved Workflow: Gemini supports workflow documentation for educating physicians, nurses and other clinicians. For example, when a resident documents care for a specific patient, the resident easily can forward the information to the attending physician for further action. Typically, the attending physician needs only co-sign and write a brief statement. Prior to Gemini, a paper-based process resulted in far slower turnaround times, and patients’ charts were unavailable to other caregivers in the interim.

Gemini also greatly streamlines the flow of patient care. When a patient is in an exam room, a nurse typically logs on to record the initial assessment, and then locks that information for security purposes. The physician who arrives in the exam room simply logs on to view the saved information immediately. He or she then easily can document problems, allergies, medication and procedures.

Other benefits of improved clinician-to-clinician communication include reduced length of patient stays, faster billing processes that improve cash flow, faster chart completion, rapid and accurate regulatory compliance and — most importantly — better patient care.
Key Lessons Learned

IT-enabled change requires internal transformation on the part of individuals, teams, departments and entire organizations. Senior healthcare executives and CIOs must work together to lead physicians, nurses and other health care staff through these crucial, though often difficult, processes.

This evolution requires intentional, supportive actions to help people let go of old behaviors, values, habits, mindsets and procedures that may be irrelevant or deleterious for the road ahead. It must bridge the chaos and confusion of moving between old and new modes, along with ensuring that new ways are integrated fully organization-wide.

UIMC’s experience suggests that IT-based organizational transformation is non-linear and multi-dimensional in nature, requiring fundamental and parallel changes in four broad areas: technology systems, business processes, structure and organizational culture. Changes must proceed concurrently for successful cultural and technical transformation. These four areas are summarized into a conceptual framework in Figure 3.

Traditionally, healthcare CIOs — like their counterparts in other industries — have tended to view transformation only in terms of technology and business processes. In the process, they may overlook, underestimate or dismiss vital structural and cultural dimensions within their organizations. UIMC’s experience clearly demonstrates the crucial role organizational and cultural considerations can — and invariably do — play.

Structurally, Gemini and its IT proponents gained high visibility, stature and credibility when the project was placed directly under the Vice Chancellor of Health Affairs. Because the complete project was driven through multiple structural forums, such as diverse committees and teams jointly led by IT and clinical professionals, participants shared ideas and accountability for their respective deliverables. These individuals and groups drove the entire project, generating gradual, ongoing changes in UIMC’s organizational mindset.

Figure 3. A Framework for understanding IT-enabled Organizational Transformation

- Process Transformation
- Structural Transformation
- Cultural Transformation
- Technology Transformation
- Organizational Transformation
Recommendations

While the transformation framework provides a useful platform for understanding IT-enabled organizational transformation, UIMC’s experience also delivers other important lessons:

- **Cast CIOs as Change Architects**
  Today, CIOs have shifted from back office to boardroom. They are expected not only to lead technology initiatives aimed at bringing about process improvements, but to drive organizational change across entire healthcare organizations. As the Gemini case demonstrates, CIOs need to be “champions of change” who smoothly blend technology, business and organizational leadership skills.

  While many organizations recognize that technology can drive operational and cultural change, they may not recognize the crucial need to empower CIOs accordingly. At UIMC, open, high-level recognition of the CIO’s role was critical to Gemini’s momentum. The Vice Chancellor of Health Affairs was highly supportive of Gemini and took direct responsibility for its successful implementation. Moreover, he empowered the CIO and stood by her throughout the project.

- **Adopt ‘Tortoise and Hare’ Tactics**
  Transformation requires time. While the overall direction should remain consistent, delivery details may evolve significantly during those years. It is important for CIOs and other executives to decide which areas can move quickly, and which will require a far more measured pace.

  As many organizations have learned, speedy implementation actually may be more inclined to fail. In a rush to ‘go live’, CIOs may overlook the people side of the equation, prompting resistance that can doom even the most capable technical initiatives. One solution: acting as hares in implementing technical changes, but as tortoises in encouraging people-related changes. Gemini applications were developed quickly but rolled out incrementally, giving users ample time to gradually accept, adopt and adjust their mindsets and actions. As a result, cultural changes happened slowly but steadily, for the better, with lasting impact.

- **Find Triumph in Tiny Tangibles**
  In the systems world, small improvements can add up to large value. Seemingly small payoffs — such as the ability to perform a task faster or gain instant access to critical information — cumulatively influence users’ openness to technology. It is vital that users have opportunities to understand and personally experience the business and quality-of-care value that new technology can deliver.

  Articulating technology value can be done by communicating through peer networks and by helping users experience that value directly. For instance, nurse power users were key in communicating Gemini’s advantages to fellow nurses. Reluctant physicians started backing Gemini when they witnessed features that saved time or delivered on-the-spot information. These and other tiny, visible benefits helped create a favorable mindset towards Gemini.
• **Anticipate Difficult Organizational Politics**

In organizational transformation, progress and resistance always go hand-in-glove. Resistance to new technologies and systems is common, natural and pervasive in organizations of all types. A predictable byproduct of such resistance is heightened organizational political maneuvering. At their worst, such insecurity-driven actions can grind even major projects to a halt. Therefore, CIOs must learn to identify, manage and respond to internal politics effectively.

Resistance to Gemini came in many forms: refusal, skepticism, non-compliance, complaints, non-acceptance and pessimism. Politics took the form of lobbying behind-the-scenes, circumventing procedures, and overtly or covertly questioning the system’s value. CIOs need to be proactive, formally and informally, in reaching out to obstructionists and sensing real issues in implementation.

Right from the outset, Keeler established relationship networks, across all levels of hierarchy, which helped her identify and respond to issues as they arose. CIOs may be able to do little to contain politics outside their organizations, such as in regulatory agencies or oversight boards. As Gemini shows, however, active support of top management is essential to keep projects moving forward.
Conclusion

UIMC’s Gemini transformation demonstrates highly successful, large-scale IT-based organizational change in a public health-care setting. Like many such projects, the project experienced ups and downs, including many moments of triumph and uncertainty. Yet the transformation is noteworthy for its breadth and depth of organizational learning. Similarly, Keeler and the senior leaders faced — and employed effective managerial mechanisms to address — a wide range of challenges along the way.

UIMC has built a substantial technology base with Gemini. It has bettered the working environment of physicians and caregivers, streamlined hospital operations, and substantially improved patient safety. These achievements are especially noteworthy given the institution’s tenuous position only a few years ago.

UIMC now is moving forward with its next set of strategic initiatives, which include deploying advanced medical applications, knowledge management solutions and Internet-based EPR systems. The lessons its leadership, physicians and staff have learned unquestionably will facilitate its ongoing journey.

In the interim, hospitals and other health care institutions across the country have begun investing heavily in enterprise-wide IT initiatives, ranging from hardware upgrades to implementation of large-scale clinical applications. We believe such projects need to be viewed as business transformation efforts rather than solely — or even primarily — as technology deployments. Only then can organizations create the multi-dimensional changes in processes, people and structures that are imperative to reach desired outcomes.

The Gemini saga should serve as an inspiration to, as well as provide vital lessons for, other institutions undertaking ambitious, IT-enabled transformation projects.

Endnotes

Appendix

Gemini: Technical Profile
Scope and Design
The Gemini applications run on “clustered” (combined) Compaq GS160 and GS60E Alpha machines utilizing VMS version 7.2-1h1, UCX (TCP/IP) version 5.0-A, and Oracle 7.3.3.6 as the database. The Alphas’ disks use a combination of RAID 1 and RAID 5 modes with complete drive shadowing, maximizing system availability, and complete system redundancy. ADSM is utilized for backups, performed nightly as online backups of the 500 GB database. Each week a full cold backup of the database is also performed against a standby copy of the database. In addition, transactions that flow through the Cloverleaf interface engine are stored online and are accessible by the Gemini Team for 30 days in case there is a need to replay any transaction. This is facilitated through UIMC-developed Web-based Cloverleaf tools that allow the Gemini Team to access and replay select transactions or select timeframes.

Integration
An interface engine utilizing HL7 standards exclusively manages interfaces between Gemini applications. The Medical Center’s approach since inception has been to keep the interface engine specifications as clean as possible, while shifting any customization requirements to the applications. This follows a clean design methodology and allows for consistent interface definitions and high quality across all interfaces. The interface engine runs on an IBM RS6000 and UNIX operating system.

Among the external interfaces is a link to a transcription services vendor. This capability supports dictation into the electronic health record (EHR). An updated copy of the UIMC master patient index (MPI) is provided to the vendor. This allows the transcriptionist to verify correct patient identifier information as entered or dictated by physicians. After the transcription is completed, the system directs documents into the correct physician Inbox and into the patient’s EHR. Because access to databases outside Gemini are critically important in the clinical environment, there is a connection from the WinStations to the Multum drug database and the CareNotes database, both of which reside on servers in the UIMC Data Center. Access to other external databases is available to support both the teaching and care processes. These databases are reached through high-bandwidth Internet access and imbedded routines. For example, shortcuts are created on the WinStation desktop that allow residents and faculty quick access to the MDConsult, Web of Science, OVID, and HealthStar (Grateful Med) knowledge bases. Another knowledge database, Medline, can be accessed through the Cerner Millennium Problems List.

Document imaging is an integral part of the electronic health record at UIMC. Images are scanned by Health Information Management and stored on optical platters. Images are then staged to DASD from the optical platters when a patient appears on a UIMC schedule. This process dramatically improves response time when clinicians seek to pull up an image.

System Architecture and Data Storage
The UIMC network configuration supports a network of 3,000 WinStations and over 4,500 clients. The network includes 185 Intel servers delivering e-mail, application, database, printing, intranet, security services and the like. Each individual client is provided personal network storage that is accessible from all network connections. Each department may have common network storage for their employees and shared departmental files.

All ancillary systems and most radiology modalities share the same physical network infrastructure with the EHR. For many of those applications not yet fully integrated with the Gemini EHR, access to results can be provided on the “WinStation” via web browsers, Citrix MetaFrame and other means. Ultrasound clips, low-resolution radiology images, EKGs, and endoscopic images also can be provided to authorized clinicians in this fashion. Special equipment is required for high-resolution, diagnostic quality radiology images.

The network infrastructure varies by building. The newest building, the Outpatient Care Center, has a 10/100 Mbit switched Ethernet available at every data jack. All switches are Cisco dual homed to network access points in two buildings. All of the digital radiography equipment is connected to this infrastructure. Image traffic is segregated with the use of a Virtual LAN (VLAN). The buildings have been designed without storage space for charts or films, so the high availability network design is critical. A gigabit Ethernet backbone network connects all switches in Outpatient Care Center to the hospital.

The hospital is also supported by 10/100 Mbit Ethernet switches. Most data connections run at the lower speed. As the wiring plant is improved or when there are special needs, data jacks are set to the 100 Mbit speed. Two physical
gigabit paths connect the hospital switches to Outpatient Care Center. Local data centers in each building are maintained for application servers, ancillary databases, and e-mail servers. Minimal communication services (network access, e-mail, and local data base applications) can be delivered if the building is isolated from the campus network.

The Information Technology Data Center provides a high security environment with independent power. All of the mission critical clinical databases are housed in this center. Three Compaq Alphas that support the Gemini patient care system reside in this location. Two of the Alphas are configured to fail over to each other. The third Alpha is primarily a testing and certification environment but also maintains another copy of production data. It is used as another level of production redundancy. Database servers and key computing hardware are connected on a 100 Mbit FDDI network within the data center. External access to the network is strictly limited to data center routers and communications equipment. The use of local modems on individual WinStations is discouraged.

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