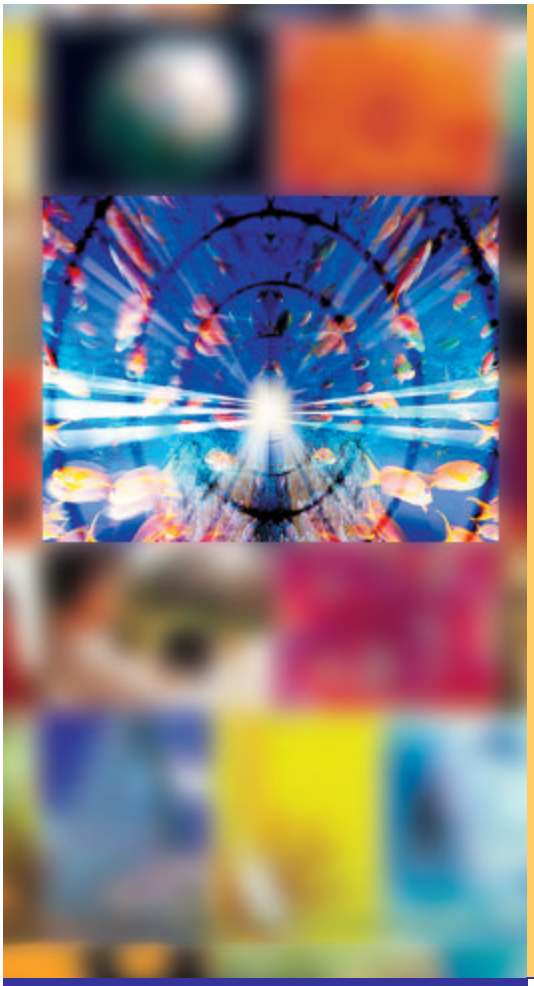
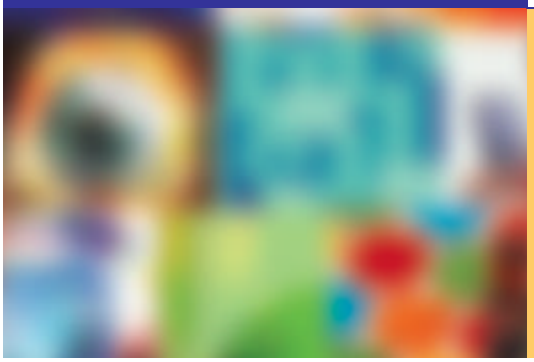


Cedars-Sinai Medical Center:

Delivering Better Patient Care with Infoimaging Technology

An IDC Infoimaging Case Study

THE SUBJECT	Cedars-Sinai Medical Center in Los Angeles, California, is the largest nonprofit hospital in the Western United States and a world-renowned leader in healthcare services. The Imaging Department at Cedars-Sinai Medical Center provides a wide range of inpatient and outpatient imaging services, leveraging the latest Infoimaging technologies.
THE GOAL	To use medical imaging and communications technology to accelerate the analysis and delivery of critical diagnostic information to referring physicians.
THE SOLUTION	The core of Cedars-Sinai Medical Center's Infoimaging initiative is a Kodak Picture Archiving Communications System (PACS) setup that integrates with medical imaging modalities and allows for patient and study information to be transmitted to a referring physician for access and evaluation.



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Digital technologies will exert the most impact on the medical imaging process in the interval from capturing or retrieving the image (taking the X-ray) to the point at which the image can be read by a radiologist and the radiology report made available to the referring physician. Most hospitals today are using both film-based and digital imaging technologies for their medical imaging needs. The trend toward a full-blown digital approach is incremental but becoming more pervasive.

Business Drivers

Growing at a rate of 10 percent annually, the Imaging Department at Cedars-Sinai Medical Center needed to accommodate this increase in image size and volume, especially as the hospital broke ground for a new imaging center in 1999. The imaging department struggled with the sheer volume of storing and retrieving increasing volumes of medical images. Ultimately, the imaging department needed to accelerate the delivery of medical image information to referring physicians to enable diagnoses and improve the patient experience.

Technology

The Picture Archiving Communications System (PACS) setup at Cedars-Sinai consists of image capture devices, display devices, archive servers, and storage devices, all connected via the hospital one-gigabit network infrastructure. At present, Cedars-Sinai has the following modalities connected to PACS: CT scanners, MRI scanners, ultrasound units, CR units, fluoroscopy units, angiography rooms, and a digital mammography unit.

Benefit Profile

Since deploying a PACS, Cedars-Sinai has experienced benefits on several different levels. Patient turnaround time has improved by approximately 30 percent. Physicians and other professionals can access medical images via the internal web server, offering them a level of convenience and enhanced productivity not possible through a film-based imaging process. By facilitating medical staff collaboration and the retrieval of historical X-ray files, the PACS enables physicians to better track changes in patients' conditions.

Future

Looking toward the immediate future, Cedars-Sinai will continue to build upon its current PACS setup to complete migrating medical specialties, such as nuclear medicine, vascular, and plain film (X-ray).

Eastman Kodak commissioned IDC to identify and analyze examples of Infoimaging at work in the marketplace today. This case study, and others in this series, demonstrates how the convergence of imaging science and information technology is driving growth opportunities for vendors and enabling companies using infoimaging to improve their mission-critical processes and better serve their customers.

Situation Analysis

Background

Since its inception in 1902, Cedars-Sinai Medical Center, located in Los Angeles, California, has evolved to become the largest nonprofit hospital in the Western United States. Today, Cedars-Sinai Medical Center is committed to providing superior outpatient, acute, sub-acute and home patient care, breakthrough biomedical research, graduate and undergraduate medical education and community service. In 1994, Cedars-Sinai Medical Center became part of the Cedars-Sinai Health System, which includes the Cedars-Sinai Medical Foundation, Physician-Hospital Organization, and the Cedars-Sinai Medical Center. Today, the Cedars-Sinai Medical Center occupies approximately 15 buildings across 5 city blocks in the heart of Los Angeles.

The Imaging Department at Cedars-Sinai Medical Center provides a wide range of inpatient and outpatient imaging services. Some examples of imaging services they most commonly provide include:

- Computed Tomography (CT)
- Magnetic Resonance Imaging (MRI)
- Ultrasound
- General Radiology
- Interventional Radiology
- Mammography
- Nuclear Medicine
- Vascular Ultrasound

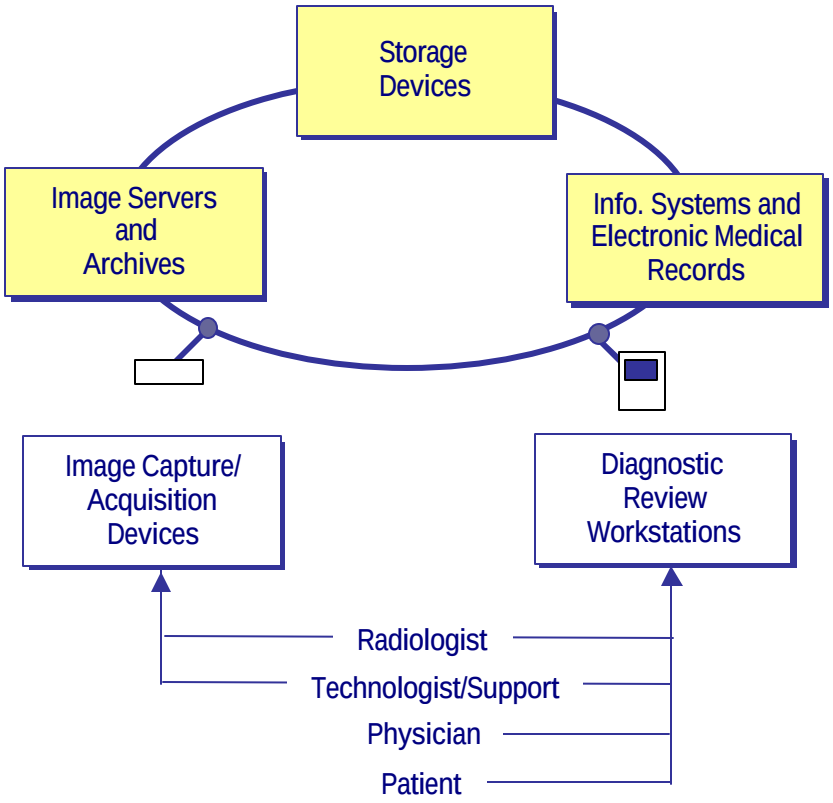
Overview of the Medical Imaging Process

Used for diagnostic purposes, medical images are critical to painting a complete picture of a patient's condition – whether in capturing that patient's condition at one point in time or whether comparing the progress of the patient's condition over a span of days, months, or years. To map out a general sketch of the medical imaging process, first put yourself in the role of an outpatient. Imagine that on your annual doctor's visit, your primary physician recommends that you get a chest X-ray. In most cases, the doctor has to first place the order for an X-ray with the radiology department and an administrative staff will enter you into the schedule for a particular date and time. If the radiology department is located in a hospital, you might be required to register at the hospital check-in before proceeding to the radiology department. After a technologist takes the X-ray, the film must be developed and printed before a radiologist can review the X-ray and present his reading to your physician, who ordered the X-ray originally, so she can make a diagnosis. The time from your initial doctor's visit, to the time that your doctor is able to communicate with you her diagnosis based on the X-ray may span anywhere from days to weeks. And what happens with the X-ray after your doctor has read the

radiology report and made a diagnosis in context of your overall health situation? The X-ray must be indexed and archived for both short-term and long-term storage and retrieval. If you decide to pursue a second medical opinion, the radiology department will need to release the X-ray and send it to another medical facility. Where digital technologies stand to make the most impact on the medical imaging process is the period of time from capturing the image (taking the X-ray) to the point at which the image can be read by a radiologist and the radiology report made available to the referring physician.

Most hospitals today are dabbling in both film-based and digital imaging technologies for their medical imaging needs. The trend toward a full-blown digital approach is incremental but becoming more pervasive. Broadly speaking, medical imaging has evolved from referring specifically to diagnostic imaging modalities (such as CT, MRI, and ultrasound) to embracing a more inclusive view of the systems that connect and support images from these modalities, such as PACS (Picture Archiving Communications Systems). PACS solutions integrate with medical imaging modalities and allow for patient and study information to be attached to a set of medical

Components of a Typical PACS Setup



Source: IDC, 2002

images. This body of medical information can then be transmitted for storage and archiving purposes, or to a referring physician for access and evaluation. Any discussion of digital imaging in healthcare usually centers on PACS. As a diagnostic tool, PACS is used to make critical patient care decisions and provide official interpretations. One of the key benefits to PACS is its long-term storage capabilities and its communications functionality. Depending on the hospital's actual PACS setup, physicians and other clinicians are able to view medical images through a secure web browser, an electronic medical records management system, or from dedicated viewing workstations.

Business Drivers: Speeding the Delivery of Information to Referring Physicians

In 1997, Cedars-Sinai Medical Center decided to build a new building to support its continued expansion as a leading nonprofit hospital in Southern California. 1999 saw the groundbreaking of the S. Mark Taper Foundation Imaging Center. Although construction of the new building will not be completed until 2003, discussions about plans for the new building sparked dialogue about how the new building would accommodate the imaging department. Until that point, all imaging at Cedars-Sinai had been film-based. Yet the imaging department was growing at a rate of 10 percent yearly. The key question was: How could Cedars-Sinai Medical Center accommodate the 10 percent year-on-year increase in images required to support all the medical departments in the hospital? In addition to the cost of film, film processing, and paper output requirements, the imaging department struggled with the sheer volume of storing and retrieving increasing volumes of medical images.

The underlying business driver of Cedars-Sinai's decision to pursue PACS was their need to accelerate the delivery of information to referring physicians.

Having researched and monitored the development of PACS since 1995, when it became more pervasive in the market, the imaging department saw an opportunity for them to make a business case to migrate their imaging infrastructure to a PACS environment. Although plans for the new building provided a timely channel through which the imaging department could build its business case for PACS implementation, the underlying business driver of Cedars-Sinai's decision to pursue PACS was their need to accelerate the delivery of information to referring physicians.

Cedars-Sinai found that their imaging process and workflow was creating bottlenecks. The limitation of film-based imaging is that film-based images can be in only one place at one time. And comparing medical images from one patient over a period time is a common practice for physicians to make diagnoses. For a large hospital like Cedars-Sinai—over 60 percent of whose patients are return patients—the manual nature of the medical imaging process was highly inefficient and could not scale with the increasing demands for imaging. At present, Cedars-Sinai conducts 338,000 patient studies per year and is growing 10 percent annually. Patient turnaround time—from ordering an image to the point at which the radiologist's final report is available to the referring physician—reached an all-time

high of 96 hours. Without an image to review, a physician could not make a diagnosis. Films could easily get misplaced, and comparing a current film with a previous film for a particular patient required time to identify the correct image and locate the print. The upshot? Inpatients would stay longer than medically necessary; and outpatients could very well wait a week to receive the results of a routine X-ray—not to mention other, more complex imaging studies. The slow process generated frustration among referring physicians, support staff, and patients alike.

Action Plan and Decision Dynamics

First Steps

The first step in Cedars-Sinai's project was to develop and issue a Request for Proposal (RFP) to potential vendors. Due to budget-related timing issues, Cedars-Sinai established a timeframe of one year within which to make their decision. As part of its decision process, Cedars-Sinai also appointed a steering committee, comprised of the chairman and representatives from Support Services, Enterprise Information Services (their IT department), and Imaging.

Cedars-Sinai formulated a set of detailed criteria for screening vendors and sent the RFP to six large PACS vendors. After holding conference calls with the vendors (with the consultant present) to answer questions and provide clarifications on the RFP and screening vendors based on the requirements they were looking to fulfill, they selected two finalists. Only when finalists were selected did price come into the equation. Cedars-Sinai attributes their successful adoption of PACS to their upfront focus on "must-have" features and usability, rather than letting price guide their decision from the start.

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The two finalists were asked to hold a daylong demo and give a two-hour presentation each in order to give the various users at Cedars-Sinai an opportunity to observe, use, and evaluate the vendors' PACS offerings. Any potential user of the PACS was invited to attend the demos. In the end, attendance at the demo and presentations was strong and included the IT department, attending physicians, radiologists, technologists, support staff, and ICU staff. Why all the pomp and circumstance? As Lynne Roy, Director of Imaging, puts it: "Cedars-Sinai is a very large organization. We don't change easily." Thus, the organization is very cognizant of going through a rigorous process to solicit bids to ensure fair competition and thoughtful evaluation of all features and usability.

"We want to be able to see all images—everywhere, all the time. It's critical that all patient studies are available on PACS so that a radiologist can access them on any diagnostic reading station."

— *Steven Broidy, Chairman of the Board, Cedars-Sinai Medical Center*

Key Decision Points

By mid-1999, Cedars-Sinai had selected Kodak as their PACS vendor. Among the several criteria that Cedars-Sinai formulated for evaluating PACS, top priority was ease of use for the direct users of PACS—radiologists. Cedars-Sinai recognized that no PACS implementation would be successful without unanimous buy-in from the direct users of the system. User-friendliness notwithstanding, Cedars-Sinai prioritized technical criteria as well, including consistency and compatibility with their existing IT infrastructure, such as operating systems and equipment. How reliable was the system design? Did it have enough redundancy? What would the PACS solution require of Cedars-Sinai's IT support team? The comments of Chairman Steven D. Broidy provide an indication of rigorous demands Cedars-Sinai had for its PACS solution: "We want to be able to see *all* images—everywhere, all the time," says Broidy. "It's critical that all patient studies are available on PACS so that a radiologist can access them on any diagnostic reading station."

Infoimaging Solution Overview

Cedars-Sinai Medical Center PACS Solution: Functionality and Architecture

The PACS setup at Cedars-Sinai consists of image capture devices, display devices, archive servers, and storage devices, all connected via the hospital one-gigabit network infrastructure. At present, Cedars-Sinai has the following modalities connected to PACS: CT scanners, MRI scanners, ultrasound units, CR units, fluoroscopy units, angiography rooms, and a digital mammography unit. Currently they have 18 diagnostic reading stations with plans to expand this number.

The PACS setup is integrated with Cedars-Sinai's Cerner radiology information system (RIS). After PACS images are pushed to a Kodak DMI web server, physicians can view images and radiology reports. This DMI web server is interfaced to another web server developed by the IT department to allow physicians to view more complete online patient information, such as PACS images, radiology reports, cardiology reports, EKG tracings, and lab results, all through a single sign-on.

The Cedars-Sinai Medical Center PACS Solution at Work

Radiologists are the direct users of the Cedars-Sinai PACS setup. They use PACS to retrieve, store, and transmit if necessary the many medical images that they must review on a daily basis. In addition to radiologists, referring physicians use PACS to access information on patients and view their medical images in tandem with accompanying medical information through the hospital's web viewing system. It is its

A physician views CR Images *Source: IDC*

ability to pull together visual image information with patient and study information that is a key value proposition for PACS.

Implementing the Cedars-Sinai Medical Center PACS Solution

Beginning in early 2000, Cedars-Sinai began an incremental rollout of PACS. The first phase was a minipacs rollout, which included MR, CT, and ultrasound. Then they added all of their off site campuses, followed by their outpatient radiology hospital practice and digital mammography. Cedars-Sinai did all of the PACS implementation themselves, in conjunction with services provided by the Kodak team. Preceding the official PACS rollout to users was a six-month period, during which radiologists still adhered to their film-based imaging processes but the imaging department ran digital imaging processes in parallel. By running the inputs in the background, the imaging department used this period of behind-the-scenes preparation to ensure that the interfaces to the system were reliable before rolling out the system to radiologists. The six-month rollout also built up some digital history on the PACS archives, allowing radiologists to review the most recent prior studies on PACS on the first day of softcopy reading.

Cedars-Sinai made the transition to PACS as quickly as possible once they considered the PACS inputs sound enough to bring live users onto the system. They knew that they could not operate film-based and digital imaging in parallel for an extended period of time because of the risk of redundancies and inefficiencies generating by trying to maintain two separate processes and systems. From the point at which they replaced the light boxes with diagnostic review workstations over

one weekend during May 2000, Cedars-Sinai was committed to making their PACS implementation succeed.

Key Components of Cedars-Sinai's PACS Solution

IDC classifies Cedars-Sinai's PACS solution as an example of Infoimaging by virtue of its use of imaging technology to improve the communication, presentation or interpretation of information. Under the Infoimaging framework, components used to develop such a solution fall under three categories:

- Devices, which are used to capture, process, or output images (e.g., scanners, digital cameras, printers, and hand-held devices);
- Infrastructure (including IT and networking resources) which is used to store, process and deliver image-based information.
- Services/Media (including the software, film and services) which are used to access, analyze and print images.

The Cedars-Sinai Infoimaging solution employs a wide range of Devices , including medical imaging devices, printers, scanners and AutoRads (which are used Cedars-Sinai's ICUs and emergency room). The key Infrastructure component of the solution is the Cedars-Sinai enterprise network, including all image and Web servers and storage devices. Within the category of Services/Media , the key elements are the image server software, the databases where images are stored and the Cedars-Sinai backend medical records system. Also included in this category are CDs, which make images "portable" for patients.

Key Infoimaging Components of the Cedars-Sinai Medical Center Solution

Devices	Infrastructure	Services/Media
Medical Imaging Devices	CSMC's Medical Imaging Network	Image Server Software
Output Devices		Various Internal Databases
Scanners		Proprietary Medical Records Software
Digital Cameras		Compact Discs
Digital Displays		
Diagnostic Review Workstations		

Source: IDC, Cedars-Sinai Medical Center

The core value proposition of PACS at Cedars-Sinai has been the improved workflow and communication among physicians, radiologists, patients, and support staff. By reducing the time required to make a captured medical image available to referring physician, Cedars-Sinai saves time and money—and most importantly patients' lives. It allows the physician to make a diagnosis. Images can be more easily shared among generalists and specialists. And patients can more easily take their images to other medical facilities if necessary.

A key benefit of PACS is that physicians and other professionals can access medical images via an internal web server. For most doctors, this means that they can access medical images from their desks in their own office.

To date, Cedars-Sinai has experienced benefits on several different levels. From an operational standpoint, patient turnaround time has improved significantly. A portion of this improvement can be attributed to PACS, but there are other factors that contributed to reducing patient turnaround time as well. After reaching an all-time high of 96 hours, patient turnaround time was reduced to about 48 hours through improvements that Cedars-Sinai made through re-engineering its workflow and processes over a period of four years. Within one year of implementing PACS, patient turnaround time decreased 18 hours and is now about 30 hours. When Cedars-Sinai completes its full PACS implementation in November 2002, they expect that this number will be reduced further, to 24 hours. This reduction in patient turnaround time has important implications for Medicare and healthcare payer reimbursements that the hospital receives—especially since some reimbursement plans pay based on per diem rates and will not reimburse for days during which a patient does not receive medical services. Another benefit of PACS is that physicians and other professionals can access medical images via an internal web server. For most doctors, this means that they can access medical images from their desks in their own office, a benefit that offers doctors a level of convenience and enhanced productivity that was not possible through a film-based imaging process.

From the perspective of technologists and staff who support the process of capturing, processing, and storing images, PACS has both changed and improved the way they perform their jobs. File room clerks who used to be responsible for storing and filing the hard copies of images now are PACS specialists who have upgraded their skill set to include downloading files and burning CDs. Cedars-Sinai recognizes that if they had continued along the path of film-based imaging, the strains on the support staff would have been enormous—and nearly impossible for radiologists to keep up with, given the increasingly sophisticated technology of the devices that capture medical images.

IDC Analysis: Infoimaging Drivers in Healthcare

IDC believes that Infoimaging will experience growing adoption in the healthcare industry, especially among large hospitals that serve a wide range of imaging needs. Adoption of Infoimaging, especially digital imaging, among hospitals may almost become a mandate for these hospitals due to the increasingly sophisticated (and complex nature of) technology of the devices that capture medical images, such as MR scanners. For example, CT technology has increasingly come to include multi-slice CT, which means an increase in the number of images associated with one CT study.

However, this need among hospitals will depend on what type of image mixture they work with the most. For example, many hospitals rely on CT as comprising the bulk of their imaging work. But other hospitals may do more X-ray work as the staple of their imaging work. Because the lifespan of a typical X-ray machine is longer than that of a CT scanner, hospitals that rely on X-rays more than CT work will have a less frequent need to upgrade their imaging setups than those that have a higher proportion of CT work.

Another driver among hospitals will be the storage and archiving capacity to accommodate the growth in size of medical images, and the increasing number of images required for one patient study. Two years ago, a standard CT exam averaged from 40-100 images per exam. Today, a whole body CT averages from 50-300 images per exam. Recent technology changes will result in an increase in this average number. Multi-slice CT scanners will generate up to 900 images per exam. A single CT image is 1/2 megabyte in size, representing up to 450 megabytes worth of data for a single patient exam. Other modalities are demonstrating similar growth patterns. In the case of Cedars-Sinai, these increasing data storage capacity requirements has meant that they have already changed their archive media, only two years after their initial PACS implementation. Currently averaging 6 terabytes of new data per year, Cedars-Sinai expects this number to double or triple over the next two years.

Two years ago, a standard CT exam averaged from 40-100 images per exam. Today, a whole body CT averages from 50-300 images per exam. Recent technology changes will result in an increase in this average number.

Digital imaging will also be driven by the trend toward patients assuming more control over their medical destiny, evidenced by patients taking their images home or to another provider on a CD. Sharing among healthcare providers or different specialties (like a generalist sharing with a specialist) raises the question of formats and standards. How can providers effectively share digital medical images? This will require consistency in standards and protocols (such as naming conventions) as well as a Web-based infrastructure for storing medical images. It will also call for the ability to flag differences in the PACS system—for example, that a patient was previously treated at another provider and that his images are from that facility.

The Future of PACS at Cedars-Sinai Medical Center

Looking toward the immediate future, Cedars-Sinai will continue to build upon its current PACS setup to complete migrating medical specialties, such as nuclear medicine, vascular, and plain film (X-ray). With this migration, Cedars-Sinai is expecting some impact to their current PACS setup—adding these areas will slow down the system and they will need to fine-tune the system architecture to accommodate the newcomers. Once this migration is complete, there will be only minor tweaks and ongoing adjustments to PACS at Cedars-Sinai. Cedars-Sinai's PACS migration is expected to be completed in November 2002. Another project in the works at Cedars-Sinai is to bring the operating room to a filmless environment. Assuming that the operating room project is successful, Cedars-Sinai will be only about five percent film-dependent, excluding the outlying mammography center, which is a satellite office.