



Washington
Hospital Center

Overview

Country: United States

Industry: Healthcare

Customer Profile

Washington Hospital Center, the flagship teaching hospital of nonprofit MedStar Health and the largest hospital in Washington, D.C., serves more than 250,000 patients annually.

Business Situation

Washington Hospital Center needed to provide instant access to all types of patient information for physicians, nurses, and managers at workstations throughout the hospital.

Solution

Washington Hospital Center created its own solution, called InSight, using Microsoft® development tools including Visual Studio® .NET 2003 and the Microsoft .NET Framework. Microsoft SQL Server™ 2000 databases support 13 terabytes of data for just the one hospital.

Benefits

- Improved patient care
- Savings in file retrieval
- Ease of use
- Pattern recognition to improve care
- Highly reliable data access
- Fast development environment

Electronic Medical Records Help Physicians and Boost Revenues While Saving Millions

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Jonathan Handler, MD, Director of Informatics and Assistant Professor, Northwestern University, Division of Emergency Medicine

Physicians need all the information they can get when treating a patient, but too often, life-saving data is trapped in disparate systems that can't be accessed easily. A development team at Washington Hospital Center created a solution that could revolutionize the way medical information is captured, stored, and made available. The InSight solution transforms patient care by bringing together all types of patient data from hundreds of data sources across the enterprise and making the data instantly available at the point of care across a range of devices—including wireless delivery to the Tablet PC and Pocket PC—using security features built into Microsoft® Windows® to keep patient information secure. Additionally, InSight brings in more than U.S.\$3 million in new annual revenues through automation of manual processes, while saving the center additional millions by reducing its dependence on paper records.

“It’s really been an almost life-altering experience.... Sitting in my office, across the street from the medical center, I can pull my films up on my laptop and show patients what I’m concerned about, or show them why they need a bypass surgery. Everything is right there—lab reports, histories, x-rays, the films that were created earlier in the day or three years ago.”

Bernard Wagman, MD, Senior Attending Physician in Cardiology, Washington Hospital Center

Situation

Hospitals provide a classic example of the need for—and difficulty of—integrating information systems. Physicians need as much information about a patient as possible—yet it can take hours to retrieve a paper-based patient record from archives, and x-ray and other imaging films are often stored separately. Storing records electronically is widely viewed as the best solution, but such systems present the twin challenges of integrating disparate systems while providing an intuitive interface that allows physicians and other healthcare professionals to maximize the value of the data.

In 1995, Washington Hospital Center recruited Mark Smith, MD, to become Chair of the Department of Emergency Medicine, and it recruited Smith’s longtime collaborator, Craig Feied, MD, to be Director of the Institute for Medical Informatics at Washington Hospital Center. The two had developed a reputation for using information technology to enhance organizational efficiency and patient outcomes in the emergency room.

At Washington Hospital Center, Drs. Feied and Smith found what is still typical of hospitals today—*islands of data* collected on one system that can’t easily be shared with other systems because of disparate data types. “The complaint we heard over and over again was, Why can’t all of this information be in the same place?” says Dr. Smith.

“We identified 300 data islands within the medical center,” says Dr. Feied. “Patient registration information was locked up in one system, while lab reports were in another; radiology readings from digital x-rays were in one format, CAT scans were in another, and electrocardiograms in another. The list goes on and on—300 different systems that couldn’t talk to one another.”

Instant access to patient information is needed everywhere across the clinical environment—and in places like the emergency room and the intensive care units; delays often are a matter of life and death. Physicians need to see current test results and images as rapidly as possible—and they need to see data from prior visits just as quickly, so they can tell what has changed and can view a patient’s current condition in the most complete context.

Washington Hospital Center had already implemented a commercially available electronic medical records solution, but it was slow and difficult to use, didn’t offer access to complete records, and wasn’t well accepted or widely used by physicians.

Drs. Feied and Smith wanted a system that could collect *all* information of *all* types from across the entire medical center and make it available instantly. When they couldn’t find such a system available commercially, they decided to build their own.

Solution

Drs. Feied and Smith guided a team of internal developers in creating the InSight Real-time Repository for electronic medical records. Launched in 1996 after 13 months of development, the InSight system was entirely created and deployed using Microsoft® technology. Since the initial launch, the development team has continually adopted new Microsoft development tools, most recently moving to the Microsoft Visual Studio® .NET 2003 development system and the Microsoft .NET Framework. The Framework is an integral component of Windows® that provides a programming model and runtime for Web services, Web applications, and smart client applications.

The InSight system provides what Dr. Feied calls a “drip pan” function: It collects data

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from all information systems within the medical center—including EKGs, x-rays, CAT scans, MRI images, and even streaming video of all cardiac catheterizations and other angiographic procedures. This is significant because, traditionally, imaging films have been stored separately from patient records, requiring additional retrieval time and effort and usually requiring the physician to go to a specific location and use dedicated equipment to view them.

For every system that produces data, Dr. Feied and his team created an object wrapper interface that collects a real-time copy of each new data element, places an XML wrapper around the data, parses it, and stores it within the Microsoft SQL Server™-based InSight Real-time Repository. The system provides an easy-to-use interface through which users can see any cohort of patients with just a few clicks. For example, filtering on “CCU” shows all patients who are in the coronary care unit, and further filtering on “chest pain” shows all CCU patients with chest pain. Clicking a single patient returns that patient’s current records, as well as all past lab results, diagnostic images, procedures, case notes, and other data about the patient in a logical hierarchy that helps medical staff find exactly what they need.

Drs. Smith and Feied arrived at the drip-pan concept—that is, the method of catching data from wherever it might be created—after studying other information systems that were so overstructured that it was difficult to enter new types of data or use existing data in different ways.

“We designed a system that would be fundamentally different from all others in that it was not going to have any preconceptions about what was important to know and what was not important to know,” Dr. Feied says. “The system’s one goal is to allow you to answer *any* question incredibly quickly.”

InSight currently runs on a mix of Microsoft Windows Server™ 2003 and Windows 2000 Server operating systems and uses SQL Server 2000 as the data store, all of which belong to the Microsoft Windows Server System™ integrated server software. To ensure subsecond response times to queries, Dr. Feied stores digital images such as x-rays and CAT scans directly in SQL Server. Paper components of the medical record can also be scanned into InSight, which contains a fully integrated document imaging system. The data store, spread across a number of servers, already totals 13 terabytes for a single hospital and is growing at a rate of about 4 terabytes a year per fully instrumented hospital.

“We like to have patient information come up within an eighth of a second,” says Dr. Smith. “We looked around for what the right database system was and we had a number of choices. We chose Microsoft SQL Server, which is at the very heart of our solution. We’re absolutely delighted with SQL Server’s ability to store and provide immediate access to large image files. You can’t practice medicine these days without having images. We have been thrilled with the performance and the reliability of SQL Server. It’s been absolutely outstanding.”

“We are using Microsoft technology across our entire solution,” Dr. Feied says. “We’re using Microsoft ADO.NET for database connectivity. We’re creating XML-based Web services to link different systems; we’re using the Windows Control Library to create custom controls for Windows Forms. All the coding is done in Visual Studio .NET—with our developers moving now from C++ to C#.”

The team used Microsoft ASP.NET to create a Web-accessible version of InSight so that physicians can see medical records, including images, from home—a remote access option that is highly valued by physicians when they

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are called about a patient in the middle of the night. The team also uses ASP.NET mobile controls to deliver the same clinical information wirelessly to personal digital assistants (PDAs) running Microsoft Windows Mobile™ software for Pocket PC. This makes real-time patient data instantly available to authorized physicians through a wireless Internet connection from anywhere in the world.

Security is a critical concern for all systems that manage medical information. InSight supports two-factor authentication using smart cards as well as a variety of hardware tokens, but Washington Hospital Center prefers to depend on biometric authentication—using iris scans and fingerprint recognition—when necessary to guarantee that sensitive data is only seen by authorized users. Dr. Feied says the security model built into the Windows operating system has been an important factor in helping to protect patient privacy.

Dr. Feied says that about 20 percent of the system is rewritten each year, allowing new functionality to emerge over time as the code base is constantly updated. In this way, the solution continually evolves to meet the needs of physicians, nurses, and others involved in patient care.

Benefits

The solution has produced many benefits for MedStar and Washington Hospital Center. Patient care is improved through instant access to clinical information. Instant access to information also helped one department double the number of patients that it served within the same basic physical space, while decreasing turnaround time and boosting patient satisfaction dramatically. The system directly increased revenues by U.S.\$3 million per year in a single department, through the automation of previously error-prone manual tasks. It has also produced significant annual

savings through reduced paper handling and file retrieval costs.

The implementation team benefited from a fast development environment that helped them provide fast delivery of customized tools for physicians, and support costs have been kept to a minimum because the underlying database and system components are robust and self-maintaining.

Improved Patient Care with Easily Accessible Patient Records

Physicians who have used the system believe that the sheer vastness and flexibility of the InSight central repository may actually revolutionize the practice of medicine.

“Their system is a monumental achievement,” says Jonathan Handler, MD, Director of Informatics and Assistant Professor at Northwestern University, Division of Emergency Medicine. “Nothing has ever been done like this before. It completely transforms the experience of treating patients and what you can do for patients. Medicine has never had a system like this, which collects every drop of clinical information and puts it into the hands of physicians, to help them make the right decisions—more quickly, and more efficiently.”

“It’s really been an almost life-altering experience here at the hospital,” says Bernard Wagman, MD, Senior Attending Physician in Cardiology at Washington Hospital Center. “I’m a cardiologist, which involves taking pictures inside of arteries, looking for blockages, and then using catheters and other devices to repair the problems. Sitting in my office, across the street from the medical center, I can pull my films up on my laptop and show patients what I’m concerned about, or show them why they need a bypass surgery. Everything is right there—lab reports, histories, x-rays, the

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films that were created earlier in the day or three years ago.”

Dr. Feied says that the streaming videos of cardiac catheterizations, angiograms, and other dynamic procedures are a recent addition to InSight. Weary of the time-consuming inefficiency of going to a film file room to obtain magneto-optical disks and videotapes of the procedures, cardiologists came to Dr. Feied and asked whether their video data could be added directly into the InSight system.

“The old way was a nightmare for the cardiologists because they had to go to a special viewing place, and then they were looking at the images without the context of the other patient information,” Dr. Feied says. “We wrote new code to import the data and store it as a BLOB [binary large object] in a SQL Server field. Within two weeks, we rolled out the new module. One click, and within an eighth of a second, you are watching the heart pumping.”

The technology is also much appreciated in the Neonatal Intensive Care Unit.

“We deal with extremely small babies—in the 500- to 600-gram range (500 grams equals 1.1 pounds)—and time is critical,” says Dr. Zacharia Cherian, Chairman of Neonatology, Washington Hospital Center. “Our people are trying to save lives. We appreciate and need the immediacy of InSight. You go to the screen, and the x-rays are there. The lab reports are there. We need that information as soon as it is available so we can see whether a baby needs a blood or platelet transfusion, or if the baby needs a change of antibiotics, or any other intervention.”

Dr. Cherian uses secure Web access to the system to monitor his young patients from home.

“When I leave the intensive care nursery in the evening, there are always things I want to check on,” Dr. Cherian says. “I used to call to talk to the nurses and physicians on duty to ask about patients. Now I can use InSight on my home computer and check on x-rays and the latest lab tests. My wife has given up on me, but you need to know you are doing everything you can for these infants, or you just don’t feel good.”

Dr. Wagman says that he also values the ability to view patient information from his home computer, because it helps him make more informed decisions when contacted after hours.

“InSight helps me be a better physician when I get a call in the middle of the night because a patient has gone to the emergency room with chest pains,” Dr. Wagman says.

“Perhaps the patient had an angiogram done six months earlier, but with the hundreds of patients I see, I may not be able to remember what his pictures looked like. Now I can go to my laptop at home, pull up those pictures and other data, and have far more information as I advise the emergency room doctor on treatment for the patient. This is how we ought to be able to practice medicine. The data was always out there, but we had no way to access it before this system.”

“This system is saving lives,” says Dr. Handler. “It is a pleasure to practice medicine when you have this realm of data instantly available. For the clinician, it means the idea of looking at past medical information isn’t affected by concerns about how long it will take to go through piles of paper to find the data, or worries about fighting with a clunky software system. These thoughts do enter into clinicians’ minds, and they may think, ‘Well there’s probably nothing significant in the old information.’ That’s a dangerous position to be in. This system makes it so

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easy to see the data that concerns about finding older data never enter your mind. The information is already there, and in a perfectly logical manner.”

Substantial Annual Savings in File Retrieval

Retrieving physical files from archives can be slow, undependable, and expensive. Industry studies show that clinical documents are unavailable during 30 percent of encounters. The cost to find and deliver a chart ranges from \$10 to \$70, depending on the setting. Eleven percent of tests are duplicated due to lost results. There are square-footage costs associated with paper storage, often causing older records to be archived offsite, with longer delays and even higher costs for retrieval. In contrast, there is no incremental cost to retrieve patient information from an electronic data repository. Electronic documents are always available during clinical encounters, and tests never need to be duplicated because results have been lost.

Dr. Feied says that with a very sick patient population, the emergency department used to request paper records about 60 percent of the time—even though delays often meant that treatment decisions had already been made before the files arrived. “Last year, we saw nearly 70,000 patients in the emergency department, but we almost never had to call for old, paper-based medical records. When you can reduce paper-handling needs like that, the savings can be enormous.”

Ease of Use

The InSight system is so easy to use that, by design, it doesn't have online Help. The team doesn't make documentation available and offers no training. Instead of forming committees, scheduling training, and announcing the arrival of the new system, Dr. Feied simply put a computer out in the

clinical area with a sign taped to the monitor that said, “Beta Test. Do Not Use.” He figured that human curiosity would do the rest.

“I came back a week later and I found seven people standing in line to use the system,” Dr. Feied says. “Each one was flipping up the paper that said ‘Do Not Use,’ using the system, and then flipping the paper back down for the next person. In one week, the word had gotten out all over the entire hospital that it was faster to go down six floors to the emergency department and stand in line with seven other people than it was to try to get the data out of paper charts or the mainframes.”

From there, Dr. Feied's team proceeded to roll out the solution to physicians and nurses who had heard about the system and wanted access. It became the standard across the medical center.

“They've never trained anybody on how to use the system,” says Dr. Handler. “You just walk up to it, and it's obvious how it should work. With this system, you can just start exploring. Click a lab test, and the system automatically shows you all the previous tests, sorted logically and beginning with the most current. Everything about what they've done is just the way it should be. It's unbelievably fast, and that encourages the exploration of the data. They will go down in history for what they've done for the field of medicine.”

Data Pattern Recognition to Improve Patient Care

When Dr. Feied looks at his system, he's most excited about putting the system's search functionality to work in recognizing patterns in the data—either within an individual patient's record or across larger populations—which can enhance the delivery of healthcare.

“We’ve had only two hours of downtime since launching the system in December 1996. That’s 99.997 percent uptime—even though the system has been in constant migration, with new code released to the production environment every day.... To us, the uptime is a tribute to the stability of the operating systems and back-end resources that we’re using.”

Craig Feied, MD, Director of the Institute for Medical Informatics, Washington Hospital Center

“When you have all of a patient’s data, you can see patterns in his or her history—and set the system to flag abnormalities,” Dr. Feied says. “If a patient normally has a heart rate of 45 and it goes up to 66, a reading of 66 might not seem bad, unless you know that the patient is normally at 45. When you look at a graph of the patient, that 66 would stick out as a spike, and you could take appropriate action.”

Pattern recognition can also be used to monitor for outbreaks such as severe acute respiratory syndrome (SARS), the viral respiratory illness that was first reported in Asia early in 2003. Over the next few months, SARS spread to more than two dozen countries in North America, South America, Europe, and Asia.

“We are very concerned about the possible reappearance of SARS and other newly emerging respiratory illnesses,” says Dr. Feied. “With a few clicks, we activated a surveillance module that’s part of InSight. We instructed the system to post a yellow flag and send out e-mail if the daily count of patients with shortness of breath reaches the ninetieth percentile compared to historical data over the past five years. If the count reaches the ninety-fifth percentile, a red flag will be posted, and people will be paged automatically. If something like SARS did break out, with one click, we could see who the patients are, see what happened to them, see who’s taking care of them, and make sure they are in respiratory isolation to keep the infection from spreading.”

Highly Reliable Data Access

InSight has achieved an impressive, nearly perfect record of uptime, which Dr. Feied credits to the progression of Microsoft operating systems he’s used, the robustness of SQL Server, the power of Visual Studio .NET, and other aspects of Microsoft technology.

“We’ve had only two hours of downtime since launching the system in December 1996,” Dr. Feied says. “That’s 99.997 percent uptime—even though the system has been in constant migration, with new code released to the production environment every day, and with no regression testing because the architecture is built not to need it. To us, the uptime is a tribute to the stability of the operating systems and back-end resources that we’re using.”

“Having just two hours of downtime in eight years is amazing,” says Dr. Handler. “The hospital systems that most of us use are routinely down for maintenance upgrades. An IT department thinks, ‘We’ll take the system down for maintenance on a Saturday night when nobody is there.’ But a Saturday night in an urban emergency department—everyone’s there. There is no good time for the system to go down. Yet all the medical information systems that I’ve seen or heard of require maintenance upgrades and scheduled downtime—and that’s in addition to any system failures that occur unexpectedly. The InSight system provides uptime that is amazing.”

Fast Delivery of Customized Tools for Physicians

Dr. Feied praises Visual Studio .NET and the Microsoft .NET Framework for slashing development time from years to days.

“The most complex projects that we deal with relate to bringing data into our system from some horrible legacy system that’s way off in ‘nowheresville,’” Dr. Feied says. “My people can do that now in three to seven days—using the incredible tools built into Visual Studio .NET and the Framework. People come to us with special requests, and I ask my developers to make it work. The next afternoon, they show me the prototype, which often is good enough to run, and we go live.”

“We’re not using any magic here, we’re just using Microsoft development tools. People don’t realize how much they can do with these tools.”

Craig Feied, MD, Director of the Institute for Medical Informatics, Washington Hospital Center

“This efficiency comes from having building blocks that can be assembled with absolute confidence that you’re not going to get any funny glitches,” Dr. Feied says. “This sets us free. I remember the days when we had to build our own B-tree and C-tree databases and write our own index pointers, and the referencing modules and so forth. It took us 24 months to build a database. Today, that database is running within eight minutes. The development tools are so good that we can build the final application 10 times as fast as we used to be able to prototype it.”

While some people praise the reusability of code, Dr. Feied praises the disposability of code.

“If we’re not sure which way a module ought to be done, or how it ought to work, or what the interface ought to do, we just build it in all the different ways we can think of, and then we let people vote with their clicks,” Dr. Feied says. “It’s faster to just build different approaches than it is to argue about it and agonize over it. We never worry about throwing code away because it’s so cheap and fast to build more. I believe that the most under-celebrated aspect of object-oriented programming is not the reusability code, but rather its disposability. That’s the gift we’ve gotten from the Microsoft development environment.”

While some organizations require developers to comment code, Dr. Feied discourages it, figuring that code comments are always out-of-date anyway and that it is faster to re-create the functionality with new code than it is to study the old.

Dr. Feied’s team recently completed a badge-tracking program for locating patients and medical staff within the facility.

“You would think that it would be a big, cumbersome task to track badge locations

and display locations in 3-D from floor plans taken from our AutoCAD system,” says Dr. Feied. “With the Microsoft .NET Framework, it took about two weeks, end to end.

“One of the coolest modules that I’ve seen in a while is one that shows me the real-time temperature of every single server we have,” Dr. Feied continues. “It shows the airflow in those areas, the average temperature in the room, how long each machine has been up, how many messages the machines have been processing, how many minutes it’s been since the last message was processed. It provides great data for managing a server farm. One of our developers built that in just a few days using Visual Studio .NET and the Framework, so obviously the tools are very powerful. It’s been a gift to us to have these advanced development tools that forever make newer things easier and faster to create.”

As other medical centers inquire about the InSight system, Dr. Feied encourages them to create their own.

“We’re not using any magic here, we’re just using Microsoft development tools,” Dr. Feied says. “People don’t realize how much they can do with these tools.”

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