

ClinicStation (Electronic Medical Record System)

A CASE STUDY PRESENTED BY:

The University of Texas M. D. Anderson Cancer Center



INTRODUCTORY OVERVIEW

In five years, leading-edge medical centers will look much like the University of Texas M.D. Anderson Cancer Center in Houston looks today. The cancer center, ranked in 2008 by U.S. News and World Report as the nation's top hospital for cancer care, has built a visionary electronic medical record (EMR) system—the first of its kind anywhere in the world—that seamlessly integrates clinical and research information. The system, called ClinicStation, redefines healthcare record keeping and represents a major advance in the healthcare industry. The new system is pioneering in seven important ways:

- It is the first EMR system to provide an interoperability foundation between clinical and research information, a capability that will significantly improve both patient care and research. The best decisions can be made about a patient's treatment utilizing the latest cancer research.
- The cancer center is the first hospital to fully deploy custom-built EMR technology from scratch on such a large scale: it involved 100 developers, encompasses 70 modules and now processes up to 4,000 service calls per second during peak periods, and approximately 325 million calls per month.
- The system uses a full Service Oriented Architecture (SOA) and the Microsoft .NET Framework, and is one of the most fully implemented SOAs in the healthcare industry.
- ClinicStation provides an integrated view of each patient that's available to authorized participants in the clinical and research chain. Most hospitals keep medical images and data in separate systems; at M.D. Anderson, separate systems are presented through SOA as an integrated working environment.
- The new system is flexible, growing and changing to meet M.D. Anderson's needs without hampering daily operations. Uniquely, physicians and others in the healthcare chain provide the leadership when it comes to introducing new capabilities.
- It demonstrates that the interoperability and flexibility made possible by SOA have the potential to improve any industry challenged by information maintained in disparate systems.
- Already ClinicStation is serving as a model. M.D. Anderson allows other institutions to view and learn from the system, promoting M.D. Anderson's role as a leading teaching institution.

In 1999 M.D. Anderson established itself as a leader in the use of electronic medical records when it built its original ClinicStation, a system that gave physicians and other healthcare workers convenient and timely electronic access to patient records. In 2003, the legacy ClinicStation was recognized by a Computerworld Honors Laureate award. Still not satisfied, however, in 2007 the cancer center envisioned a significantly improved system that would provide a host of new capabilities, like the ability to integrate research data, access data from virtually every electronic source within the institution, and enable the integration of both outpatient and inpatient data.

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Because no commercial software offered such capabilities and interoperability, M.D. Anderson took the unprecedented step of developing the customized application itself. Today the SOA environment encompasses all of M.D. Anderson's patient data, including everything from patient diagnosis and treatment to clinical trials research and pharmaceutical data. No other system is as comprehensive or built to so easily enable the development of new capabilities suggested by healthcare providers. ClinicStation boosts workflow, making it possible for physicians to handle more patients, and because it maintains so much information, it greatly reduces the time spent looking for data or images. Patient care has also been improved. Physicians now can make faster and better-informed decisions from any location, 24/7. By integrating clinical and research data, ClinicStation is making an invaluable contribution to M.D. Anderson's battle against cancer. It serves as a model for any healthcare institution because the future of medicine will require the linking of clinical and research data, and the incorporation of new data forms that have been found with genomic analysis.

The field of medicine is constantly changing. New data models, new treatments, new discoveries of biological processes, and new genetic relationships are all emerging, and M. D. Anderson is leading the way with an EMR system that is responsive to them all.

THE IMPORTANCE OF TECHNOLOGY

Because of its unique and sophisticated needs, M. D. Anderson chose to build an EMR system in-house, with a Service Oriented Architecture (SOA) to connect and display data using the Microsoft .NET Framework. The .NET Framework provides a programming model and runtime environment for Web services, Web applications, and smart-client applications. The cancer center selected Microsoft because it wanted a set of technologies to provide a foundation for the integration of numerous existing systems, many of which are commercial software applications.

“Such an ambitious project was only feasible with tools that weren't available even three or four years ago,” says M.D. Anderson Vice President and Chief Information Officer, Lynn Vogel. M. D. “Anderson needed an integrated set of technologies that would support continued, disciplined software development, and be flexible enough to serve as the foundation for its IT strategy for years to come. The challenge was to connect 60 different back-end systems into a single comprehensive presentation and analytic capability, while creating an environment that facilitates the addition of modules now and in the future.”

Adds Chuck Sutor, Director of EMR Development and Support, “The cancer center's IT department had two technical goals. First, we wanted to make sure the architecture would support us for a good long time to come. Second, we needed an infrastructure that could guarantee performance, scalability and reliability.”

The system needed to support not only growth in the numbers of patients served and the enormous amount of data and radiology images gathered to treat each cancer patient, but also potential new technologies and functionalities. The choice of SOA was critical to the success of the new EMR system. SOA, which treats services as components that work together to accomplish business goals, enables interoperability for the exchange of both data and images between the clinical and research departments. It also provides the flexibility to easily customize and add features as the needs of M.D. Anderson—and the field of medicine more broadly—change. SOA enables a common access framework for all current

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and potential sources of patient data. M. D. Anderson takes a best-of-breed approach that gives different departments the prerogative to choose commercial software applications that address their specific needs. Now the data from these systems appears to the clinician as a single working environment. The early version of ClinicStation, with its presentation of various types of data, had anticipated the eventual move to SOA. While many organizations have expressed interest in SOA, most still are in the initial stages of planning, prototyping, or perhaps setting up a single application. At M.D. Anderson, however, the new ClinicStation is not just an application with SOA. It is the foundation of a service-oriented enterprise.

ClinicStation's success refutes popular industry assertions that SOA cannot support large organizations. The proof is that on a routine basis, there are 7,000-8,000 ClinicStation users. The system serves about 13,000 unique users per month and up to 4,500 users simultaneously. Among the innovations of M.D. Anderson's new EMR system is the development process itself. The software development methodology, like the EMR system, is flexible, highly secure, and scalable to support future growth. The cancer center used a software factory concept that allows M.D. Anderson developers to build and customize the software when commercial software doesn't meet their unique needs.

BENEFITS

ClinicStation represents a major advance for M.D. Anderson's patients, caregivers and the research community. In the past, physicians endured a lengthy process of tracking down and retrieving patient data or radiology images. Time delays slowed the process of treatment, sometimes stalling important medical decisions. Meanwhile, difficult data access hampered the ability of consulting physicians to collaborate on patient cases. The process of incorporating research data into the care process was equally challenging. As a result, M.D. Anderson's top researchers were unable to fully benefit from the knowledge gained in the clinical realm, and clinicians could not take advantage of research findings that would help them deliver the best possible patient care.

"With ClinicStation, M. D. Anderson has improved the accuracy of its data and the quality of caregivers' decision making. It has provided a scalable foundation for continued high-performance growth. It has increased the productivity of its medical staff and lowered costs. At the end of the day, all of these benefits really accrue to the patient," says Dr. Kevin McEnery, Professor of Diagnostic Radiology at M.D. Anderson. Historically, if one physician wanted to consult another, they'd have to be in the same physical location. Now, they can consult over the phone, while looking at the same data and images on their computers, even across state, local or international boundaries. Because the system also provides links for appropriate resources outside the facility, it is not just M. D. Anderson medical staff who benefit. Referring physicians and patients have their own portals to relevant data. Vogel recalls one situation where an M. D. Anderson patient was hospitalized in London and the physicians were able to share electronic images as part of a joint consultation. In this example, it turned out there was no serious complication, Vogel says, so the patient was able to be discharged, rather than having to be operated on due to a lack of information.

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According to Suitor, “Our care pattern involves intense two-day or three-day encounters with patients, who see various specialists and get all the diagnostic tests they need, but physicians want to have instant access to new information, because if newly created data were not instantly available, it would slow down the decision-making process in this series of appointments. This system makes everything instantly available to everyone with a need to know.”

In the past, patient charts were so heavy that patients at times required wheel chairs to carry them from one place to another during the testing and consultation process. Wheel chairs are no longer needed because charts are available electronically for physicians and caregivers. The system has delivered many important benefits. Among them:

- **Data accuracy.** When a physician looks at image data or clinical data in ClinicStation, he or she is looking at the most up-to-date data, in the originating system.
- **Flexibility.** Adding new systems and data sources is extremely easy. That flexibility is facilitated by the SOA framework, because it is not necessary to move data around.
- **Increased performance.** A single server on the new architecture can easily handle the load of the entire 11-server Web farm in the old architecture.
- **Stability.** A custom monitoring solution helps the IT department see developing problems and resolve them before they affect users.
- **Increased productivity.** The flow between the hospital and all of the clinics is much faster.
- **Reduced costs.** By some internal estimates, every physician who uses ClinicStation saves a half-hour a day, every day.

Dr. Garrett Walsh is Professor, Thoracic & Cardiovascular Surgery. In his words, “ClinicStation allows us to compare radiographs, previous CAT scans or MRIs to measure tumor response to see if they are improving with treatment or not. The computer will link the images and we can go down slide by slide, slice by slice and make decisions as to whether tumors are growing or not. That was virtually impossible before, even with hard copy films, because you would be looking at one film trying to compare it to the other and getting out your ruler. ClinicStation gives us the ability to magnify images, rotate images and use all sorts of imaging alterations to better define what is going on in someone’s chest, brain, abdomen or long bone. We, as surgeons, are extremely dependent on having reliable radiographs available at all times. Fortunately, ClinicStation has been an extremely reliable system for us. I could not imagine practicing medicine without ClinicStation.”

Dr. Ron Walters is Professor, Breast Medical Oncology. He says “ClinicStation is very much my lifeblood as far as everything we do in the clinic and also as far as research goes. Whether I’m at home or at work, I can look ahead to see the schedule for the next day, anticipate the problems I might have, know who’s coming in, what kind of situation they are in, and then map out how that day is going to go so that it doesn’t hit me by complete surprise in the morning when I come in. One of the biggest disadvantages that the outside world suffers from is the cross-coverage for other physicians, or even getting adequate follow-up for my own patients when I am offsite. Because ClinicStation is web-based, I am able to perform almost everything I do from home, except, of course, examine the patient. This includes responding to

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questions, looking up medications, ordering medications, writing out chemotherapy orders—anything that needs clarification is easily done at home or actually from any place where, with proper security, I have access to ClinicStation.”

Dr. Randall E. Millikan is Associate Professor, Genitourinary Medical Oncology. As he puts it, “The business of academic oncology is about making it possible for the next generations of patients to not have the same prognosis that today’s patients have. This requires advanced information technology, especially in this current era when research information and genomic information is exploding. This is a huge challenge. What’s ironic is that it is easier to measure the expression of 500 genes in a 100-tumor sample than it is to characterize in a structured way patients, their clinical follow-ups, and their clinical outcomes. This is because the clinical side of the house lags far behind in the ability to generate structured information. So people who work at M.D. Anderson who just can’t stand not knowing what causes cancer and how to cure it, need ClinicStation in order to do this work. Through its Outbound module, currently under development, M.D. Anderson is planning to add online access for patients and their referring physicians to ClinicStations, resulting in direct access to virtually all the contents of online medical records.”

ORIGINALITY

One of the major breakthroughs with ClinicStation is that its SOA provides the foundation for the integration of research and clinical data, as well as inpatient and outpatient data. This is the first time a hospital or research institution has gained such a capability. The new system solves the interoperability problems that have plagued institutions with siloed sources of data. Today, all of a patient’s information is available to every authorized caregiver, physician, researcher, radiologist, lab technician, pharmacist and others. For the first time, providers have complete and convenient electronic access to a wide range of patient information. With the legacy system, physicians and others could do little more than view information using different passwords, presentations and navigation tools. Now they can create information, add orders for treatment, and fully interact with the data and images while the data remains in the source system. These are significant achievements in healthcare and they ensure that M.D. Anderson remains a premiere and visionary cancer treatment and research facility.

ClinicStation fosters unmatched levels of collaboration, increases the pace of research and patient care, strengthens decision-making, streamlines workflows, lowers costs and improves the patient experience. The system’s use of SOA is unique in the healthcare industry. No other hospital here or abroad has used the innovative technology at such a scale or with such success. Among the many benefits, SOA helps deliver unprecedented data accuracy. Every time you move a piece of data from point A to point B, there is a risk that you will lose the data, or that point B will become out of synch with point A, explains CIO Vogel. The SOA framework, where services expose or present data, and then consume data, eliminates these problems. When a physician looks at patient data in ClinicStation, he or she is really looking at that data as it exists in the host system. Most hospitals use commercial EMR systems and don’t perform in-house development of this magnitude for such a mission-critical application.

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Not only did M.D. Anderson undertake the unusual challenge of creating custom-built technology, it also innovated a development model that is unique in the healthcare industry. M.D. Anderson's software factory model started out with the challenge of re-platforming a legacy system, and has expanded into a sophisticated development model for adding functionality to the EMR platform through multiple parallel development efforts. The aim is to deliver new capabilities to physicians, nurses and clinicians as fast as possible. And it is working beyond anyone's expectations. Unlike commercial systems, which typically require feature prioritization across multiple customer sites, ClinicStation was designed so that M.D. Anderson's own internal resources can add the capabilities. The company created what it calls a flexible virtual repository that makes adding new systems and new data sources extremely easy.

"That flexibility is facilitated by the SOA framework, because we don't have to move data around," says Vogel. The new architecture also introduces significant new safeguards. For example, M.D. Anderson has used Microsoft Operations Manager 2005 to integrate a custom monitoring solution into ClinicStation. This helps the IT department identify potential system issues and resolve them before they affect users. And because the new system demonstrates the potential for SOA to scale to serve the needs of a major institution, it sets a new standard, and in the process shows how the technology can power a service-oriented enterprise in any industry. M.D. Anderson has also won a number of awards for its innovative use of technology.

DIFFICULTY

Building the new and highly complex ClinicStation EMR system over the course of an 18-month transformation period required overcoming numerous challenges. Perhaps the biggest obstacle was the fact that the new system needed to be developed without disrupting the legacy system and its operations, even as the legacy system continued to be enhanced with new functionality every three months—functionality that needed to be available in the new, re-architected system as well. It is always difficult to build a system to the scale required by M.D. Anderson. That challenge was multiplied when the institution made the daring decision to use custom technology and start from scratch. It meant scaling up from a three-person development team to an army of 100 developers at the height of the program. The dimensions of the program were staggering and unmatched by any hospital here or abroad: no fewer than 60 back-end systems needed to be connected into a single comprehensive, SOA.

At the same time, developers needed to create a process for adding individual modules now and in the future. When the effort began, ClinicStation had about 30 modules. Today it has expanded to encompass 70 modules, including:

- **Order Set Management:** This module automatically creates, manages and routes chemotherapy order sets to the appropriate recipients along with the patient's medical context, increasing efficiency, reducing adverse events and improving overall patient safety.
- **Structured Clinical Documentation (SCD):** This module addresses one of the most challenging areas in medicine—adding structure to clinical documentation that was previously only captured in free-text format. SCD enables the capture of this information in a discrete manner to support critical care decision analysis, while improving accuracy and speed for data entry by physicians so that they can spend more time on patient care.

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- **Medication Reconciliation:** This module accurately and completely reconciles medications across the continuum of patient care, decreasing the potential for medication errors.
- **Nursing Needs Assessment:** This module allows a nurse to document and automatically route a patient's need for—or request from—the ancillary services of the institution (e.g., Social Work, Nutrition, Physical and Occupational Therapy, Wound Ostomy and Continence, Chaplaincy, Speech and Audiology, Case Management, etc.), improving the overall patient experience.

The new ClinicStation system now has triple the functionality of the legacy system, and it was all introduced in eight separate releases. M.D. Anderson's SOA permeates the historical wall that has separated research and clinical care departments, and has allowed the development of processes for integrating inpatient and outpatient data as well as radiology images and data. It has also entailed building a system that would accommodate emerging clinical and research needs like personalized genomic medicine, in which clinicians and researchers will draw heavily from a patient's genetic makeup in the development of both diagnoses and treatment regimens. Genetic data represents a major departure from the type of data historically used to assess patient conditions.

The new system needed to be constructed to accommodate this move towards personalized medicine, which requires gathering and tracking a complex database not only of clinical data, but of genomic data for each patient. Another major difficulty: incorporating images into the system, which is a challenge developers with commercial vendors have struggled with for years, but one M.D. Anderson was able to overcome by relying on SOA. And the very decision to pioneer SOA in healthcare created its own major hurdle. Developers could not look to trailblazers experience for guidance—M.D. Anderson was the trailblazer.

The major obstacle to ClinicStation was the bold decision to defy healthcare industry convention as well as M.D. Anderson's history and build its own EMR system from scratch. M.D. Anderson turned its back on 20 years of investing in its legacy architecture for the promise that a new SOA would dramatically change the way it delivers cancer treatment and help researchers eliminate cancer. The standard in virtually all of the healthcare industry today is to purchase commercial application suites from one of a small number of companies, which base their applications on architectures that were introduced 15 to 20 years ago. In every case, these companies have been challenged to incorporate new forms of data, such as images, into their base products, and none have yet done so seamlessly.

M.D. Anderson views image integration as only the first example of significantly greater challenges already presented by the introduction of genomic or personalized medicine. Given the thin margins that commercial healthcare software companies must work on, they are understandably reluctant to re-architect their systems to take advantage of the many benefits of SOA; M.D. Anderson had no such limitation. And since cancer medicine in many cases is leading the medical revolution toward greater and greater incorporation of genomic data, it was imperative that M. D. Anderson find a way to overcome challenges facing other providers. This forced the decision to implement in-house development and the commitment to SOA. The hospital's executive management embraced the challenge, made the commitment to move up the learning curve to find out what SOA was all about, recognized the benefits, and as a result has fully supported creating an SOA-based ClinicStation from the ground up.

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SUCCESS

“Because we are a cancer center, things that happen here are likely to be harbingers of change that will happen across the field of medicine generally in the next couple of years,” says CIO Vogel. “As you get into genomic medicine and personalized medicine, what used to be research will increasingly be part of the clinical process. So the ways we are seeking to link research and clinical data will also become appropriate in other fields of medicine. Similarly, the inpatient and outpatient worlds are becoming part and parcel of the same process and package of care. These developments mean that the IT implications of what we are doing reach beyond cancer centers and out into the business world.”

Though many organizations talk about using SOA, most are in the initial stages. They are planning, prototyping, or perhaps setting up a single application. At M.D. Anderson, however, ClinicStation is not just an application with SOA. It's the foundation of a service-oriented enterprise. And the interoperability of its IT environment will allow the institution to change with the times, a critical capability for any complex service-oriented enterprise. With the success of its state-of-the-art EMR system, M.D. Anderson has gained widespread attention from counterpart medical institutions, which are eager to discover how they can replicate that success. Invitations to make keynote presentations at national meetings ranging from bioinformatics conferences to SOA-focused forums are becoming routine. By inviting competitors to view the pioneering system, M.D. Anderson is making it possible for other hospitals and organizations outside of healthcare to learn from its lessons. Ultimately, this is the goal of any prominent teaching institution.

The new ClinicStation has become an instant success with physicians and all members of the healthcare process, who have readily embraced an interactive system in which all of a patient's real-time information was easily available and could be used within a single presentation environment. A key advantage of ClinicStation over the previous system is that users decided what ClinicStation would do. Instead of radically altering workflow processes, the new system accommodated them. Because the end users controlled what is in the system, adoption has been widespread. This represents a contrast to so many commercial systems in hospitals, which have often failed or achieved much less than desirable physician adoption rates.

Another measure of success is the continued demand for more capabilities. As many as 8,000 users rely on the system at any given time. ClinicStation has become core to the treatment of the nearly 80,000 patients served by the nation's top cancer treatment facility each year. Patients are benefiting from faster treatment and better-informed treatment decisions. And, as one clinician noted, “ClinicStation is simply the way we practice medicine at M. D. Anderson.” But it is essential to keep in mind that the ultimate beneficiaries are not only today's cancer patients but the millions who will be served in the future as research continues working toward a cure. ClinicStation is contributing to M.D. Anderson's growth. The institution continues to expand dramatically, says EMR director Suitor: “In every measure—number of patients seen, clinic visits, surgeries, and revenue, it grows every year. While I don't think we can claim ClinicStation is the only cause of that growth, it is certainly a significant contributor.”

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How do you think Information Technology will be different in 2020?

By 2020, the use of information technology in healthcare will have improved significantly the quality of the decisions being made in the midst of a significantly more complex and data-rich working environment. M. D. Anderson already is laying the groundwork with its Services Oriented Architecture-based Electronic Medical Record. The interoperability built into this system will continue to enable very different types of clinical and biological data to be stored in numerous repositories, says CIO Vogel. It also will promote our progress in understanding how empirical data can be used to improve the quality of decisions needed for both the diagnosis and treatment of our patients. Between now and then, the hospital will continue increasing its understanding of how to manage the vast amounts of data being generated by genomic analysis and how to analyze that data to improve our understanding of biological processes and their relationship to the onset of disease. We must figure out how to develop compounds that promote prevention, and when disease is evident, how to attack and eliminate it. Information technology will never replace the role of the trained clinician or researcher, but by 2020, physicians can expect to have access to a wide-range of very complex data and tools, explains Vogel. This will include: electronically-collected data on the patients individual biology, health and disease; sophisticated tools to analyze that data and indicate possible underlying maladies and/or conditions that put the patient at risk; recommended pathways for treatment (including medications personalized to the patients diagnosis and specific biology); and predictions of outcomes based on historical experience and evidence. All of this adds up to a higher quality, more personalized medical care environment based on a foundation of sophisticated information technology which can already be seen in very early stages at M. D. Anderson.

What does being a part of the 2009 Computerworld Honors Program mean to you?

Being a part of the 2009 Computerworld Honors Program would provide recognition of the importance and central role that information technology can and must play in ongoing efforts toward higher quality and more personalized health care. The initial sequencing of the Human Genome in 2003 set the stage for both a broader and deeper understanding, not only of human biology, but the importance of a much more highly personalized approach to the diagnosis and treatment of patients. The tsunami of data that has been released and is now being generated almost on a daily basis threatens to overwhelm the analytic capabilities of our medical researchers as well as the decision-making processes of our clinicians. Nowhere are those challenges being met more forcefully than at M. D. Anderson. It has created, in conjunction with strategic partners like Avanade, commercial grade software development capabilities focusing on a unique Electronic Medical Record system. M. D. Andersons ClinicStation supports seamless access to patient data, and through a Services Oriented Architecture, provides a potential bridge between the fundamental areas of clinical and translational research and patient care challenge which has eluded commercial vendors in the healthcare information technology market. M. D. Anderson has been consistently recognized as the world leader in cancer prevention, cancer research, cancer care and education. Recognition by the 2009 Computerworld Honors Program would acknowledge that M. D. Andersons pioneering EMR work is on the same world-class level as its prevention, education, research and clinical care activities. This includes information technology investments in support of research and patient care, MD Anderson's vision (already being realized) for the integration of research and clinical practice supported by information technology and its commitment to an EMR system based on a fully implemented Services Oriented Architecture. ■