information edge

October 2005
Volume 11, Number 9

The Convergence of IT and Biomedical Engineering: Separate but Equal Not for Long

EXECUTIVE SUMMARY

There's nothing like the advance of technology to bring people together, whether they're ready for it or not, and the converging worlds of IT and biomedical engineering provide a case in point. As more and more biomedical devices like IV pumps and monitors incorporate IT components like chips and software, they become part of the expanding universe of IT.

What this means technically, organizationally and culturally is still unfolding. If IT can be stereotyped as the folks who hook things up, then biomedical engineering or clinical engineering are the folks who fix things. A few biomed departments have been subsumed under IT departments, but most hospitals and health systems still maintain a "separate but equal" structure and literally patch things together when there's an overlap.

And while IT has recently come out of the shadows to take a place in the executive suite, biomed remains largely unseen, tinkering in the hospital basement with the machinery of medicine. That's changing with the maturation of clinical IT, whose demand for the right information at the right time for the right patient views all data sources as its own. This issue of Information Edge picks up the thread of discussion from a breakout session on the topic of IT and biomed convergence at last spring's Scottsdale Institute conference. It's a thread worth following into the future.

Drinking from several fire hoses

"We're absolutely convinced there's convergence between biomed and IT because biomedical devices have become clinical data sources," says Narendra Kini, MD, MHA, executive VP for clinical operations at Trinity Health, based in Novi, Mich. "The data are in no way different than that from clinical IS or paper-based systems. Biomed data, from clinical monitors, EKG, IV pumps and ventilators are just in different formats," he says.

Kini says two major issues arise from this convergence: 1) There's still a major lack of standards and 2) There's little information on how to manage this data. For example, while it's possible to move information around the network that an IV pump is operating, there's no standard way to move information related to its rate of perfusion. The same thing goes for an ultrasound image—it's easy to move the image but not the ejection-fraction figure.

Trinity is examining how to predict clinical events by looking at the entire array of life-critical information about a patient. "It requires a deliberate integrative strategy, not only in terms of feature functionality, but also the ability to interface

SCOTTSDALE INSTITUTE

Membership Services Office:
1660 Highway 100 South
Suite 306
Minneapolis, MN 55416
T. 952.545.5880
F. 952.545.6116
E. scottsdale@scottsdaleinstitute.org
W. scottsdaleinstitute.org

with the EMR and CDR. There are obvious implications for clinical workflow. If a nurse doesn't have to program an IV pump, he or she can spend more time on direct patient care," Kini says.

TRINITY HEALTH

Narendra Kini, MD, MHA, VP, Trinity Health, Novi, Mich.

Trinity is working with vendors to standardize their products. But that is just one aspect of a larger change Kini says is breaking down old organizational structures. "I'm beginning to not like the terms IT and biomed anymore. They should become an overall part of the clinical strategy because of all the data sources they bring at the end of the day," he says.

Yet, IT and biomed remain distinct departments at Trinity. "They're still separate, but the link is getting closer and closer at the corporate level. We're trying to bring these activities together through initiatives related to sourcing, vendor-selection and IT platform," says Kini.

Cedars Sinai Los Angeles

Similar scenarios exist in other leading delivery organizations across the country.

"We have distinct organizational lines but blurred functional lines" between IT and biomed, says Furley Lumpkin, director of enterprise information systems and telecom at Cedars Sinai Health System in Los Angeles. EIS works closely with clinical engineering although it has a different reporting schedule. "Virtually every project biomed does involve IT," he says.

"We're very fortunate that all the people know the issues when they are identified,

CEDARS-SINAI

Furley Lumpkin, director, EIS, Cedars Sinai Health System, Los Angeles

but it's not always immediately clear when there's a potential impact on the network. We catch most of those, but every now and then something slips through," says Lumpkin. "For example, many new projects are identified as 'wireless,' which can be easily misunderstood. We know that wireless infrastructure is not wireless behind the walls and requires extensive network engineering, and the organization's Clinical Engineering staff works closely with EIS to plan for these projects," he says. "We are still working on identifying these systems prior to being purchased, rather than after the fact, and have made significant progress through a strong collaborative relationship with Clinical Engineering."

Still, it's not necessary to organizationally align IT and biomed, Lumpkin says, "as long as we have an open line of communication. At Cedars there's a strong and trusting relationship between the executives and staff of the two departments, who know each other and know what each other knows and doesn't know. Who reports to whom is irrelevant as long as we're focused on the single common objective of quality patient care."

Advocate Health Care

But it's not always easy.

Bruce Smith, CIO at Advocate Health Care in Oak Brook, Ill., says, "We're seeing over the years the overlap of biomed and IT, especially in radiology, but also in IV

For information on any of these teleconferences, please contact the Scottsdale Institute office at 952.545.5880 or register on our Website scottsdaleinstitute.org

November 15
CPOE Rollout at Northwestern: The Embedded Coach
- Stephanie Kitt, RN, director of Quality, Northwestern Memorial Hospital, Chicago
- Paula Elliott, project director, Impact, Northwestern Memorial Hospital, Chicago, and implementation director, FCG, Long Beach, Calif.

November 16
A Collaborative Forum on Quality Improvement
- Janet Guptill, principal, KM at Work, St. Louis, Mo.

November 17
(co-hosted with AMDIS) The CMIO Role: 2005 and Beyond
- Vi Shaffer, research director, Healthcare, Gartner, Inc., Washington, D.C.
- William F. Bria, MD, clinical associate professor of Medicine and medical director of Clinical Information Systems, University of Michigan, Ann Arbor and president, AMDIS

more events on next page

pumps and other devices." Typically one of three events occurs as a result of this overlap: 1)IS and biomed have worked out a solution together; 2) The two departments fight over who's in charge; 3) They both ignore who's in charge and do their own thing.

Advocate Health Care

Bruce Smith, CIO, Advocate Health Care, Oak Brook, Ill.

"We're trying to push for the first one," he says, adding that leadership from the two departments meets every quarter to iron out issues.

As the result of participating in last spring's conference breakout session, Smith says he launched a special task force to address the issue: first, to list all areas of current overlap and, second, identify a protocol for those overlaps. "It's a tedious process but both agree it's necessary," he says.

A typical example: A traditional biomed equipment vendor releases new software versions for its devices and the biomed staff, unused to the process, overlooks the upgrades. "When we tried to implement interfaces we found that we were three or four releases behind," says Smith. In contrast, it has become a routine job for IT managers to negotiate and manage software maintenance contracts with vendors.

And, while radiology has been more accustomed to such tasks because of its work with picture archiving and communication systems (PACS), the advent of software-enabled IV pumps and other devices is relatively recent. The challenge was brought home during a heavy thunderstorm last summer in which power was lost temporarily, requiring several pieces of biomedical equipment to be restarted. "There was a bit of confusion as to who we were supposed to call," says Smith. "The importance of it was that we had a good spirit of cooperation between IT and biomed in resolving the issue."

There have been some discussions about biomed reporting to IS over the past few years, but it was not something the biomed staff were excited about. "They are engineers and preferred to maintain their current reporting status. We have developed a very positive working relationship with the director of biomed and his leaders. This has led to a spirit of cooperation, and the two groups are working on defining roles and responsibilities to make sure that all of our customers and services are supported and covered appropriately," says Smith.

Context-aware healthcare

Bill Woodson, VP of Sg2, a Chicago-based healthcare research organization, says the convergence of IT and biomed is all part of what many in healthcare are calling the advent of the context-aware organization in which data is gathered in real-time about everything including the patient, staff and equipment.

Bill Woodson, VP, Sg2, Chicago

Sg2 health care intelligence

"I see some convergence occurring because, to achieve Don Berwick's goal of standardization and elimination of variability to cut medical errors, you have to see things in real-time. Everything we've done in the past has been retrospective," he says.

Upcoming Events continued

November 21
IT Benchmarking Pilot meeting
- Derek Mazurek, Spectrum Health, Grand Rapids, Mich.
- Troy Hottovy, Saint Luke's Health System, Kansas City, MO.

December 6
California P4P Results Indicate IT-Quality Link
- Dolores Yanagihara, program development manager, Pay for Performance, Integrated Healthcare Association, Oakland, Calif.

January 18
Automating Ambulatory Procedure Notes
- Rebecca Craig, administrator, Harmony Surgery Center, Poudre Valley Health System, Ft. Collins, Colo.

January 26
The Value of IT in Disease Management
- Davis Bu, MD, The Center for Information Technology Leadership (CITL), Partners Healthcare, Boston
- Eric Pan, MD, The Center for Information Technology Leadership (CITL), Partners Healthcare, Boston
- Jan Walker, The Center for Information Technology Leadership (CITL), Partners Healthcare, Boston

For information on any of these teleconferences, please contact the Scottsdale Institute office at 952.545.5880 or register on our Website scottsdaleinstitute.org

"A healthcare CIO told me she hates the 64-slice CT scanner because it's going to completely overwhelm her network storage capabilities."

Woodson says a prime example of convergence is active-RFID technology because it began in the biomedical engineering department as a way to track costly medical equipment like infusion pumps, cardiac pacers, large equipment like bariatric wheelchairs and even the 12-lead cables used to monitor patients, whose loss can run into hundreds of thousands of dollars annually. Real-time indoor positioning systems using active-RFID can track not only assets but staff and patients as well, feeding real-time information on identity, location and time to provide medical context—all adding to the data flood.

"Early adopters have started using RFID tags to track equipment and patients, but who's tracking the data?" asks Woodson. "The next challenge is making sense of the data."

Too many slices

First, hospitals have to be able to handle the flood of information. Despite a decade or more of building network backbones and other IT-infrastructure components, we may be unprepared for the coming technology surge, he says. A case in point is the new 64-slice CT scanner, which produces thousands of images that can overwhelm existing data networks and infrastructure. "A healthcare CIO told me she hates the 64-slice CT scanner because it's going to completely overwhelm her network storage capabilities," says Woodson.

Chris Farr, VP, Sg2, Chicago

Chris Farr, an Sg2 VP who covers medical imaging, asserts that big radiology vendors incorrectly assume most hospitals already have the infrastructure to support 64-slice CTs. "Most simply cannot handle the volume of data," he says, noting that a chest/thorax exam using the new scanner can produce about 4,000 images that must be archived, assembled, separated and routed to cardiologists and radiologists for manipulation and reading. "That requires very sophisticated systems," especially given the typical flow of four patients an hour, fifteen hours a day in a radiology department, he says.

"For a lot of hospitals there's a huge disconnect between radiology and IT," says Farr. What that means—in the absence of an adequate IT infrastructure like PACS—is that these new imaging modalities will not be able to use new and emerging applications. Devices will not offer their promised functionality without the infrastructure in place.

"The whole paradigm has changed," says Farr. In the past each axial cut of a CT scanner might produce 5mm-thick slices; in contrast, the new 64-slice scanner's images are only .4mm thick, producing 10 to 12 slices for every previous one. Add in 3-D manipulation and other post-processing software and the IT load grows even more complex.

Hooked on technology

This convergence of imaging and IT has resulted in changes in workflow for both radiologists and radiology technologists. Radiologists now must sit at sophisticated clinical workstations that have customized and configurable tools to display and interpret images; technologists must use PACS software to ensure quality and integrity. Physicians have gotten hooked on the power of the technology. "Surgeons love it when they use 3-D and other software techniques because they can see the same

view that they see when they're going into the body," says Farr.

And like other biomedical technology, radiology's IT component has broken out of the departmental cell wall and is running rampant in the body of the enterprise.

Amit Sharma, analyst, Sg2, Chicago

"PACS isn't just a radiology tool anymore," notes Amit Sharma, an Sg2 consultant. Web-based PACS have decentralized imaging, in the process making images available outside the radiology department to referring physicians. As imaging becomes more and more integrated with the network—including cardiology and pathology systems that produce their own digital images—PACS will become the central point for storing and managing all the pictures generated anywhere in the hospital. Those sources include the cardiac catheterization lab, which produces video, ECG and blood-pressure data, as well as surgery, which produces planning data and CT and MR images signals from surgical guidance monitors.

"Suddenly that network is way underpowered," says Farr.

Perhaps a sign that solutions to the problem may lie outside the hospital walls can be found in new business models for radiology groups that are leveraging the fact they can read images from anywhere in the world. NightHawk is such an example of a startup that operates radiology reading stations in Australia and Europe to serve hospital night shifts. The company is going public. "A sign," says Sharma, "that this business is growing."

An *e*ICU® center opening near you

A near-perfect example of the trend may be *e*ICU® technology, which provides a centralized site for scarce intensivists to remotely monitor ICU patients using integrated high-definition video and data feeds from critical-care monitors. Such data supports a collaborative effort between the *e*ICU and ICU care teams in providing proactive patient care. The *e*ICU® program is a gee-whiz combination of IT and biomed, but its real significance lies in the way it changes care delivery.

Bill Super, VP & CTO, VISICU, Baltimore

"The technology is only enabling, so it's really about clinical process transformation," says Bill Super, VP and CTO at VISICU, Inc. a Baltimore-based firm that makes the *e*ICU® system. It uses a hub-and-spoke model that gathers data about ICU patients from multiple, disparate sources including ADT, lab results, medication orders, and continuous bedside vital-sign information and combines it to help develop and administer the patient's care plan. Using evidence-based-medicine algorithms and clinician-set parameters, it parses patient data in real-time to identify incipient clinical events—if the patient is taking a turn for the worse—and alerts clinicians before adverse events develop.

"It's all about getting ahead of the curve to deliver preventive medicine as opposed to reactive care," says Super. Besides the quantification component, the *e*ICU® program provides visual sources of information via high-quality video and audio contact with the patient and/or bedside

As imaging becomes more and more integrated with the network—including cardiology and pathology systems that produce their own digital images—PACS will become the central point for storing and managing all the pictures generated anywhere in the hospital.

care giver, which is always pre-announced and never recorded to protect privacy. Besides making it possible to virtually visit patients on the hour, the video component acts as a "workaround" for biomedical devices that do not provide data feeds to the core clinical system. For example, until ventilator data can be interfaced with the *e*ICU® system in early 2006, intensivists will continue to train the camera on the patient to observe breathing patterns and also view the ventilator device itself. That goes for a handful of other in-room devices as well.

"We'll be able to use that workaround until such time as standards for connectivity are widely embraced and deployed," Super says.

In the meantime, the increasing flow of information from biomedical devices like urimeters, ventilators and infusion pumps into the IT stream has spawned companies who take that raw data output and convert it into HL7 format for use by point-of-care clinical systems such as VISICU.

"The lines are blurring between biomed and IT because of applications like the *e*ICU® program as we evolve in the industry to care that is preemptive and not so reactive. To do that, systems have to be standards-based and open in terms of their interoperability," says Super.

Like reading stock-market trends

William F. Bria, MD, president of the Association of Medical Directors of Information Systems (AMDIS) and associate professor of medicine at the University of Michigan, Ann Arbor, says, "The evolution of IT into IV pumps, monitors and other critical-care devices is what has enabled companies like VISICU to become a reality. People want virtual review just like the stock market. The notion of having blood pressure and other physiological parameters instantly available is only increasing."

William F. Bria, MD, president, AMDIS, Ann Arbor, Mich.

Bria, who is also medical director for clinical information systems at the University of Michigan, says the biggest question is "how we integrate that to make better decision support. You can describe that environment but you can't see it yet. The fact that people want more and more information begs the question as to how you present that data and convert it from huge data streams first into understandable information and then into actionable information. Some of the best thinking today is addressing those questions."

He cautions that the task requiring the most lead time is developing the software rules for best clinical practices that constitute actionable information. "You need well-designed studies to establish that a particular approach is not only feasible but is as good or better than a clinician's best judgment," says Bria.

As this change takes place in healthcare, it's inevitable that clinicians—physicians and nurses—will become the heads of IT because only they will be able to make final decisions on use of all the converging electronic information. "The entire network becomes another medical instrument and the medical content becomes the deci-

"The entire network becomes another medical instrument and the medical content becomes the decision-support systems."

sion-support systems. The latter are just in their infancy," Bria says, adding that "in the future if you don't use a computer it will be like you don't use a stethoscope."

To that end, the University of Michigan has just completed design of a brand new five-year curriculum for a combined MD and Masters' of Information degree.

That will come as welcome news to Trinity's Kini, who sees convergence resulting in a new, clinically-centered organization—not IT or biomed gobbling up the other. At its foundation will be intelligence characterized by decision support and knowledge management—and it will require a new kind of knowledge worker. "That's one reason it won't go as fast as you think. There's a crying need for newer competencies. Now we need this new combined human being," says Kini, who believes the CMIO is as critical as the CIO in the new model.

Making sense for the clinician

Leading clinical IS vendors are keeping close eye on the explosion of IT-enabled devices.

Cliff Illig, vice chairman & co-founder, Cerner, Kansas City, Mo.

"We'll see more and more portable wireless devices," says Cliff Illig, vice chairman and co-founder of Cerner Corp. "There's a need to attach to them, a need to transmit their data, but there's also the need for a comprehensive data model for the individual patient. Most of the world thinks if you just hook things up all good things will happen. The real good stuff happens when you take all that data and make sense of it for the clinician," he says.

Historically, two categories of biomedical devices have existed, according to Charles Fox, RN, Cerner's director of medical device strategy: Devices like patient monitors and anesthesia devices that connected directly to the patient but were not interfaced with the core clinical IS; and ICUs with fixed connectivity that was lost as soon as the patient was moved.

Under either scenario, clinicians had to validate the data they wanted by manually retrieving data most relevant to them and posting it to the EHR. "It was great for record-keeping but not for decision-making in real-time," says Fox, adding that the need today is to receive the data in real-time and make the system smart enough to sort it out in terms of relevance. "We're getting to the point where we can use algorithms to decide what the significant data is," he says.

If, for example, a stream of data notes that a certain factor has dropped but that the heart is still beating normally, it's a relatively easy job for an algorithm to decide the patient is ok.

Factoring in time and frequency

Doug McNair, MD, PhD, Cerner's senior VP for clinical research, says the goal of such systems is not just to react but to assess leading indicators based on either *time series*, which econometricians have been using since the 1970s to analyze stock-market trading, or *frequency*, which manufacturing industries have used for years in process control. "These are relatively novel in healthcare. It's still relatively unusual for clinical people to anticipate events. We'd very much like to have better analytics to head things off at the pass," says McNair.

The University of Michigan has just completed design of a brand new five-year curriculum for a combined MD and Masters' of Information degree.

"We're getting to the point where we can use algorithms to decide what the significant data is."

Underlying this new vision is the realization that looking at a single parameter over time is of little value in terms of predicting clinical events. Multivariate analysis—in which clinical parameters are evaluated relative to each other—is critical. "Event-stream processing" is the term Fox uses to describe such multivariate analysis of dense data in real time. The challenge is then to package that capability with a graphical user interface (GUI) for easy navigation by clinicians.

"More and more devices are being connected *and* becoming wireless so they can move with the patient," says McNair. "If you're a clinician and being bombarded with data from all these sources, you can be very quickly overloaded. The trend is toward even more data from even more devices," he says, which places more burden on the clinical IS to analyze it—and more value in using algorithms. Cerner expects to release such functionality in 2006.

"The change that's occurred," says McNair, "is that in the past most devices produced information; devices coming out today are interactive: you can request information from them and set parameters via software on a handheld device." The company has unveiled a product called Cerner CareGuard™ that allows such remote programming of infusion devices via a portable wireless device. The goal is to expand the interactive feature to other biomedical devices.

McNair says the IT/biomed convergence should shed light on biomedical engineers as the unsung heroes of healthcare, and that collaboration with them is critical. "If biomeds and CIOs don't work together, polarization will occur," he says.

The same goes for medical-device makers.

"Device manufacturers tend to be held at arm's length rather than be full-fledged partners. With the dramatic increase in interfaces with devices, there's the possibility of more collaboration between providers and manufacturers," he says. For one thing, manufacturers maintain registries of devices and can help schedule maintenance and replacement in the device lifecycle, especially of implantable, programmable, telemetry-based devices, notes McNair, who has held executive positions at artificial-heart maker Abiomed and other medical device manufacturers.

Conclusion

Sg2's Woodson predicts that the convergence will eventually lead to biomed becoming a node on the network, "A living, breathing part rather than just the group in the basement that fixes things. They will become part of the IT department as IT becomes many, many things within the hospital, including clinicians within IT, biomed tracking and managing the equipment piece as manufacturers put chips in all their devices. Every department will have an IT liaison," says Woodson. He also expects the ASP model for IT to become more prevalent as more mainstream hospitals need to invest in IT to become part of the "grid" of regional health information infrastructures.

"It scares me," says Cerner's Fox. I'm very concerned and trying to design systems so data is manageable, so they have the potential of improving quality of care and increasing efficiency."

Scottsdale Institute Conferences 2006/07

Spring Conference 2006
"Physician Leadership in Information Technology"
April 6-8, 2006
Camelback Inn
Scottsdale, Ariz.

Fall Conference 2006
"Information Technology/Quality Link"
Sept. 28-29, 2006
New York-Presbyterian Health System
New York, N.Y.

Spring Conference 2007
April 25-27, 2007
Camelback Inn,
Scottsdale, Ariz.

REGISTER SOON

SPRING CONFERENCE 2006

"Physician Leadership in Information Technology"

April 6-8, 2006
Camelback Inn,
Scottsdale, Ariz.