Mining for Answers from Big Data

For healthcare facilities, the promise of data depends entirely on the technologies surrounding patient care—which puts HTM departments everywhere in a very important place.

Chris Hayhurst
If you ever find yourself in Baltimore, MD, take a few minutes to make your way to 1800 Orleans Street, where, beneath a dizzying array of soaring glass, stunning color, and reflected light, you’ll find the tree-lined piazza and airport-style canopy that mark the main entrance to The Johns Hopkins Hospital. As the flagship facility of Johns Hopkins Medicine, a $7 billion “integrated global health enterprise” of medical education, biomedical research, and world-class clinical care, the hospital is—on its surface—an architectural marvel, perhaps the best example in the country of a healthcare institution long known for its cutting-edge services taking its vision of what care should look like and wearing it on its sleeve.

But forget about that. What makes Hopkins interesting, at least for biomeds, is inside, and it has nothing to do with the views across the harbor or the art installations that were part of the recent remodel. Go through that front door, past the sculptures, and, with some guidance, you’ll eventually bump into Maria Cvach, DNP, RN, CCRN, the hospital’s assistant director of nursing, clinical standards. And if you happen to be there on a Monday, you might even find her at her desk, where—in a room in the Billings Administration Building—there’s a good chance she’ll be reviewing a list of numbers neatly organized on an Excel spreadsheet. This review, Cvach explains, is part of her weekly routine, and for one major aspect of her job, it’s absolutely critical.

“This is where I get to see the actual data,” says Cvach, who heads Hopkins’ Alarms Management Committee, a group that has worked since 2006 to reduce the potential hazards and workflow disruptions associated with unnecessary and overly active device alarms. That data, she explains, is sent to her via e-mail from the Clinical Engineering Department. “And it gives me everything I need to know: Overall numbers, like alarms per bed per day, and duration of each of those alarms; but also unit-specific data, with individual sheets that separate the alarms” according to priority type, such as high, medium, low, and technical. “Every unit is unique,” she says. “The numbers coming out of the emergency department,” for example, are “much different than the telemetry unit,” which in turn look nothing like the alarm-related data from the facility’s neonatal intensive care unit. Those differences, Cvach notes, are the main reason this information is useful. “When a unit asks me to help them with [alarm-related] interventions, I start with their data. I mean, you can read the literature and learn a lot about ways you can reduce alarms, but unless you have solid numbers—numbers that really tell the story of what’s happening in that specific unit, and even at the bed level in that unit—you can’t possibly know where to begin.” Thanks to that weekly set of spreadsheets e-mailed from CE, she says, “I don’t have to guess at what we should do. We have everything right there in front of us.”

Big Potential
That data can be used to find answers is of course nothing new. Researchers, businesses, institutions—entire industries for that matter—have looked to the numbers from whatever niche they’re in for as long as they’ve been able to count. What’s different now is the sheer volume of data being produced, and the increasing ease, thanks to steady improvements in a wide array of technologies, in which that data can be collected, organized, analyzed, and put to use. Needless to say, 21st-century data looks nothing like the data that was available back in 1889, when The Johns Hopkins Hospital first opened for business. In fact, it barely resembles the data on hand from 2009, three years after Cvach and her colleagues began looking at alarms and three years before “big data,” as it’s now well known, made what was

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likely its first major public appearance at the 2012 World Economic Forum in Davos, Switzerland. (Also in 2012: The U.S. government unveiled its so-called “Big Data Research and Development Initiative,” pledging $200 million to fund programs that promised to “improve the tools and techniques needed to access, organize, and glean discoveries from huge volumes of digital data.”) Today’s most promising data—“big data”—is the data of systems, that enormous mass of digital information collectively held between dozens or hundreds or even millions of devices. Question its value? Consider how retail, for example, long ago turned to data analytics to streamline business operations, refine their sales techniques, target customers with the products they’re most likely to spend money on, and gather other actionable—and highly profitable—information. Yes, “big data” has become an overused and oft-scorned buzz phrase; but for big chain stores, the banking industry, military defense, and a host of other sectors, it has also become a real game-changer.

And now, experts say, with the average hospital expected to produce more than 665 terabytes of data this year alone, it’s doing the same for healthcare. In fact, notes a 2013 report by the global management consulting firm McKinsey & Company, despite challenges related to both technology and privacy, “an era of open information” in the industry is finally underway, as digitized data, primarily accessed through electronic health records, become increasingly “usable, searchable, and actionable by the healthcare sector as a whole.” McKinsey & Co. calls this trend improved “data liquidity,” and offers a list of persistent problems—from variability in healthcare quality, to shifts in reimbursement, to skyrocketing medical spending—that might be resolved because of it. “Many innovative companies,” the report notes, “are building applications and analytical tools that help patients, physicians, and other healthcare stakeholders identify value and opportunities.” As these tools become more sophisticated, it continues, “the traditional obstacles to compiling, storing, and sharing information securely” are gradually being overcome.

Indeed, the McKinsey report says, what the healthcare sector is verging on today is nothing short of a “big data revolution”—a technological shift with the potential to change almost every aspect of the industry. Which leads to some obvious questions: As the regulatory, clinical, financial, supply-chain, research, and other healthcare-related data streams grow bigger, what does this mean for healthcare technology management? That is, as hospital systems and medical technologies are increasingly designed to collect and store patient and healthcare data, what role will HTM professionals play in ensuring that information is not only secure, but easy to access, organize, manipulate, and understand? Will the ability to maximize the potential of big data depend on the devices in play? On making sure, during purchasing, that every device placed in every unit is functional and useful not only on its own, but also as part of the larger enterprise system? And what about those obstacles?

Like the incompatible EHR systems in different facilities, which can make it cumbersome or even impossible to send digital records from one facility to the next. Or the issue of privacy and security, and the increased risk of unauthorized access to patient records as the potential payoff for a successful hack, for example, grows larger and larger. Smaller facilities might lack the budget they would need to take full advantage of the data they might access. And larger facilities, awash in data and obsessed with analytics, could lose sight of the fact that these are individual patients walking through their doors, with personal needs and specific concerns. Where can HTM help?

“Procurement is key,” says Carolyn McGregor, PhD, Canada Research Chair in Health Informatics and professor at the University of Ontario Institute of Technology (UOIT). “But so is network bandwidth. And data storage and retention. And medical device connectivity.” To get a sense of the challenge ahead, McGregor says, consider the typical infusion pump, which is designed to hold the data it collects not for the healthcare enterprise, but for the manufacturer. Ensuring your facility has
access to that data—whether it’s infusion-pump information or the digital stream from any patient-connected device—is critical. “If you’re trying to improve clinical care,” to better understand, for example, the impact of those drugs that are administered through these pumps, “you have to be able to see things in real time,” McGregor says.

There are, of course, numerous data-focused firms attempting to help healthcare facilities do just that. Informatica Corporation, for example, which bills itself as “the world’s number one independent provider of data integration software,” boasts that at least one of its clients, thanks to their services, “is now using clinical and administrative data in a way they were previously unable to do.” Clinicians and business leaders at CHRISTUS Health in Texas, the company notes, now “have immediate access to all relevant data in any facility across the system,” allowing them to “make decisions about patient care and operational efficiency that impact lives and save money.

According to Informatica, CHRISTUS achieved this by creating an “enterprise data warehouse with a healthcare data model capable of accommodating all patient information,” and by incorporating enterprise-information-management tools that “enable data to be efficiently captured, normalized and interrogated.” Which leads us to a realm that many believe could be big data’s biggest benefit: its impact on healthcare analytics, or the use of patients’ demographic details, past diagnoses, and other medical data to predict future health risks, healthcare needs, and potential costs. Also known as predictive analytics, the technique can be used to help identify those patients most likely to face medical complications, for example, allowing healthcare providers to better implement proactive measures that might reduce those risks. In the end, it’s about saving lives; but it’s also about saving time, money, and resources.

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and zeros captured by monitors, nurse-call systems, and wireless devices into something that approximates an understandable snapshot of what is alarming and when. “But I’m a nurse,” notes Cvach. “So I really don’t have to worry about the software, or about how it’s done. All I know is that I get the data. And clinical engineering—they’re the ones that give it to me.”

A Small Piece of the Puzzle
“To do this right,” says Andrew Currie, Hopkins’ director of clinical engineering, “you really need someone like John Chang.” Chang, Currie explains, is the department’s resident computer-programming expert, and the one tasked with the job of “massaging the data so that we can put it on a server and report on it.” Currie, who is on the alarm-management committee with Cvach, says that when it comes to “big data,” his department, and the work it does, “is just a small piece in this very big and important puzzle.”
Their job, he notes, involves “collecting data from disparate medical equipment systems” and then packaging that information so that clinicians and administrators like Cvach can use it for quality-improvement projects. (In terms of alarm review, says Currie, they produce both seven-day short-term reports and longer-term quarterly reports in order to provide not only “near-real-time feedback,” but also “a historical review of trends.”) The middleware is key, but so too are the servers, which he describes as “pretty heavy,” and the “ability to manipulate those servers and their operating-system software to pull everything together.”

Going forward, Currie says, “whenever we look at purchasing new medical equipment and systems,” whether it’s alarm-related or not, “we’ll be looking at the data” associated with that equipment and “really considering its interfacing capabilities and interoperability.” Today, he says, “the data is almost as important as the hardware itself and can really pay dividends” when it leads to safety improvements or informs facility leadership as they consider quality-improvement projects. At Hopkins, Currie adds, they’re fortunate to have the resources to work around the hurdles that often prevent smaller facilities from fully leveraging the power of data. “None of this is possible unless you have the funding and expertise to do it. If you don’t have middleware software, which is quite expensive, or you don’t have that person who can sit in the middle and take the inputs and outputs and direct them to the right places, unlocking the data” becomes just too difficult.

Rebecca Gandillon, a biomedical engineer at VA St. Louis Health Care System in Missouri, agrees. “I think HTM needs to speak up during purchase decisions so that the devices we end up with are able to collect the necessary data.” — Rebecca Gandillon, a biomedical engineer at VA St. Louis Health Care System in Missouri

Gandillon, who describes herself as a “data geek,” says she’s been with the VA for almost four years, and during that time much of her work has involved HTM data analytics—finding ways, for example, to better track work orders and otherwise manage the ins and outs of their day-to-day jobs. “All of this data from the VA was being extracted into this national data warehouse, but at that time not much was being done with it from an HTM perspective,” she explains. “So that’s where I decided to focus my efforts—putting that data to work.”

Since then, Gandillon says, her mantra has been, “we need to have access to this data and we need to be able to get actionable knowledge out of it.” And the work is paying off. “Within the VA, it’s enabled us to more easily visualize, for example, if technicians are tracking their time appropriately. That wasn’t something we were readily able to see previously.” Nationally, meanwhile, analysis of CT scan data allows the VA to determine how often veterans receive CT scans outside of the VA network instead of at a VA facility. Knowing that, she explains, “could enable us to make more informed decisions about where we’re placing these pieces of major medical equipment. We can easily pick out geographic hot-spots for CT scans done outside of the VA and attempt to plan our equipment placement based on that data so that veterans don’t have to travel as far to take care of their imaging needs.” Without the data, adds Gandillon, placement of major medical equipment runs the risk of being determined by guesswork or convenience. But, “leveraging this data can lead to an improvement in patient care.”

A New Device-Management Paradigm

“Big data,” notes UOIT’s Carolyn McGregor, is given that name “not just because it has lots of data, but because it has particular characteristics,” including volume (substantial size),
velocity (the speed by which it arrives, i.e. every second or every minute), and variety. “Essentially, though, ‘big data’ is sensor data, streaming data,” and it’s made possible thanks to an “explosion of all these different types of devices that are now able to communicate with each other” and with other systems. “It's like the ‘internet of things,’” she adds, and it's a veritable goldmine for anyone with the resources to dig into it.

In her work, McGregor says, she's exploring sensor readings to look at “every breath, every heartbeat, all of the signaling data that we have”—a traditional electrocardiogram can take a thousand readings per second, she notes—“and trying to learn what it can tell us about when a patient is becoming unwell,” to look for “subtle nuances that might be indicators for onset of an illness.” It’s research that has led her to see medical devices in a new light, she says. “You can no longer assume that a device is just going to be used to display information at the bedside.” Instead, as an HTM professional, “you have to be thinking” in terms of “real-time clinical decision support”—about how the data this device is collecting can be processed in real time.” You should also be thinking long-term, McGregor adds. “That is, how am I going to ensure that the data can be stored and then used retrospectively for other studies? And how am I going to help people understand the structure of the data that’s coming from this device? It’s a very different role than just understanding the integrity of the devices at a patient’s bedside and ensuring they’re displaying information.”

Andrew Rosenberg, MD, chief medical information officer (CMIO) for the University of Michigan Health System and director of the UMHS Office of Clinical Informatics, agrees. “We need to become much better organized around how we produce, manage, distribute, and analyze our data,” he says. “And one of the ways we can do that is by improving our ability to harness sensor data,” whether it’s from facility-based physiologic monitors, ventilators, and smart pumps or from wearable sensors offering constant streams of clinically relevant, real-time information, even after a patient has been discharged. At Michigan, Rosenberg says, they’re exploring how they can use “big-data assets to find answers” to an endless variety of medical questions, from how to best treat patients with acute and critical illness, to finding molecular targets for cancer and other chronic diseases. As part of that, he explains, a major goal is to develop a system that allows “basic discovery research, especially where the work is highly computational,” as in pharmacogenomics, to be “repurposed across the entire enterprise, so that data that are discovered or produced by

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**Tips for Making Sense of Big Data**

1. **Figure out what you want.** Collecting lots of data isn't very helpful unless you know what you want to do with that data.

2. **Be collaborative.** Understanding the needs of other departments will help you realize the full value of big data.

3. **Keep your data needs front and center during the purchasing process.** Can the technology collect, store, and organize the data as you want?

4. **Know the law.** Some data, especially that dealing with patient information, is protected by federal and state law. Make sure your technology is secure.

5. **Start small.** Look for high-value opportunities in analyzing smaller data sets and build on your successes.

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one group can be easily shared with other groups” that might also benefit from that knowledge. HTM’s role in this brave new world is nothing short of critical, Rosenberg says. “Think about it. All these devices they’ve traditionally managed, and especially the new ones we’re seeing now, are the single biggest source of truly big data today. Device data”—especially as those devices are further connected into the healthcare ecosystem—“is big data.” HTM professionals will increasingly be involved in “all aspects of getting the data from those devices” into systems (like data warehouses) where it can be carefully analyzed, says Rosenberg. So they’ll need to know how to do so properly. “If it’s not done right, then it just becomes a huge amount of noise.”

More Than ‘Just Devices’

When you look at devices through the lens of big data, Rosenberg adds, “you can’t think of them as just devices anymore. You have to think of [each device] as one of the major nodes of data” in the larger enterprise system. “So, it’s no longer, ‘We need a new fleet of physiologic monitors.’ It should be, ‘We need another source of truly actionable data that can be used for all sorts of things,’” whether it’s for the bedside clinician who is working in the OR “who just needs to look up at the monitor and know that it works reliably, 24-7, or it’s the CMIO who plans to use the data that’s pouring out of those monitors for dozens of projects.”

There was a time, agrees Alan Gresch, chair of the Healthcare Technology Leadership Committee at AAMI and VP of client success at Mainspring Healthcare Solutions in Waltham, MA, “when our data was our data. And you could make up your own rules about how that data should be captured and handled with little thought” as to how it might plug into what others were doing. “My feeling now is those days are gone.” For instance, consider the implications that data has for capital planning: “Consistently and accurately capturing your service costs and parts expenses,” and maintaining an accurate inventory that allows you to track the estimated lifespan of each device, for example, “is critical,” Gresch says. Without that information, “you have no hope of generating the kind of report you would need” to make informed purchasing decisions. Or another example, in the supply-chain realm: “Talk to any healthcare supply-chain executive about what his biggest challenge is relative to his supply expense, and more often than not what you’ll hear is it’s physician-preference items.” Doctors, that is, claiming that if they don’t have a particular device, their patients will be put at risk. “If you have a mechanism in place to do cost-per-procedure analytics, versus patient outcomes, that’s a really good way to address those arguments,” Gresch says. “If you can say, ‘Look, Dr. Smith, most of the other physicians are using this, but you’re using this, and your cost per procedure is 25 percent higher than theirs with no difference in outcomes’—their argument doesn’t hold water.”

And finally, adds Gresch: the fact that successful new-device integration is now highly dependent on careful collection of “core data” prior to installation. “It used to be you just needed things like description, model number, serial number. Well, now you’ve got other things in play, like IP addresses and versions of software.” In earlier work as the head of clinical engineering for a large healthcare system, Gresch says, “we were intimately involved in the integration and implementation of smart pumps.” The process involved a multidisciplinary team that included clinical engineering, IT, nursing, and

The Role of HTM in Big Data

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Gresch also notes that HTM has an important role to play when it comes to privacy concerns, “especially considering the potential costs associated with violating the HITECH Act.” When you’re collecting data, he says, “how you get it really matters. You have to make sure you’re doing so in a way that is secure and HIPAA compliant.”
pharmacy. “Not only did we work hand in hand with them to make sure the profiles and formularies were correctly programmed into the pumps, but we were also part of the team that met on a monthly basis to review the data that was collected” from each of those pumps.

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**Big Future**

That things are no longer the way they’ve been is a recurring theme in the world of big data, where new headlines touting record-level terabytes are almost as common as shifts in the weather. What this means for HTM professionals is a matter of debate, but there does seem to be some consensus. Facility size, for example, and resources, will in large part determine just how fully any given healthcare enterprise can leverage big data’s potential. Many healthcare organizations will decide that having dedicated informatics professionals on staff makes financial sense. Others will determine the more practical approach is to outsource the data work to third-party firms. Ultimately, those facilities that do turn to high-volume, high-velocity, high-variability data for answers will want demonstrable returns—better healthcare outcomes, better earnings and financial savings—on their costly investments. And to ensure the data they’re using is “clean,” easily accessible, and accurate, they’ll likely turn to their HTM department. Again: Procurement. Installation. Interoperability. Reliable storage and retrieval capabilities.

Today more than ever, Gresch says, healthcare organizations are “spending a lot of time and money looking very closely at the various ways that big data might impact their bottom line.” To avoid Medicare penalties associated with the Affordable Care Act, for example, many facilities are using big data in an attempt to minimize readmissions. The same goes for HAIs, or hospital-acquired infections. The data, through predictive analytics, is giving such facilities answers, he notes, and they’re adjusting their practices accordingly.

In healthcare, says Eugene Kolker, PhD, chief data officer at Seattle Children’s Hospital and the head of the facility’s in-house data analytics team (team mantra: “You pick the problem. We’ll help you solve it.”), the implications of big data, while they’re “80 percent similar to any other industry,” are also very different. “There are vastly different challenges,” he notes. “It’s not like the data you can get to improve a customer’s experience with an appliance, or a car. In healthcare we’re talking about that patient standing in front of us. We’re talking about people’s lives.” In his work at Children’s, Kolker says, “we’re trying to leverage data as a strategic institutional asset, to transform data into information we can use to make informed decisions.” This could be as simple as how many beds the facility should add over the next five or ten years. Or it could involve a purchasing decision, “like whether it makes sense to buy some off-the-shelf tool.” Or, more critically, it could entail the creation of a data-based model that clinicians can use to immediately determine if a child is medically complex—and if she is, what the next step should be. “The data can almost always tell us something,” says Kolker.

Which is why, when you think about it, people like Mary Wills, a senior student in the Health Care Management program at the University of Alabama, Tuscaloosa, has her sights set on an eventual career in health informatics. Wills considers real-time analytics “the area to watch” as big data continues to gain steam. “It’s expensive, and very few facilities have the means to invest in it, but it allows a clinician to process information right there as they’re talking to their patient. That, in my opinion, is revolutionary.” For her, Wills says, “data matters because every decision you make directly impacts a patient, a person. So it’s extremely important that you use all the tools you have available to you to try to make the best and most educated decision you can.” Still, Wills
says, for data to truly live up to its promise—and to truly make a difference in healthcare—it’s clear to her that the industry has some work to do. “The biggest hurdle, I think, involves accepting the idea that health IT should no longer be a separate project or just something that you’re adding on, but instead should become an integral part of your facility and your overall strategic plan.” Once that happens, she says, “I can’t even begin to predict all of the advances that are going to be made.”

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Even as she’s been wrapping up her undergraduate degree, Wills says, she’s also been working with a firm in Birmingham that analyzes Medicare data to make strategic recommendations to healthcare facilities seeking to improve or streamline their operations. For one recent project, she developed a system that allows hospitals to compare their outcomes with those of their peers based on facility size, overall reimbursement levels, patient volume, and other factors. “And now it’s built into their report system,” she says, “so if they want to, they can automatically produce this report that compares them to their peers. I think of it as a great way for facilities to exchange ideas about best practices. If you see someone else doing extremely well in an area that you could use improvement in, you can talk to them about what they’re doing, and what works best.”

She wouldn’t have been able to develop that system if she didn’t have the data to do it, adds Wills; and the facilities now using it—they’d be stuck comparing themselves with competitors that look nothing like them. One day, she hopes, she’ll find herself working for one of those facilities, or perhaps in a consulting position where she is brought in “to analyze their data, see where their problems are, and find ways to address them.” And indeed, it’s easy to imagine her someday approaching that entrance to Johns Hopkins, its glass towers gleaming, with a briefcase in hand and the data at her fingertips. “Data,” says Wills, “is powerful. It really is.”