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Data Warehousing and Business Intelligence: Transforming the Organization

EXECUTIVE SUMMARY

As healthcare organizations become increasingly data-driven—especially with the impetus of looming pay-for-performance and public reporting of quality (see last month's Information Edge)—data warehouses, data marts and business analytics tools are becoming more and more critical to success. Leading health systems and health plans are spending significant resources to gather, extract and analyze the massive amounts of data required to compete and thrive in the era of information transparency.

In this issue of Information Edge we speak to data-warehouse experts at Northwestern Medical Faculty Foundation, New York City Health and Hospitals Corporation, Sentara Healthcare, Hewlett-Packard and UnitedHealthcare who have built or are building data warehouses and a culture to support them. We also highlight a recent Harvard Business Review article on what makes a successful analytics organization.

Data warehouses and data marts are useless without business-analytics tools to exploit the data. And for those tools to be of value requires sophisticated, well-trained analytics professionals and a supporting culture that respects measurement and testing in every aspect of operations. In the end, the familiar troika of people, process and technology must work together

to transform any organization into an analytics competitor.

Emerging market for clinical intelligence

Hewlett-Packard Company, a Scottsdale Institute sponsoring-partner, has targeted data warehouse-based business intelligence in healthcare for at least the last five years. "Clinical intelligence is an emerging, growing market," says Beverly Quarles, Solutions Director for HP's NonStop Enterprise and Open Source Division. "There's lots of energy in clinical intelligence in hospitals both large and small," she says, accelerated by the federal government's push in recent years for the EMR.

Says Jim Jones, HP's manager of healthcare solutions: "All of the initiatives we're seeing are driving toward capturing data from every location, which makes us data rich and knowledge poor." Data volumes are doubling every year, he says, driven by HIPAA regulations and technological advances like 64 and 128-slice CT scanners.

"Now that they've got the data, organizations are asking, 'Why don't we mine it?'" Jones notes. Also, those organizations are seeking ways to capitalize on their data-warehouse capabilities by selling data-storage and analytics services to smaller healthcare organizations that can't other-



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wise afford it. Physicians, for example, want to depersonalize patient data and sell it to pharmaceutical companies. "You're seeing providers get into that business and offering to share the revenues," says Jones.



Jim Jones, manager, healthcare solutions, HP



i n v e n t

"Over the last four years, as people have really begun to realize the impact of HIPAA requirements to save data for 20 to 30 years," he says, "the significance of saving, storing and managing ever larger amounts of data is hitting home. Now that they realize they have to save it, the epiphany of doing more with it in more ways is beginning to sink in. Also, with their need to track Bird Flu and West Nile, NIH and CDC not only need data—but now that more of it is electronically available—can and will negotiate to get more direct feeds from providers so they can be more responsive."

Acting like an enterprise

Quarles adds that integrated delivery systems have been collecting data for years in traditionally non-interoperable systems. Now that they're beginning to make that data meaningful with basic reporting, they're realizing they can use that data for supporting more ambitious efforts that bring in new revenue like clinical trials and grant applications. "It really depends on where the healthcare group has gotten the data. A lot start at a small level and grow: 'Now we're realizing we're an enterprise and we need to act like an enterprise,'" she says.



Beverly Quarles, solutions director, NonStop Enterprise and Open Source Division, HP



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"What we've seen when we talk to hospital groups is that a lot know merely how to do traditional reports. But as soon as they get even a

data mart in place they realize they can begin to ask questions—factors to improve quality and lower costs," says Quarles. Even if a health system has lots of analysts on staff, prior to a data warehouse they would spend a lot of time gathering data. Now they can spend time doing what they were hired to do in the first place: analyzing that data. That goes for end-users as well. Getting data in their hands, she says, eliminates the demand on the IT department to produce reports and allows them to concentrate on IT. "You start building efficiencies into the system as a result of the right people doing the right things at the right time," she says.

As the tools for data mining and analytics improve and the culture to support them grows, it forces more IT standardization, says Jones, but great strides have already been made. "People have historically looked at business intelligence as a massive undertaking, but new software has made it much more affordable," he says.

A different Chicago warehouse

It won't add to the existing architectural skyline, but an ambitious cross-institutional data warehouse is rising in Chicago that could enhance its healthcare profile. Leading this effort is Dale Sanders, CIO at the Northwestern Medical Faculty Foundation, a 600-physician multi-

specialty group associated with Northwestern Memorial Hospital and the Northwestern University Feinberg School of Medicine. He has been tasked as chief architect of a data warehouse and analytics infrastructure for use by the foundation, the hospital and the medical school.



Dale Sanders, CIO,
Northwestern Medical
Faculty Foundation,
Chicago



“We’re trying to function more and more as a single IS resource to the greater academic medical center,” says

Sanders, who is partnered closely on this project with his CIO-colleague, Tim Zoph, at Northwestern Memorial. Sanders founded the Healthcare Data Warehousing Foundation (www.hdwa.org) during an eight-year stint at Intermountain Healthcare as a way to facilitate data warehousing as a specialty in healthcare. “The data warehouse has taken off like wildfire in healthcare; it’s a self-sustaining movement. But what I saw was a lot of people making very expensive investments in data warehouses without adequate experience, and the mistakes were costly,” he says.

After eight years experience as a captain and IS engineer in the Air Force followed by another eight years in corporate-IT consulting gigs with the likes of Intel, Motorola and IBM, Sanders was ready to bring the gospel of data warehousing to healthcare. “It was relatively easy to build successful data warehouses in healthcare because I’d made my mistakes elsewhere,” he says.

Today, the objective at Northwestern is to build an enterprise-wide data warehouse with data from each of the three entities and some external sources—and then add analytic value to it from a structural, vocabulary and data-type perspective so researchers and process-improvement gurus can access it across all the organizations.

Like a library

If the data warehouse is analogous to a library, then data marts are specific subject areas within the book stacks, says Sanders. Northwestern is building data marts, for example, focused on Epic ambulatory care information, IDX and Medical Manager practice management information, Cerner PowerChart and hospital case-mix data.

Extending the library analogy, a content indexing system provides the data warehouse’s equivalent of the Dewey decimal system. “That’s critical,” notes Sanders. “We make it easy to browse the contents of the data warehouse and find the information you’re looking for. Then, imagine the key words that link those books together. We accommodate everything that happened in a patient’s Northwestern care experience, including costs, outcomes and past history.”

A glimpse of the future lies in a genetics data mart under development in conjunction with the school of medicine. Begun in October 2002, the NUGene project involves collecting DNA samples from patients who enter the Northwestern healthcare environment, including Evanston Northwestern Hospital. “The whole idea is to collect DNA, store the genetic data in the data warehouse and blend it over time with clinical outcomes data to better understand the role genes play in the development and treatment of diseases; providing truly personalized medicine,” says Sanders.

What’s New? continued

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April 18

Medication Reconciliation: Insights on Advanced Practices

- Melinda Muller, MD, FACP, medical director, Legacy Clinics, Portland, Ore.
- Kristine Gleason, RPh, research pharmacist coordinator, Patient Safety Team, Northwestern Memorial Hospital, Chicago
- Gary A. Noskin, MD, associate professor of medicine, Northwestern University Feinberg School of Medicine and medical director, Healthcare Epidemiology and Quality, Chicago
- David W. Baker, MD, MPH, associate professor of medicine, chief of the division, General Internal Medicine, associate director, Institute for Healthcare Studies, Northwestern University Feinberg School, Chicago
- Judy Davis, RN, systems analyst III, Nebraska Methodist Hospital, Omaha
- Paula Danekas, PharmD, pharmacy clinical coordinator, Nebraska Methodist Hospital, Omaha
- R. Michael Kroeger, MD, director, Medical Informatics, Nebraska Methodist Hospital, Omaha

more events on next page

About 6,000 patients have contributed genetic data, and a study linking aneurysms and DNA information in the gene bank is underway, but the project is still a few years away from applicability to bedside care because the infrastructure for links between systems is a work in progress. Still, Sanders is elated at the strides the Northwestern entities have made in such a short time. Just since Nov. 2, 2005, the small team of 1.5 people has completed data marts for Epic and IDX as well as a meta-data (metadata is data about the data) repository which acts as a “card catalog” for the data warehouse. The first disease-specific registries constructed from these data marts will soon appear.

“It’s a case study in how fast you can progress if you reuse knowledge and experience, and have good people. It’s the fastest, healthiest progress I’ve seen on a data warehouse in my career,” he says. While the pace has accelerated, the emphasis has also shifted: Much of the data-warehouse work he was involved in previously was focused on compliance and continuous quality improvement reporting. At Northwestern, those are still important areas, but research is now a big influence, too.

Now, from New York

Four years ago New York City Health and Hospitals Corporation launched development of a clinical data warehouse using an Oracle database and data-extraction technology from Per Se (since acquired by Misys) that today houses 70% of its EMR. Seven clinical data repositories contain a core set of patient-centered data concerning diagnoses, allergies, all laboratory tests and results, prescriptions and medication orders. They also contain patient

assessments in which the data is codified—smoking cessation, for example—as in a check-box format.



How NYC takes care of its own.



**Lou Capponi, MD,
CMIO, NYCHHC**

“We don’t currently support data mining for free text,” says Lou Capponi, MD, CMIO at NYCHHC. That is likely to change as the clinical data warehouse progresses. The organization is developing

data sets that identify primary care providers (PCPs) and support auditing capability for follow-up monitoring, for example, of a patient’s abnormal labs.

NYCHHC has trained more than 120 end users with an IT and clinical background for the data warehouse. Capponi says the data warehouse will provide four major contributions:

- 1) A core data set for patient registries, for chronic illness management;
- 2) A core data set for a pay-for-performance initiative;
- 3) Ad hoc reports to answer individual questions of “power users” such as the usage of blood platelets or ordering of tests with certain diagnoses;
- 4) Standardized reporting to enable comparisons across the enterprise for quality assurance reports or to build standardized reports on the roll-out of new functionality like EHR implementation.

‘A team sport’

With eleven hospitals that act as hubs throughout the boroughs of New York,

215,000 inpatient discharges and 5 million ambulatory care encounters each year, “It’s not easy identifying PCPs,” says Capponi. “We’ll use the data warehouse to monitor the assignment of PCPs” as well as to monitor patients with hypertension and/or diabetes. The information will become part of formal QA organizational reports this year.

That QA reporting is confidential, given only to the QA committee on the board of trustees. Individual departments, however, can develop data on their patients, comparative data on performance and utilization. “Most of our physicians are either salaried or contracted so the audience is comprised of facilities, then they filter the information down to the providers. They work collaboratively. Chronic disease management is a team sport—it’s less about the individual clinician than the team,” says Capponi.

NYCHHC’s data warehouse is a key tool to activating the six components of the Improving Chronic Illness Care (ICIC)¹ model:

- 1) Community—Health systems must take advantage of community-based programs that enhance chronic illness care;
- 2) Health System—Better care means not only identifying best practices, but creating policies and organizations that allow such policies to flourish;
- 3) Self-Management Support—Successful self-management programs rely on a collaborative process between patients and providers;

- 4) Delivery System Design—Effective chronic illness management requires more than simply adding interventions to an existing system focused on acute care. Basic changes in delivery system design are required for effective care management;
- 5) Decision Support—Practice teams require evidence-based protocols to guide their decisions about patient care;
- 6) Clinical Information Systems—Effective information systems can measure the success of treatments across populations and deliver reminders about care for individuals.

Those elements support productive interactions between the “Informed, Activated Patient” and the “Prepared, Proactive Team.”

“We’ve been working with ICIC on a collaborative model and that’s been a driving force for completion of the data warehouse and data-mining tools,” says Capponi, adding that a focus on pay for performance has also reinforced that goal.

Interdisciplinary effort

NYCHHC currently has 30,000 diabetes patients within the registry, “so, we’re really using the registry to actively monitor patients. Our goal is to enter all 52,000 active diabetics into the system by the end of the year,” he says. The registry application enables the clinical team to monitor factors such as blood sugar, blood pressure and cholesterol—plus how well patients are meeting goals of self management.

Upcoming Events continued

April 24

Enterprise Deployment of SNOMED at Kaiser

- Robert H. Dolin, MD, Kaiser Permanente, HL7 Board Member and Co-chair of the HL7 Structured Documents Technical, Oakland, Calif.

April 26

Options for Hosting Community IT Solutions

- Keith MacDonald, research director, FCG Emerging Practices, Boston

May 4

A Comparison of Effectiveness in Reducing ADE’s: CPOE, Bar Coding, and Smart Pumps

- Douglas Thompson, senior manager, FCG, Long Beach, Calif.

June 1

Go Lives or Saved Lives? Aligning IT Incentive Comp with Clinical Outcomes

- Jonathan Manis, CIO, Provena Health, Frankfort, Ill.

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¹ ICIC is a national program supported by the Robert Wood Johnson Foundation with direction and technical assistance provided by Group Health Cooperative’s MacColl Institute for Healthcare Innovation. More information on the ICIC model is available at www.improvingchroniccare.org.

Predictive modeling broadly speaking is a toolset to help stratify populations according to risk. When applied to health management it offers an opportunity to identify not just what's going to happen but early enough to intervene in an appropriate manner before an adverse occurrence.

“It’s really been an organization-wide effort, leveraging multiple major areas of medical and professional affairs,” including 17 interdisciplinary teams and 30 teams of primary care providers, says Capponi. While the organization has not yet implemented patient portals, this year the focus is on building other data warehouse applications and inputting patients into the registry. “We want to work another full year to maximize utilization,” he says.

The effort should be well worth it.

“We should see changes in outcomes. In pilot collaboratives we’ve anecdotally seen improvements in outcomes,” Capponi says. In the first year, a group of 1,187 diabetics improved cholesterol outcomes 35% to 63% and blood pressure control 31% to 57%. Also, an impressive 72% of the population received management planning.

“We’ve invested a lot in terms of time, energy and money, but everything points to dramatic improvements in quality and efficiency,” says Capponi.

Predictive modeling for a health plan

Minneapolis-based UnitedHealthcare, a Scottsdale Institute sponsoring partner, has been using data warehouses and data marts to support predictive modeling since the late 1990s. “Predictive modeling is a featured part of our identification of consumers and an evolving area of continuous improvement,” notes Harlan Levine, MD, chief clinical officer at UnitedHealth Group’s specialized health solutions unit.

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**Harlan Levine, MD,
CMO, Specialized
Health Solutions unit,
UHC, Minneapolis**

Levine cautions there is no single statistical approach that meets all needs. Whether it’s medical management, underwriting, physician or member profiling, the predictive modeling approach will be different. This is one of the reasons

why a predictive modeling tool, ImpactPro (offered by Ingenix, a member of the UnitedHealth Group’s family of companies) is receiving a lot of attention these days. It combines multiple risk grouper applications with statistical regression algorithms into a flexible, user-friendly platform, allowing the user to deploy one solution for medical management, population risk adjustment for physician performance measurement and interpreting program performance outcomes, and for underwriting.

UnitedHealthcare uses multiple techniques to identify high-risk consumers for its medical management programs such as hospital admissions data, notifications and nurseline referrals, but uses ImpactPro to enhance its ability to proactively identify the 60 percent of the high-cost members that become newcomers to that group each year. “A predictive model allows us to identify above and beyond, and faster than, the traditional methods for identifying these people,” says Levine. “It also allows us to understand the key drivers of risk for a person and how we may best intervene.”

In addition to ImpactPro, Ingenix also provides large capacity data warehousing, business-analytics tools and data management expertise to UnitedHealthcare and a large list of other healthcare organizations that conduct predictive modeling and healthcare data analytics and management.

Holistic approach

Among other initiatives UnitedHealthcare has designed to leverage its predictive modeling asset is a consumer-centered outreach program that involves nurses contacting individuals to better help them manage their illnesses. “We have more than 25 programs based on a person’s condition. We’re an integrated care management program that looks at the person as a whole and at all points along his or health continuum,” says Levine. For example, the program can identify and comprehensively manage high-risk individuals with both heart disease and liver disease, who may also be suffering from depression.

Opportunities for bringing value to consumers and employers lie in:

- **Patient Education**—assess and support consumers’ self-empowerment to make them better managers of their own health;
- **Assessment**—ensure individuals are receiving care in accordance with evidence-based medicine, best practices, national standards;
- **Facilitation of Care**—coordinate transportation and appointments;
- **Decision Support**—advise consumers of treatment options, of cost-effective ways to procure the best medication and of the importance of seeing the appropriate specialists or leveraging UnitedHealthcare’s Premium Program, which uses data to identify the best physicians available for treating particular conditions;

- **Psychosocial evaluation**—“We find a high incidence of stress or depression as a co-morbidity, and help connect those appropriate individuals with United Behavioral Health,” notes Levine.

“Our programs are designed to support our company goal to improve affordability, quality, usability of and access to healthcare for all consumers,” he says. Levine emphasizes the fact UnitedHealthcare is not merely seeking to identify high-cost or high-risk individuals, but those with condition-specific risk (like diabetes) so the organization can try to address specific outcomes such as, say, the risk of admission to a hospital. “It allows us to add specialty expertise and focus on best-in-class intervention.”

In addition to its predictive-modeling capabilities, ImpactPro helps track more than 200 evidence-based-medicine care opportunities and is able to identify them in the high risk, chronic disease and general risk populations.

“The value of the predictive modeling tool,” says Levine, “is that it allows us to allocate high intensity resources to where they’re needed most—the highest risk and most complex individuals—creating capacity to offer cost-effective solutions for the general population, for example wellness and nurse-line programs, and self-help tools on our myuhc.com Website.”

Levine says the next generation of predictive-modeling products will leverage new data sources such as consumer-oriented information and other data common to other industries, but considered non-traditional in healthcare today. The products will also incorporate input from non-claims based health sources such as health risk assessments and electronic medical records. “This will not only refine the risk but also lend itself to new insights on how best to intervene,” he says.

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Sentara's data-warehouse users report to senior leadership and represent all segments of the organization: hospital administration, financial staff and RNs; health-plan senior leadership, employer groups and physicians. By the end of last year, the organization had built an executive dashboard with reporting on 80 metrics, four scorecards and had trained 150 users.

Virginia is for data

Sentara Healthcare, a six-hospital integrated health system based in Norfolk, Va., has been a leader in IT for years, being the first in the country, for example, to implement an electronic ICU. Now it is poised to forge leadership in the area of clinical and business intelligence.

Kathie Zimbardo, PhD, RN, director for clinical and business intelligence at Sentara Healthcare, says the organization's plan is to be able to extract clinical business intelligence from its 2.5-terabyte data warehouse for four areas of emphasis: 1) healthplan; 2) employer groups; 3) analytics for the physician community; 4) hospital. It currently has two large data marts—one for the hospital and another for the health plan.

The hospital data mart has great breadth, she says, because it stores patient information from admission to discharge and allows the organization to view standardized information across all of its six hospitals. All payers are represented in the data. Such data standardization is key to telling if physicians are following treatment protocols for chronic diseases like CHF and diabetes. However, to date it cannot tell if a patient is being compliant unless that patient is a member of OptimaHealth, Sentara's health plan.

The strength of the health-plan data mart, on the other hand, says Zimbardo, is its depth, covering the continuum of care—at least for a single payer—from claims data. It is possible to co-mingle clinical data and claims data as well as mix in data from other sources, including pharmacy data, laboratory values and immunization data from state and local health departments and physician offices. "We obtain information on

childhood immunizations wherever we can track it and then we tie all the data sets together on the health-plan side," says Zimbardo.

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Business links

Bert Reese, VP and CIO at Sentara, says notwithstanding the fact that municipalities are linked to the data warehouse (with secure, HIPAA-compliant access) customers are those with business relationships with Sentara, including physicians and reference laboratories. "We don't extend the data capabilities to stakeholders in the larger community as in a RHIO," he says.

Research follows two veins. While Sentara doesn't conduct clinical trials research, it does do retrospective research on the impact of how patients comply with prescription drugs. It also conducts several types of research—both retrospective and prospective—related to disease management and medical care management, exploring, for example, how effective Sentara's "Life Coach" program is in assisting health-plan members to maintain their health and stay out of the hospital.

On the hospital side, the organization conducts research through the IRB on various nursing strategies, including the best way to position patients in order to avoid bed ulcers, or physician-sponsored research on

outcomes related to a specific physician's practice. "But we can't open up data on physicians other than the ones receiving the reports," notes Reese.



**Bert Reese, VP and CIO,
Sentara Healthcare,
Norfolk, VA**

The objective is to make Zimbro Sentara's "single source of truth." Reese notes "that's a big deal in the organization and we've been very fortunate. At the 60,000-foot level, if you're an employer under our

health plan, it makes it more attractive to stay with Sentara because we can show data as to how healthcare-premium dollars are being spent. We're the first mover in this community to show that kind of information. It's all about transparency," says Reese, who is confident that IT-enabled strategies to support quality pay off.

"Sentara implemented the first electronic ICU because we felt it was the right thing to do. Then we discovered it saved us the equivalent of two patient lives a month, shortened length of stay and generated more throughput for the ICU. Patients are getting better care and we're making money on it. That told us: Good patient safety has good economic outcomes."

Conclusion

"Competing on Analytics" by Thomas H. Davenport in the January 2006 issue of Harvard Business Review featured a 10-point checklist for being an organization focused on business analytics. While not healthcare specific, we think it's an apt way to conclude this report on data warehousing and business analytics:

"You Know You Compete on Analytics When..."

1. You apply sophisticated information systems and rigorous analysis not only to your core capability but also to a range of functions as varied as marketing and human resources.
2. Your senior executive team not only recognizes the importance of analytics capabilities but also makes their development and maintenance a primary focus.
3. You treat fact-based decision making not only as a best practice but also as a part of the culture that's constantly emphasized and communicated by senior executives.
4. You hire not only people with analytical skills but a lot of people with *the very best* analytical skills—and consider them a key to your success.
5. You not only employ analytics in almost every function and department but also consider it so strategically important that you manage it at the enterprise level.
6. You not only are expert at number crunching but also invent proprietary metrics for use in key business processes.
7. You not only use copious data and in-house analysis but also share them with customers and suppliers.
8. You not only avidly consume data but also seize every opportunity to generate information, creating a "test and learn" culture based on numerous small experiments.
9. You not only have committed to competing on analytics but also have been building your capabilities for several years.
10. You not only emphasize the importance of analytics internally but also make quantitative capabilities part of your company's story, to be shared in the annual report and in discussions with financial analysts."

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