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Drowning in Big Data?

Reducing Information Technology Complexities and Costs For Healthcare Organizations

A Frost & Sullivan White Paper

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Healthcare organizations, globally and in all subsectors—from providers and payers to medical device and pharmaceutical companies to research institutions—are facing a flood of electronic data as never before experienced. And the data will keep flowing at an ever increasing rate.

While this data is being hailed as the key to improving health outcomes and reducing healthcare costs, the sheer volume of data is so overwhelming that most organizations are unable to take full advantage of it with their current resources. Managing and harnessing the analytical power of these large datasets, however, is vital to the success of all healthcare organizations.

In this paper, we examine Big Data—what it is, where it comes from, and its impact on healthcare organizations—and discuss strategies for managing Big Data and minimizing its costs, focusing on the products and services of a global company who has partnered with healthcare organizations in every subsector.

BIG DATA IN HEALTHCARE ORGANIZATIONS

Big Data refers to electronic datasets so large and complex that they are difficult (or impossible) to manage with traditional software and hardware. The volume of all electronic data in the world is staggering. It is estimated that in 2010, medical centers hold almost 1 billion terabytes of data, or almost 2 trillion file cabinets worth of information. The scan of a single organ in 1 second creates about 10 gigabytes of raw data. In 2011, the amount of all digital information created and replicated is expected to exceed 1.8 zettabytes (1.8 trillion gigabytes).[1]

Big Data is overwhelming not only because of its volume, but also because of the diversity of data types and the speed in which it must be managed. Volume, velocity, and variety—often referred to as the three V's of Big Data—capture the true meaning of Big Data.

In the global healthcare sector, there are three major types of digital data: Clinical records, health research records, and business/organization operations records. With technological advances, the increasing drive to adopt digital platforms for health information, and the computerization of business operations, it is easy to understand why a flood of Big Data is inundating the healthcare sector.

Clinical Records

Clinical records include electronic medical records (EMRs), digital images, and information-sensing wireless medical devices. EMRs and longitudinal patient medical records containing multiple file types are the center of computerized health

[1] See Appendix 1 for an explanation and comparison of the measurements used in describing digital data.

information systems. They contain the varied data that, if properly managed and stored, has the potential for transforming the practice of medicine by providing insight, for example, into the efficacy and safety of medical practices.

The healthcare sector has been much slower than other industries, such as finance and retail, in transitioning to and utilizing computerized information systems, like EMRs, largely because of traditional processes and concerns over the privacy of personal health information. Additionally, rates of adoption vary across countries. For example, in 2009, 99% of primary care physicians in the Netherlands used EMRs. In contrast, 36% of primary care physicians in Canada and 46% of primary care physicians in the United States used EMRs.[2] Government initiatives promoting EMRs are accelerating the contribution of digital health information to the volume of Big Data in many countries.

Medical images, at one time stored on film, are now created digitally and stored in Picture Archive and Communication Systems (PACS). They are the largest contributor to the expanding volume of Big Data in healthcare. And, as medical imaging devices improve in digital resolution capabilities, the data files dramatically increase in size.

Information-sensing wireless medical devices have the potential for being major contributors to the flood of Big Data. With advances in sensor technology, there has been rapid growth in the number of wireless medical devices that continuously monitor patients and send reports to providers. For example, the Nuvant Mobile Cardiac Telemetry System from Corventis, continuously monitors cardiac arrhythmias and captures ECGs, which are automatically transmitted wirelessly to a monitoring center. Such devices have the potential to dramatically increase the amount of healthcare data, both real-time and stored, captured for each patient.

Health Research Records

Health research—from drug development to biotechnology to public health—has long been data-intensive, and today its output is growing exponentially as well. The Coriell Personalized Medicine Collaborative Research Study provides a clear example of the phenomenal data production of health research today. The study, which examines individual genetic differences to understand the causes of disease, aims to include 100,000 participants. Each participant is genotyped, resulting in approximately 1.5 GB of data per person—an astounding 150 TB of data.[3]

Additionally, research often generates large amounts of raw data that remains unstructured and unlabelled, effectively making it useless to other researchers who then must expend time and resources collecting and storing similar data.

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[2] The Commonwealth Fund, International Profiles of Health Care Systems, New York: The Commonwealth Fund, June 2010, pp. 6-7.

[3] Miliard, Mike, "IBM helps Coriell Institute keep cool," Healthcare IT News, http://www.healthcareitnews.com/news/ibm-helps-coriell-institute-keep-cool (14 July 2011).

Business/Organization Operations Records

Fundamental business processes in healthcare, such as billing and scheduling, have been digitized for years. However, ". . . the information is not generally in a form that payers can use for the kind of advanced analysis necessary to generate real insights, because it is rarely standardized, often fragmented, or generated in legacy IT systems with incompatible formats."[4]

THE CONSEQUENCES OF BIG DATA—INCREASED COMPLEXITY AND COSTS

Big Data, in its volume, velocity, and variety, creates two major problems for healthcare organizations: potentially overwhelming complexity and increased IT expenditures. Given the great expectations placed upon Big Data analytics to transform medicine, healthcare organizations need to move beyond collecting and storing data to the gathering and sharing of information, and the implementation of strategies gleaned from the information.

Big data, by definition, is complex. And in healthcare, the expectations and urgency of such data compound that complexity. For instance, as previously noted, the volume of Big Data overwhelms conventional software and hardware. Algorithms capable of handling smaller datasets are insufficient for managing the volume of healthcare data—in the range of petabytes—now being produced. However, purchasing more storage media is not an affordable solution, nor does it reduce the complexity of the data so that it may actually be used. As researchers at the University of Otago, New Zealand, who are developing secure storage capabilities for researchers working with sensitive patient data, note:

> The proliferation of cheap, high-capacity storage technology has made it straightforward to collect large amounts of data; however, managing those data within the scope of collaborative research projects is another matter entirely. Often researchers make do with an ad hoc workflow, without fully appreciating (or even considering) the risks involved, often because of the (perceived) inaccessibility of higher quality solutions.[5]

[4] Manyika, James et al., Big data: The next frontier for innovation, competition, and productivity. McKinsey Global Institute (May 2011), p 42.

[5] Eyers, David and Russell Butson, "Managing sensitive 'Big Data,'" eResearch New Zealand, http://www.eresearch.org.nz/content/managing-sensitive-%E2%80%9Cbig-data%E2%80%9D (26 May 2011).

In another example, Big Data variety—in its type, source, and location—prevents healthcare organizations from utilizing it. In the United States,

> . . the insurance sector is positioned to highly benefit from big data, but only as long as barriers to its use can be overcome. What are some of those barriers? First, the insurance industry's data is highly fragmented. Underwriting data lies in systems disparate from claims, contracts and financial/accounting systems. Next, little insurance data is standardized – every enterprise has their own standards and each company wants their standard to be "the industry standard." And, finally, data is stored in legacy IT systems that are both difficult to extract and incompatible with other systems.[6]

Managing IT Complexities and Costs—Solutions

The IT departments of most healthcare organizations have expanded rapidly in recent years in response to the increasing complexities of the IT systems used to manage the growing data and communication system needs. In many European countries, EMR systems and exchange of health information are currently established, supported by new IT systems and communications infrastructure. Healthcare organizations on every continent are making investments in EHR, mHealth, and many other clinical and nonclinical health IT systems, with investments in advanced analytics on the horizon. Other factors, such as consolidation of hospital systems in the U.S., add to the costs and complexities of IT infrastructure within healthcare organizations.

The good news is that it is possible for healthcare organizations to manage these complexities without breaking their IT budgets. Virtualization and cloud computing are two cost-effective means of reducing complexity, but healthcare organizations have been slow to adopt them. For example, in a cloud computing tracking poll conducted in the United States in 2011, only 37% of healthcare organizations had developed a written strategic plan for adopting cloud computing.[7] Based on a global survey from 2010, healthcare organizations are currently far behind this benchmark, with only 9% stating they use cloud storage for archived data.[8]

Larger healthcare providers are more likely to stand up their own private cloud infrastructure, with siloed applications—like imaging-based apps, which have previously existed primarily in departmental silos—being the first to move. Some

[6] Anderson, Archie, "Is the Insurance Sector Ready for Big Data?" http://www.workcompwire.com/2011/05/archie-anderson-oci-insurance-sector-ready-for-big-data/ (31 May 2011).

[7] CDW, From Tactic to Strategy: The CDW 2011 Cloud Computing Tracking Poll (2011).

[8] The BridgeHead Software International 2010 Data Management Healthcheck Survey (2010).

of the larger healthcare providers are looking at leveraging their private clouds to become service providers to smaller hospitals. Smaller healthcare providers are more likely to use public clouds, and to even adopt a "pay as you drink" approach, viewing storage as a service.

Cloud infrastructure and services will become even more important as providers come to rely on analytics in patient care, and cloud models will be necessary to get analytics to the level that smaller hospitals can leverage. Analytics today are retrospective, but in the not-too-distant future, will drive care decisions more dynamically, requiring analysis of larger data sets, and requiring analysis of structured and unstructured data. Diverse data sources will be pulled together using cloud connections to create a cohort large enough to find patient situations, which mirror the patient in front of a provider in an emergency department waiting for diagnosis and treatment.

Vendor-neutral archiving of imaging files is another strategy to reduce complexity and manage IT system costs over time. Vendor-neutral archiving greatly improves the ability of healthcare providers to find any image, no matter what vendor platform is being used, and supports simpler and cost-effective migration of imaging data in the case of a shift in PACS systems, for example. With vendor-neutral archiving, the application that supports viewing an imaging file does not know or care where an image is stored. A single, enterprise-wide archive can support different departments or locations using different vendor viewing solutions. Updating how applications talk to infrastructure via metadata allows providers to manage the lifecycle of their clinical images, and links to images in their EHR do not have to be changed in the case of PACS vendor shifts. With the average life cycle of healthcare application at around eight years, having a strategy for data migration to a new application (and possibly vendor), becomes even more important in a world where IT systems eat up an increasing share of the budgets of healthcare organizations, yet are vital to their processes and services.

As health information is consolidated through organizations with wider reach (whether national health organizations or large payers and providers), there is a movement toward centralizing information via cloud services, allowing data from local repositories to be shared regionally or nationally. Authorized caregivers (e.g., doctors) can go into the EMR system locally, and at the click of a button, view all files stored in any location. In this environment, an open standards-based architecture and vendor-neutral archiving are key to the success of the system. Managing storage and compliance policies for different types of files are crucial in this environment, from determining what files need to be supported with rapid access, to policies on compression, and eventually actions to delete files.

In the end, it is not just about images and large data files, but the increasing data sets being developed from many sources across the healthcare spectrum: medical records, data from remote monitoring and mHealth sources, genetic information,

etc. As more and more data is being stored by healthcare organizations, more is being ignored as well. The challenge is not just in storage and access, but in making this data usable. Healthcare organizations are overwhelmed, and are not able to incorporate all this data for business intelligence and analytics. Successful healthcare organizations need to integrate data into the fabric of an organization–data collection, storage, management, exchange, processing, and analytics. Data must be integrated into processes and drive actions. As we move towards using this wealth of information to determine what really causes a good outcome, managing Big Data is a key strategic process in healthcare.

The goals of IT systems in the future healthcare environment include:

- enabling the fluidity of information
- delivering the supporting content (and analytics) to the right person at the right time
- enabling information aggregation and sharing
- supporting the expansion of how and where content is displayed in a collaborative environment

Developing an IT system at the enterprise level that supports this is becoming an increasingly costly and complex exercise. IT decision makers are increasingly being asked to make strategic decisions on how IT will support the future of healthcare organizations. Managing the increasing IT costs and complexities within healthcare organizations requires leveraging strong partners.

Managing IT Complexities and Costs—Choosing an IT Partner

Developing and implementing data storage, management, sharing, and analytic strategy requires expertise and experience in the latest IT solutions. Forming a partnership with an information solution company, rather than simply an IT vendor, is the most logical and cost-effective means for a healthcare organization to manage IT complexities and costs. The vast majority of organizations will not be able to maintain cost-effective, in-house expertise, simply because of the rapid advances in IT and the shortage of skilled IT workers. Businesses will be better served directing resources towards their core healthcare, research, or business operation functions, while relying upon partners to formulate IT solutions.

In choosing an IT partner, healthcare organizations should look for companies with healthcare expertise and experience, a range of solutions that can be tailored to unique needs, and a history of integrity and security with enterprise-level clients. In the healthcare industry, the greatest barrier to the adoption of Big Data solutions is the legitimate concern for the privacy and security of health information. Experienced IT partners understand these security requirements and can build the best solutions for protecting data and complying with regulations.

EMC is a global IT services provider with extensive healthcare experience, and a proven track record of managing enterprise-level clients. Working with small to large businesses and government entities, EMC has a broad range of solutions for managing Big Data. It considers cloud computing fundamental to transforming business operations, and is a leader in virtualization and cloud computing solutions. EMC has numerous solutions specifically tailored to the needs of healthcare organizations:

Greenplum

Acquired in July 2010 by EMC Corporation, Greenplum Inc. is a data warehousing software company that has developed the world's fastest, most scalable database software for business intelligence.

DCD (Data Computing Division) within EMC Corp. is built on top of Greenplum analytics database platform to provide best-in-class data warehousing solutions that utilize open source software and leverage the power of commodity, general-purpose hardware. Greenplum's solutions allow decision makers to perform complex analyses of terabytes of data, thereby accelerating and improving business decisions.

Greenplum's data warehousing and analytics solutions include Greenplum Data Computing Appliance, Greenplum Database, Greenplum Chorus, and the new enterprise-ready Apache Hadoop: Greenplum HD product family. Designed to handle extremely large and fast-growing data volumes, Greenplum Database enables companies to gain critical insights into their data and extend their competitive advantage in the market at a fraction of the cost of traditional solutions. The Greenplum HD product family utilizes open systems, cloud computing, virtualization, and collaboration, enabling cost efficient data management and analysis.

Isilon Systems

A division of EMC, Isilon Systems is the pioneer and leader in scale-out storage and software for digital content, enabling enterprises to transform data into information. Isilon's award-winning family of IQ clustered storage systems combine Isilon's OneFS operating system software with the latest advances in industry-standard hardware to deliver modular, pay-as-you-grow, enterprise-class storage systems.

Adopting an Isilon storage solution that is tailored for the unique requirements of healthcare digital content, data and workflows enables organizations to store more content in more formats and make it instantly accessible at a lower cost. With a single file system, organizations can have an easy to manage, common storage solution across multiple applications.

EMC Cloud Computing Solutions

EMC believes that one of the most significant uses of cloud computing is the management and analysis of data. Cloud computing promises to transform the way healthcare organizations manage their technology assets and computing

requirements. It also provides IT cost savings by allowing organizations to procure computing resources such as servers, storage and software on a pay-as-you-use basis, freeing them from having to make large investments in infrastructure.

EMC's Atmos products enable the transfer of data across clouds cost effectively, while delivering reliable and secure access—vital attributes when considering sharing sensitive data across organizations. Atmos products can run in a virtualized environment with an organization's own legacy storage solutions or within an EMC purpose-built, low cost, high-density hardware solution.

Atmos is a globally accessible cloud storage platform to manage content in modern content-rich applications, such as medical imaging. Atmos provides new, more efficient ways to manage image distribution and archiving, such as VNA (Vendor Neutral Archive); and offers collaboration enhancements across multisite healthcare facilities, like hospital networks, academic centers, and large regional medical centers.

EMC Virtualization Solutions

Healthcare IT professionals are faced with multiple challenges related to EMRs, computerized physician order entry, and health information exchange: managing and storing an increasing volume of data, reducing costs while improving service levels, and ensuring security while increasing flexibility.

Virtualization holds great promise for healthcare IT environments and its benefits are numerous: smaller data center footprint, lower energy costs, easier management and movement of applications, improved efficiency and quality of patient care with desktop virtualization, easier implementation of business continuity, and disaster recovery plans.

VMware, an EMC partner, is the global leader in virtual infrastructure software for industry-standard systems. VMware solutions of Healthcare IT–which include VMware vSphere, VMware Virtualization and Cloud Management Solutions, VMware View, VMware ThinApp, VMware vShield, VMware vCloud Datacenter Services–enable customers to lower their costs and simplify their operations by deploying virtualization technologies across their heterogeneous IT infrastructure, to create a single pool of available storage and computing resources.

While virtualization's benefits can apply to both private and shared data center environments, it is widely accepted that the technology is a necessary enabler of cloud computing solutions. VMware vSphere virtualization platform dramatically expands IT effectiveness and efficiency, going beyond basic virtualization to deliver critical management and quality of service capabilities that provide a complete cloud infrastructure solution. VMware View extends the vSphere platform to the desktop for unparalleled levels of availability, while streamlining desktop management for reduced costs. VMware View provides a centralized approach to delivering, managing, and protecting desktop and laptop environments.

EMC Consulting

EMC Consulting helps healthcare organizations to strategize, design, implement, and manage comprehensive technology solutions to streamline their operations. With its deep healthcare experience and consulting expertise across organizations' business, applications and infrastructure architectures, EMC Consulting provides Business Intelligence solutions that enable healthcare providers and payers to transform information into strategies, manage risk and compliance, comply with regulations, and improve business results with limited resources and lower costs.

EMC Enterprise Content Management

In addition to clinical data, healthcare providers and payers have a great deal of additional content that can be managed and incorporated via an Enterprise Content Management (ECM) solution, allowing for increased data analysis and manipulation, and improved business operations.

EMC Corporation offers an ECM suite of products and solutions, including business process management, collaboration and document management, compliance, document capture, records management, digital asset management, Web content management and content security.

EMC's ECM solution is a platform consisting of three main layers, all within a compliance infrastructure:

- A repository for all content types
- The services supporting that content
- The presentation or user display of content

Healthcare providers and payers drive significant benefit from the ability to mix and match content types, so a common repository is the preferred strategy. A common set of services can be coordinated and utilized in modular fashion, providing the functionality needed for a particular point solution implementation, keeping costs down.

Three of EMC's most widely used offerings for healthcare are Documentum, Captiva and Document Sciences. Using EMC Documentum xCelerated Composition Platform (xCP), organizations can create virtual folders and aggregate information to provide a consolidated view of patient records. The EMC Healthcare Integration Portfolio (HIP) supports seamless, standards-based integration, allowing EHR applications to leverage this virtual repository and technologies such as content management, business process management (BPM), records management, collaboration, intelligent capture, customer communications, and comprehensive reporting in their new comprehensive workflows.

The Captiva family of products is part of the Documentum platform and helps transform information from paper, fax, and electronic sources into business-ready digital formats. It includes not only document capture, but also forms processing, invoice processing, intelligent document recognition and classification, distributed capture, imaging solutions, applications monitoring and premium services. All these products can be embedded into any specific application so that one can leverage the power of these capture and extraction tools to manage data better.

EMC Document Sciences software suite enables organizations to automate the creation and delivery of well-designed, highly personalized customer communications, including relationship statements, contracts, profit/loss reports, marketing collateral, and correspondence.

CONCLUSIONS

The global healthcare sector is facing a dramatic increase in the volume of data produced and stored. With this data, healthcare organizations have the possibility of transforming the practice and outcome of medicine, but only if they are able to manage its complexity and costs. Virtualization and cloud computing provide affordable solutions to organizations faced with a flood of Big Data, but insufficient resources for managing it.

Healthcare organizations in all subsectors—from providers and payers to pharmaceutical and device manufacturers and researchers—will need to develop strategies for managing the complexities and costs of Big Data. Partnering with a respected provider with expertise and experience in healthcare is the best option for success.

Appendix 1: Measurements of Digital Data

Table 1: Measurements of Digital Data

Unit	Size	Definition
Bit (b)	1 or 0	A binary digit, 1 or 0, used by computers to store and process data.
Byte (B)	8 bits	The basic unit of computing; it may equal one letter or number.
Kilobyte (KB)	1,000 B	Equivalent to 1,000 English letters or numbers; 2 KB is equivalent to one typed page.
Megabyte (MB)	1,000 KB	200 MB is equivalent to one digital mammography procedure.
Gigabyte (GB)	1,000 MB	1 GB is equivalent to five digital mammography procedures.
Terabyte (TB)	1,000 GB	1 TB is equivalent to 5,000 digital mammography procedures.
Petabyte (PB)	1,000 TB	It is estimated the human brain's memory storage capacity is 2.5 PB; this is equivalent to three million hours of television shows.
Exabyte (EB)	1,000 PB	1 EB is equivalent to 10 billion copies of The Economist magazine.
Zettabyte (ZB)	1,000 EB	All of the digital information created and replicated in 2011 is expected to reach 1.8 ZB.
Yottabyte (YB)	1,000 ZB	"Currently too big to imagine."

Sources: The Economist, "All too much: Monstrous amounts of data," The Economist, http://www.economist.com/node/15557421 (25 February 2010); Archer, Stephen, "Is Your Infrastructure Ready for Digital Mammography?" TBMA Bulletin (November-December 2006): 18; Reber, Paul, "What is the Memory Capacity of the Human Brain?" Scientific American,

http://www.scientificamerican.com/article.cfm?id=what-is-the-memory-capacity (19 April 2010).

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