

The Application of Analytics in Healthcare

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Abstract

This research will examine the role of Analytics in Healthcare. In 2010, healthcare costs in the U.S. accounted for 17% of GDP (2.2 trillion dollars) ⁽¹⁾. It is projected that by 2017, these costs will reach 4 trillion dollars per annum ⁽²⁾. Trends in the public and private sectors indicate that these high costs are not sustainable. In the public sector, title XIII of the American Recovery and Reinvestment Act (HITECH Act), includes incentives to providers for the adoption of electronic health records (EHR) over traditional paper ⁽³⁾ ⁽⁴⁾. The private sector is also working to address the problem. They are striving to drive down costs, improve coordination and outcome, and provide more with less ⁽⁵⁾ by leveraging advanced analytics. Descriptive analytics in healthcare is not a new concept ⁽⁵⁾. What this research paper will show is that for both the public and private sectors, the need to move beyond descriptive analytics is critical in solving the problems of modern day healthcare. Adoption of predictive and prescriptive analytics against clinical data is key in addressing these issues.

Introduction

In 2012, 47 million Americans were uninsured ⁽⁶⁾. With the roll out of the Affordable Care Act (ACA), these Americans can now avail themselves to affordable healthcare coverage. Recent estimates indicate that 10% ⁽⁷⁾ of the uninsured population have taken advantage of the ACA. This slow adoption will surely keep growing with time.

“The launch of the federal health insurance marketplace last week represented more than the first visible manifestation of the Affordable Care Act. It was a symbolic moment in the future of U.S. healthcare, one that’s drawing attention to the broad metamorphosis of every stage of the healthcare value chain—from payers to providers to patients.” ⁽⁸⁾

This simple quote, while directly speaking to a fundamental shift in healthcare, also hints at a wave of new challenges associated with the increase of the newly insured. These once uninsured will undoubtedly put pressure on all facets of the industry.

There is no debate that there is a huge strain on our healthcare system. From a shortage of providers (expected to be 91,500 by 2020) ⁽⁹⁾, to the soaring costs of health insurance ⁽¹⁾ ⁽¹⁰⁾, it is clear that something must be done. Analytics holds great promise in helping resolve the most challenging issues facing the healthcare industry today.

There may never be one panacea to the issues of healthcare. However, analytics will play a major role in helping providers break through the deluge of data. Payers, like providers, have incentives to leverage analytics as well. The high costs of inefficiencies in the healthcare system result in payers paying out more than is necessary. Using techniques like predictive analytics, payers are empowered to assess the

optimal patient stay in a hospital for a given treatment. Reducing the stay by as little as a half day has a large impact on cost savings ⁽¹¹⁾.

Analytics can provide the right tools, methodologies and processes to help address the many facets of healthcare issues. This research sets out to demonstrate the significant role analytics is playing in healthcare, both today and in the future, as more people are trained in the methods of healthcare analytics.

A Brief History of Healthcare Informatics

The story of analytics in healthcare cannot be told without first discussing healthcare informatics. Healthcare informatics has a rich history that is irrevocably and necessarily tied to technology. Dr. Vicki L. Sauter of the University of Missouri at St. Louis concisely summarizes the primary objective of healthcare informatics:

“Health Informatics (HI) focuses on the application of computer information systems to health care and public health. Informatics extends beyond simply using the computer as a tool for computation into the process of knowledge acquisition, storage, retrieval, representation, and manipulation. A major focus of Informatics is the support of information systems for reasoning, decision-making, and learning. Health Informatics encompasses the fields of information science, computer information systems, and educational technology in support of health care delivery, education, and management.” ⁽¹²⁾

Healthcare Informatics covers a wide array of dimensions. However, implied its definition is the need to derive useful information and insight from patient data.

In 1928 Healthcare Informatics was organized. What took hold was the American Health Information Management Association (AHIMA). Today the AHIMA is considered the leading authority of Healthcare Information Management knowledge ⁽¹³⁾. Since then, many professional organizations have been created and technical advances have sprung up in support of healthcare informatics:

- 1949 – Gustav Wagner created the first professional organization for early informatics ⁽¹⁴⁾.
- 1952 – First Computer used in a clinical practice by Dr. Arthur E. Rappaport ⁽¹⁴⁾.
- 1959 – Robert S. Ledley and Lee B. Lusted published an article in Science titled *“Reasoning Foundations of Medical Diagnosis.”*⁽¹⁶⁾ In this article, they “expressed hope that by harnessing computers, much of physicians’ work would become automated and that many human errors could therefore be avoided.”⁽¹⁴⁾.
- 1961 – Kaiser Permanente established the Department of Medical Methods Research. Their aim was to begin the use of computers in the practice of medicine ⁽¹⁴⁾.
- 1964 – Massachusetts General Hospital developed the first clinical programming language MUMPS ⁽¹⁴⁾.
- 1980’s – Healthcare providers begin using small computers for patient data. The focus was on financials ⁽¹⁷⁾.
- 1984-2003 – Human Genome project ⁽¹⁴⁾.
- 1996 – HIPPA signed into law by President Clinton ⁽¹⁴⁾.
- 2004 – NWHIN developed with the goal to connect all Electronic Health Records, Health Information Organizations, and government agencies ⁽¹⁴⁾.

- 2009 – American Recovery and Reinvestment Act created an incentive program through Medicare for hospitals to adopt technology for EHRs ⁽¹⁴⁾.

As early as 1928, it was acknowledged that the organization of information was an important aspect of patient care. Since then, many organizations have been created to support managing patient information. Also, an organic progression of technological advances (computers, software, hardware, etc.) has enabled providers to better manage and serve patients.

Today the face of modern healthcare includes a wide array of technologies from paper (small practices still rely on paper), to Electronic Health Records (EHRs) and Health Information Exchanges (HIEs). What is common to these technologies is the need to be able to report on and analyze patient data, lab results, financials, scheduling, etc.

Influences on Healthcare

“Necessity is the mother of invention.” Although the origins of this quote are unknown ⁽¹⁵⁾, its meaning is ubiquitous and universally understood. This pithy quote sums up the profound role analytics is playing in the healthcare industry today. Over the past several years, healthcare has been in the throes of re-inventing itself. With that said, this forward progression isn’t without its detractors. One of the biggest challenges today in healthcare is an urge to protect the status quo ⁽¹⁶⁾. However, the tidal wave of change is a force that cannot be held back.

The biggest drivers for these changes fall into two broad buckets:

- Governmental
- Economic

With the signing into law of the Health Information Technology for Economic and Clinical Health Act (HITECH) in 2009, providers were incentivized to adopt Electronic Health Records (EHRs). In fact, before a provider can receive incentive payments they must also be able to demonstrate certain analytics capabilities (e.g. Meaningful Use Requirements) ⁽³⁾. The adoption of EHRs is creating a deluge of structured and unstructured data. This data affords healthcare organizations (HCOs) a well of untapped business relevant information and insight that can be used to drive better decisions and processes.

“As of today, 80 percent of medical data is unstructured but clinically relevant. If this data can be better leveraged, it could create more than \$300 billion in value each year.” ⁽¹⁷⁾

As with any free market, the business of healthcare is to drive profit. Government incentives to adopt EHRs will necessarily create a disruptive event in healthcare by encumbering organizations with massive amounts of structured and unstructured data generated by the EHRs.

Driving in parallel to the economic incentives to adopt EHRs, is patient focus. The Institute for Healthcare Improvement (IHI) advocates a three pronged approach to improving the state of healthcare in the United States. Known as the Triple Aim, it sets out to:

- Improve the patient experience and care (including quality and satisfaction) ⁽¹⁸⁾
- Improve the health of populations ⁽¹⁸⁾
- Reduce the per capita cost of health care ⁽¹⁸⁾

Each of these drivers present a myriad of challenges to healthcare organizations. Particularly, with the introduction of ICD-10 (International Statistical Classification of Diseases), organizations can expect to see a much finer granularity of patient data. With this granularity, organizations will be enabled “for new levels of analytics, including quality reporting, pay-for-performance and bio-surveillance.”⁽¹⁹⁾ Further, new technologies such as Health Information Exchanges (HIEs) will provide a much better picture of patients by leveraging data from disparate sources and bringing it together into a common portal or Continuity of Care Document (CCD).

It is apparent that new approaches to data management and analytics must evolve. Descriptive analytics has played an important role in healthcare. HCOs use it to understand what has happened with the patient and to categorize historical data.⁽⁵⁾

“Today, most healthcare organizations are extensive users of descriptive analytics. They are using reporting tools and applications descriptively to understand what has happened in the past and to classify and categorize historical, usually structured data.”⁽⁵⁾

In this ever evolving and complex world of healthcare, progressive HCOs are embracing advanced analytics to help create measurable business and patient value⁽²⁰⁾ from their data. If successfully implanted, these analytics will have a positive impact on an HCO’s bottom line. The quality of care and patient experience will also see benefits through the application of advanced analytics.

Evolving Modern Healthcare with Analytics

It is evident that all of the data being generated by HCOs and hospitals contain a wealth of untapped information. In this era of big data, these organizations must adapt to, and contend with, volumes of structured and unstructured data.

“As an industry, we’re only scratching the surface of the potential of big data. When you have this much healthcare data available, albeit still in multiple silos, the challenge shifts from, “We don’t have the data to make that decision,” to “We have the data to make that decision. It’s somewhere in this growing mountain.”⁽²¹⁾

To achieve this goal, these organizations need to evolve their technology and resources to align with what is required to achieve success. In order to move beyond simple descriptive (operational) reporting, organizations need to invest in technologies that will augment:

- Electronic Medical Records (EMR)
- Health Information Exchange (HIE)
- Practice Management Systems (PMS)
- Laboratory Information Systems (LIS)
- Enterprise Resource Planning (ERP)
- Financial Applications

By augmenting these systems with an external analytics platform, an organization will be able to blend structure (well defined operational reporting from commercial software applications) with the flexibility of analytics.⁽²²⁾ Figure (1) demonstrates what HCOs can achieve with healthcare analytics:

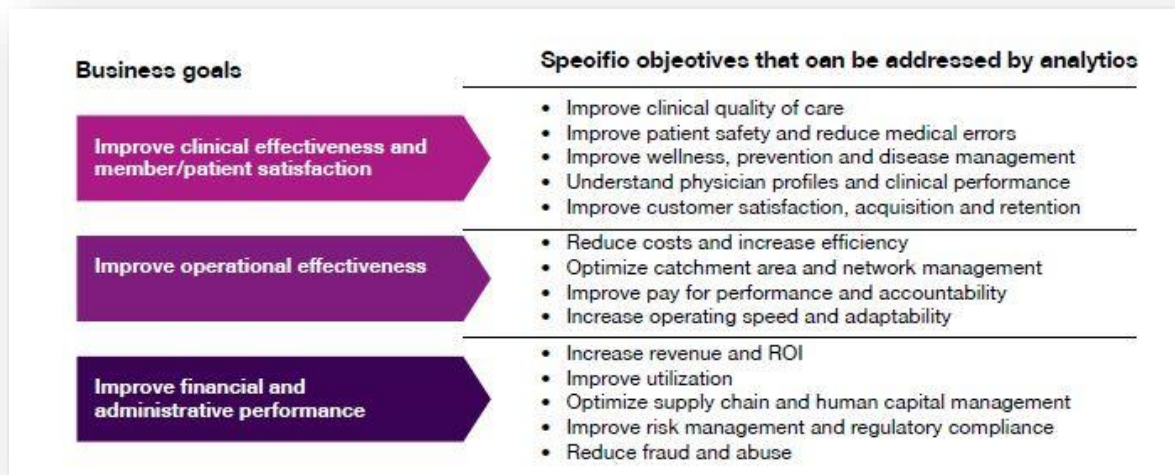


Figure (1) ⁽⁵⁾

It is an immutable fact that HCOs and Hospitals can expect that their viability depends on their ability to manage, process and analyze their data. Industry sentiment is that those organizations that adopt predictive and prescriptive analytics will be well positioned to have a significant advantage in the market ⁽²³⁾.

As identified earlier, much of this data is not structured (semi-structured or unstructured). In order to perform analytics on this data, HCOs need to fully understand its many forms. For most commercial EMR systems and lab Information systems, the system of record is built on the Health Level Seven International (HL7) specification.

“HL7 and its members provide a framework (and related standards) for the exchange, integration, sharing, and retrieval of electronic health information. These standards define how information is packaged and communicated from one party to another, setting the language, structure and data types required for seamless integration between systems. HL7 standards support clinical practice and the management, delivery, and evaluation of health services, and are recognized as the most commonly used in the world.” ⁽²⁴⁾

HL7 data comes in two forms: Version 2 (Pipe delimited semi-structured), and Version 3 (XML semi-structured). HL7 itself is built around the Reference Information Model (RIM) that defines constructs addressing every aspect of healthcare. Examples include: 1. Patient Registration, 2. Clinical Encounter, 3. Lab Order, 4. Insurance Payment, etc. RIM and HL7 are very complex and fall outside the scope of this research. However, most EMR systems provide an interface to their messaging bus that allows for easy consumption of HL7 messages. It is also possible for HCOs to directly mine the persistence store of the operational system, though the complexities of HL7 RIM would present many challenges to this endeavor.

Getting access to and processing data is just one piece of a bigger puzzle. All of the data in these proprietary operational systems are persisted in proprietary schemas that have the single goal of serving the application they support. HCOs need to consider, as part of their analytics solution, repositories of

their own. These repositories could include: 1. Data Warehouses, 2. Operational Data Stores, 3. Analytics Sandboxes. The data warehouse allows an organization to create formal dimensional persistence. This would facilitate performance against volumes of data that can be sliced a number of ways. The operational data store allows for rapid deployment of catered data sets (distilled and normalized data). Finally, the analytics sandbox allows for data exploration against raw and disparate data sources ⁽²⁵⁾. This last type of persistence is generally geared towards users with advanced skills.

Once data is in a workable form, the next step is to ask questions of the data as a basis of forming a narrative. The questions being asked (implemented via SQL, API, etc) are thought out in advance and help shape how extracted data is persisted. Depending on the goal (descriptive, diagnostic, predictive, or prescriptive analytics) of the analytics, the tools used can vary. For example,

- Data Analysis Tools – Microsoft Excel, Revolution Analytics (R) ⁽²⁶⁾, SAS ⁽²⁷⁾
- Data Mining Tools – Data Detective ⁽²⁸⁾, Pentaho ⁽²⁹⁾
- Presentation Tools – Tableau ⁽³⁰⁾, BIRT ⁽³¹⁾
- Data Extraction Tools – Informatica ⁽³²⁾, Talend ⁽³³⁾
- Data Manipulation Tools – Hadoop (unstructured data) ⁽³⁴⁾

Even with these tools, an organization that has a volume of unstructured and structured data still needs a well-informed and trained staff. To successfully implement an analytics program, there has to be subject matter experts. Some of the core roles needed may include a Project Manager, a Business Intelligence Analyst, a Data Engineer / DBA, a Data Scientist (advanced analytics), and a Visualization (graphics and presentation) Expert ⁽³⁵⁾.

The tools and skills needed for healthcare analytics are numerous and varied. From the simplest software (Microsoft Excel), to the more complex (Hadoop, R), HCOs are afforded many options that best fits their resources, budget, and stated goals for healthcare analytics.

Inquiries, Innovation and Insights

With the adoption of incentivized healthcare, HCOs are presented with new and more complex challenges (Meaningful Use, Triple Aim, EHR). Compounding these challenges, is the need to drive down costs while keeping focus on patient care delivery. Some of these challenges include:

- Reducing administrative costs and wastage ⁽³⁶⁾
- Clinical decision support ⁽³⁶⁾
- Fraud detection ⁽³⁶⁾
- Optimizing care coordination ⁽³⁶⁾
- Improving patient wellness ⁽³⁶⁾

The benefits of analytics are not in the sole domain of the HCOs. Payers are also incentivized by the application of analytics. They are in the unique position of being able to influence a course of care. They do this by deciding what they will pay and how it is paid. This becomes evident when a claim denial is challenged. The unfortunate subscriber who is trapped in this doctor/insurer loop will find that claims are sometimes denied due to a disjoint between diagnosis codes (ICD) and procedure codes (CPT). The insurers define what procedures will get paid based on a diagnosis.

Insurance companies are in the perfect position to derive actionable insight from their stores of data. By influencing diagnosis and procedure pairings, payers are able to monitor via follow-up encounters just

how well the treatment is working. Of course, this monitoring ability also applies to providers. This data can be mined, and forecasting can be applied to determine just how effective a course of treatment is. The goal for the payer is to see the patient cured as fast as possible.

Another example from a provider perspective is that of drug interactions:

“As one example, increasing complexity of medication regimens used by patients, coupled with a fragmented health care system involving multiple prescribers, has made the occurrence of serious drug-drug interactions more likely today than ever before. For example, one study suggests Preventable Adverse Drug Events injure 1.5 million people a year, costs the U.S. healthcare system \$3.5 billion and resulting in an estimated 44,000 to 98,000 deaths every year.”⁽³⁷⁾

This type of problem lends itself nicely to predictive analytics. With an aging population and more and more medication treatment plans, the problem of drug interactions will only get more complex. Predictive analytics can be applied to help determine and alert a physician to drug interaction complications early on.

Despite some differences, data and its applied analytics, are the common thread that tie HCOs and payers together. Analytics provide both with a viable path to resolve problems in their domains.

Healthcare Analytics and the 3rd Platform

We live in a digital age where computers, smart phones and the internet are unfolding massive changes within many organizations. As these technologies evolve, companies are adapting to the 3rd platform⁽³⁸⁾. The 3rd platform is comprised of 4 components: Social Technologies, Cloud Infrastructures, Analytics (Big Data) and Mobile Technologies (SCAM). Like organizations, people too are adapting to the 3rd platform. Social technologies and mobile computing (two of the four components) are already being championed by people who are essentially helping define what the 3rd platform is by their adoption of these technologies.

The viability of HCOs in the future will depend on their ability to adapt to technological advances that have an indirect but strong influence on their business. The 3rd platform is an example of this - specifically the HCO's ability to deliver cloud based analytics to providers and patients alike.

“According to Darwin’s Origin of Species, it is not the most intellectual of the species that survives; it is not the strongest that survives; but the species that survives is the one that is able best to adapt and adjust to the changing environment in which it finds itself.”⁽³⁹⁾

Additionally, tech savvy patients are demanding a more pro-active approach to their healthcare delivery, convenience and transparency. Mobile technology is a vehicle that enables providers to engage patients much more efficiently and pro-actively. With mobile technology, patients can be empowered to control many aspects of their healthcare including scheduling, real time test and lab results review, and secure patient/physician communications.

The future of healthcare will see a bigger demand for the adoption of the 3rd platform along with an increase in tech savvy patients and providers. These examples share a common theme - each will

present new challenges to healthcare analytics. Organizations will always be striving to achieve the Triple Aim. However, due to the 3rd platform HCOs will be challenged with the new ways the data will be gathered, processed and presented. Analytics in this progressive era will not only be charged with providing relevant information to the organization, it will also have to serve the analytics needs of the patient.

Summary and Conclusion

Healthcare in the United States today is big business. As with any big business the problems are numerous and the challenges can be formidable. With the introduction of the Affordable Care Act (ACA), some of the barriers to entry for healthcare coverage have been removed. More Americans today are insured thanks to the ACA. The introduction of the HITECH act has incentivized providers to espouse technology. This technology, if used as intended, will help ensure that a more patient-centric approach is facilitated. Technology and analytics will help drive down costs, increase profits and facilitate efficiencies that otherwise could not be realized.

Big Data and advanced analytics are hot topics today amongst businesses of all sizes and across many industries. There is a natural convergence taking place between the major shifts in healthcare and the adoption of big data and analytics. Healthcare organizations are faced with the challenge of taking all their data, applying analytics and deriving relevant business value from it. This is going to require that the organizations adopt new technologies, new skill sets and a whole new way of thinking about their data. This is necessitated by the fact that HCOs now have to deal with more data, most of which is unstructured.

Today progressive HCOs, hospitals and payers are on the vanguard of addressing the challenges associated with unstructured content and big data. This should come as no surprise as progressive companies are always early adopters of technology. Payers and hospitals have boards of directors and stock holders to appease and have the most to gain due to their size and volume. Smaller HCOs can gain from big data and analytics, although their adoption of commercial products will surely be slower due to cost. They are not at a complete disadvantage, open source and free tools make it possible for companies of any size to collect, cleanse, munge, analyze and derive meaningful insight from their structured and unstructured data.

Analytics in modern healthcare is an indispensable facet of the HCOs business. This paper has outlined ways in which its reach is helping drive down costs, improve coordination of care and provide more with less (Triple Aim). The business of healthcare is driven by data and that data is going to become more complex and much more voluminous as time goes on. Analytics provides the tools, methodologies and processes that will help HCOs achieve their business goals.

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