Who Knew? A Process Perspective for Building Analytics from Electronic Health Records

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ABSTRACT
With the emergence of big data capabilities, as well as legislation leading to the implementation of electronic health records, we find analytics have become a natural extension to our understanding of how organizations can leverage information. Often times, it is the case that a hospital or care provider is capturing more data than it knows what to do with; the market has answered this opportunity with specialty firms that take a provider’s information, and build custom analytics for that provider, based on the provider’s processes, as well as government mandated processes. In this paper, we examine the interposition of the healthcare provider’s data and the opportunity of an analytics firm’s model to gain insights as to how healthcare costs can be lowered from a data-driven process analytics perspective. This research presents the initial findings from case study conducted with a large healthcare provider to define their needs, and an analytics firm to define their offerings. The results will serve as a baseline towards building an understanding of generalizable process analytics that will serve two purposes: 1. Healthcare cost reductions. 2. Patient Suffering reductions.

Keywords
Healthcare, Healthcare Information Technology, electronic medical records, analytics, process analytics, patient suffering, cost reduction

INTRODUCTION
Recent legislation has made it so that healthcare providers in the United States must implement a form of electronic health record (EHR) tracking (ASPA 2013). If providers implement their EHR systems before the end of fiscal year 2014, they will receive a kickback from the US Federal Government; if they fail to implement by end of year 2015, they will begin to become penalized. This requirement presents an opportunity for healthcare providers to manipulate the data captured in their EHR system to gain an understanding of common illnesses that are being treated in their facilities. It has been shown in prior literature across various fields of study that preventative care is preferable to treatments (Chaudhry et al. 2006; Fries and Koop 1993). From here, we can obviate a natural extension between government mandate and healthcare provider opportunity in the utilization of the data that is Federally required to be captured, but can be turned into a competitive advantage in terms of healthcare provider cost, as well as reducing the patient suffering while at the facility. The goal of this research is to examine the interposition of healthcare provider, government mandate, and data analytics. Specifically, we see to answer the question: how can data inform healthcare processes to minimize cost?

To answer this question, we turn to the work that has been conducted in the domain of analytics. Prior work has identified two types of analytics: predictive and explanatory (Shmueli and Koppius 2011). These analytics are often found in business domains, driven by data, to inform processes (Chen et al. 2012). What we find is that analytics offer an opportunity to take a vast amount of data, and using informed statistics, turn that data into knowledge that can be used for the firm’s advantage (Kumar et al. 2013). Prior work has identified six areas in healthcare in which EHR can serve as the basis for analytical modeling opportunities for improving healthcare delivery: 1. HIT Implications as Quality, Cost Productivity, and Adoption, 2. Workflow and Cognitive Processes, 3. Home care and patient centric care coordination, 4. Clinical decision support system, 5. Serious gaming for medical training, and 6. Disease, drug, and policy management (Gupta and Sharda 2013).

While these are six identified opportunities, we will focus on the workflow aspect, as well as the disease, drug, and policy management aspect, as we adopt a view that these two are compatible with one another, and that an improvement on policy management can improve workflows and processes in terms of analytics (Agnew et al. 2006).
To execute this research agenda, we have started conducting work with a large healthcare provider, as well as a third party EHR analytics firm. Using case study, we begin to identify the opportunities and challenges that healthcare providers face, and fit those opportunities with the work being conducted by the analytics firm.

The remainder of this paper is organized as follows. First, we offer a focused literature review around analytics, as well as healthcare as it relates to the information systems field. Next, we offer a research model built from this literature in order to guide our work. We then offer a conceptual understanding of the benefits to both the healthcare provider as well as any firm working with EHR data. We conclude the paper with a future research direction and contributions of this study.

FOCUSED LITERATURE REVIEW

There is a developing body of work in the information systems discipline around analytics for business workflows (Chang et al. 2013; Chen et al. 2012; McAfee and Brynjolfsson 2012; Shmueli and Koppius 2011). Chen et al. (2012) found a myriad of domains for which analytics could be employed, ranging from e-commerce to public safety, including smart health and wellbeing. Chang et al. (2012)’s findings include data coming from genomics and sequence data, EHR, and health and patient social media, and proposed that the impact of analytics in this domain includes improved healthcare quality, long-term care, and patient empowerment. Chang et al’s 2013 work found that large data sets can be found across multiple fields, including healthcare, and offers three types of issues that can be addressed through analytics: business issues, consumer issues, and social issues. Business issues are the issues for which the analytics can improve the business’s processes, consumer issues are the issues for which the analytics can offer customer feedback based on the data captured, and social issues are the issues in which society as a whole can benefit from the outcome of these analyses. From Harvard Business Review, we get a practitioner viewpoint of how big data is shaping the future of large firms vis-a-vis improved airline ETAs and personalized promotions (McAfee and Brynjolfsson 2012).

We also offer a brief summary of predictive and explanatory analytics, as defined in the information systems field (Shmueli and Koppius 2012). Shmueli and Koppius (2012) offer us definitions for both predictive analytics as well as explanatory analytics, and defines several roles in which these analytics can shape. We adopt their definition for both predictive and explanatory analytics. That is to say, we define predictive analytics as a data driven statistical model for predicting outcomes based on previously collected data; we define explanatory analytics as statistical models for explaining post facto phenomena.

Next, we examine the work that has been conducted relating to electronic health records as well as hospital workflows. Work has been conducted that looks at the provider’s bottom line in terms of EHR implementation (Bardhan and Thouin 2013; Huerta et al. 2013). Huerta et al. (2013) found that hospitals that rush the implementation of EHR have lower total factor productivity than those that planned the implementation, as attributed to the shakeup in workflows. Bardhan & Thouin (2013) identified a positive correlation between best practices, implementation of health information technology, hospital workflows, and cost reduction.

Lastly, we want to offer some definitions from the public health domain. We define patient suffering as the amount of pain an individual experiences from inception to discharge within a hospital (Linn & Greenfield, 1982). We define patient activation as the process by which a patient follows up after their discharge from provider in terms of follow-up visits, medication, and engagement with the external facing health information technology that the provider has in place (Hibbard et al. 2004).
PROPOSED RESEARCH MODEL

From this literature review, we can begin to gain a grasp on how analytics can be beneficial to healthcare organizations in terms of their processes. We have identified the government forces, as well as provided a literature review around internal processes, external processes, and potential best practices. We now propose the research model offered in Figure 1.

![Proposed Research Model Diagram]

Figure 1. Proposed Research Model

INTERNAL PROCESSES AND GOVERNMENT MANDATED PROCESSES

When we refer to the internal processes, we are referring to the workflows of the healthcare provider. Whether these workflows be at a hospital or from a secondary location, typically these workflows are uniform throughout the entire organization. What we have found thus far from our initial interviews with a large healthcare provider, is that the organization has already put a large EHR system in place in order to be in compliance with the government mandate. Where this organization is at, however, is capturing some of the kickback offered from the US Federal Government in the form of working towards meeting predefined thresholds for preventative care in terms of patient activation. That is to say, this organization is interested in taking the EHR data and transforming it into analytics to engage patients after care has been rendered.

It is the case that under the Affordable Care Act (ACA) preventative care mandate that an organization with which treats an individual, and that illness returns within 30 days, does not get any federal subsidization for the second time around for treatment. From this insight alone, we can begin to understand the underlying power of utilizing the EHR data in order to build predictive analytics for preventative healthcare. From our initial interview with the organization, we were provide this direct quote from a senior level vice president: “Anything that touches the patient experience is innovation.”

In the same vein as the internal processes as to how the data is handled, the US Federal Government also has regulations in place, as well as emerging regulations tiered over the course of the ACA’s inception. Working with EHR, previously presented a quagmire of challenges in order for a patient to transfer their health records from one provider to another, but under the ACA, this process is now handled by the health information technology for both providers. While this is just one example of the process improvements offered by EHR, we can find evidence of other improvements for not just the patient, but the provider as well.

Proposition 1a: Government mandated processes will positively impact the predictive power of healthcare analytics.

Proposition 1b: Government mandated processes will positively impact the efficiency of internal workflows.

Proposition 2: Internal workflows will positively impact the predictive power of healthcare analytics.
BEST PRACTICES

When considering process improvements, it also behooves us as researchers to examine the best practices in place at the time of the research. While these best practices will align with ACA mandates at points, there is still valuable knowledge that can be gained by examining the best practices for different procedures. In this light, we can find different medical procedures are synonymous with business workflows, and that there are best practices in place for each procedure, whether it is an intervention or surgery.

In same vein of best practices for procedures and interventions, we can also identify best practices for capturing the data for the EHR. This could take shape in the form of training employees on the system, or provider specific data that needs to be captured. While there are leading implementations for EHR, it would also benefit the analytics to know the best practices for the methods by which the data has been generated.

**Proposition 3:** Healthcare best practices will positively impact the predictive power of healthcare analytics.

EXTERNAL PROCESSES

At the core of any analytics is the data. There are firms that specialize in predictive and preventative healthcare analytics. These firms present their offerings as a percentage increase in preventative care and interventions, even if it is marginal, because an increase in 20% to 21% on high cost care would still benefit the organization to make use of these statistical prowess of these external organizations. This creates interesting phenomena, in that the healthcare providers have data that can improve the external parties models; the external parties models are improved as they get more data. This synergy can be conceptualize in several different lights, but for the purposes of this research, we define the external processes as organizations with which have the statistical ability to improve the internal organization’s predictive power through data. We have found evidence to support this through interviewing an external firm as well: their models improve as they gain more data, and as the models improve, more providers are interested in their predictive powers.

**Proposition 4:** External processes will positively impact the predictive power of healthcare analytics.

ANALYTICS FOR HEALTHCARE

At the core of this research is the analytics. That is, the model for which healthcare is improved, costs are reduced, and patients suffer less. Along with this, patient activation is improved, thus improving the analytics. We have proposed four contributory factors that can improve healthcare analytics. Our goal is through utilization of case methods, we can identify factors with which information captured through EHR can improve predictive analytics, and thus improve healthcare.

FUTURE DIRECTION

While we have laid the foundation to conduct this research, there are several avenues in which will proceed with the research. The first is to identify the healthcare provider side of the analytics in depth, and gaining an understanding with which the healthcare providers can use data for patient activation. Along with this, we seek to explore how the healthcare processes are impacted by the predictive analytics; that is to say, we are curious if costs are in fact reduced to the point where the external organization is a worthwhile investment.

In terms of the external organization, we are curious as to what data is useful and what data is not. While we know that geographic distribution data, health condition data, and demographics data are important for predicting outbreaks for certain conditions, we are also curious if analytics can be applied onto the analytics themselves. That is to say, can the predictive power of a cardiovascular event also be applied to a stroke event?

CONCLUSIONS

At the intersection of data, healthcare, and government, we find an opportunity to not just improve healthcare provider’s bottom line, but also to improve patients suffering. This study presents the beginnings of an examination of how EHR data is being used with analytics to improve the patient experience. Future research plans will examine each side independently, and then merge perspectives into an overarching theme for generalizing the benefit of strategic sharing of not just data, but analytics models as well. At the core of this research, we seek to improve, eve if marginally, the patient experience for healthcare providers.
REFERENCES


