The Impact of Business Intelligence on Healthcare Delivery in the USA

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Abstract

The challenges of how to manage healthcare and achieve clinical integration in today's payment setting has become a national concern. The use of technology to help ensure healthcare quality and control cost is an ongoing research subject. Business intelligence solutions are used in many industries to garner insight from financial and operational data to make more informed decisions towards the ultimate goal of achieving efficiency and effectiveness.

This paper aims to bring the reader up-to-date with the current literature on two basic topics; business intelligence and healthcare delivery and form the basis for the justification of research on the impact of business intelligence on healthcare delivery in the U.S.A. To achieve that goal we examine BI deployment in the healthcare industry, address relevant issues and challenges, and explore the role of BI to foster certain organizational capabilities. Examples of how BI capabilities have supported organizational capabilities impacting the problems of accessibility, cost, and quality of healthcare are presented. Scholars and professionals, alike, could benefit from this study where BI is presented as a mechanism to ensure a robust and systematic approach to healthcare management with an ultimate goal of enduring impact on quality improvement and cost control.

Keywords: Healthcare, Business Intelligence, Quality, Cost, Capabilities, Sustainability.

Introduction

To improve healthcare quality, safety, and efficiency is an economic and national necessity. The role of technology to ensure healthcare quality and control cost is an ongoing debate within the industry and a subject of interest to researchers. Delivering quality healthcare requires the integration of patient health information from many different sources and availing a diverse set of users; health providers must be able to readily access and use the right information at the right time and patients should be able to access their health information in order to be able to self-

manage their conditions. Supporters of the adoption of advanced technology in healthcare consider it as an opportunity not only to enhance the quality of health services, but also transparency of economic activities and the availability of information in real time (Mettler, 2009).

As technology has enhanced diagnosis and treatment options and since lifesaving medicines are entering the market at

an increasing rate, life expectancy is on the rise. Healthcare organizations are investing millions in computer systems, diagnostic technology, and preventive care programs in an attempt to meet healthcare quality goals. These developments, however, come with a huge price tag. Health care costs now consume nearly 18 percent of the U.S. GDP (Ramsey, Ganz, Shankaran, Peppercorn, & Emanuel, 2013). Payers face difficulties compensating providers for high-cost treatments made possible by advances in technology. Claims that are inflated as well as outright fraudulent are intensifying the problem. The payers and providers in the healthcare industry, public and private, are looking into technology to reduce costs, while keeping the quality care intact.

The predicament doesn't end with the notion of quality versus cost; the healthcare industry is experiencing more scrutiny and complexity than any other single industry in modern history. Health providers and the affiliates have to understand and respond to privacy laws and information security. In addition, a vast range of factors such as health care practice regulations, patient records and requirements, practice and staff management, training, financial stability, facilities and equipment management influence the holistic view of quality healthcare. Another force altering the current condition of healthcare in the United States is the passing of the Patient Protection and Affordable Care Act (PPACA). Healthcare industry is under pressure to reduce costs and better manage care. Burke and Ingraham (2008) note that healthcare in the U.S. is at the point of colossal change. The entire industry is struggling with the notion of management of quality and cost metrics. Intensified focus on compliance with evidence-based care protocols and, a staggering number of reimbursement programs affect revenue and the ability to compete. Healthcare industry executives must evaluate an increasing amount of information to best assess their organization's wellbeing and future. Furthermore, data overload is a common problem for many care providers and executive teams, who are grappling with too much information and looking to find ways to simplify acquiring knowledge from raw data (Byrnes, 2012). Coddington (2012) argues that decision-support capabilities allow collecting data from multiple sources, such as cost accounting systems, electronic health records and other sources, and make them available to physicians and other users. He suggests that a balance between cost control and the other priorities of healthcare organizations is necessary to provide quality care. The most important issue surrounding quality healthcare is the development of measurement goals to find validated metrics. Since usually high quality is perceived to be correlated with high cost, a statement such as "reduce costs, while keeping the quality care intact," sounds paradoxical. However, Process improvement initiatives facilitated by business intelligence solutions constitute a cost-effective option. Business intelligence solutions allow garnering insight from financial and operational data to make more informed decisions towards the ultimate goal of achieving efficiency and effectiveness so badly needed in healthcare industry. In order to be able to affect financial, operations, and care management, there is a need to transform data into actionable insight, which starts with understanding that, "having ready access to timely, complete, accurate, legible, and relevant information is critical to health care organizations (Wagner, Lee & Glaser, 2009)."

Ferrand (2010) suggests the use of business intelligence tools for the analysis and reporting of quality measures. He further argues that their goal-oriented approach, facilitated by business intelligence tools, allows objectivity and diversity across clinical specialties and regions when goals differ from one scenario to the next. Frye (2010) reminds us that successful companies use business intelligence for their competitive advantage. They understand that the process of transforming data into information and then to knowledge provides answers to not only the question "what?" but also "why?"

The healthcare industry is now realizing that business intelligence framework, using root-cause analysis, yields meaningful and actionable knowledge about opportunities for improvement. Organizations are recognizing the importance of using a rigorous and systematic approach to improve return on their investment. A recent study by KLAS, a research firm specializing in moni-

toring and reporting the performance of healthcare vendors, revealed that the top five healthcare-specific functions sought by organizations from their BI products are the following: (1) enterprise analytics; (2) predictive analytics; (3) ACO analytics; (4) healthcare data integration/data warehousing; and (5) population health. Currently, a third of healthcare organizations have no BI tools, according to the KLAS study, while half are using a single BI vendor or product, and 17% have multiple BI products or vendors. Clarke (2012, p. 120) in his "rethinking business intelligence" lists four areas where the leaders of healthcare industry should build organizational capabilities by "[1]Creating a culture that advocates value, collaboration, and accountability, [2] Developing robust business intelligence systems that integrate clinical and financial data, [3] Driving performance improvement throughout the organization to improve safety, reduce variation, and eliminate waste, [4] Building risk and contract management capabilities that create, manage, and mitigate actuarial risk of provider networks of care." This paper focuses on the second area; the role of business intelligence in building organization capabilities.

While decision makers in the healthcare sector are facing the multifaceted challenges of quality, cost and compliance with regulations and patient-specific requirements, based on both clinical and administrative data, a holistic view of BI solutions can help address these challenges. Sabherwal and Becerra-Fernandez (2011) offer such holistic views of business intelligence capabilities. We build our argument upon their views and explore how business intelligence capabilities can facilitate organizational capabilities. We focus on deployment of BI capabilities in healthcare industry, address relevant issues and challenges and offer examples of how BI technology has impacted the problems of accessibility, cost, and quality of healthcare delivery.

Scholars interested in BI research should be interested in learning about BI as a mechanism to ensure a robust and systematic approach to healthcare management. Health industry professionals should benefit from this study that justifies investment in BI with an ultimate goal of enduring impact on quality improvement and cost control.

The organization of the paper is as follows: Section II describes the methodology used for literature review. Section III lays the background of the study by describing the healthcare condition in the United States. Section IV provides a description of BI benefits in health industry and addresses the (why?) question. Section V addresses the (how?) question by relating the four capabilities of BI to Healthcare Industry. Section VI offers examples of successful BI implementation in the healthcare industry. Section VII addresses the complications of BI deployment in healthcare industry. Section VIII, the final section is the conclusion and future research.

Methodology

Google scholar and other academic databases such as *EBSCO* Business Source Complete were used in an iterative manner between April-August 2013 to retrieve articles related to concepts addressed in this paper. The literature search started using search terms on the two basic topics: business intelligence and healthcare in the U.S.A. and broadened to include application of business intelligence to healthcare, business intelligence capability, organizational capabilities, and capabilities of BI in the healthcare industry. The authors of this paper independently read the sum of fifty articles and a number of federal documents, evaluated the relevance of the articles, studied the main findings, and decided for "inclusion" or "exclusion" of the articles. The criteria for inclusion were obviously the relevance of the articles to the research interest; the application of business intelligence in general and business intelligence capabilities in particular to healthcare industry. We further searched for examples of BI applications in health industry in real world settings to support the paper objectives.

Understanding organizational capability, which is the mediator between BI capabilities and healthcare delivery was an important part of this research. Organizational capability is a well-

researched topic and there are research experts with landmark articles published throughout the years. We focused on resource-based theory of organizational capabilities and emphasized the role of BI in empowering the users and elevating knowledge-based decision making. Since the use of BI in healthcare also encompasses creating a new IT infrastructure, another component of resource-based organization capability, a number of landmark articles on the topic were included. Electronic health record, a good example of the use of technology to improve healthcare delivery and related articles, were examined and included in this study. However, the notion of application of BI capabilities to improve the delivery of healthcare is quite new and not too many major articles could be found to address these issues in a comprehensive manner. The search for scholarly publications on support of organizational capabilities via BI solutions was even more limited. Hence we relied on the real work examples to support this aspect of our research.

Our goal was to bring the reader up-to-date with current literature on two basic topics; business intelligence and healthcare and form the basis for the justification of the research on the impact of business intelligence, via improvement of organizational capabilities, on healthcare delivery in the U.S.A.

Healthcare in the United States

Due to the passing of the Patient Protection and Affordable Care Act in 2010 (PPACA), the U.S. healthcare system has dramatically changed. This act is an attempt to reform the current healthcare industry through making healthcare more accessible and affordable to a greater range of patients. The PPACA has many components including incorporating technology as well as coordinating healthcare within a group of providers. Within the PPACA there is a mandate requiring healthcare practices and facilities to incorporate Electronic Medical Records (EMR). EMR's are technology based systems that are believed to have the ability to lead to major savings in healthcare costs, reduced medical errors and improved health (Hillestad et al., 2005; Meinert, 2005). The EMR mandate is set to take effect in 2014, and by this time, all healthcare facilities and practices will have some form of a technology based system in place to promote increased efficiencies.

Interoperability is needed to make it possible to share electronic health records with physicians, pharmacists and hospitals. Interoperability can even integrate individual records with evidence-based clinical decision support that provides reminders and best-practices for treatment (Hillestad et al., 2005). Through mandating that EMRs become part of healthcare delivery, PPACA provides a technology based foundation to ensure coordination of care, better quality outcomes and lower costs.

Coordination of care within a group of healthcare providers is another feature of the PPACA. Accountable Care Organizations (ACOs) are the vehicles that have been developed to deliver healthcare to populations through coordinating efforts of all the members of a patients' care team (Walker & McKethan, 2012). Since patient care involves multiple facets, it is necessary to have a system in place to plan, transition, and execute treatments. Care delivery in this system requires collecting all relevant external and internal data, then extracting and transforming this information in order to guide patients' care. The ACO model also relies on providing evidence based care that takes into consideration specific patient circumstances as well as affordability. Through this system, ACOs provide incentives for healthcare providers to work together to treat an individual patient across care settings. ACOs' focus on affordability, access and coordination is a shift from the current US healthcare system, and therefore requires the development and use of healthcare specific business process management systems and software to support the care of individual patients and entire populations (Walker & McKethan, 2012). ACOs have the potential to become successful delivery outlets as long as community wide care processes are designed so that they embody a patient centered vision of optimal care and all users that contribute to patient care are

capable of utilizing new healthcare delivery tools (Walker & McKethan, 2012). In order to coordinate care and make decisions that result in the delivery of high quality, low cost healthcare, it is essential to incorporate and utilize EMR's and shift to ACOs. Ghosh and Scott (2011, p. 396) look at quality and cost issues in healthcare and argue that "an analytic capability is especially critical in healthcare because lives are at stake and there is intense pressure to reduce costs and improve efficiency." They further argue that "the rapid growth in clinical data repositories from increased use of EMR (Electronic Medical Record) systems in patient care facilities has motivated Business Intelligence (BI) in healthcare to facilitate decision-making and improve healthcare processes" (p. 396).

The debate on use of BI in healthcare "to guide more informed decisions on financial, administrative, and clinical questions" (Hennen, 2009, p. 92) has gained general support, however the question remains as how to capture the benefits of BI in a systematic and robust manner to justify the initial investment of BI. Before addressing this question, we need to review what are the benefits and challenges of BI in the healthcare industry in the USA and the possible differences from other industries when it comes to deploying BI.

BI Benefits and Challenges in the Healthcare Industry

Deployment of business intelligence, like any other technology-based approach, to solve business problems not only brings about benefits, but also challenges to overcome. As regulations change and the amount of data increases, health organizations are turning to business intelligence (BI) solutions to harness data for precise decision-making to help improve patient outcomes, reduce costs, and ensure the future of healthcare industry. Access to timely, relevant, and accurate healthcare information is the first step. An effective healthcare practice relies not only on the availability of public health data sources, but also assessment tools to communicate information to investigators, practitioners, policy makers and the general public (Jinpon, Jaroensutansinee, & Jaroensutansinee, 2011). Incorporating business intelligence tools into healthcare practice has the ability to streamline available data and improve population health. Sabherwal and Becerra-Fernandez (2011, p. 6) view business intelligence as a system, "providing decision makers with valuable information and knowledge by leveraging a variety of sources of data as well as structured and unstructured information." Generally, there are two different perspectives of the BI systems: data centric and process centric. The data-centric view deploys BI systems to understand the capabilities within organization by collecting, transforming, and integrating data to present complex and competitive information to planners and decision makers. The objective is to improve the timeliness and quality of inputs to decision making. The process-centric perspective views an organization as a set of well-integrated processes (Hammer & Champy, 2001), where BI is to be deployed to assimilate the information into processes.

Information is the key to a successful business. The health industry is no different from any other business where the simple model of Plan, Do, Check, and Act is the key to successful processing of data into useful and actionable information. To make appropriate operational judgment, each of these steps must be completed using accurate data. The health industry has similarities and differences with other industries. Like other industries, healthcare focuses on revenue, expenses, utilization, and quality, but it differs, as it should, on using information to influence the behavior of a more diverse set of constituencies such as physicians, patients, government, insurance companies, hospital administrators, pharmacies, and more. Similarly, BI operations can be a challenge for any company, but when it comes to the healthcare industry there are added layers of complexity such as privacy issues (Cucoranu et al., 2013). Healthcare organizations collect and analyze sensitive data about patients that is governed by privacy rules.

In today's healthcare environment, there is no shortage of data, in fact; organizations are reeling in an ever-deeper pool of data. The challenge is how to convert the vast amount of available

data to valuable information and knowledge. Emerging business intelligence tools are capable of delivering all components of the "who, what, when and where" quartet more quickly than ever, with a potentially higher level of quality and assurance, and using new analysis and visualization tools (Yi et al. 2008).

Through business intelligence capabilities, healthcare providers have immediate access to knowledge that allows them to provide quality care at a low cost (Hsia, Lin, Wu, & Tsai, 2006). Mettler (2009) views BI solutions as triggers for information and data collection, processing, and distribution. Sabherwal and Becerra-Fernandez (2011) introduce four synergistic capabilities of BI – organizational memory, information integration, insight creation, and presentation, which make BI essential for every industry and specifically healthcare organization. To appreciate how BI, as a tool and a facilitator, can weave the four capabilities into the fabrics of the organization, we need an understanding of BI and its capabilities.

Capabilities of BI in Healthcare Industry

The amount of data generated by and for the healthcare industry is overwhelming and it is business intelligence capabilities that deliver value by pulling data from various sources and bringing them into a common repository, enabling a thorough analysis of data, and creating insights into routine operations while providing decision support mechanism. Whether data collection, transformation, and analysis of data triggered by the processes or routinely deployed to support decision making process, BI capabilities improve and fosters organizational capabilities by empowering the users, facilitate the IT structure, and enhance the use of structured and unstructured data. Four key capabilities of business intelligence addressed in this study are (1) organizational memory capability, (2) information integration capability, (3) Insight creation capability, and (4) presentation and communication capabilities.

Organizational Memory Capability

To start, historical data has to be captured and stored to establish the foundation of organizational memory, which is one of most important capabilities required in the healthcare industry. Organizational memory is usually acquired over the years, passed on to the newcomers through personal contacts, meetings, training courses, and mentor-protégé relationships and if not stored safely, is destroyed through downsizing, frequent layoffs, unmanaged employee attrition, and/or disasters.

Patient data comes from a variety of sources and providers, which makes it difficult to track history or manage a specific population's health without this information being readily available. According to Figlioli (2011) data are neither the problem nor the solution. The issue is the lack of ability to manage these data in a meaningful way. He asserts that a person's medical history includes data on previous medical procedures and tests, medication allergies, and prescription dosage. While this information is needed to ensure the best possible care, a physician may have access to only 10 or 20 of these critical pieces. As a result, individuals are often treated episodically by providers who have access only to a limited amount of necessary clinical information.

Health care involves a diverse set of public and private data collection systems, including health surveys, administrative enrollment and billing records, and medical records, used by various entities, including hospitals, CHCs, physicians, and health plans. None of these entities has the capabilities to collect all data for entire population of patients. Nor does any single entity currently collect all health data on individual patients.

Organization memory capability of business intelligence facilitated by data warehousing is the first step for a systematic and robust approach to capturing, structuring, and conceptualizing of knowledge assets across a range of healthcare environment. Electronic medical records systems

(EMR's) provide important input into the data warehouse, where population health information is stored and transformed. These systems make it possible to access individual records online from many separate, interoperable automated systems within an electronic network (Hillestad et al., 2005). The wealth of information on care accessibility, ambulatory services, emergency visits, patient health, insurance, healthcare disparities, healthcare quality, healthcare spending, healthcare use, hospitalization, payer information, state information on healthcare, as well as Medicare and Medicaid are staggering. Clinicians, purchasers, policy makers, researchers, and patients are the creators and consumers of the data. Organizational memory capability represents an organization's accumulated history reflecting past experiences, insights, and knowledge. Extraction, transformation (making data consistent) and loading this humongous amount of data collected over the years is the responsibility of data warehousing, a component of business intelligence. According to Sabherwal and Becerra-Fernandez (2011) organizational memory enabled by data warehouse helps organizations by enabling creation of new knowledge based information about the past.

Information Integration Capability

There is a need for better integration and sharing of data within and across health care entities and even within a single entity. According to National Research Council (2009), one way to increase the usefulness of data is to further integrate them with data from external sources. Stefanelli (2001) points out that improving the quality of shared care between a professional team "depends critically on the ability to share patient-specific information and medical knowledge easily among care providers".

Organizational memory focuses on historical data, information integration; another organizational capability supported by BI, integrates and links past data from a variety of sources that encompass organizational memory with the new, real-time content. It links structured and unstructured data from a variety of sources, such as internal databases and knowledge repositories. BI integration capability significantly reduces the time it would take a human to catalogue these data and it is intended to solve cost and quality problem in healthcare. Peter Osborne (2013) argues that an integrated approach to data could deliver efficiency and lower cost. He provides an example of a patient arriving at a primary care facility; a doctor examines him and, if required, sends him to a secondary care facility where he is re-examined and provided specific treatment if needed. The patient is then discharged, but if repeat visit is needed, the whole process is replicated with all the associated costs. BI integration technology such as text mining that allows automatic reading of large documents of text written in natural language is probably the most useful in healthcare environment where large and diverse set of documents containing all sorts of information about patients (clinical, personal, and financial) has to be integrated to provide a comprehensive view of a patient to be used by care providers and payer no matter where, when, and who.

Insight Creation Capability

This capability enables the organization to understand past events and make predictions about the future and perhaps is the most talked about contribution of business intelligence to health organizations. The first two capabilities, organizational memory and integration provide input to insight creation. In complex domains such as healthcare, when quick reflexes requires quick decisions based on information from diverse sources, a mechanism to provide reliable and quick answers is badly needed. Technologies enabling insight creation include data mining and real-time decision support systems. According to Koh and Tan (2011), data mining tools are becoming very popular in healthcare industry, where they provide an in-depth analysis of data with the purpose of building predictive models and answering questions. The authors cite examples such as helping payer, e.g., insurance companies to detect fraud and abuse, care providers to improve patient relationship management, and clinicians to identify treatments and best practices, and patients to receive

improved and better services. They continue that "The huge amounts of data generated by health-care transactions are too complex and voluminous to be processed and analyzed by traditional methods. Data mining provides the methodology and technology to transform these mounds of data into useful information for decision making (p. 64)." Benko and Wilson (2003) argue data can be a great asset to healthcare organizations, but they have to be first transformed into information.

Presentation/Communication Capabilities

It is generally agreed that ineffective communication among medical teams is a leading cause of preventable patient harm throughout the health care system. The presentation capability of BI fosters effective and quick communication and is the capability that displays generated insights in different ways to make them easy to grasp and to utilize. Online analytical processing, for example, supports multidimensional data views and allows users to aggregate, filter, drill down, and pivot the data. Dashboards allow users to customize the information they would like to monitor and facilitate display.

Business Intelligence not only provides the detailed data for analysts, but also allows for monitoring performance. In the past, BI was used only by IT specialists who had been trained to query and format data. Today, however, BI provides workers with easy access to relevant, actionable information, when they need it. BI can be used in Organizational level to achieve larger strategic initiatives, such as operating margin, return on investment on strategic investments, and quality of care goals. At the Departmental level, BI helps employees work more effectively as a team, ensuring the goals of the department are met. Personal BI helps workers in tasks they do every day.

In summary, the four main capabilities of business intelligence, build upon each other and are significant contributors to organizational capabilities. According to Bharadwaj (2000) organizational capabilities refer to "organization's ability to assemble, integrate, and deploy resources, usually in combination or co-presence." In modern business where the concept of "big data" is integral to the operation of any business, the most valued resource consists of data, information, and knowledge. As Dinesh Kumar (2009) indicates, the role of the IT industry is transitioning from a limited capability of individual/functional reporting and analysis to one that is defined by a connected, collaborative, and contextual world of BI. As the need for real-time data gathering, analysis, and decision making increases, business intelligence capabilities to assembles, integrates, and deploys data to help strategize the future path of an organization becomes more relevant.

Furthermore, one important aspect of BI is empowerment of the user to manipulate the data and ask "what if" questions. In a world of constant change, enabling employees to take responsibility for their own work situation is becoming increasingly important for organizations. According to business experts "implementing BI solutions for quick access of company resources and tools empower employees to become more adept in handling daily responsibilities with quick, positive ramifications (Blatche, 2012). Empowering the employees as the users of BI, the company adopts a more efficient use of resources in term of people, IT infrastructure, and IT deployment; the necessary components of organization resources.

Examples of Business Intelligence Capabilities in Healthcare

Business intelligence tools make the healthcare industry's shift to a technology driven, patient-centric system possible. The advantage of correlating technology and healthcare is the ability to manage various forms of data within user-friendly systems that help drive decision making. Business intelligence produces contributions, which, in turn, produces a variety of benefits in terms of

organizational performance. In what follows, we provide examples to demonstrate these capabilities in the context of the healthcare industry.

The first example illustrates how organizational memory captured in data warehouse helps provide accurate data. Business intelligence systems have several advantages, yet these systems are only effective if they have accurate data. In healthcare, data is obtained from a variety of sources, including patients, hospitals and physicians. Business intelligence tools are then able to leverage data obtained from these structured and unstructured resources to produce information of value. Data serves as the foundation for business intelligence, it is therefore essential to enhance the quality of data before embarking on business intelligence solutions. In fact, data quality is considered to be the most important technical factor for successful business intelligence, which amplifies the need for using data with strong integrity (Howson, 2008). In healthcare, determining how to best obtain and manage data is a difficult endeavor.

Cardinal Health, a global provider of integrated solutions for the healthcare industry, focused on first creating a solid data warehouse so they were capable of implementing a strong and reliable business intelligence system (Carte, Schwarzkopf, Shaft, & Zmud, 2005). Management at Cardinal Health understood how an effective business intelligence system could benefit their organization, and also recognized the need to first enhance the quality of the data in their data warehouse before embarking upon business intelligence solutions (Sabherwal & Becerra-Fernandez, 2011). This strategy of ensuring quality data was being incorporated into their business intelligence solutions and allowed Cardinal Health to develop a software system capable of assisting with making the best quality decisions for the organization.

The second example shows how integration capability helps identify patients at risk for disease. One of the greatest features of business intelligence, affecting health management, is that it has the ability to identify patients at risk for disease. This allows medical personnel to reduce risk, eliminate unnecessary tests and save patient lives. The NorthShore University Health System is an example of a healthcare organization that used business intelligence tools to tackle a specific disease state. Identifying and treating hypertension is an elusive goal that exposes millions of people in the country to the risk of heart attack and stroke. So to combat this epidemic, NorthShore University Health System took steps to control this disease (Degaspari, 2013). NorthShore's aim was to develop a way to better link practicing physicians with research and quality improvements, in order to eliminate undiagnosed hypertension within their network (Degaspari, 2013). Through the use of EMR, the team at NorthShore was able to better identify hypertensive patients who were undiagnosed or at risk, then created algorithms to determine which patients should be flagged for additional follow-up. Since the new program went live, the system has been used to identify, test and diagnose more than 500 patients with previously undiagnosed hypertension (Degaspari, 2013). Program's like NorthShore's can be implemented all over the country for a variety of disease states, which will assist with identifying patients at risk for disease and lessens the number of people who slip through the cracks of the healthcare system.

Third example indicates how insight creation capability helps discover complications from procedures. Business intelligence solutions also assist medical facilities determine potential complications resulting from procedures. At Sahlgrenska University Hospital in Gothenburg, Sweden, business intelligence was used to provide doctors with a simple, easy and fast way to sift through test results and evaluate whether a patient recovering from brain surgery had meningitis and how it should be treated (Sabherwal & Becerra-Fernandez, 2011). The hospital implemented a business intelligence tool that was able to provide a real-time decision support system that doctors could use to see the most recent test results compared with patient records over time (QlikTech International, 2007). Without a business intelligence solution in place, the physician would be tasked with manually sifting through vast amounts of data to hopefully make an accurate diagnosis. In this instance, business intelligence software helped address complications arising from cra-

nial surgery, and was able to make the hospital more efficient and improve the treatment of critically ill patients (QlickTech international, 2007).

The last example is to portray how presentation capability of BI helps improve care communication. Communication is a key area improved through business intelligence. With the addition of multiple practitioners, various facilities to obtain services and involvement of insurers, it is necessary to have efficient means of communication to ensure best patient outcomes. Colorado Beacon Consortium is an example of how a regional health information exchange, a large independent physician association, the largest hospital in the area, and the regional health plan, came together to share data so that they could improve care management and care communications across a vast patient region (Hagland, 2013). Although these four Colorado care groups ran on different EMR systems, the CBC's goal was to implement their business intelligence solution into the existing EMR based practice workflows. This integration allowed all areas essential to patient health in this region to share data and information, and enabled better decision making related to patient care.

Table one illustrates business intelligence area in healthcare.

Table 1: BI Deployment in Healthcare			
ORGANIZATION NAME	**INDUSTRY**	**BI TOOL**	**BENEFIT**
Cardinal Health	Healthcare	Data Warehouse	Quality Data
Northshore University Health System	Healthcare	Integration	Ability To Identify At Risk Patients
Sahlgrenska University Hospital	Healthcare	Insight Creation	Discover Procedure Complications
Colorado Beacon Consortium	Healthcare	Presentation	Electronic Communication Between Multiple Care Sites

Complications

While the benefits of using business intelligence for health management are recognized by the industry, there are still a variety of factors that have prohibited new systems from transforming the healthcare industry. One of the major obstacles is the difficulty in implementing technology into current practice. Researchers from RAND Corporation suggest that the adoption of healthcare technologies could, on the average, save more than $77 billion (Hillestad et al., 2005). Yet despite the savings and efficiency, technology based systems have not been embraced by all healthcare providers. Some experts note that high initial costs for BI technology implementation deter providers, especially those in small group practices, from adopting new technologies (Takvorian, 2007).

Even with the government mandate for healthcare providers to put EMR into action, as well as providing incentive programs and assistance with implementation, broad adoption has been slow. In fact, even for those providers who have some form of EMR, it is rare that they are using a fully operational system capable of collecting patient information, displaying test results, allowing providers to enter medical orders and prescriptions and helping doctors make treatment decisions (Takvorian, 2007). For population health to be managed successfully, technology based systems must be fully operational and incorporate all areas of patient health.

Privacy and security are also concerns when technology systems are involved with patient care. While the Health Insurance Portability and Accountability Act, more commonly referred to as

HIPPA, protects patients' personal health information, it does not alleviate anxieties related to electronically storing healthcare data. Polls show that Americans remain deeply concerned about the privacy and security of electronically stored health information (Blumenthal, 2011). In order to better protect patients' personal data, stronger security solutions for technology systems must be developed, as well as implementing safeguards to limit issues arising from human error related to using healthcare technology. Developing tools that not only give patients the confidence that their private health data is protected, but also defends against potential security breaches is an essential part of incorporating business intelligence into population health management.

Finally, in order for business intelligence tools to be utilized at their full extent, they must possess strong usability and presentation abilities. While some systems offer many technological advances and have the ability to generate vast amounts of data, the end users are not always capable of interpreting this information, determining what is relevant and avoiding mistakes. Poor usability can result in errors that threaten patient safety, loss of productivity and the failure to realize the quality and efficiency benefits of health information technology (Blumenthal, 2011). The main advantage of incorporating business intelligence into business operations is producing useful data. Therefore, it is essential that systems are simple to both integrate and navigate in order to provide information leading to better decision making. Additionally, the information generated via business intelligence tools should produce valuable results that are easily interpreted by the end-users. These presentation capabilities are especially significant because organization members need technologies to support tactical and strategic decision making (Ward, 2012) but the information produced is only valuable if the end results are easy to comprehend and put into practice (Sabherwal & Becerra-Fernandez, 2011). If a business intelligence tool is implemented and it lacks usability or does not present data that assists with strategic decision making, the final result is an expensive undertaking that generates information of little value.

Conclusions

The best approach to managing population health has become an increasingly discussed topic. As changes are made to the healthcare system, and cost and quality have become frequent concerns, the current approach to healthcare delivery is evolving. One of the biggest challenges in responding to this change is how to coordinate patient healthcare needs. If the healthcare system can effectively coordinate healthcare between patients, providers and facilities, it will contribute to better management of entire communities' health. Business intelligence tools provide solutions that help healthcare providers effectively manage population health. Since technology has now become an integral part of the healthcare industry, it is essential that healthcare organizations integrate appropriate business intelligence systems into their operations.

To survive in a competitive market, healthcare providers need a strong BI foundation to correlate, analyze, and glean insight from financial and operational data. Providers are hoping BI tools can accomplish an assortment of functionality, including analysis of financial and departmental data, including emergency, surgical, and pharmacy analytics, as well as insight into physician quality, performance improvement, and patient outcomes. The insights garnered from these tools can also help leaders better understand accountable care organization (ACO) activities, especially as new ACOs and reimbursement change emerge under healthcare reform.

The contribution of this research is to show how the four capabilities of BI, in combination, use data and information to generate knowledge that serves as input for decision making in health care industry. How these capabilities are realized in different contexts is a valid research question and requires an understanding of the context and the idiosyncrasy of the industry. Based on this argument, we have relied on existing literature to show how BI capabilities support organizational capabilities in healthcare industry and provided examples of their effectiveness to improve quality care and reduce cost.

Overall, the literature search concentrated on the existing knowledge on basic concepts such as BI, BI capabilities, healthcare in the United States, organization capabilities, and use of technology in healthcare. We then built upon those existing knowledge to show how in combination they further the efforts to improve healthcare delivery in the United States.

Future studies could generalize these concepts by collecting data from care providers to find out the extent to which these BI capabilities are implemented and measure their impact on the effectiveness and efficiency of healthcare delivery. Questions such as which capability is the most crucial, which is the most costly, and which is the best in terms of cost-benefit analysis could be examined. The authors of this paper are investigating the possibility of conducting this line of research through a case study.

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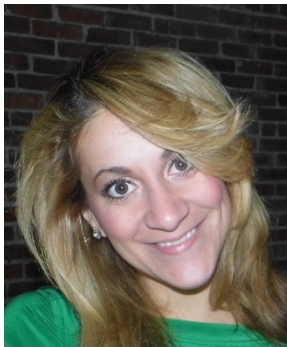
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