

**EXAMINING THE USE OF BUSINESS INTELLIGENCE IN HEALTHCARE
MANAGEMENT: AN EXPLORATORY STUDY**

Kakoli Bandyopadhyay
Lamar University
Department of Information Systems and Analysis
Beaumont, TX 77706
409 880 8627, bandyopaku@lamar.edu

Dyni Brookshire
NaphCare, Inc. at the Jefferson County Correctional Facility
Beaumont, TX 77705
409-729-2526, dyni.brookshire@naphcare.com

Victoria Duncan
Lamar University
MSN Administration
Baytown, TX 77523
281-794-2301, vnduncan@my.lamar.edu

Troy Felix
CHRISTUS Health
Beaumont, Texas 77702
409-899-8276, troy.felix@christushealth.org

Mansi Saha
Lamar University
College of Business
(409)504-2731, mansi224@gmail.com

ABSTRACT

In this paper on Business Intelligence (BI), we discuss four healthcare organizations where decisions are supported by a BI system. First, we define Business Intelligence. Second, the overviews of the organizations are presented. Third, we discuss how the organizations gather business intelligence and what the drivers of BI are. Fourth, we report what kind of tools and technologies and data analyses they use. Fifth, we list the benefits and the costs associated with the solution. Finally, we discuss the strategic advantages achieved by the organizations from the use of BI and the possible future options that they may expand on.

BUSINESS INTELLIGENCE

Business Intelligence (BI) refers to architectures, tools, databases, applications and methodologies to help a business acquire better understanding of its operations. Business Intelligence often aims to support better decision making. BI can also help a company achieve increased sales through marketing changes based on demographic data, or help create efficiencies with operations.

Company Overviews:

Cleveland Clinic: Cleveland clinic is among the nation's top 10 and the world's largest health care providers. Cleveland clinic works with more than 2,000 physicians and scientists and manages around 4.2 million patient visits per year. It's a multi-specialty medical center which has eleven hospitals, sixteen family health centers and five ambulatory surgery centers. The organization has expanded its branches in Florida, Nevada, Canada and Abu Dhabi. Putting everything together, the organization has a combined total of 3,400 beds and 40,000 employees.

NaphCare, Inc: NaphCare, Inc. is a corporation that provides managed care for correctional facilities in the United States. NaphCare employs approximately 800 people in locations in 24 different states. In the penitentiary market, NaphCare provides comprehensive health care specific to each inmate's needs. The CEO of NaphCare, Mr. McLane describes his mission for the company as utilizing "technology to the fullest with implementation strategies and techniques."

Harris County Hospital District: Harris County Hospital District (HCHD) has two major hospitals. Ben Taub General Hospital is located in the Texas Medical Center at Houston, Texas. Ben Taub provides care to more than 10,000 emergency room patients on a monthly basis. Lyndon B. Johnson hospital is the other large hospital within the Harris County Hospital District system. LBJ provided care to approximately 64,743 emergency room visits as per 2009 census. The total number of patients that were seen by HCHD in the year 2009 was 891,475. The magnitude of patients that are seen by HCHD employees requires a competent, trustworthy and reliable computer system that supports the functions needed to provide appointments, scheduling, and order entry.

The Christus Health System: The Christus Health System is primarily a health care service oriented company which has established a domestic presence within Texas, Louisiana, New Mexico, Missouri, Arkansas, and Utah. Christus Health has also established international businesses comprised of hospitals, and minor care clinics within Mexico, Ireland, and several nations on the continent of Africa. In most cases, Christus Health does have competition within each community of operation and often these competitors have comparable technologies. The Health Care Reform Act, 2010 has forced an unprecedented change in the way that health care is delivered in terms of cost, quality of care provided, and patient satisfaction. The current and emerging health care re-imburement environment coupled with the demand for reliable quality data have driven the Christus Health system to rely on business intelligence systems of data mining allowing the company maximize re-imburement and access to up-to-date information.

Intelligence Gathering and BI Drivers

Cleveland Clinic gathers intelligence from the databases of its various departments. Each department in the hospital has its own self-contained processes, systems and databases. The primary challenge for implementing the BI project was to integrate this data and bridge the gap between different information silos of hospital's departments. To overcome this problem, IBM business consulting services designed an integrated solution for Cleveland Clinic. IBM gathered and integrated information from various sources such as patient's billing and treatment databases. Data mining process was performed on accounting, inventory, human resources, and various other departments of the organization. Cleveland Clinic took assistance from business intelligence tools to streamline the flow of information within the hospital, and to make key processes more efficient. In addition to enabling changes in the flow of patients' information, it also helped in transforming information to a more strategic asset, and eventually utilizing this strategic asset as analytical and decision making tools. During the time period of 1993 to 1994, Cleveland clinic identified a few operational drivers which had a very deep impact on company's financial performance. As a result, the company started to look for hidden triggers that can start bringing drastic changes in performance, lowering the cost, and at the same time increasing the effectiveness and the efficiency of the use of company's scarce resources.

NaphCare gathers much of its intelligence through Tech Care software and the many reports that are available. The Tech Care system increases the efficiency and accountability of the health care program, while following local, state, and federal standards of care. TechCare is not only an electronic medical record for the inmates but it is also a tool that can be used by the site administrator for reports on a daily, monthly, or yearly basis. These reports are used not only for accreditation purposes, but can be used for gathering information for jail administrators as well. The drivers for the BI project in NaphCare are to maintain quality as well as cost efficiency. Correctional health care is very competitive and the ability to contain cost is one of the key factors to compete with other companies.

HCHD uses the Epic computer system to collect data. The Epic software is used to schedule patient appointments, make referrals, track patients throughout the hospital stay to discharge and follow up care within the community clinics. Epic allows doctors to make notes, prepare discharge summaries and any documentation that is required for tracking needs. Hospital employees can use Epic to make follow up referrals and appointments via electronic scheduling. Trends in diagnostic results over the years can be observed, which is very helpful when monitoring patients' healthcare over a period of time. Epic also has the capabilities for charge entry in order to bill patient accounts. Epic allows all departments within the facility to enter pertinent information related to the patient and to access information from any HDHC location according to their role in the organization. Entry of information serves as a legal documentation of patient information and cannot be deleted or changed and is protected by government agencies.

The need of having a healthcare system that provides integration and entry and retrieval of functional data is the major driver that promotes business intelligence within HCHD. Business Intelligence capabilities provides optimal healthcare to the residents of Harris County along with the better work environments for employees.

The Christus Health system utilizes a variety of information gathering systems such as Meditech for clinical documentation, Medmarx for medication related adverse reactions, PAC's for imaging documentation, an access database as well as a RiskMaster database for entering other adverse or unexpected outcomes, as well as a host of other databases used by local and corporate wide entities. In spite of having many information gathering systems in place, a newly adopted system called Crimson offers perhaps one of the most dynamic, cost effective, and reliable information gathering and reporting capabilities to date for the health care system in Christus Health system.

The drivers for business intelligence for Christus Health are increasingly evident as we move away from an environment where costs and expected profit margins are covered by payers to an environment where the patient satisfaction quantified by lower lengths of stay, lower pharmaceutical costs, lower durable medical equipment use, and generally better health in a shorter time frame, is achieved. The Joint Commission which accredits hospitals on behalf of the governmental payers has now required providers including hospitals to conduct "ongoing professional performance evaluations" on each physician at least every 6 months. This includes scrutiny of physician's outcome for patients under their care, complications during the stay, mortality rate, citizenship issues, documentation requirements, and currency of licensure and continuing education as required by the state board by the hospital or clinic. This new requirement of sharing information on an every 6 month has also necessitated the use of a business intelligence system that can produce reliable and timely results in a cost effective way.

BI Tools and Technologies and Data Analyses

In Cleveland Clinic, IBM Healthcare and Life Science Clinical Genomics Solution are being used. This solution was used with the support of software such as WebSphere which includes a web server, WebSphere Application Server, LDAP directory, IBM DB2 database, development tools, web site templates and other essential site management tools such as a configuration wizard. They are using IBM DB2 for the data warehousing. Business Object Set Analysis Dashboard Manager, Web Intelligence and Application foundation are some other tools being used by the company. For the data analysis function, the company used "Tableau" – a data visualization software.

Cleveland clinic uses multidimensional visual data analysis to analyze multiple data sources—diagnostic, clinical, demographic, genomic, phenotypic, life style and more—to enable focused clinical research. Multidimensional data analysis provides a variety of charts, graphs, and other visuals which are easy to interpret. Data analysis also enables the clinic to build dashboards to share data with others. Visual analysis helps to better understand integrated genotypic and phenotypic data for medical research and patient treatment. Cleveland clinic also uses Tableau for visual data analysis, trending, and reporting. Visualisation allows the clinic to identify trends among large groups of data.

NaphCare uses Microsoft SQL database server for its BI tools as well as dot.net and PHP processors. The company has looked at the Cognos BI system but has not purchased it, at this time, due to the cost of the software.

Health Service Administrators (HSA) at each of NaphCare's sites are able to access the BI network to obtain many different reports. Each individual health care institution is capable of not only accessing periodic reports but also generating other reports on demand as per the Health Service Administrators' request. This allows the administrator to closely watch costs incurring at the site from medication, employee salaries, and supplies ordered, etc. As all health care is contracted by the correctional facility, the information gleaned by the BI system helps the HSA to ensure that contractual obligations are being met. The pharmacy at the corporate level can also access drug orders as soon as the order is entered and can monitor and notify for contradictions that may occur between different medications.

In HCHD, the tools and techniques used include the Epic software system. The tools include the use of point and click medication reconciliation system, collapsible/expandable flow sheets, electronic medication administration record, interdisciplinary care plans, outpatient support systems, clinical pathways, and pharmacy reconciliation documentation.

In HCHD, the Epic computer system provides tools that aid in analyzing information to better serve the needed queries and documentations required to guide and maintain a large healthcare facility. HCHD continuously monitors and evaluates the effectiveness of the system that is in place. Support teams nurture the opinions of employees in meeting the needs of every department. HCHD uses the system to collect data pertinent to average wait times in emergency rooms, length of hospital inpatient admissions for certain medical diagnosis, and cost of certain surgeries. Analysis of time, cost and productivity can be measured as needed by managers, directors and administrators.

In Christus Health, the BI tools called "Computerized Physician Order Entry" or CPOE and the electronic order entry system have improved the process of correlating utilization of resources to the appropriate physicians. The power in this approach is in motivating physicians to change a practice pattern when their peers are having better results with a lower level of utilization of resources.

Christus Health recognizes that not only is business intelligence needed for the traditional health care delivery models such as hospitals and clinics but also for other emerging trends within the outpatient setting. Outpatient services are expected to continue to diversify and business intelligence has helped determine where the emerging trends may be directed. The concept of "remote monitoring" of patients in their own home with the use of emerging technologies has been determined through business intelligence as a viable near future direction that Christus Health would like to pursue.

Benefits and Costs of BI

Many problems were solved at Cleveland Clinic through the implementation of BI. Some of the key benefits are:

- Clinic used the method called 'Performance wheel'. This helped Cleveland Clinic to view the monthly performance against the monthly targets and goal. Various changes were made to the financial and accounting function of the clinic. To decrease the denial of the

claims, the revenue cycle was generated. The accountability for having prior authorization from the clients is established. All the afore-mentioned changes lead to better patient access and increase in operating income.

- Business intelligence system such as dashboard helped unit managers to concentrate only on the information they think is helpful. This helped in generating more accurate results.
- Dashboards are helpful tool for performance improvement. Clinic uses dashboard for recording the performance improvement of the nursing department.
- Key Performance Indicators displayed in dashboard are used to cut overtime cost and to solve the agency problem at the Cleveland Clinic by nursing managers.
- Reduction in the Nursing agency expenses resulted in major decrease in the annual expenses. The annual expenses were reduced by more than \$ 5 million.
- Blood utilization dashboard proved to be a very useful tool in monitoring and controlling blood products. This is used to control the excessive use of blood and blood products in the hospital by physicians.

Cleveland business intelligence project costs approximately 4 million dollars. Some of the costs associated with the project are: Installation and running of DB2 data warehouse; purchase of various business intelligence products from IBM business partners including business objects; installation and management of WebSphere portal for multi platforms; and integration of various parts of BI project.

One of the major benefits of Business Intelligence to NaphCare is the efficiency in assisting the health care providers in the delivery of care. Nurses have quicker access to patient information and that too in real-time. Another benefit to NaphCare is the quality assurance that Business Intelligence provides. As information is provided in real-time there are fewer chances for error. With medication entering on the patient medication administration record as soon as it is ordered, the medications are administered in a timely manner. Patients can be referred to a provider as soon as they enter the correctional facility and there is no delay on care while waiting for a chart to be made and papers to be found and filed.

The IT Department at NaphCare consists of seven people at this time. There are also costs associated with licensing and fees for the SQL database server. At the Jefferson County Correctional Facility in Beaumont there are 13 desk top computers, five laptop computers, and a server for the site, multiple printers, and a wireless network connection. This is one of the medium size penitentiaries with about 900 inmates. The facility in Clark County, Nevada houses over 3000 inmates and the number of equipment and the infrastructure cost is much more. There are records that are not available in Tech Care system and they have to be scanned into the system and placed in the patient record. For this process there is a printer/scanner that is utilized.

The major benefits of the business intelligence within the HCHD community are the effectiveness and accuracy of data collection. It supports the operations of the entire healthcare system. Without the use of the Epic system within the organization, there would be ultimate chaos and confusion. The benefits of the use of Epic outweigh the cost and complication of training and updating. The additional benefits include support in training and promote a collaborative work relationship.

The cost associated with the use of the Epic computer software system in HCHD is enormous. For instance, the cost of overtime for employee training is outrageous. The estimated amount of money spent for one nurse on an 8 hour overtime day is approximately three hundred and fifty dollars. Throughout the year there are several updates that require additional training time. The cost of the system periodic updates is also substantial.

The Christus Health system has utilized a labor productivity model known as “Visionware” which accounts for patient census, patient acuity, and case mix index as a means to determine an overall productivity index. The goal is to maintain an overall productivity index of greater than or equal to 100% over a 2 week timeframe. Managers are able to run reports related to productivity on a daily basis to determine an appropriate staffing and experience level needed to safely care for patients at that time. These reports would be at best difficult to run with any level of reliability without the use of a business intelligence system that draws from a variety of sources for reporting recommendations. The fact that reports are generated daily equates to a much more responsive organization to downward as well as upward trends in census and case mix index (severity of patients illness) and the end result is an organization that can “flex” staff as needed to care for patients and to maintain a much more predictable bottom line in terms of profitability.

The true costs of business intelligence for the Christus Health system are difficult to quantify because there are a many complexities to the system including numbers of information gathering and support personnel, functions within the system that are done solely for the purpose of gathering business intelligence, and a great deal of variability in the cost of using products such as the previously mentioned Crimson product. However, after speaking with an information systems specialist there is currently a significant expenditure allocated toward business intelligence and this expenditure is expected to grow as the system becomes more adept at utilizing electronic operational databases and supports the conversion of physician office systems in the endeavor as well. Use and access to the Crimson product alone accounts for about \$250,000 to \$300,000 per region of which there are 7 regions within the system.

Strategic Advantages

In Cleveland Clinic, starting from the year 2006, there is a reduction in the nursing agency expenses and this reduction is more than \$5 million per year. Careful analysis of blood product use has enabled Cleveland Clinic to reduce its expenses by more than \$400,000 annually. Blood utilization dashboard is used to extract physician ordering information and haemoglobin level of the patients for whom the blood product was ordered. This can be done from the organization’s data system and then can be drilled down to the department and physician if blood products were ordered for patients with haemoglobin level greater than or equal to nine (patient for whom blood product may not be needed). Also, data has shown that there is seasonal shifts in employment. The human resource department can use this information to prepare for changes in advance.

In NaphCare, one advantage from the BI system is cost containment. When stock can be monitored in the BI system, there is control over what is ordered versus what is needed. There is also the advantage of quality. Since the system is in real-time, information is accessed

immediately. In a health care setting this is important to maintain quality and minimize errors that might occur.

In HCHD, advantages include the use of the Epic computer system and the ease of learning with supportive measures provided by the company. The epic computer system allows for quick retrieval, clear, and concise steps to obtain requested documentation. There is less confusion and loss of information due to the tabular system. Another advantage of the Epic system is the ease of tracking employees' use of the system. This allows system administrators to determine misuse of medical record, to prevent fraud and health insurance portability and accountability act (HIPAA) violations.

In Christus Health, strategic advantages in terms of lower costs, more appropriate allocation of resources, and overall better care delivery are all advantages to using the business intelligence systems. The problem of patients accessing the wrong type of care has begun to see improvements as the hospital system has supported the use of medical homes known as "Federally Qualified Health Care Centers". Just as in the inpatient setting where access to current, reliable information is essential to the success of the organization the free-standing community based Federally Qualified Health Care Center (FQHC) is in need of this information as well. This is where data mining applications are able to assist each organization in directing and coordinating the best care setting for each patient.

Recommendations

Cleveland clinic has a large database of clients and the volume of data is increasing on a daily basis. As the volume of data increases, the Clinic needs to upgrade various components of business intelligence systems to handle the changes. A periodic check is necessary to see the efficiency and productivity of the current business intelligence system. If the productivity or efficiency seems to decrease, a corrective action should be taken immediately. Cleveland Clinic holds the critical data and they should emphasize on the preciseness and validity of the results they are getting from various researches. Clinic should always check and make sure that the procedures and methods used to safeguard the information of clients are up-to-date. Cleveland Clinic is extending its operation to other countries as well. Therefore they need to upgrade their communication component of their business intelligence system according to the country of operation. This is important to match with the communication capability of the new branch.

One of the recommendations for NaphCare, Inc. would be to provide a better tool for the sites to maintain an accurate inventory count. At this time, supply inventory is done with pen and paper. While the medication inventory can be monitored at the corporate pharmacy level, there is no inventory for medications at the site level. This would assist not only the person in charge of ordering supplies and medication, but would also give the site administrator a day-to-day cost analysis of these items. In the medication administration record, medications are documented as given or not given, with a reason that the medication is not given, at the time of pill pass. Another suggestion for the medication aspect of the BI system is an alert that comes up at a certain time interval for any medication that was missed. This would provide a safety feature to prevent missed medications. Another aspect of the medication administration record is the ability

to order the medications. However, there is no alert that shows if a medication is ordered in which the patient has an allergy. Medications administered that the patient may be allergic to can have an adverse outcome. An alert that is put in place to notify the ordering provider that the patient has an allergy to a medication that is being ordered would notify the provider as the medication was ordered to ensure that a different medication could be chosen. The last thing that could be recommended is some way to track the sharp instruments at each site. In a correctional environment, all sharp instruments must be counted every shift. This can be a tedious task as this includes counting needles, intravenous catheters, syringes, toenail clippers, scalpels, sutures as well as suture removal and staple removal kits, dental instruments, etc. If part of the BI system could include an inventory and tracking system of sharps, i.e., what it is, the amount of the item, who might have used one and on whom, this would increase the accuracy of the system as well.

After reviewing and utilizing the Epic system from the standpoint of an HCHD employees, we would recommend the continuous use of the system. The emergency center track board is easy to monitor, including the length of emergency room stays, the updated process of diagnostic studies and easy accessibility. The choice to operate with the Epic system prevents unnecessary down times that slows patient flow and care. The recommendation to the company is to offer onsite training sessions. Many times it is necessary to travel to the medical center for required training. We would also recommend the increase of computers for nursing staff. At this time there are limited number of computers. The other recommendation is the EMAR program has multiple repeat screens that require duplicate entries, causing greater time to document medication administration. Many times the crossover between pharmacy and EMAR is delayed. The recommendations are minimal and are suggested from an employees' perspective, without prior knowledge of cost and editing ability.

Home care is expected to grow in this environment but the industry will look quite different than what we know as home care today. This switch to home care is thought to significantly decrease cost. Christus Health would do well to plan now for this transformation to the home setting by establishing how business intelligence should be designed in order to sift through large databases of information for trends that can be used from clinical decision making, an operational, as well as tactical standpoint to market goods and services. Another recommendation for Christus health is that there are still many databases which contain valuable information that could be used to the companies advantage if only there were a defined process and personnel that could tap into the information. The Crimson product that was previously mentioned is a step in the right direction but working closely with the administrators of the product to further enhance the data mining and reporting capabilities would certainly benefit Christus Health. A final recommendation would be that Christus Health should be applauded for the current level of use in the area of business intelligence and would be well advised to continue to refine and enhance this important aspect of doing business in a competitive environment that exists today.

References Available Upon Request.