Business Intelligence Primer for Healthcare Professionals

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Abstract

This whitepaper defines business intelligence (BI) concepts in the context of the healthcare domain. A BI solution is defined by the business specific questions it can answer. BI adoption has been slower in healthcare while BI adoption has been successfully implemented in many other areas. This white paper explains BI in both the general and healthcare specific contexts, defines the most common BI terms, explains the various BI maturity levels, and discusses how to implement a BI solution effectively, both in cost and effort.

This document was written for those in various healthcare professions, clinical or administrative, who wish to learn more about business intelligence. A physician, nurse, surgeon, office manager, business analyst, or a CIO will find useful information that will help navigate through the BI paradigm and its related concepts and terminology.

Introduction

Business intelligence as a concept is elusive in healthcare. While BI has caught up and advanced rapidly in other sectors (financial, insurance, retail) it remains mostly uncharted territory for both physician practices and hospitals. The primary reason for this is lack of understanding of the benefits of BI and justification for taking the time to deploy and use BI as a strategic tool.

Although the healthcare industry produces massive amounts of data it has failed to produce some of the most important data due to the failure of properly implementing or not using meaningfully, or at all, an Electronic Health Record (EHR). This shortcoming is easy to fix. Meaningful Use initiatives promoted by American Recovery and Reinvestment Act of 2009 (ARRA) are driving adoption of EHR systems. Once installed and used, the next logical step is to use the data captured by the EHR system for advanced analytics.

Many hospitals and physician practice organizations feel overwhelmed with the requirements and demands imposed by implementing technology. BI is a guiding compass that can help alleviate the difficulties and challenges. BI will help you better understand your business or organization by providing clarity using data necessary to make the right decisions at the right time. BI will help you identify broken processes and best practices. Your
organization can use this knowledge to save costs, minimize problems, and improve healthcare – sometimes in dramatic ways.

Both Meaningful Use (MU) and the Accountable Care Organization (ACO) model will place demands on both primary physician practices and hospital organizations to be effective at making timely decisions with accurate information. Staying competitive no longer will allow you to maintain paper charts in manually searchable folder racks. The future is electronic. The benefits are clear.

If you are modernizing your business, this white paper will provide clarity and insights on how to most effectively proceed.

What is Business Intelligence?
Business intelligence is an organizational framework comprised by a set of platforms, tools, capabilities, and processes mostly powered by Information Technology, that assist an organization in converting their data and information, which may be dispersed throughout various source and storage systems, into actionable and predictive knowledge. BI is also known as Clinical Informatics, Healthcare Informatics, Health Analytics, among others. With some subtle nuances, they all mean the same thing.

One of the primary goals of BI is to leverage existing data and information to make better and quicker decisions. A well-tuned BI system can also be called a Decision Support System (DSS). DSS uses past performance to model future performance and predict outcomes.

In short, BI should offer accurate and trusted information delivered in a timely manner to ensure precise decision making.

What is the Value of BI for a Healthcare Organization or Professional?
As a healthcare professional, whether you are a physician, surgeon, clinician or a manager, you spend hours every day generating, consuming, and transporting large amounts of data as a routine function of patients care. Business intelligence enables you and others to use this data for reporting, quality, research, monitoring, and statistical and predictive analysis to improve many facets of providing healthcare to your patients.

BI provides the ability for a health system, provider, payer, or other healthcare-related organization to get the right information to the right people at the right time in the right format via the right channel. Healthcare is already accustomed to volumes of data and the issues related to archiving, retrieving, and protecting this data.

Business intelligence enables the organization to use this data to identify broken workflows, locate trends, improve performance, increase profitability, and make patients healthier.

BI technologies provide historical (past), current (present), and predictive (future) views of business operations. BI is a key requirement to make this information actionable and is instrumental for fulfilling the goals of the four following initiatives.

1. Meaningful Use
Recent healthcare reform and specifically the ARRA HITECH Act has placed providers of all sizes in a very challenging position. Adhering to the Meaningful Use provision of the Act requires not only that your electronic medical record system helps you collect the required data, but that you are also able to report on specific measures.

For Stage 1 of Meaningful Use it seems trivial and possibly something that can be done with little effort and even manually, but as the stages progress to 2 and beyond, the complexity can be overwhelming for both small and large organizations. BI is a way to make this data actionable and give your practice or health system the ability to smoothly navigate through the ever-increasing complexity of MU.

2. Accountable Care Organization
Accountable Care Organizations (ACO) are an indirect result of the ARRA HITECH Act. The intention of an ACO was primarily to create a patient-centered model in order to manage the health of the patient before the onset of a disease or the down-spiraling of an existing one and to also save money for both Medicare and Medicaid programs. Surprisingly, the ACO concept has been gaining traction throughout the entire U.S. healthcare system and it is being adopted by organizations regardless of whether they operate under the terms of CMS or not.

More than 88 private organizations have initiated their own ACO initiative aside from the 32 pilot ones that were sponsored directly by CMS.

The complexities underlying an ACO cannot be underestimated. Complex systems have to interact with each other; data will have to be gathered from multiple origins or sources; users will have to be able to access the data in a way that it is trusted and reliable. Data governance becomes critical.

Population health management and chronic disease management become of paramount importance to manage and keep patients healthy and out of the hospitals.

There is no other way to be a successful ACO without the aid of BI or clinical intelligence.

3. Core Measures
The Joint Commission (former JCAHO) and Centers for Medicare and Medicaid Services (CMS) require hospitals and ambulatory clinics to abstract patient compliance
data and report specific results on a quarterly basis. This information is compiled and is available to the public at http://hospitalcompare.hhs.gov.

Reporting this information up to three months after the patient has been discharged is slightly useful. Some health systems are using BI concepts to identify these patients in real time and managing their completion of the requirements of Core Measures while the patient is still in the hospital.

4. Physician Quality Reporting (PQRS)
The Physician Quality Reporting System provides an incentive payment for eligible professionals who satisfactorily report data on quality measures for covered professional services furnished to Medicare beneficiaries.

Common Business Intelligence Terms
Let’s start by defining and explaining the most common BI terms. We’ve categorized the terms and concepts in two groups: basic and advanced. The advanced terms and concepts are primarily for information technologists and business analysts. Knowing these terms and concepts will enable you to use, purchase, and design systems to leverage business intelligence.

Basic Terms and Concepts — Key Performance Indicators (KPI)
Key Performance Indicators are quantifiable measures that reflect the critical success factors of an organization. They help a business define and measure progress towards successful target goals. KPI are the fundamental components of an organizational report card. The goal for any KPI is improvement. Process improvement is realized by identifying the right KPI and monitoring their values and trends over time. Some healthcare KPI include:
- Number of patients admitted
- Number of patients discharged
- Average length of stay
- Number of readmissions
- Number of patients who are smokers
- Patient weight and height
- Amount of claims accepted
- Amount of claims denied
- Gross days revenue outstanding
- Payer
- Aspirin administration at arrival
- Pneumococcal vaccination
- Median time from ED arrival to ED departure for admitted patients

Scorecard
A scorecard is also known as a report card. It is a list of KPI that are specific to a given program or department. It is generally a small window showing each KPI, the goal for that KPI, and the actual value achieved. Scorecards are usually categories of KPIs. Healthcare categories can include:
- Meaningful Use measures
- PQRI measures
- Core measures
- Financial measures
- Operational measures
- Patient satisfaction measures
- More advanced scorecards will use icons and color to prove a visual representation of the group’s progress.

Dashboard
A dashboard is a term taken from the automobile. Every car or truck has a collection of gauges, lights, and numbers that give the driver an immediate snapshot of the current condition of the automobile. Automobile dashboards contain at least a speedometer, an oil pressure indicator, a temperature indicator, a battery indicator, and an odometer.
A healthcare dashboard adheres to the same concept, only the data displayed is specifically related to the healthcare journey for a given department. A nursing department might have a dashboard showing patients along with their current status. The finance office dashboard would include measures and data that are more relevant to the day to day, month to month, and yearly financials. The quality office dashboards would include core measures, patient satisfaction measures, or physician quality measures. Most business intelligence systems enable the health system to organize measurement data in ways that are meaningful to the specific audience.

**Figure 2 - ACO Dashboard** is a sample dashboard showing a scorecard with drill-down capabilities on the right side of the page. **Figure 3 - Orthopedics Dashboard** shows another sample dashboard based on several different chart types. **Figure 4 - Medical Dashboard** shows a dashboard that includes a scorecard, trend analysis, plus drill down. Note, there is no single “best” format for a dashboard. The key is to include information in a format that best illustrates the measures and analysis needed.

**Drill-Down**

Drill-down makes reporting more powerful and useful. This gives the healthcare user the ability to see data and information in more detail. For example, you may have a dashboard with a chart showing admits by month for the last year. Drill-down enables the researcher to right-click on a month, select a different dimension for this data such as by provider, by payer, or by patient gender. Selecting a dimension repaints the chart highlighting the selected dimension. The researcher can now select another dimension and...
that make up the measure they are researching. Drill-down is one of the key benefits of a Business Intelligence system. It is different from static reports and scorecards because it helps the researcher understand what might be the root cause of a problem.

**Reporting Services**

Sometimes a simple report is all a department needs to manage their process. Most database engines include a type of reporting that see this same information categorized by another dimension. The researcher can continue doing this “slice and dice” of the data until they are able to determine cause and effect for specific measures.

Drill-down lets the researcher drill into the details that cause the results. The ability to drill is limited only by the number of dimensions captured for each measure. Drill-down gives the researcher deeper insight to the data by letting them see the details that make up the measure they are researching. Drill-down is one of the key benefits of a Business Intelligence system. It is different from static reports and scorecards because it helps the researcher understand what might be the root cause of a problem.
Advanced Terms and Concepts
Decomposition Diagram

A decomposition diagram is a different type of drill-down that lets the researcher break down components into their parts. In the example shown in Figure 6- Decomposition Diagram, total receivables are decomposed by denial reason. Denial reason is further decomposed by Insurance plan. Insurance plan is decomposed by region. The ability to visualize data in this format leads to conclusions and analysis that might otherwise be missed.

Facts and Dimensions
Facts and dimensions form the heart of a data warehouse. Facts are the key metrics that healthcare professionals would monitor to make care or other healthcare business decisions. Without context, facts are just numbers. Dimension provide context. Dimensions give different views of the same data. Some dimensions include:

- Time
- Source
- Physician
- Payer
- Diagnosis
- Complaint
- Patient Gender
- Patient Age
- Patient Nationality
- Location/Facility
- Department

Dimensions give structure to the facts. For example, Aspirin on Arrival might be a fact (or KPI). Dimensions for this could include the

PivotTables and PivotCharts
PivotTables were popularized by Microsoft Excel although many other products share the same concept.

A PivotTable is a versatile cross-indexation and summarization artifact that allows performing a free-form presentation of business data.

PivotTables are interactive summary spreadsheets or reports that allow you to automatically extract, organize, and summarize data. You can use these summaries to analyze the data, make comparisons, detect patterns and relationships, and discover trends.

PivotCharts are a newer concept to Excel and are similar to normal Excel charts with the difference that PivotCharts allow to drill-down into hierarchies in order to view specific items.

Both PivotTables and PivotCharts allow the analyst to navigate through the data.

Health BI leverages Pivot Tables and Pivot Charts because underlying SharePoint 2010 there are two services provided by Excel and PerformancePoint that assist in generating these types of reports.

Since SharePoint 2010 PerformancePoint is no longer a separate product but has become an integral component of it.
Data warehouses can be divided into data marts. These are subsets of the data warehouse and generally contain data that is specific to a given program such as meaningful use, Accountable Care, or Core Measures. These might also be separated by type such as patient, visit, chart, episode, operations, or pharmacy.

**Extract Transform and Load (ETL)**

ETL is the process used to extract data from the source system such as the EMR, Pharmacy, Lab, Imaging, or ADT system for loading into the data warehouse. Often, when this data is extracted, it needs to be converted, re-mapped, or transformed in some way. ETL applications are designed to do this efficiently. For example, an HL7 message might be received containing patient demographic information. The health system might prefer all states to be stored using the 2-letter code. The ETL would receive the HL7 message, transform Georgia to GA, and then load this revised data into the data warehouse.

The ETL tools are the most important of all the capabilities because the healthcare data and their structures are extremely complicated. There are several standards and coding systems for each sub-domain: DICOM for radiology; HL7 for general health information exchange; SNOMED and ICD for coding diagnoses and procedures; LOINC for observations; RxNorm for pharmaceuticals.

There are also areas for which there really are no standards whatsoever, such as: patient satisfaction, measuring accessibility to healthcare services, measuring the effects of improved outcomes, etc.
It is complex to extract and transform the data for all of these sub-domains, whether they have standards or not. To get the value out of the data requires powerful ETL tools with the proper features set to successfully accomplish this.

ETL is generally done using Integration Services tools.

**Big Data**

Big Data is a hot term in the industry that describes very large amounts of unstructured and semi-structured data that is created by a health system. Structured data is information that is carefully broken into constituent parts. Data such as last name, first name, phone, fax, address, city, state, zip would be structured data. Clinical documentation, phone notes, radiology reports, and other random text files are considered unstructured data. Data that has some metadata plus some random text is considered semi-structured data.

Unstructured data accounts for over 80% of a health system’s files. Big data is a set of tools and process that attempts to discover repeatable patterns. We have to be careful when using big data in healthcare, since a systematic derived pattern could create a patient safety issue.

**Self-Service Reporting**

As business intelligence use evolves throughout an enterprise, the ability to get reports, scorecards, dashboards, and other BI components is enabled by self-service programs. Initially, the researcher will request a report get written by the IT department. Often these reports become canned and are reused on a regular time interval and potentially shared with others in the health system. Over time, the need to involve IT for a new report, dashboard, or cube becomes minimized by the creation of self-service tools. These enable the researcher to create their own after some training or coaching.

**Data Governance**

Data governance focuses on managing the quality, consistency, usability, security, and availability of information. It incorporates policies, procedures, and decision-making parameters to ensure ongoing relevancy and accuracy of the health systems data systems.

**Business Intelligence Maturity Model**

Healthcare is one of the most data-intensive industries in the world. Yet most of this data is on paper or in silos making it difficult or impossible to use for actionable intelligence. Each health system fits into one of the following BI maturity levels.

**Level 1: Unaware**

Level one is easy to spot. There are a lot of users of data who do not share or try to share with others. When they do try and analyze their data, it is done using spreadsheets and self-contained databases that only include facts and dimensions for a single analysis. They might use reports, but these are one-off reports that only focus on a tiny fraction of the data available.

It is complex to extract and transform the data for all of these sub-domains, whether they have standards or not. To get the value out of the data requires powerful ETL tools with the proper features set to successfully accomplish this.

**Level 2: Tactical**

No business sponsor. IT executive in charge. Limited users. One-off reports. Data inconsistent and stovepiped systems.

**Level 3: Focused**

Funding from business unit on project-by-project basis. BI Competency Center (BCC) in place. Specific set of users realizing business values.

**Level 4: Strategic**

Business objectives drive BI and performance management strategies. Deploy and enterprise metrics framework. Governance policies are defined and enforced. Establish balanced portfolio of standards.

**Level 5: Pervasive**

Analytics are inserted into and around the business processes. Information is trusted across the enterprise. Use of BI is extended to affiliates, patients, and business partners.

![Figure 7 - BI Maturity Model](source: Gartner 2008)
The organization includes a lot of individual users who do not share or consider collaborating with this information a priority. There is very little security around this data. Most of it is stored in spreadsheets on the individual’s local hard drive.

To move from maturity Level 1 to Level 2, the BI team should communicate with the business owners or department managers, to identify the facts that drive their business. Once they know the key measures, they should work with these same department managers to get commitment and resources for an overall BI strategy. They should endeavor to understand the types and sources of data within the enterprise, the quality of this data, and the architecture of this data.

**Level 2: Tactical**

Tactical BI maturity tends to put all BI in the laps of the Information Technology department. The CIO or one of his reports is responsible for the overall success of any BI initiatives. BI users primarily include managers and some executives. Much of the data is still stovepiped and there is a significant amount of inconsistency. Most tactical solutions are developed by the IT organization based on their perception of the needs of the department users.

Moving from maturity Level 2 to Level 3 requires funding for more enterprise-related BI initiatives from the executives. Metrics that analyze specific department or functional priorities are defined. Roles and dashboards are created that enable users and researchers to track and monitor the progress of specific measures within the department. Now is when the executive team can, and should, justify the creation of a BI competency center that provides governance and oversight for BI initiatives at the enterprise level.

**Level 3: Focused**

Focused BI maturity is recognized by a formal BI system but funding is normally provided by departments on a project-by-project basis and a small subset of the total user community is using BI and realizing the value of BI. Generally, there is one or two departments who are highly successful with BI. There is some self-service reporting and this is offered to a limited audience. Users can independently drill-down into the details of their data, but cannot see how their data is affected by data outside their control.

Moving from maturity Level 3 to Level 4 requires increases in BI scope across multiple departments. This is where BI starts to get enterprise-wide appreciation and application. Other data including operations, quality, meaningful use, and population health information are included in the data warehouse. The data marts start integrating this data and consolidating the information into disparate analytical applications enabling cause and effect analysis between data starts to emerge. An enterprise-wide metrics framework is created and the user base is expanded to include constituents from the entire health system.

**Level 4: Strategic**

Strategic BI maturity includes a balanced portfolio of metrics and standards across the enterprise. Business and department objectives drive BI and performance management systems. These are supported by an enterprise-wide metrics framework that incorporates data from multiple systems to support facts and dimensions for the measures. BI governance policies are defined and enforced. Data is pulled from OLAP cubes instead of OLTP database tables. This maturity level enables insight into past performance and provides enough enterprise-wide detail to begin what-if analyses.

Moving from maturity Level 4 to Level 5 requires extending BI or data entry to suppliers, patients, physician groups, and other affinity groups at the enterprise level. BI is used extensively to support evolving business, health objectives, and strategy. BI analytics is integrated into the day-to-day workflow and policies and procedures are updated to incorporate BI analytics.

**Level 5: Pervasive**

A pervasive BI maturity extends BI to suppliers and patients. Analytics are used in and around business processes. Information is trusted across the entire health network. Level 5 BI leverages statistics, advanced techniques, algorithms, and sophisticated search capabilities. Researchers are able to extrapolate past performance to forecast future events as well as answer questions that might have never been asked.

**Reaching Pervasiveness from Unawareness**

Now that you are familiar with the most important terms, concepts and maturity levels of BI you may be asking yourself how to get started with such a daunting task. Take it one step at a time and you will get there.

The first step is having capable professionals assess your current state. This team would work together with your team and determine where you are at and what it will take to get you to where you want to be. You will need to start by understanding the business. BI is all about leveraging technology to improve business objectives. At this point, the technology is least important.

Now that you understand the measures that drive your business, the next step is to determine what tools you have to put in place. You may require new source systems or upgrade existing ones; you may have to adopt common industry vocabularies and standards; you would have to acquire BI tools for extracting, transforming, aggregating the data. Tools for reporting and visualization would also be required. Now is the ideal time to implement a data governance model.
Summary

Using BI requires a bit of a change in attitude from dependency on IT for all information to a more self-sufficient, exploratory way of thinking. Making this transition requires a change management strategy to be completed in parallel with deploying the BI tools.

Many health systems have blazed this trail already and are reaping huge rewards in terms of efficiency, cost effective treatments, more consistent staffing, and healthier patients.

References

http://www.jointcommission.org/core_measure_sets.aspx