

# Healthcare Business Intelligence

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## Executive Summary

It is no surprise that, in the current economic crunch, healthcare providers are facing their own financial hardships. As these providers are being pulled in many directions while facing the need to provide high-quality healthcare at competitive costs, many are struggling to do what they're supposed to do without risking dissatisfaction. Factors ranging from lower reimbursement rates to a slow-down in service due to overcrowded emergency rooms only add to the issues. Healthcare providers are called upon to provide what is literally a life-or-death product, and because of lower reimbursement rates and budgets that are already stretched tight, these services can't always be provided in a prompt manner. This doesn't just include large insurance providers, but hospitals, healthcare practices and individual medical practitioners as well.

A rise in cost is always a concern, not just for the provider, but for the consumer as well. In an inundated market such as healthcare, the need is not necessarily for an expansion in customers or services offered, but a streamlining of the business model in order to add to the bottom line. Paul D. Mango of McKinsey & Company states that "Income statements of the hospitals have been ailing. The cure? Serious attention to Operating Efficiency."<sup>1</sup> Business Intelligence (BI) is needed to help define metrics and measure performance, as well as to take corrective action to improve the bottom line. By organizing and analyzing available data through data warehousing, healthcare providers can find where corrective action is needed to prevent this unnecessary loss of income, overcoming that financial hardship and providing more efficient and life-saving services.

## Healthcare Organization Objectives and Metrics

In order to maintain quality and integrity of service, each industry puts forth a series of objectives and milestones to meet. By meeting these milestones and objectives, an industry can track its own productivity as well as managing processes and determining which produce the necessary results and which might need to be adapted. Within the healthcare industry, these objectives take on a new importance, as it's not just mechanical parts and processes that these metrics measure, but human lives.

In his book, The Data Model Resource Book, Len Silvertown<sup>2</sup> includes the following as performance objectives for the healthcare industry:

- Effective treatment of patients.
- Reimbursement for treatments.
- Reduction of administrative costs.
- Effectively record and track patients' medical history
- Efficient management of health care delivery schedules for practitioners as well as patients

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These objectives are benchmarks of effective and streamlined service that results in not only satisfied customers, but healthy clients. Efficient management and analysis of records and other patient-related data results in a number of cost-savings that help healthcare providers achieve these necessary objectives.

Key performance indicators (KPIs) are also a thorough form of measurement when it comes to efficiency, service and effectiveness. While performance objectives have a more general scope, KPIs narrow in on a specific focus within an industry, assigning an acceptable numeric value to each goal. Sample KPIs for the healthcare industry, as mentioned by industry-expert Jamie Wyatt<sup>3</sup>, may include:

- Average length of stay
- Maintained bed occupancy
- FTEs per adjusted occupied bed
- Case-mix index
- Monthly surgical cases (outpatient and inpatient)
- Inpatient and outpatient revenues
- Cost per adjusted patient day (outpatient and inpatient)
- Percentage of revenue from charitable sources
- Revenue and expense per physician
- Margin per department
- Admitting-process performance

There are also performance metrics that can be used as benchmarks for tracking performance. These can be broken down into categories, such as:

- Emergency Room
  - Door to Provider Time
  - Admission to Provider Time
  - Length of Stay
  - Wait Time for Ambulances
  - Throughput (Urgent/Non-Urgent)
  - Triage to Initial Assessment
  - Bed Turnover
  - Staff Applied To Each Type of Patient
  - Type of Cases
- Operating Room
  - Utilization Rates
- Customer Satisfaction
  - Wait Times
  - Quality of Physician
  - Cleanliness
  - Food Taste
- Learning And Growth
  - Licenses Updates
  - Continuing Physician Credentials

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- Interaction with Patients

Similar metrics can be applied to the financial side of healthcare as well. As the revenue flow in and out of a healthcare provider is often a complicated endeavor, integrating reimbursements from insurance companies as well as reconciling all of the billing associated with individual patients and physicians, it is important to set specific financial metrics to track revenue and cost. The CAH Financial Indicators Team of UNC Chapel Hill propose a series of metrics to track the median performance at Critical Access Hospitals across the nation<sup>4</sup>. Through the creation of national comparative financial performance data, they set the standard for a number of metrics that hospitals should meet. Some of these financial metrics include<sup>4</sup>:

- Revenue Indicators
  - Outpatient Revenues to Total Revenues
  - Patient Deductions
  - Medicare Inpatient Payer Mix
  - Medicare Outpatient Payer Mix
  - Medicare Outpatient Cost to Charge
  - Medicare Revenue per Day
- Cost Indicators
  - Salaries to Total Expenses
  - Average Age of Plan
  - FTEs per Adjusted Occupied Bed
- Utilization Indicators
  - Average Daily Census Swing–SNF Beds (Skilled Nursing Facility)
  - Average Daily Census Acute Beds

As mentioned previously, electronic medical records (EMR) and paper patient files can be a complicated matter. As the relationships between patient, physician, medical supplier and insurance supplier become more and more entangled, it is often difficult to track the relationships between all parties involved. If such relationships cannot be deciphered, then it is impossible to run the necessary tracking and trending reports. In order to populate reports, it is recommended that the following data be tracked<sup>2</sup>:

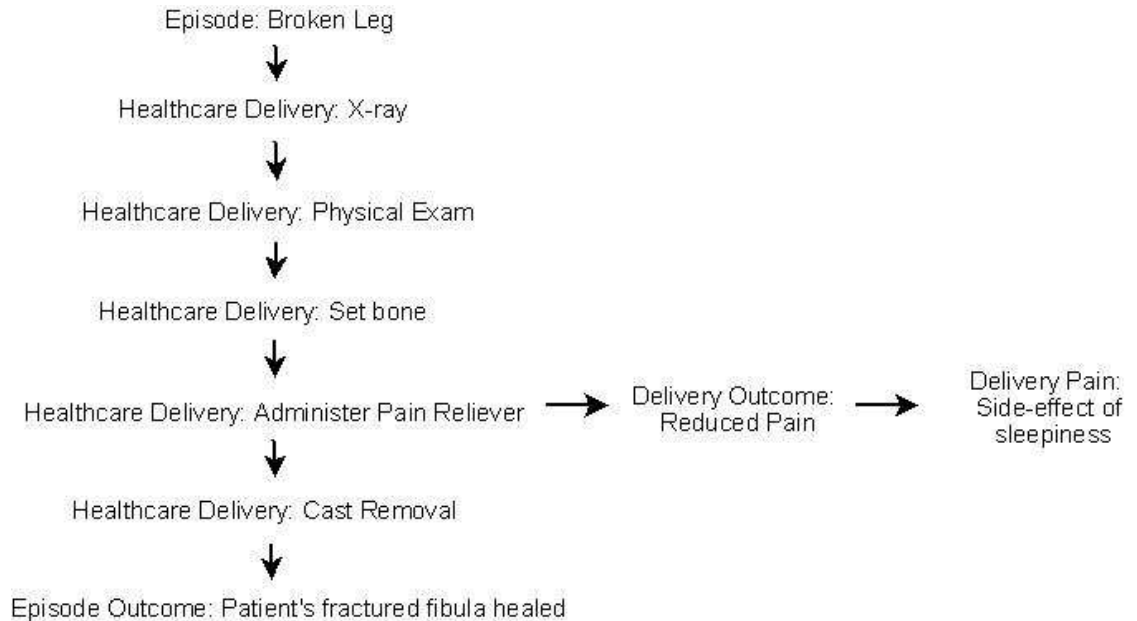
- People and Organizations
  - Patients, health care provider organizations, individual practitioners, insurance companies
- Relationships between:
  - Patient / Practitioners
  - Provider / Health care networks
  - Practitioners / Health care provider organizations
- Services and products provided by the healthcare providers
- Agreements
  - Patient / Practitioner
  - Provider / Network
  - Provider / Supplier

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- Records of health care services performed as it relates to various health care incidents, visits and episodes
  - Claims submitted and the status of claims
  - Other data needed to track financial statement and personnel data

## **Reporting Options and Capabilities**

If the above data is housed in a data warehouse and documented, reports can be run that analyze the very delivery of healthcare that is provided on a case-by-case level. Healthcare providers can track an entire episode (i.e. a medical treatment) from initial medical observation through the delivery of the treatment and onto the final outcome.

These episodes can even be broken down into individual phases: episode, healthcare delivery, delivery outcome and episode outcome. For example, if the episode<sup>2</sup> entails a broken leg, it could be broken down as:



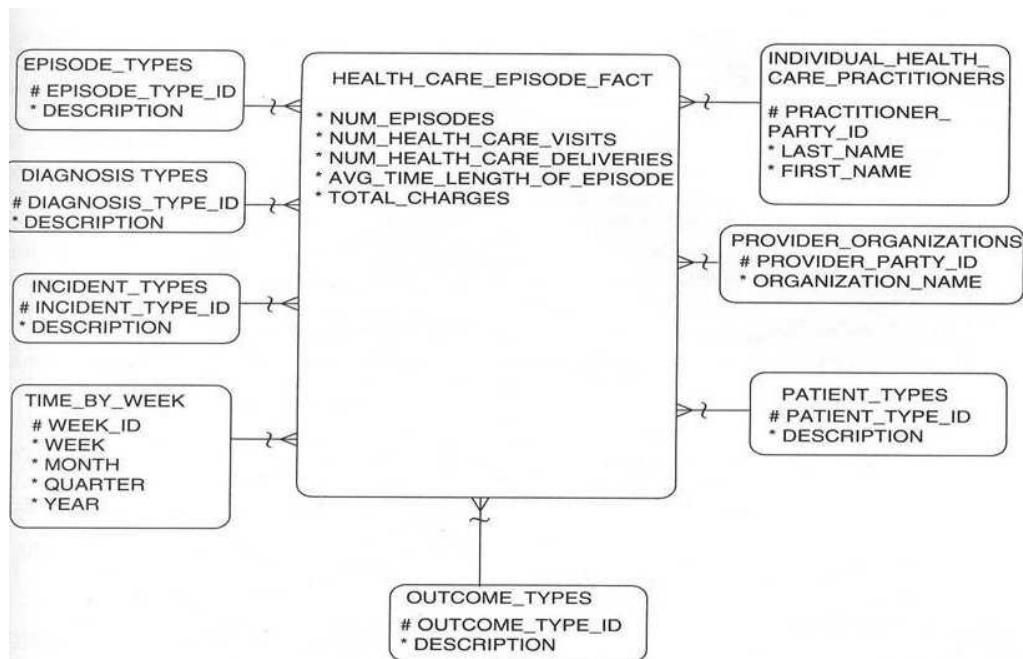
- I. Episode
  - a. Broken Leg
- II. Health Care Delivery
  - a. X-ray
  - b. Physical Examination
  - c. Set bone in place
  - d. Administer pain reliever drug
  - e. Cast removal
- III. Delivery Outcome: Administer Pain Reliever Drug
  - a. Reduced pain
  - b. Side effect of sleepiness
- IV. Episode Outcome
  - a. Patient's fractured fibula healed

Because the data is broken down and categorized, each set can be tracked and analyzed in a number of different data sets in order to create a gamut of business reports. With the ability to take into consideration each piece of data and its connectivity to other data sets, healthcare providers can find previously-unknown relationships that can be streamlined and otherwise eliminated, if redundant.

Once this data is tabulated, it can be organized into data models such as the star schema. The star schema<sup>2</sup>, putting the fact table relating to the episode (any quantifiable data) at the center of the diagram, and having the dimensions and tracking measure radiating outward from such data as with the points of a star, allows for easy analysis of each

individual episode, or even by certain dimensions across a range of episodes. As seen in the star schema below, these dimensions can include<sup>2</sup>:

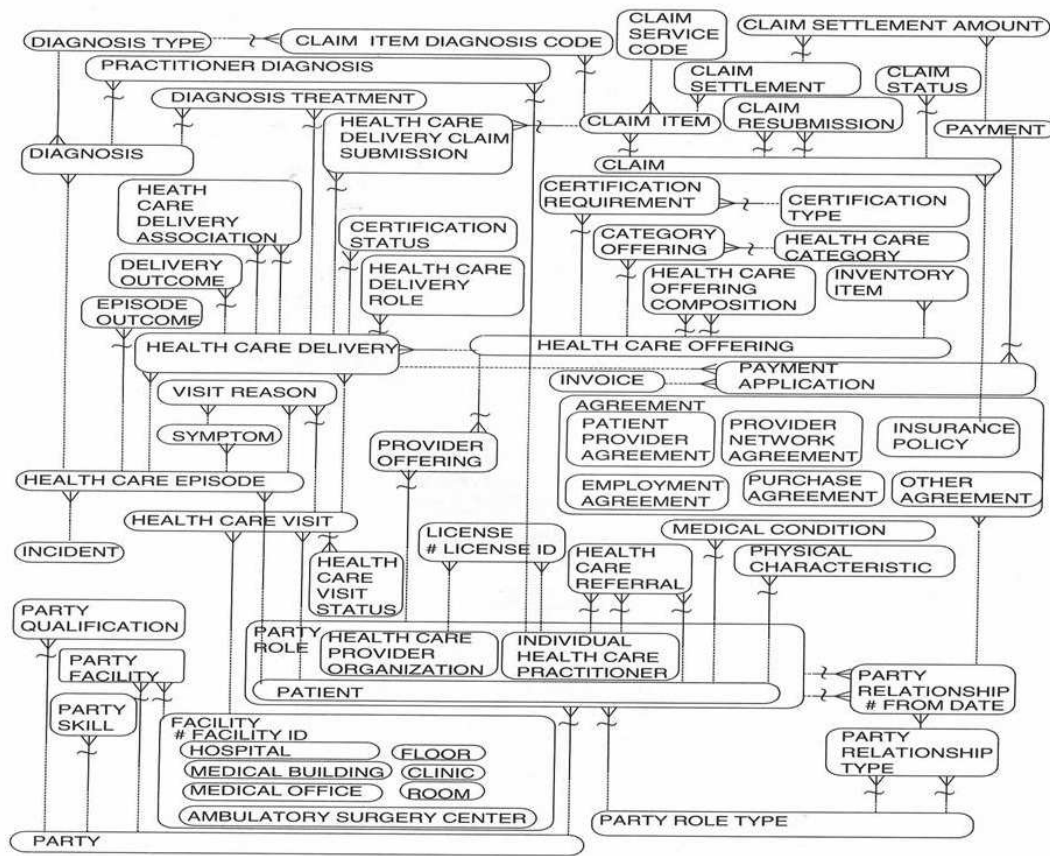
- Diagnosis type
- Episode type
- Incident type
- Individual healthcare practitioner
- Outcome type
- Provider organization
- Time by week



Star schema for health care-episode outcome analysis.

## Data Modeling: BI Architecture in Action

As imagined, the healthcare data model is very complex. A data model is the organization of data within the data warehouse, showing the various relationships between each bit of data. In some industries, this relationship is as simple as relating customers to particular account information. Within the healthcare field, though, there are a few more fields to consider. Below is an example of a typical healthcare data model<sup>2</sup>:



Overall health care model.

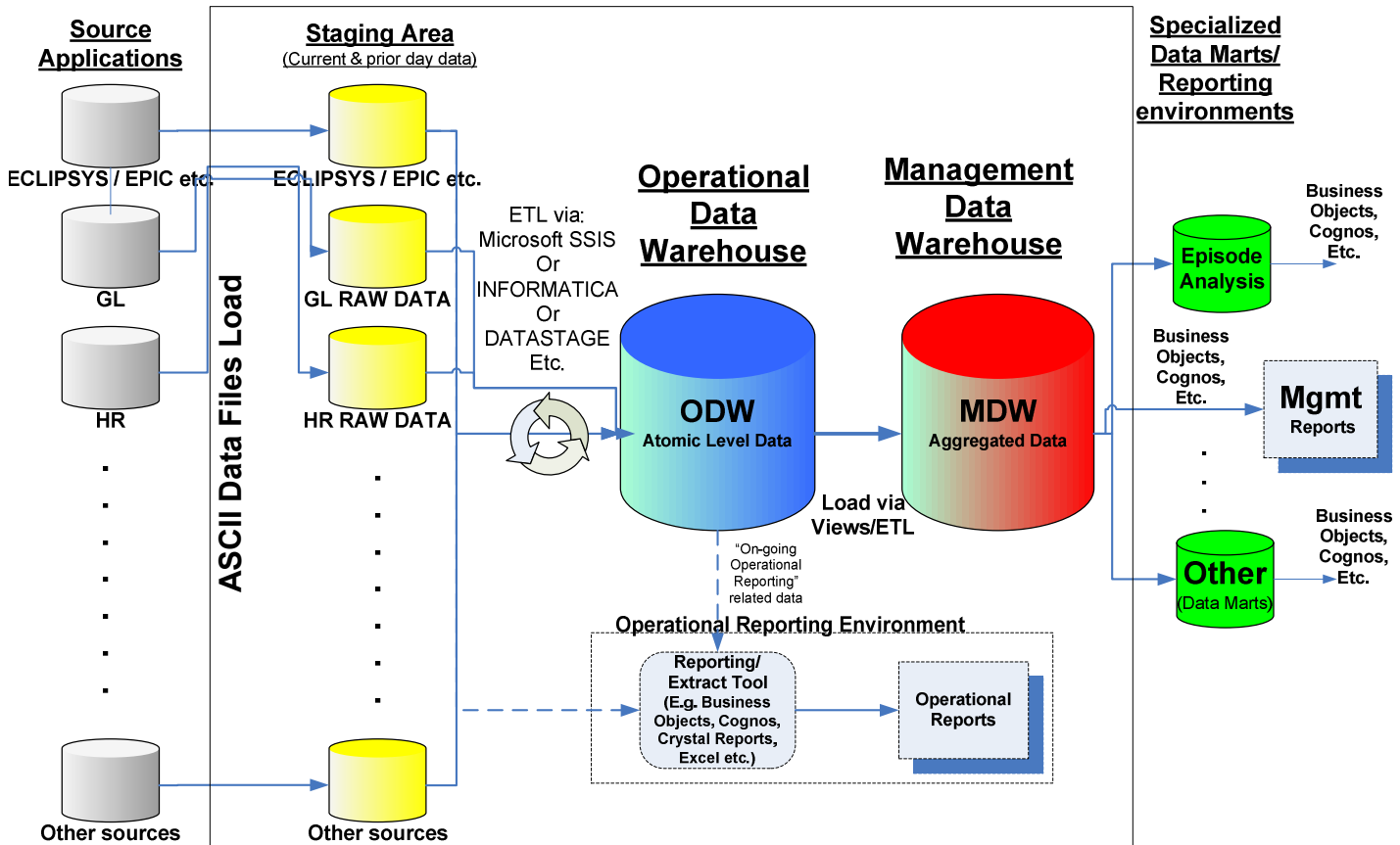
While complex-looking, this data model shows the interconnectivity that exists between the data elements of the healthcare system. By organizing a data model in such a fashion, these individual bits of data can be tracked in a comprehensive fashion, providing for a number of useful and cost-saving reports.

Once the data is organized according to the data model and the correct paths are set within the data warehouse, it is a simple procedure to extract the data from the source application, take it into the staging area, and then generate any reports as wished.

As seen below, in the BI Architecture diagram, data is taken from the source applications and moved into the Staging Area. This extraction eliminates the possibility of running reports taxing the source applications, which were not engineered to withstand that sort of extrapolation occurring at the same time as day-to-day functions. By removing the data and putting it into a separate area for analysis, the day-to-day functions of the source applications will operate just as quickly and function as normal. Within the staging area, the raw data taken from the source applications is extracted, transmitted and loaded into the Operational Data Warehouse for day-to-day operational analysis and reporting. Once this data is available at a detailed level, it can be aggregated and moved to the Management Data Warehouse for further management level analysis and reporting. Reports can be run as high-level or into as detailed minutiae as is necessary.

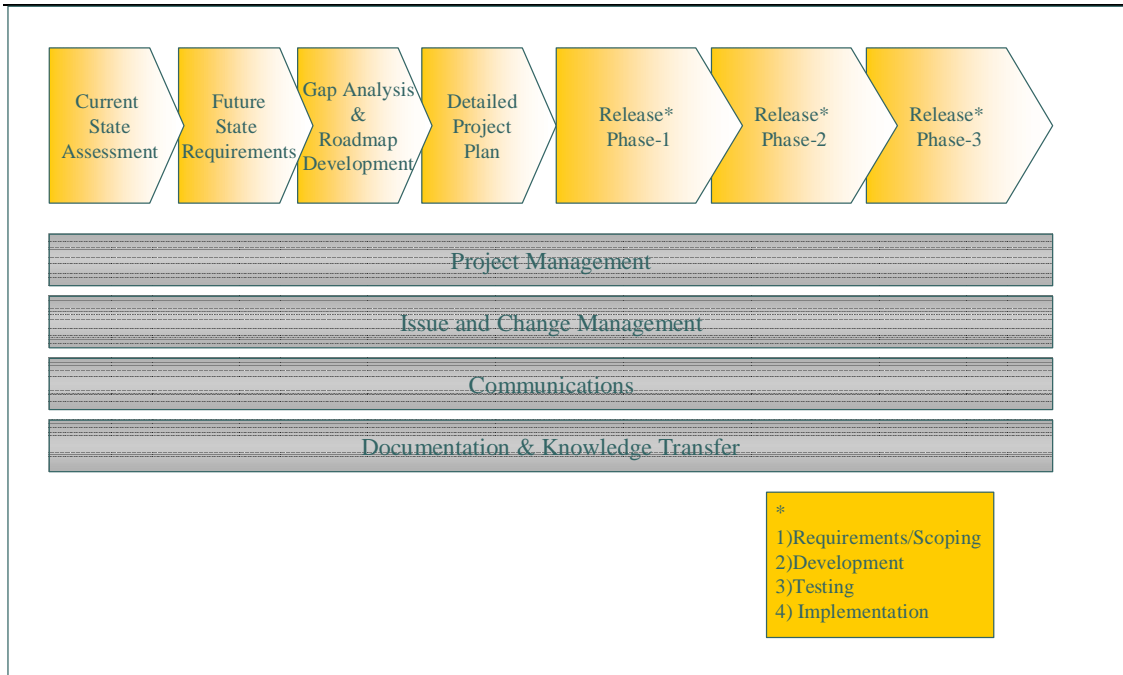
**An Approach to Health Care Conceptual BI Architecture**

\*\*Discussion Draft\*\*



**Project Methodology – Initiating the Data Warehousing**

It is imperative that data warehousing is not attempted without a solid, phased-in project methodology. As this can be an arduous project, a detailed and well-developed plan will ease the implementation process. A well-structured implementation team will consist of key personnel from both the data warehousing specialists as well as the healthcare provider client. These two groups, working in tandem, will be able to customize a project methodology and implementation plan that will be suit the needs of the healthcare provider. A general project methodology may include:



**Phase I: Current State Assessment**

The Current State Assessment allows a data warehousing team to analyze the healthcare provider’s current data situation. This includes discussing the overall goal of the Business Intelligence initiative as well as examining the infrastructure as it presently exists. The data warehousing team will consider the applications that are currently in place, what technologies and infrastructure the healthcare provider is using, what resources are available in-house and an in-depth knowledge of the present business processes.

Through a high-level knowledge of a healthcare provider’s in-place systems, a good data warehousing team can devise a BI initiative that will conform to the unique needs of each individual healthcare provider.

**Phase II: Future State Requirements**

In the Future State Requirements phase, the data warehousing team meets with key healthcare provider personnel to assess the healthcare provider’s missions and goals and exactly what the healthcare provider is looking to achieve through data warehousing. In this fashion, the data warehousing team can get a better idea of the objectives and critical success factors that the healthcare provider has designated as necessary.

At this point, specific measures are defined in order to generate the proper range of reports. Each department is allocated twenty-five measures, ensuring that only ‘measures that matter’ are analyzed. It is important to note that too much data can bog down an analysis, and that limiting benchmarks and other performance metrics to no more than twenty-five per department or business unit helps to streamline the data analysis.

At the same time, the implementation team will also identify the level of granularity needed for specific data analysis. This will show how deep the dimensions of data will be measured at, be it by healthcare provider department, individual patient, etc. Platform and reporting requirements are also designated at this time, such as if the healthcare provider wishes to convert to Hospital Information Technology (HIT) vendors such as Cerner, Eclipsys, Epics, GE/IDX, Lawson, McKesson, etc. When looking at vendor-integrated BI solutions, it is important to look at their complete solutions in addition to their platform offerings.

### **Phase III: Gap Analysis and Roadmap Development**

The Gap Analysis phase is perhaps the most important, as it compares the Current State to the Future State and determines which changes need to occur in order for the two states to be the same. During this phase, the implementation team will:

- Determine the source of the gap between measures – looking at the source systems to ensure that all data is accounted for and where to locate such data if it's not captured anywhere (e.g. measuring weight time, look at source systems and see it's not captured anywhere—find data to report for that measure if it's not captured anywhere)
- Determine technology gaps – ensuring that all the tools are in the right place
- Determine resource gaps – ensuring that healthcare providers have the resources they need in order to run the reporting process on an continuous basis

In conjunction with the Gap Analysis, the implementation team will also develop the roadmap that will be followed throughout the remainder of the process. This includes confirming which existing applications are needed, what changes need to be made to the existing applications and identifying the new applications that are necessary to bring the data warehouse up to speed.

Also, key personnel perform research and evaluate appropriate BI technologies, based on the healthcare provider's specific selection criteria and weights. This will help the healthcare provider select the right technologies appropriate for their needs. Once this is decided, it is possible to develop high-level architecture and data models, providing a blueprint for exactly how the data will be organize, as well as to identify the exact number and type of resources that will be needed.

### **Phase IV: From Project Plan to Release Phase**

Once the proper studies have been performed and the initial data return analyzed, the implementation team develops the project plan. Upon approval, this project plan is implemented in a series of controlled release phases. As long, single-phase implementations are often cancelled midstream due to lack of continued senior management interest in the project, a multi-phase project plan is suggested. If the data is integrated in smaller, more manageable chunks, the healthcare provider will see results

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sooner. These quick results often boost management morale and inspire the staying power needed to see the project through. When confidence-building results are seen in earlier phases, it can assure management's commitment to seeing the completion of the data warehouse, and thus to a more efficient data-analysis system for the healthcare provider.

Each release phase should include the following steps:

- Requirements/Scoping
- Development
- Testing
- Implementation

Though it may seem redundant and time-consuming, such research and testing will ensure that the implementation is done right the first time, and will not require a second attempt to correct any unforeseen issues that arise during the process.

### **Implementation Team: Who Are They?**

As mentioned previously, the implementation team should consist of representatives from both companies: the healthcare provider, as well as the data warehousing specialists. This ensures buy-in from all parties, as well as the knowledge and resources that might not otherwise be available, if the healthcare provider was not actively involved in the process. The healthcare provider's subject matter experts will have the necessary knowledge to make the implementation process as smooth and efficient as possible, because of their familiarity with their own systems and data. With the addition of high-level personnel to the team, such as management and other stakeholders, decisions can be made quickly without having to bring such decision-makers into the loop every time a crucial resolution comes up. As these key personnel are already involved in the process, they will be aware of what any potential concerns might be.

By including both sides, this also opens up lines of communications, allowing for the healthcare provider to always know what the progress is on the implementation and proactively preventing any issues that might arise because of miscommunication.

A solid team structure would include:

- Core Business Intelligence Team (Data Warehousing Specialists)
  - Project Manager
  - Architect
  - Data Loading
  - Database administrators
  - System administrators
  - Report Developers
  - Business Analysts
  - Testers

- Technical Writers
- Stakeholders (Healthcare Provider)
  - Client Project Manager
  - Executive Steering Committee, enabled to make decisions on key issues
  - Subject Matter Experts/Testers
  - Other stakeholders

## **Key Core Business Intelligence Team Personnel**

While the healthcare provider personnel will undoubtedly have the most accurate and in-depth knowledge of the data, it is important to consider the qualifications of the key personnel that the data warehousing specialists bring to the table. Their core business intelligence team should consist of subject-matter experts and other knowledgeable staff who have the necessary skills to fully implement such an undertaking.

- Sample Profile: Operations Manager

A good Operations Manager will have at least ten years of experience within the healthcare field, preferably in planning, consulting, or hospital operations. Having led and participated in many complex engagements in hospital re-engineering, renovating or other high-level negotiations, he/she will bring the necessary service line delivery and corporate strategic planning experience to orchestrate the implementation operations. His/her education may include higher degrees in Public Health, Health Services Management, Administration or other science and medical-related fields.

- Sample Profile: Nursing Manager

The exemplary Nursing Manager will bring at least ten to fifteen years of clinical and field related experience. This can include hospital operational and administrative experience. Among his/her many accomplishments, she/he may have led service line and system implementation projects, as well as assisting or managing operational improvements within a hospital or healthcare provider system. His/her degrees will include at least an Associates in Nursing, but ideally will extend to some business administration courses in addition to any other sciences he/she may have studied.

- Sample Profile: Health Information Technology Specialist

The Health Information Technology Specialist should bring a diverse background in IT, preferably with at least five to ten years in the healthcare industry. His/her professional experience may include application design and development, database architecture and systems programming. In addition, he/she will have a strong technical knowledge and leadership ability, with exceptional client relationship skills. Extensive experience working with the provider's Hospital

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Information Technology (HIT) system, such as Eclipsys, Cerner, etc., is a critical requirement.

In addition, it helps to consider the different BI technologies that are currently in place. A good data warehousing provider should have expertise in technologies like:

- Oracle
- SQL Server
- Informatica
- Data Stage
- Cognos
- Microstrategy
- Business Objects
- Etc.

## **Conclusion**

As a financial tool, healthcare Business Intelligence (BI) can be a priceless addition to any provider's technological offering. Not only providing the healthcare provider with a wealth of accessible information, BI and Data Warehousing puts the life-saving information at the healthcare provider's fingertips. As the data is stored in a standardized manner, this also ensures that records and reports will always be accurate and uniform.

The healthcare industry is one that affects every person, young or old, insured or not. With accurate and easily-accessible records, healthcare providers can streamline the services they offer, even as budgets grow slimmer and slimmer each year. In the current healthcare and financial slump, any cost-savings tool is a valuable asset. In the case of healthcare providers, data warehousing might assist in saving lives as well.

## About The Author

Rajat Sharma is the CEO of Onward Systems Inc., a world-class data warehouse/business intelligence strategy and implementation company.

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## Resources

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<sup>1</sup> Mango, Paul D. and Shapiro, Louis. "Hospitals Get Serious About Operations." McKinsey Quarterly 2 (2001).

<sup>2</sup> Silverston, Len. The Data Model Resource Book, Vol. 2: A Library of Data Models for Specific Industries. Hoboken: Wiley Publishers, 2001.

<sup>3</sup> Wyatt, Jamie. "Scorecards, dashboards, and KPIs keys to integrated performance measurement: to effectively measure performance, providers need more than just a balanced scorecard; they also must be able to access performance data from a central data warehouse." Healthcare Financial Management February 2004.  
Healthcare Financial Management, Feb, 2004 by Jamie Wyatt