Hospital Billing Optimizer: Advanced Analytics Solution to Minimize Hospital Systems’ Revenue Leakage
Tapping the hidden assets in hospitals’ data

Revenue leakage can have a major impact on hospital systems’ results. But successfully addressing the problem with the latest analytics can significantly improve them.

For example, recovering 50 basis points of outpatient revenue from previously missing charges in a hospital that earns 2% net income, half of it from outpatients, improves profitability by 12.5%. That can amount to millions of dollars annually; inpatient savings can add millions more.

Hospitals are, of course, aware of the problem. Indeed, according to one survey, nine out of ten hospital executives believe the current business environment has become much more challenging in just the last few years; more than three-quarters of them consider improving operational efficiencies across all departments to be the strongest area of opportunity in today’s economic climate.  

“54 percent of hospital executives added additional staff to address revenue integrity issues, while 25 percent went so far as to establish an entire revenue integrity department.”

But the constantly growing complexity of billing codes, a plethora of different systems, and facility-specific billing policies and protocols have made addressing revenue leakage increasingly more difficult. The two methods most hospitals have been relying on—rules-based systems and manual review by auditors—have proven unable to completely keep up with the challenge.

Rules-based systems that report potential missing charges based on flags triggered by the coexistence, or absence, of certain diagnosis, procedure, and billing codes, have two basic problems: they can be either too aggressive, flagging too many invoices for review, which wastes resources; or too conservative, failing to detect all missing charges. They’re also time-consuming to maintain, and always require subject-matter expertise to update with additions or edits. And every time a change is made to billing, the rules system needs to be updated.

“Although the healthcare industry has lagged behind other industries in adopting business intelligence applications, increasing internal and external financial pressures have created prime conditions for healthcare organizations to begin making greater use of advanced analytics technology.”

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1 Business Intelligence in Healthcare: Have Providers Found a Cure? (Aberdeen Group report, 2008)

2 Survey conducted by Stop the Leakage

3 Ibid.
Also, the more facilities involved, the potentially more costly and complex the problem for large systems with many hospitals.

In addition to being highly labor-intensive and costly, the effectiveness of manual review relies to a very large extent on the skills of each auditor. More experienced or better trained auditors are more effective. But even the best auditors can review just so many charges in the course of a day. Further, all auditors need to be constantly updated and educated regarding changes in medical care and billing rates and procedures. The audit process is also subject to human error.

In short, both rules-based systems and manual reviews can result in many exceptions and false-positives that waste time and money. Analytics-based approaches that utilize machine learning, predictive modeling, anomaly detection, and other advanced tools can successfully address the weaknesses of rules- and auditor-based systems and deliver a rapid and ongoing improvement to hospitals’ bottom lines.

More missed charges captured more quickly

An analytics-based system from Opera Solutions has been highly effective in addressing revenue leakage. It has captured 25bps–75bps in incremental revenue—over and above that found by its existing rules and manual review approaches—due to missing charges in both pre-bill and post-bill environments.

The Hospital Billing Optimizer uses advanced analytic models to detect outlier behavior and score patient invoices based on the likelihood of missing or incorrect charges. Then it prioritizes and rank-orders the patient invoices with the highest scores as well as highest potential positive bottom-line impact based on total dollar value of each missing charge and expected reimbursement from the payer. The prioritized invoices are then reviewed by nurse auditors to confirm whether the predicted charges are, in fact, missing, thus allowing expensive auditing resources to be focused only on the highest priority review items. Once confirmed, the missing or incorrect charges are edited and added to the patients’ accounts.

The solution automatically adapts to hospital billing practices and process modifications.
The Hospital Billing Optimizer is much more accurate than rules-based systems alone, significantly increasing detection of billing errors while reducing the number of false positives. In addition, its sophisticated models uncover subtle patterns within the data that may be indicative of missing charges but are much too complex to be handled in an exclusively rules-based system.

For large hospital systems, the solution’s models use both local hospital data and, as necessary, system-wide consortia data. Using pooled data from multiple hospitals can increase the accuracy of the results. For example, data from a single hospital may be very limited with respect to certain procedures. But by evaluating data across a system, the models can recognize anomalies that could otherwise not be found.

**Constantly learning, continually adapting**

The Hospital Billing Optimizer incorporates feedback provided by the auditors to continuously refine the analytic models and even more intelligently prioritize missing charges. Its output can be adapted to the latest billing procedures and guidelines by superimposing facility-specific protocols to the core data-based machine recommendations.

This is a hosted, software as a service solution, requiring no additional IT investment, and with no process disruption. No software is installed; the solution leverages the existing data flow, requiring no infrastructure changes. Opera Solutions can also adapt its solution to any existing rules-based reports and recommend which missing charges to pursue after they have been internally cleared by the hospitals.

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**SOME VERY HEALTHY RESULTS**

A large US hospital group with both urban and rural hospitals was losing revenue due to omitted fees, despite their rules-based system and expensive audits. The Hospital Billing Optimizer was implemented to uncover signals in historical patient data.

Using highly advanced analytic techniques such as pattern recognition and machine learning algorithms, the solution predicts the missing charge codes for individual visits by comparing them to all historical visits in the hospital and identifying patterns and correlations.

The result? The solution identified between 0.25% and 0.75% of revenue being missed for each of the hospitals in the system. Additionally, Opera Solutions identified an immediate opportunity to reduce audit expense by up to 80%.
Using science to identify savings

The Hospital Billing Optimizer uses highly advanced analytic techniques to maximize the accurate detection of missing charges while minimizing false positives. Leveraging world class expertise in machine learning and pattern recognition, Opera Solutions has developed an analytic solution that uses historical patient billing data to more effectively identify missing charges.

For inpatients, Opera Solutions applies linear and non-linear Dimension Reduction Methods to characterize the distribution of billed amounts associated with each Diagnosis Related Group (DRG). Using advanced analytics, the models reconstruct the invoice and compare it to the actual bill to identify outlier behavior and the likelihood of missing charges.
For **outpatients**, the solution employs an Ensemble scoring methodology that combines multiple models. Each has a unique ability to address a particular aspect of the problem. This allows the solution to capture the complicated structure of procedure and diagnosis codes at the visit level and maximize performance in predicting missing charge codes.

Below is a high level overview of the models contributing to the Ensemble results:

![Models Diagram]

**A PATENTLY SUPERIOR SOLUTION**

*Opera Solutions applies advanced statistical modeling techniques to discover the complicated relationships between codes.*

*The use of historical patient billing data to train various statistical models that capture relationships between procedures, diagnoses, and other billing codes is unique among existing revenue leakage solutions.*

*This is a significant breakthrough in dealing with the challenges presented by revenue leakage. That is why in early 2012, patent papers were filed to protect this unique and superior modeling approach to revenue cycle management.*
Using Ensemble techniques to knit together results from different analytic methodologies results in a better-performing solution that draws on each individual technique’s unique strengths.

This cumulative performance improvement is illustrated in the graph below. The Ensemble model demonstrates higher performance than any of the individual component models.

Results of Ensemble Model
Receiver Operating Characteristic (ROC) Curve

Our solution uses a cascade approach to include feedback. It takes into account input from the auditors, providing a self-correction mechanism to capture changing patterns and exceptions. This additional modeling layer helps differentiate subtle nuances in the data, and increases predictive performance.
Rapid implementation and results

The Hospital Billing Optimizer works in conjunction with existing systems or as a stand-alone solution, and is proven to rapidly capture 25bps-75bps in incremental revenue due to missing charges in both pre-bill and post-bill processes. The solution uses pattern recognition and advanced analytics to bring precision and accuracy to identifying and recapturing missing charges. It provides a cost-effective way to scan all bills for missing charges, as opposed to only those related to selected procedures.

In addition, hospitals can select the score and dollar threshold over which bills are routed for review, providing hands-on control. To increase efficiency even more, auditors can access the information they need to investigate a high-scoring invoice through an automated web interface.

The solution is very effective in detecting patient billing record abnormalities and can also be adapted to identify fraud, waste, and abuse in overcharges.

The latest insights and approaches

With over 220 advance-degree scientists specializing in machine learning, plus deep domain expertise in healthcare, Opera Solutions is breaking new ground in applying analytics to drive operating and performance improvement in the industry. Our approach to revenue leakage is so original, in fact, that we are in the process of patenting it. And since our solutions are designed to integrate easily within existing processes, they deliver bottom-line impact right away. For more information please click here or email healthcare@operasolutions.com.
ABOUT OPERA SOLUTIONS, LLC
Opera Solutions applies advanced analytics to drive front-line productivity gains for industry and government. With 220+ data scientists among its 650 employees, the company is an internationally recognized leader in machine learning. Opera Solutions combines this scientific expertise with the deep industry knowledge of its professionals in creating its Signal Hub™ technologies, which provide new enterprise-wide capabilities to continually extract valuable predictive and descriptive information from Big Data flows. The company also creates and hosts applications built on its Signal Hub technologies. It delivers its Signal Hub technologies and related applications “as a service” through a software licensed model or Cloud-based SaaS. Opera Solutions serves leading organizations in Financial Services, Healthcare, Government, Supply Chain, Marketing, and other selected sectors.