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Understanding Risk Stratification, Comorbidities, and the Future of Healthcare

By Eric Just

> Healthcare organizations working to change their cost structure and improve outcomes must design interventions that target high-risk, high-cost patients who need to be managed carefully and proactively.

As value-based care delivery models—like accountable care organizations (ACOs)—enter the mainstream of healthcare, managing population health and risk stratification becomes more important than ever. Healthcare organizations working to change their cost structure and improve outcomes must design interventions that target high-risk, high-cost patients who need to be managed carefully and proactively.

The foundational step of targeting these high-risk patients is, of course, to identify them. For example, ACOs have to be able to pinpoint which heart failure patients are at high risk for readmission. Armed with this knowledge, clinicians can schedule follow-up appointments and ensure that those patients understand their medications and other aspects of the care plan. Likewise, ACOs must be able to identify patients with a rising risk index that could be triggered by sudden weight gains or hemoglobin A1c values that are trending upward.

The process of separating patient populations into high-risk, low-risk, and the ever-important rising-risk groups is called risk stratification. Having a platform to stratify patients according to risk is key to the success of any population health management initiative.

Overview of Risk Stratification Methods

Several different methods are available for stratifying a population by risk. The following are some of the most common methods.

Hierarchical Condition Categories (HCCs):

Part of the Medicare Advantage Program for CMS, HCC contains 70 condition categories selected from ICD codes and includes expected health expenditures.

Adjusted Clinical Groups (ACG):

Developed at Johns Hopkins University, ACG uses both inpatient and outpatient diagnoses to classify each patient into one of 93 ACG categories. It is commonly used to predict hospital utilization.

Elder Risk Assessment (ERA):

For adults over 60, ERA uses age, gender, marital status, number of hospital days over the prior two years, and selected comorbid medical illness to assign an index score to each patient.

Chronic Comorbidity Count (CCC):

Based on the publicly available information from Agency for Healthcare Research and Quality (AHRQ)'s Clinical Classification Software, CCC is the total sum of selected comorbid conditions grouped into six categories.

Minnesota Tiering (MN):

Based on Major Extended Diagnostic Groups (MEDCs), MN Tiering groups patients into one of five tiers from Tier 0 (Low: 0 Conditions), Tier 1 (Basic: 1 to 3), Tier 2 (Intermediate: 4 to 6), Tier 3 (Extended: 7 to 9), to Tier 4 (Complex: 10+ Conditions).

Charlson Comorbidity Measure:

This method is explained in further detail below, but as a brief explanation, the Charlson model predicts the risk of one-year mortality for patients with a range of comorbid illnesses. Based on administrative data, the model uses the presence/absence of 17 comorbidity definitions and assigns patients a score from one to 20, with 20 being the more complex patients with multiple comorbid conditions. It is effective for predicting future poor outcomes.

One thing all of these models have in common is that they are based in some degree on comorbidity. Understanding comorbid conditions is a critical aspect of population health management because comorbidities are known to significantly increase risk and cost. In fact, a study from the Agency for Healthcare Research and Quality reports that care for patients with comorbid chronic conditions costs up to seven times as much as care for those with only one chronic condition.

Applying Comorbidity to Healthcare Analytics

> "At Health Catalyst, we've developed an analytics application called the Comorbidity Analyzer. The application indexes every patient for a variety of comorbid conditions.

What is the best way to use comorbidity to more accurately predict risk? The truth is that the industry as a whole hasn't developed standard processes for doing this. Using technology to predict risk while incorporating comorbidities is a new and evolving area. The best analytics vendors are providing platforms that allow healthcare systems to tailor risk stratification models to their specific populations.

Here is one of many ways the Health Catalyst® platform addresses risk stratification.
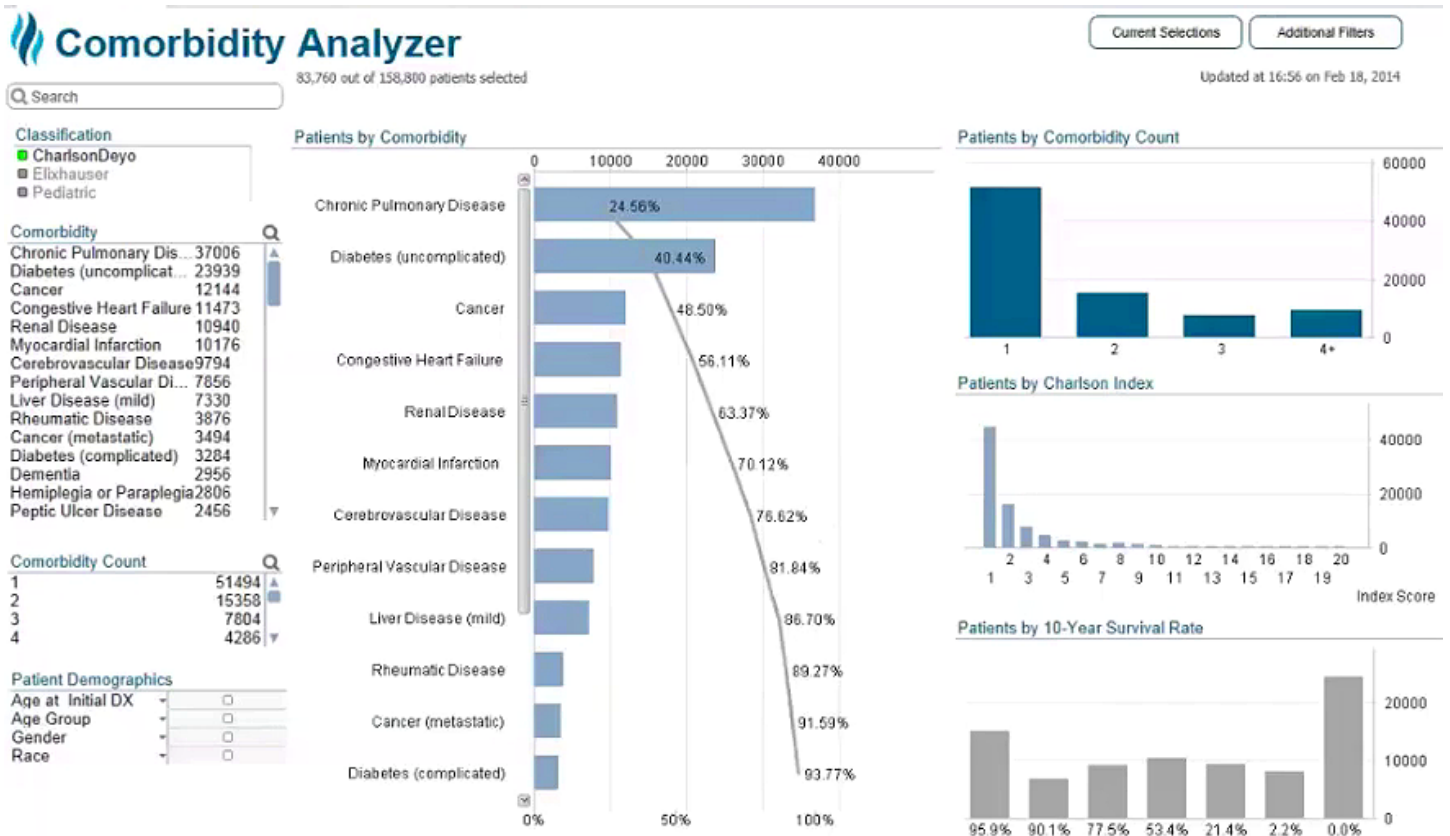

Calculating a Comorbidity Index:

At Health Catalyst, we've developed an analytics application called the Comorbidity Analyzer. The application indexes every patient for a variety of comorbid conditions. It performs the indexing based on prebuilt comorbidity models taken from peer-reviewed literature. However, a significant strength of this application is that it is flexible enough to enable clients to either define their own comorbidity models or modify the out-of-the-box models.

> The Charlson/Deyo model allows calculation of an index score that summarizes risk based on the number and types of comorbid conditions a patient has, as well as age. It can be used as a general risk stratifier and a mortality predictor.

The flexibility of the system to adapt to any comorbidity model is key to successful implementation across a wide variety of healthcare organizations. For example, we have multiple clients that are children's hospitals. The prebuilt models in the system were developed for comorbidities in adults. To address the needs of the pediatric hospitals, we found a peer-reviewed pediatrics model and plugged it into the architecture—where development, validation, and implementation only took two days.

One of the models that can be used in the Comorbidity Analyzer is the Charlson/Deyo model (a commonly used variation of the Charlson Comorbidity Measure explained above). The Charlson/Deyo model allows calculation of an index score that summarizes risk based on the number and types of comorbid conditions a patient has, as well as age. It can be used as a general risk stratifier and a mortality predictor. The Charlson/Deyo Index is pre-computed for all patients in the Comorbidity Analyzer making it easy to include this risk stratifier in several other analytic applications. Incorporating the index into other applications means we can use it as a powerful filter to quickly identify higher-risk patients. It can also be used to assess the risk profiles of particular populations.
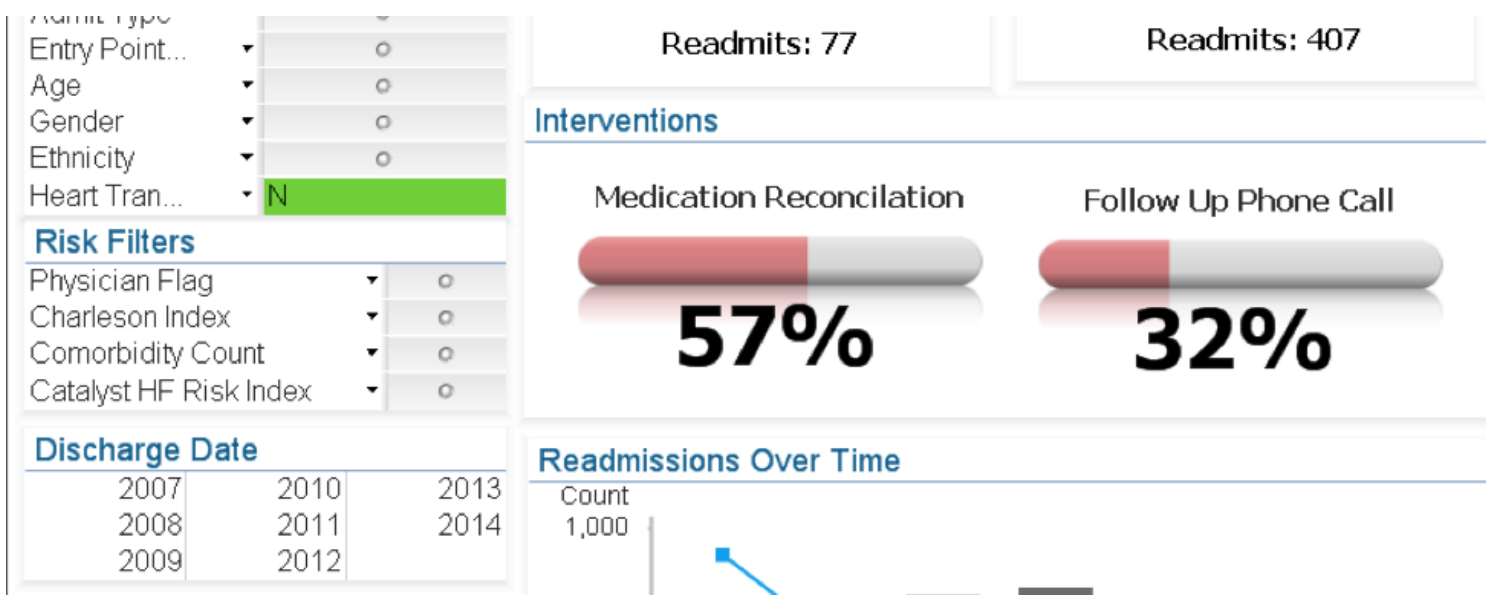
This is a portion of a screenshot from our Heart Failure Dashboard. A red arrow shows the index risk filter among other risk filters that are available in the application.

Charlson Index Distribution
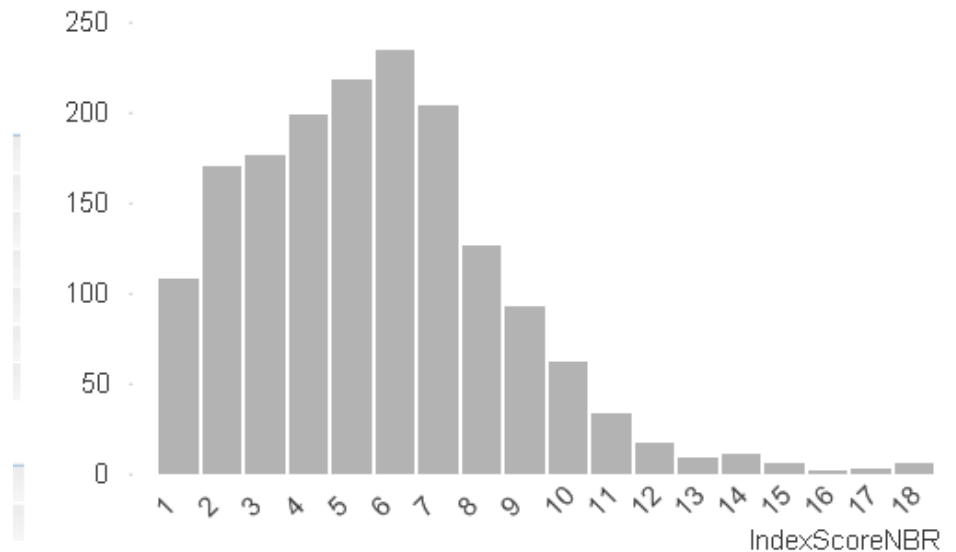
A chart showing the distribution of Charlson/Deyo Index scores for heart failure patients. Looking at this distribution helps to gauge level of risk in the population.

Using Comorbidity Data to Build More Sophisticated Predictive Models

So far, I have described how we at Health Catalyst generate a basic risk score out-of-the-box using our Comorbidity Analyzer. Our platform supports the construction of more complex predictive models than the Charlson/Deyo Index. As those complex models are created, the comorbidity score serves as just one of many important parameters.

One example that incorporates the comorbidity index at its base is our heart failure readmissions risk index. To create a model that would predict readmission risk for heart failure patients, our algorithm used historical data to identify the 10 clinical and demographic parameters most likely to predict readmission. Comorbidity—already scored and stored in our comorbidity data mart—was one of these key parameters. Other parameters included length of stay, gender, and age. Then, we ran a regression on historical data to determine the weight that should be given to each parameter in the predictive model. Those weights determine the impact each parameter has on predicting readmissions for the particular hospital or health system.

> " the comorbidity index is just one part—albeit an important one—of a sophisticated predictive model customized to a particular hospital's data. This ability to layer analysis on top of analysis—adding sophistication incrementally—is just one more reason why the enterprise data warehouse (EDW) approach to analytics works so well. "

In this case, the comorbidity index is just one part—albeit an important one—of a sophisticated predictive model customized to a particular hospital's data. This ability to layer analysis on top of analysis—adding sophistication incrementally—is just one more reason why the enterprise data warehouse (EDW) approach to analytics works so well. In a data warehouse, the various risk stratification models can be persisted and leveraged as inputs to one another. Non-persistent architectures, like using a business intelligence tool without a data warehouse backend, do not allow this building block approach.

Other Risk Stratification Methods

This article addressed a few specific risk stratification methods. At Health Catalyst, we stress flexibility in our platform. To that end, we also have risk stratification methods based on HCC rules, DRGs, and other customized algorithms.

Resources

- Accountable Care Organization (ACO) Solutions http://www.healthcatalyst.com/aco/

- What is an ACO? A Definitive Guide to Accountable Care Organizations http://www.healthcatalyst.com/what-is-an-ACO-definitive-guide-accountable-care-organizations

- Population Health Management Solutions http://www.healthcatalyst.com/population-health/

- Leveraging Healthcare Analytics to Reduce Heart Failure Readmission Rates http://www.healthcatalyst.com/reduce-heart-failure-readmissions-with-healthcare-analytics/

- Centers for Medicare & Medicaid Services http://www.cms.gov/Medicare/Health-Plans/MedicareAdvtgSpecRateStats/Risk-Adjustors.html

- The Johns Hopkins ACG System http://acg.jhsph.org/index.php/the-johns-hopkins-university

- The Relationship between Elder Risk Assessment Index Score and 30-day Readmission from the Nursing Home http://www.ncbi.nlm.nih.gov/pubmed/21441764

About the Author

Eric Just joined the Health Catalyst family in August of 2011 as Vice President of Technology, bringing over 10 years of biomedical informatics experience. Prior to Catalyst, he managed the research arm of the Northwestern Medical Data Warehouse at Northwestern University's Feinberg School of Medicine. In this role, he led the development of technology, processes, and teams to leverage the clinical data warehouse. Previously, as a senior data architect, he helped create the data warehouse technical foundation and innovated new ways to extract and load medical data. In addition, he led the development effort for a genome database. Eric holds a Master of Science in Chemistry from Northwestern University and a Bachelors of Science in Chemistry from the College of William and Mary.

- Effect of Multiple Chronic Conditions among Working-Age Adults http://www.ncbi.nlm.nih.gov/pubmed/21473661

- Care Coordination Tier Assignment Tool http://www.health.state.mn.us/healthreform/homes/payment/HCHComplexityTierTool_March2010.pdf

- A new method of classifying prognostic comorbidity in longitudinal studies http://www.sciencedirect.com/science/article/pii/0021968187901718

- Agency for Healthcare Research and Quality Report http://www.ahrq.gov/research/findings/factsheets/costs/expriach/expendria.pdf

- Comorbidity Analyzer http://www.healthcatalyst.com/demos/comorbidity-analyzer/

- Why Your Healthcare Business Intelligence Strategy Can't Win without a Data Warehouse http://www.healthcatalyst.com/healthcare-business-intelligence-data-warehouse

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Health Catalyst is a mission-driven data warehousing, analytics, and outcomes improvement company that helps healthcare organizations of all sizes perform the clinical, financial, and operational reporting and analysis needed for population health and accountable care. Our proven enterprise data warehouse (EDW) and analytics platform helps improve quality, add efficiency and lower costs in support of more than 50 million patients for organizations ranging from the largest US health system to forward-thinking physician practices.

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