Predicting Behavioral Health Severity in the Medicare Population

Using Big Data Sources, Advanced Data Science and Analytical Methods

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Outline

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Background
Behavioral health (BH) conditions have been linked to the prevalence and progression of numerous chronic medical conditions.\(^1,2\)

Among high-cost patients who also had high BH costs, overall costs were 30% greater than for other high-cost patients.\(^3\)

Proactively identifying a population in need of an appropriate and supportive BH intervention may help to achieve optimal health outcomes.

3. Claire de Oliveira et al. *Health Affairs*, 2016 [http://content.healthaffairs.org/content/35/1/36.short](http://content.healthaffairs.org/content/35/1/36.short)
Objective:

To develop a predictive model that estimates BH severity for a Medicare Advantage population in the next 12 months and identifies high risk members for timely clinical intervention.
Methods
• **Study design:** predictive model development

• **Data sources:** enrollment data, claims data, lab results, program data, information collected during welcome calls

• **Inclusion criteria**
  - Enrollment in Medicare Advantage with prescription drug plan in December 2013 and continuous enrollment during 2014
  - 1 BH diagnosis or 2 BH prescription fills in 2013

• **Approach to model development:** machine learning
Measurement of BH Severity

$: Medical claims
BH diagnosis or procedure code in primary position

+$:
Rx claims
BH drugs

= Total BH Cost

Total BH Cost

$\approx$ BH Severity

BH severity was a function of cost.
Machine Learning Pipeline

1. Data Extraction

2. Feature Engineering and Transformation
   Over 4,000 potential features were used for development.

   - **PREDICTOR CATEGORIES**
     - **Demographics**
       - E.g., Age, sex, race, disability
     - **Behavioral**
       - Lifestyle, health programs
     - **Clinical**
       - E.g., chronic conditions, BH, hospitalization, screenings
       - **Medication**
         - E.g., asthma, diabetes, heart failure, BH

3. Model Development
   - Selection of the most important predictors
   - Different modeling techniques and combinations explored
   - **MODELING CHOICES**
     - Branching
     - Linear Regression
     - Decision Trees
     - Neural Networks
     - Least Angle Regression
     - Ensemble

   **BH Severity Predictive Model**
Results
Study Population Characteristics

698,894 individuals
Mean age, 69.5 (SD, 11.3)
62.3% female

SD, standard deviation

BH Diagnoses

Most participants had anxiety (34.6%) and/or depression (40.4%)
Current BH Severity, BH drug utilization and severe mental illness indicators such as schizophrenia, bipolar, major depression and suicide attempt proved to be the top predictors.

Examples of top predictors

- Current BH Severity
- Antidepressants utilization
- Antipsychotics utilization
- Severe Mental Illness
- Anxiety drugs utilization
- Major Depression

Correlation
Model Performance: Actual vs Predicted BH Severity

Actual BH severity (square root of total costs) for 2014 closely follows the model-predicted score for 2014 across different percentiles of the population.

Spearman Correlation: 0.794; Top 10% ROC: .923
Discussion
The BH severity score can be paired with a medical score (Charlson Comorbidity Index) to create an analytic framework called the **Behavioral Health Quadrants**, allowing:

- Better understanding of the relative severity of medical & behavioral health in an individual
- Greater ability to direct individuals to the right level of care

28% of Medicare Advantage participants had sufficient BH utilization to be assigned to a BH quadrant.

Conclusions

• A predictive model that estimates the future BH severity of Medicare individuals was developed using advanced analytical methods.

• Model will allow us to:
  - Identify individuals likely to have high BH severity in the future
  - Accordingly deliver appropriate interventions.

• Future work will seek to identify the top reasons behind an individual’s BH severity score.
Limitations

• Missing data and coding errors inherent to claims data

• Model performance is specific to the Medicare Advantage population and the plan’s access to particular sets of data

• No direct measurement of BH severity

• Due to claims lag, members will be typically scored 30 days after a BH service
Thank you!