Predicting Behavioral Health Severity in the Medicare Population

Using Big Data Sources, Advanced Data Science and Analytical Methods

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October 2017

Humana.

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Outline

1. Background
2. Methods
3. Results
4. Discussion

Background

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.

1. Chapman DP et al. *Prev Chronic Dis.* 2005. http://www.cdc.gov/pcd/issues/2005/jan/04_0066.htm
2. Benton T et al. *Ann Clin Psychiatry*. 2007. https://www.ncbi.nlm.nih.gov/pubmed/18058286
3. Claire de Oliveira et al. *Health Affairs, 2016* *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 Details

- **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 ≈ **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.*

3

Model Development

- *Selection of the most important predictors*
- *Different modeling techniques and combinations explored*

DATA

- Demographic
- Medical & Claims
- Pharmacy Claims
- Lab & Test Results
- Welcome Calls
- Health Programs
- Consumer Data

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

MODELING CHOICES

- Branching
- Linear Regression
- Decision Trees
- Neural Networks
- Least Angle Regression
- Ensemble

BH Severity Predictive Model

Results

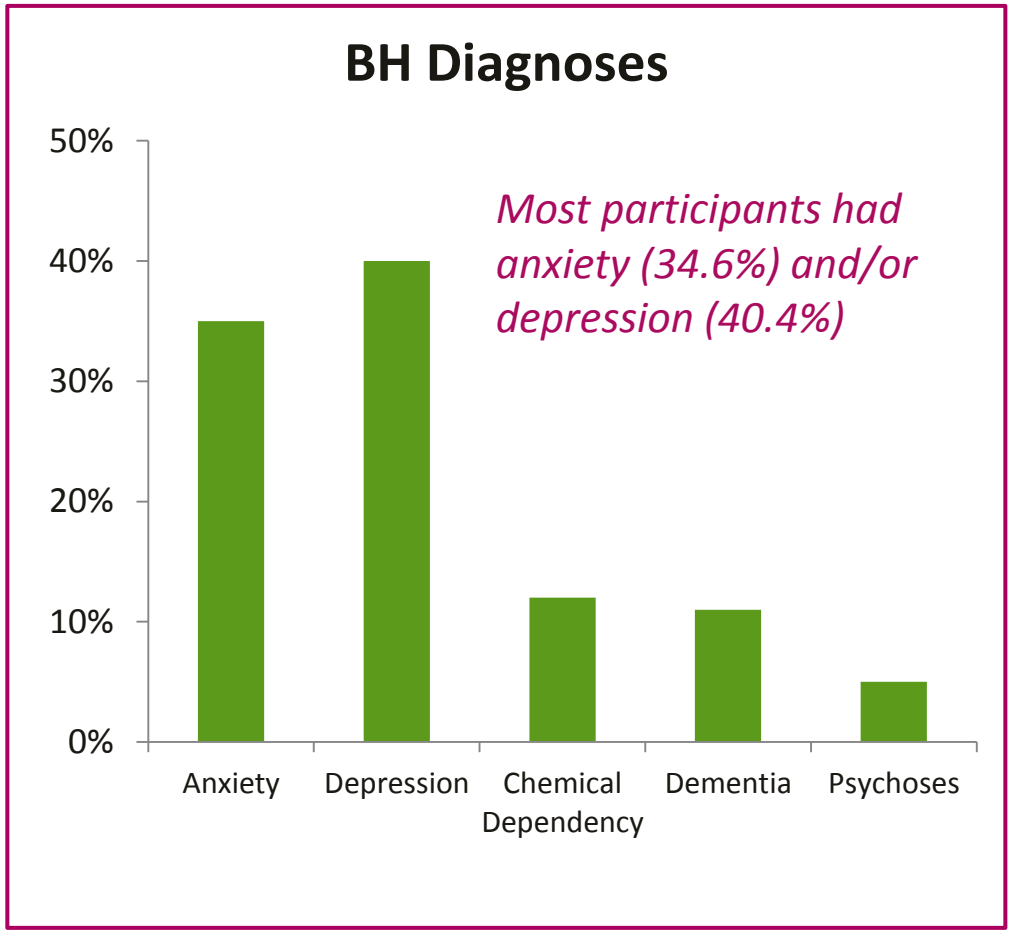
Study Population Characteristics

698,894 individuals

Mean age, 69.5 (SD,11.3)

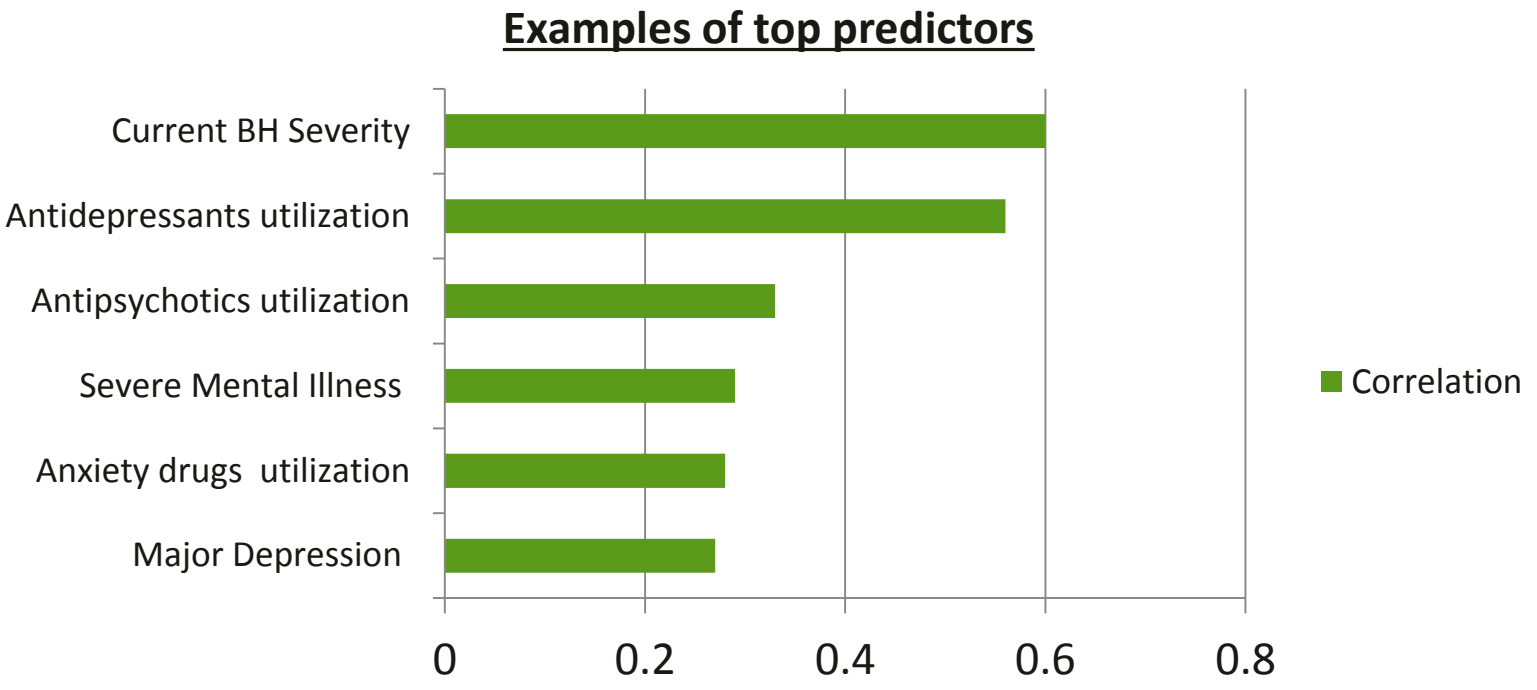
62.3% female

SD, standard deviation



Top Predictors of BH Severity

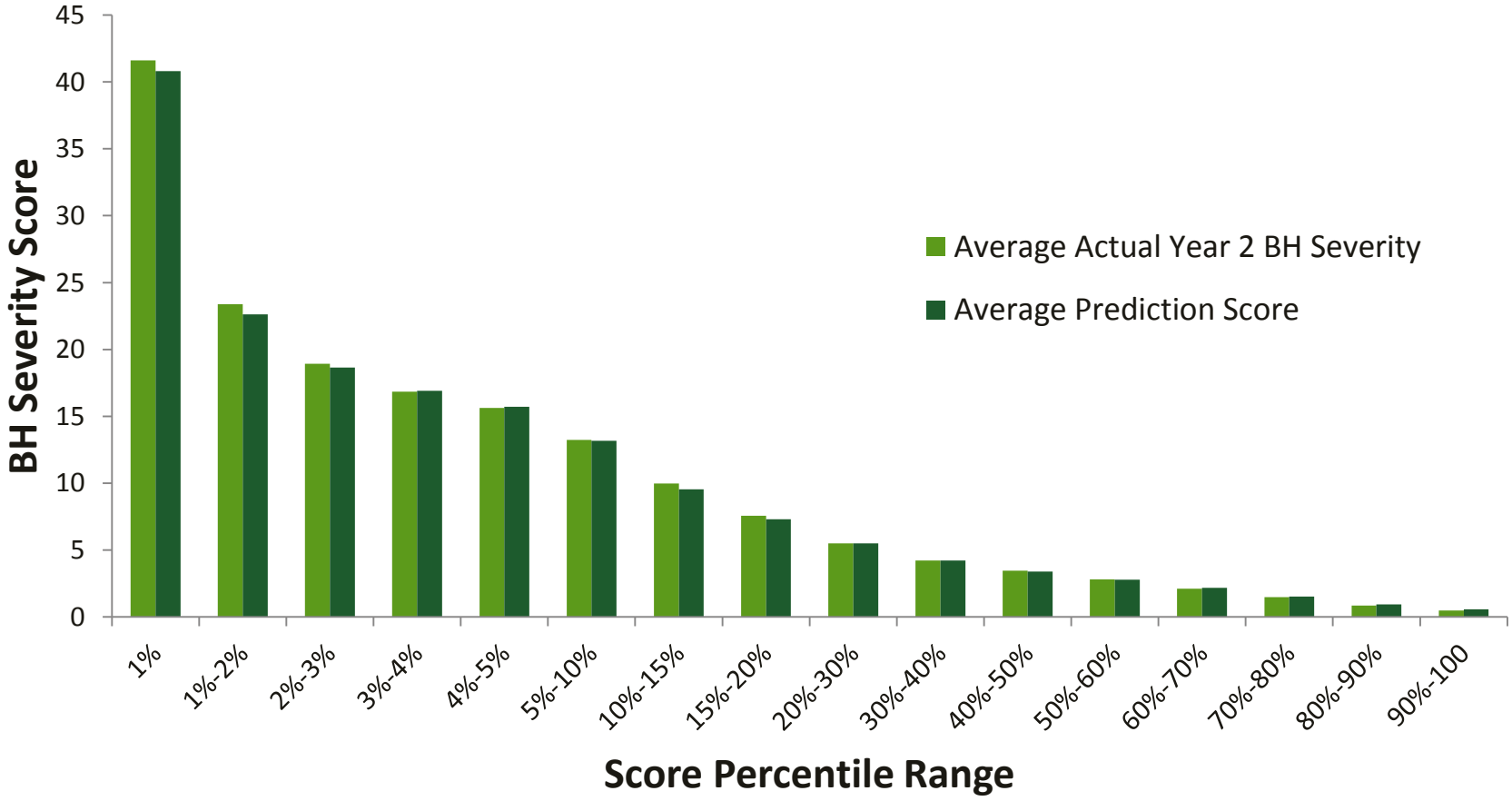
Current BH Severity, BH drug utilization and severe mental illness indicators such as schizophrenia, bipolar, major depression and suicide attempt proved to be the top predictors.



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

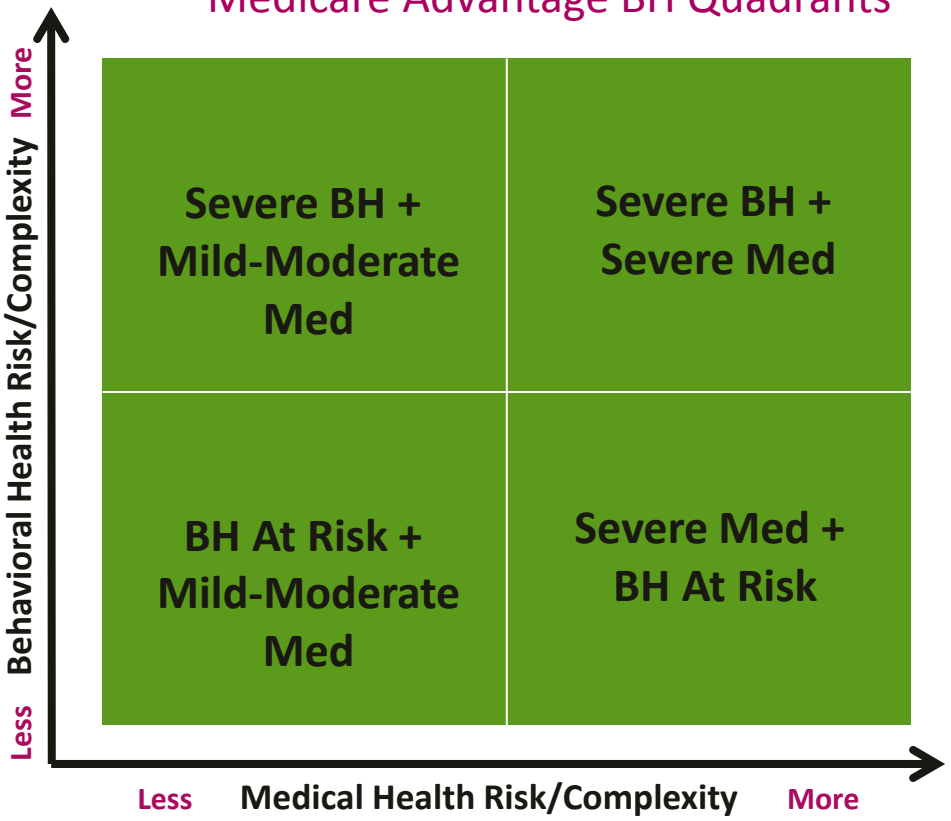
Application

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.

Medicare Advantage BH Quadrants*



*Adapted from Four Quadrant Clinical Integration Model (National Council for Behavioral Health). Values as of Jan 2016. Based on membership as of Dec 2015 and claims Jan 2015 – Dec 2015.

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!