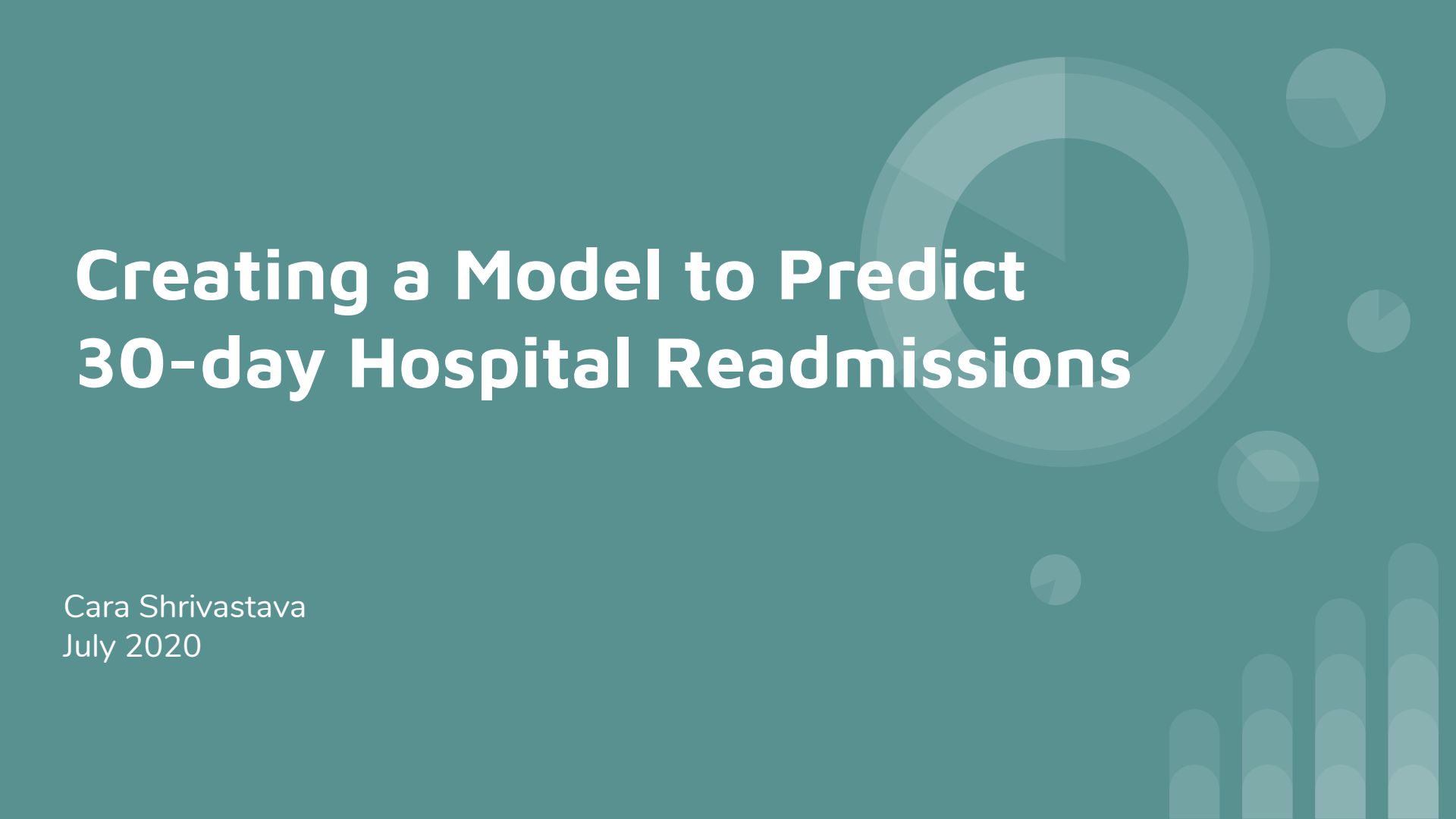# Creating a Model to Predict 30-day Hospital Readmissions

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Background

High hospital readmission rates are associated with poor patient outcomes and high financial costs

Hospital readmissions account for an estimated $17.4 billion in spending annually by Medicare.

The Hospital Readmissions Reduction Program (HRRP) was established by the Affordable Care Act in 2012, and authorized Medicare to decrease payment to hospitals with high readmission rates.

Objective

Our objective is to update healthcare system recommendations and best practices on the prevention of 30-day hospital readmissions.

The Client: Center for Medicare and Medicaid Services (CMS)

The Plan: to perform an initial analysis using updated US population data to develop a model that predicts hospital readmissions.

The Data

National Health and Nutrition Examination and Survey (NHANES).

NHANES provides a cross-sectional survey of health status of the US population each year. The data is collected through a series of health and nutrition surveys, physical examination and laboratory tests conducted by the US Centers for Disease Control and Prevention (CDC).

In the 2015-2016 survey, non-Hispanic Asians, Hispanics, non-Hispanic blacks, older adults, and low income whites/others were over-sampled.

Target Variables*

Data was obtained from the following portions of the survey: Demographics, Laboratory, Examination, and Questionnaire.

The table indicates a few of the features we examined.

* Target variables were renamed during data preparation for ease of use.

Feature	Variable Type	Description
numhosp	Continuous (float)	Number of hospitalizations
newcvd	Categorical(bool)	New onset of cardiovascular disease
depr_score	Continuous (float)	Depression score
ethnicity	Categorical (category)	Ethnicity
age	Continuous (float)	Age
hgb	Continuous (float)	blood hemoglobin (g/dL)
hct	Continuous (float)	blood hematocrit (%)
foodsec	Categorical (category)	Food security score
chf	Categorical (bool)	Congestive heart failure
kidney	Categorical(bool)	Kidney disease

Initial Findings

The total number of participants examined: 5592.
Participants with 1 hospital stay: 466
Participants with 2 or more hospital stays: 204

Because congestive heart failure (CHF) is a common predictor of hospital readmissions, our initial plan was to examine only readmissions related to new onset congestive heart failure..
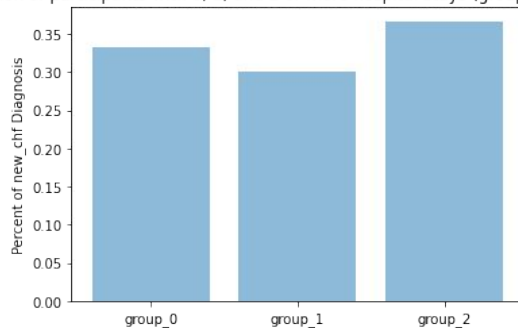
Initial Findings

New Onset CHF is associated with high readmissions.
We found that although the number of participants with CHF alone seemed adequate (n=498), only 49 reported hospital readmissions, and many fewer reported onset of disease during the year of the study (n=30 total new onset with n=11 readmissions).

new_chf - Proportion of participants with 0, 1, and 2 or more hospital stays (groups 1, 2, and 3 respectively)
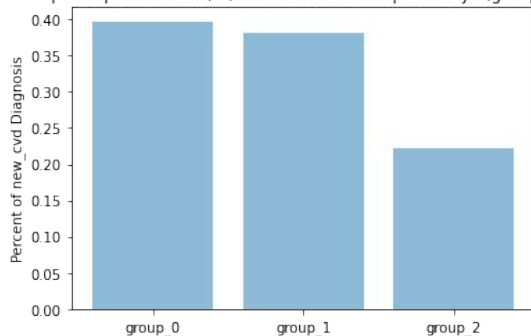
Initial Findings

In attempt to increase the sample size, we included new onset cardiovascular disease in general, and created a new diagnosis feature 'newcvd' which included new onset 'chf', 'chd', 'mi','angina',and 'cva'. The sample size of newcvd was larger than that of 'chf' (n=63) with 14 readmissions, but the percentage of readmissions was much smaller.

new_cvd - Proportion of participants with 0, 1, and 2 or more hospital stays (groups 1, 2, and 3 respectively)

Initial Findings

Other Features

Although the 'newcvd' and 'newchf' proportion of readmissions was compelling, due to small sample size of new onset CHF and also since the overall dataset is very rich, we investigated other diagnosis features (which included a compilation of both current and new disease onset).

We found positive readmissions to be correlated ($\rho>0.01$) with with the following diagnosis features:

'chf', 'kidney', 'copd', 'stroke', 'emphysema', and 'cancer'.

Initial Findings

Depression Scores
Participants were divided into two groups based on depression scores:
Group 1: depr_score < 5 # little/no depression detected
Group 2: depr_score >= 5 #mildly depressed or worse

Based on a two-proportion z-test, those with depr_score>5 had a higher proportion of hospital readmissions when compared with those with depr_score<5 (p=0.03).

Initial Findings

Ethnicity

For the overall nhanes group, a Chi square test implied that ethnicity did not affect readmission status ($p=0.65$. However, when we examined new onset CVD, ethnicity did appear to have an effect on the proportion of hospital readmissions ($p=0.03$).
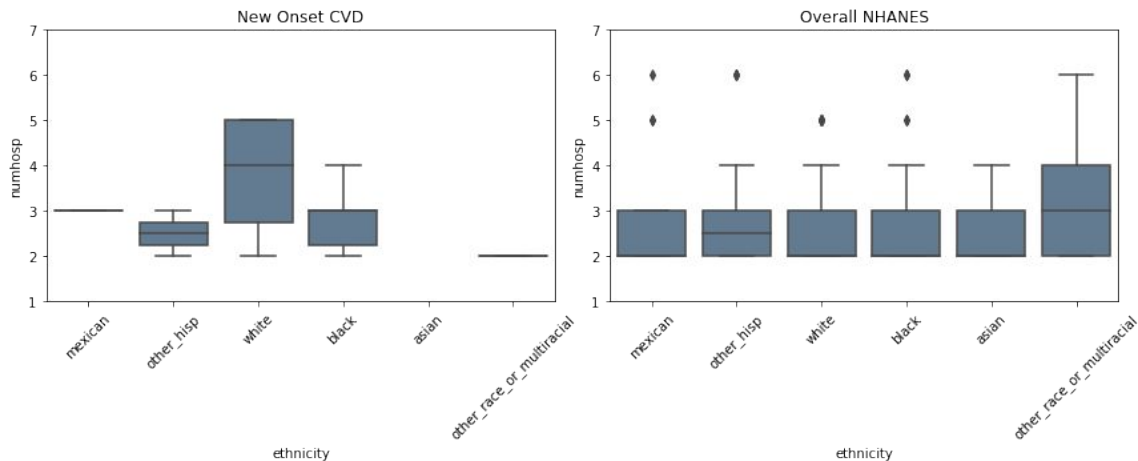
Initial Findings

Laboratory Samples

A 2-sided t-test allowed us to to compare the means of each of various laboratory values between the two groups of interest: readmission == 1 (positive readmission) and readmission == 0 (negative readmission.

Results:

Mean BUN ($p<0.01$), creatinine ($p<0.05$), and osmolality ($p<0.01$) varied significantly between the two groups. These lab values relate to kidney function and fluid balance.

A few other lab values approached significance: hgb ($p=0.052$) - which is an indicator of anemia; and tchol($p=0.055$) - an indicator of heart health.