Quality Predictive Modeling for Diabetes and Hypertension

Background and Project Motivation

- Boston Medical Center (BMC) the General Internal Medicine Clinic serves 40,000+ patients as a MassHealth ACO
- The hospital has just switched to a Pay-For-Performance system
- Payments from Medicaid are pegged to whether they achieve their target for control
  - Diabetes: at least 60% of patients with A1c level <= 9
  - Hypertension: at least 60% of patients with BP < 140/90
- Build a quantitative model to predict whether BMC is likely to meet its targets in the next three years

Objective

Summarize effectiveness of current treatment pathways and develop predictions for quality measures over the next three years assuming annual increase in quality requirements and population

Methodology

- Analyzed A1c and blood pressure measurements for 1262 patients recorded between 2018 Q1 and 2019 Q3
- For each patient, two A1c / blood pressure measurements recorded between 3 – 16 months apart (mean: 7.06 ± 3.21) were analyzed
- Constructed a transition matrix to capture patient movement among A1c / blood pressure bands between the two time points
- The distribution of patients in each A1c / blood pressure bands at the first recorded A1c / blood pressure is the initial vector, the transition matrix propagated the distribution for the next three years
  - The proportion of deaths in each band was estimated from the literature
  - New incoming patients assumed equal to initial distribution
- Several models were analyzed to fit to the data
  - Linear Regression
  - Logarithmic Regression
  - Logarithmic Regression with Constant Annual Growth Rate
  - Logarithmic Regression with Moving Average (order 3)
- Monte Carlo simulation was used to generate a confidence interval

Results

Diabetes – A1c

- Logarithmic Regression with Moving Average (order 3) was the best fit: $R^2 = 0.98$
- Model Results: the percentage of patients with A1c <9 will be slightly over 75% in every season from 2019 semester 2 to 2022 semester 2
  - Expected to continue meeting A1c quality target over the next 3 years

Hypertension – Blood Pressures

- Transition Matrix was only model that fit the data
- Current available blood pressure does not show a noticeable trend

Recommendations for BMC

- Save all A1c and BP values for each patient instead of overwriting them each time a new one is recorded
  - To observe long-term trends and build more robust models
- Record patients’ medication histories and pharmacist interventions in an easily accessible format
  - To examine the effect of medication changes and pharmacist interventions on A1c values
- Examine possible reasons why the proportion of patients in the clinically healthy band (A1c < 7) has been decreasing
  - Ideally, the goal would be to increase or maintain the proportion of patients in the A1c < 7 band

Key Finding

With a confidence level of 95%, Boston Medical Center will be able to achieve its diabetes quality target in the years ranging from 2020-2022

Non-conclusive predictions for addressing the quality metric for hypertension

The Team

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