Predicting Influenza Vaccinations using Administrative Claims and Consumer Health Data

Background
Influenza is a major public health and medical concern, affecting between 5-10% of adults and 20-30% of children worldwide on an annual basis. Annual influenza vaccination is recommended for children and adults to reduce the individual burden of disease as well as strains on the healthcare system. Vaccination rates among adults, however, are estimated at about 40% despite recommendations from the Centers for Disease Control and Prevention. Predictive modeling of influenza vaccination can play an important role in identifying behaviors and individual or population factors that are associated with interventions for increasing vaccination rates. Current models, which rely on survey responses or medical claims, are limited by the need for active user input and the sporadic availability of data relative to the influenza event or vaccination. Consumer Mobile Health data collected after user consent through wearable activity monitors (WAM) may potentially address these challenges by providing unobtrusively monitoring for a number of individual behaviors at granular time scales of day, hour, and even minute level studies.

Objective
To compare and contrast the predictive ability of consumer health data from wearable activity monitors with conventional medical claims data for the prediction of influenza vaccinations in a large commercial insured population. We hypothesize that the inclusion of WAM data will provide additional information to predictive models beyond the use of conventional medical claims data alone.

Methods
STUDY DESIGN: Retrospective cohort data source
- Medical claims and enrollment records from commercial health insurance
- Humana wellness app for all members that can connect WAM and acts as a portal for logging wellness behaviors like obtaining an influenza vaccination

SELECTED CRITERIA:
- The prediction period covers one year after June 1, 2015 to June 1, 2016.
- Training data for medical claims and for WAM were obtained from the June 1, 2015 – June 1, 2016 period.
- Eligible participants were adults (age 18–64), with evidence of commercial insurance coverage during the analysis period. Influenza vaccination status was based on medical claims data and participant reporting through the wellness app.

ANALYSIS:
- Two predictive models were compared:
  - The first model used medical and pharmacy claims data.
  - The second model used a subset of the first cohort that also had WAM data from the wellness platform.
- To be included in the second model using WAM data, individuals must have had tracking data available in the training period and at least one recorded activity during the prediction period (June 1, 2015 – June 1, 2016).
- A total of 679 features were computed for analysis. For each model, we split the dataset into training and test sets. On the training set, we used L₁-regularized Lasso regression with influenza vaccination in the outcome to identify a subset of most predictive features. We then trained a random forest classifier on the training set and report predictive power with a Receiver Operating Curve and its Area-Under-Curve (AUC) on the test set as the performance metric for the models.

Conclusions
This study found that WAM data in combination with prior influenza vaccination status performed comparably to conventional medical and pharmacy claims data as is typically used in real world evidence. Advantages to WAM data include: 1) Following user consent, WAM is unobtrusively collected and does not require active user engagement, and 2) information can be summarized over different time granularities of day, hour and even minute level studies. WAM can interact with mobile applications and cloud based analytic engines for real time predictions and analysis. This enables the delivery of mobile app notifications to users that are personalized and thereby relevant to the individual.

Current limitations in WAM data such as inconsistent use, device inaccuracies and a user profile that skews to younger and more affluent people who likely become less relevant as technologies improve and use becomes more commonplace within the consumer market.

Predictive modeling using consumer mobile health data gathered by wearable activity monitors in conjunction with prior year vaccination status can be used to predict influenza vaccination behaviors in a large population. This finding has implications on the development of interactive mobile technologies to positively influence healthy behaviors at a population level.

Limitations
- Results are subject to limitations inherent to claims data (e.g., coding errors, missing data, fixed variables).
- The model includes data from a single health company and may not be generalizable to all populations.

This research was funded in part by DBPA-BAA-15-35, Award Number N9119J-16-C-0055.

References