FORECASTING EMERGENCY DEPARTMENT PATIENT ADMISSIONS UTILIZING MACHINE LEARNING

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Abstract

Background

Multiple studies have identified inpatient bed availability as a key metric for Emergency Department operational performance. Early planning for patient admissions may allow for optimization of hospital resources.

Objectives

Our study aimed to predict the need for admission at the time of patient triage utilizing data already available in the electronic health record (EHR). We performed a retrospective analysis of EHR derived data to evaluate the effectiveness of machine learning techniques in predicting the likelihood of admission for patient encounters in an academic emergency department. We hypothesized that more comprehensive & inclusive models would provide greater predictive power.

Methods

All patients who presented from 1/1/2012 to 12/31/2013 and met inclusion criteria were included in the analysis. The data were then partitioned into two sets for training and testing. The primary outcome measured was the ability of the trained models to discern the future admission status of an encounter, measured in terms of area under the receiver operator curve (ROC AUC). A secondary outcome was accuracy (ACC). Model features included a mix of patient specific factors (demographics, triage vital signs, visit and chief complaint history), the state of the ED (census and other performance metrics); and timing factors (time of day, etc.). The most comprehensive models included 682 variables, encoding 328 features, aggregated into 3 feature groups.

Results

Our final analysis included 91,060 patient encounters. 28,838 (31.7%) of these encounters resulted in an inpatient admission. Compared to using a naïve model, single feature group models provided improved predictive abilities (1.8% - 50.8% improvement in ROC AUC), see figure for details. More sophisticated models, including all available feature groups provided greater predictive power with the greatest achieved at ROC AUC score of 0.756.

Conclusion

We have demonstrated that including information about incoming patients and the state of the ED at the time of triage can aid in the prediction of individual patients' likelihood of admission. More sophisticated models using claims, weather, and social media data may lead to greater predictive power to prospectively estimate patient admission likelihood at arrival.