Real-time prediction of inpatient length of stay for discharge prioritization

Barnes S, Hamrock E, Toerper M, Siddiqui S, Levin S. Real-time prediction of inpatient length of stay for discharge prioritization. *Journal of the American Medical Informatics Association: JAMIA*. 2016;23(e1):e2-e10.

Presenter: Evelyn Yeh

Our Project

- Patient simulation and census model for medical-surgical unit
- Finalizing the census model with nurse matching
- Create nurse schedules to adequately staff unit while minimizing cost

Paper Selection

- Paper was co-authored by our mentor Dr. Siddiqui
- Provides background on the benefits of improving patient flow
- Describes a process of predicting patient discharges that we have adapted for our own simulation
- Discusses factors that affect a patient's length of stay, a key component for determining patient census

Paper Summary

The objective of this study was to use supervised machine learning methods to automate and improve discharge predictions for a medical unit.

Background

- Patient flow is linked to patient safety and satisfaction and is a main determinant of hospital resource management
- There is increasing pressure on hospitals to deliver cost-efficient care

- Real-time demand capacity management (RTDC) is a novel process for making discharge predictions and to improve patient flow
- In this study, machine learning is utilized in an effort to automate and improve this prediction process

Basics of the Study

RTDC process:

- Machine learning models designed to match the current clinician process

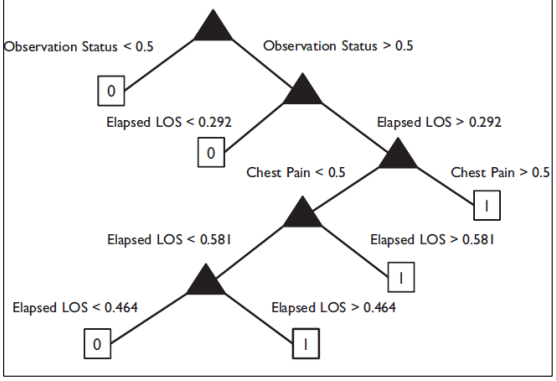
Data that models are trained on:

- Patient flow data over 34 months (January 2011 to November 2013)
- Includes demographics, admission diagnoses, day of the week, elapsed length of stay, observation status

Methods of the Study

- Classification trees are developed by training algorithms with patient data
  - A patient's attributes can be used to traverse the tree to determine whether they are likely to be discharged
- Example on right: they found that observation status is important predictor

Figure 1: Classification tree for end-of-day discharge predictions.



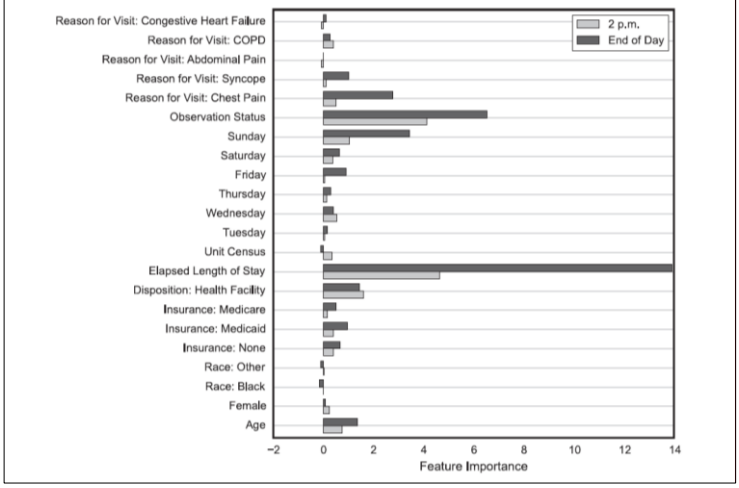
Results of the Study

- Model produced by Random Regression Forest (RRF), one of the machine learning algorithms they used, was most accurate
- Three areas of results were produced
  - Importance of variable predictors
  - Individual discharge predictions
  - Average discharges per day

Variable Predictors

- Using model, produced summary of which variables were more important in predicting discharge

Figure 2: Variable importance summary from training regression random forest models for the 2 p.m. and end-of-day discharge predictions.



Individual Discharge Predictions

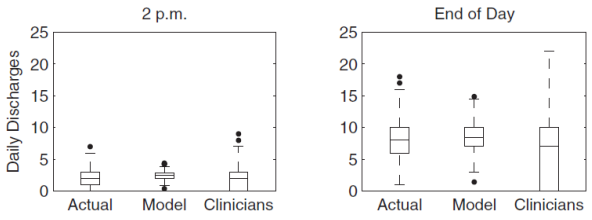
- Sensitivity = TP / (TP+FN)
- Specificity = TN / (TN+FP)
- Youden's Index J = Sensitivity - Specificity - 1

- Model was slightly more sensitive to predicting discharges than clinicians, but difference in global (Youden's) index was not statistically significant
- So model performed comparably well

Daily Discharge Averages

- Model performed better than clinicians

Figure 3: Comparison of actual, model prediction, and clinician prediction distributions of the average number of patients discharged from the unit each day.



Discussion and Further Work

- Overall, this study showed that the discharge prediction process can be automated and potentially improved
- This would eliminate the need for clinician huddles
- Study can be expanded upon by figuring out how to further improve predictions and patient flow
- This can be studied to determine more efficient resource management by hospitals – staff scheduling, bed management, etc.

Assessment

Pros

- The study provides results that show automation of the prediction process is possible
- The model showed promising results for improving upon clinicians' predictions as well

Cons

- The study was done in only one medical unit and is not generalizable
- Authors compared probability-based predictions from the model with binary predictions from clinicians
- Authors failed to explain their methods in depth – the model they deemed most accurate was not mentioned in the paper until the results section

Relevance for Our Project

- The paper gave us background on how to use patient flow data
- Provided adequate insight into the process of discharge predictions, which is directly related to length of stay in our simulation
- Provided factors that affect length of stay, which we have adapted to use for our simulation

Citation

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