# Precision Prediction of Individualized Outcome in Traumatic Brain Injury Patients after Acute Rehabilitation

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CNS 2018 ANNUAL MEETING
HOUSTON, TEXAS
OCTOBER 6-10, 2018

## Introduction

No model currently exists that predicts individualized patient outcome after traumatic brain injury (TBI). For the first time, we developed modern statistical models and assessed their accuracy in predicting individualized patient-specific outcome in the Functional Independence Measure (FIM) scale after acute rehab using clinical data before rehabilitation.

## Methods

All patients (n=629) admitted to Casa Colina Acute Rehabilitation Unit (ARU) from 2010-2015 with a TBI diagnosis were included. 37 variables (Table 1) were used to predict 17 different (Table 2) FIM scales (each scored initially from 1-7, then mapped to 4 predicted scores: 1 [total assistance], 2-4[moderate assistance], 5[supervision only], 6-7[independence]) at time of discharge from ARU for each patient. Three statistical methods: random forest, support vector machine (SVM), and adaptive boosting (adaboost), were used to create 2 different models each, using either sequential binary classification, or one-vs.-one multinomial classification, resulting in 6 different models. For each model, we randomly sampled with replacement the entire dataset, selected the first half (n=314) as the training set and the rest (n=315) as testing set, repeated the process 1000 times, calculated 1000 bootstrap classification errors, and derived the mean and standard deviation for the classification errors.

**Figure 1**

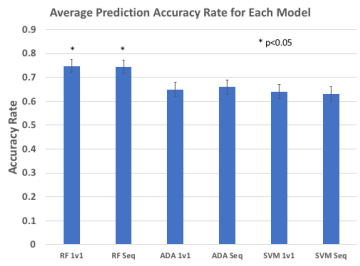


Figure 1:

The accuracy rates for 17 FIM outcome measures were averaged for each statistical model. The two models created from random forest consistently predicted with more than 70% accuracy, which is significantly higher ($p<0.05$) than from adaboost or support vector machine models.

RF=random forsest; ADA = Adaboost; SVM = support vector machine; 1v1: one-vs.-one multinomial classification; Seq = sequential binary classficiation

## Results

The average FIM prediction accuracy ranged from 63-75% in our 6 models with an average standard deviation of 2-3% (Figure 1). The 2 models from Random Forest predicted with higher accuracy rates compared to Adaboost and SVM ($p<0.05$), averaging 74-75% +/- 3%. FIM score for Bowel Control was the most accurately predicted category for all models, with Random Forest predicting correctly more than 80% of the time (Figure 2).

## Conclusions

Modern statistical methods, particularly random forest, can predict patient-specific outcome after TBI to a reasonable degree, with our best models averaging over 70% accuracy for every feature for every patient. As datasets become larger in the future, we expect improved accuracy rates.

**Figure 2**

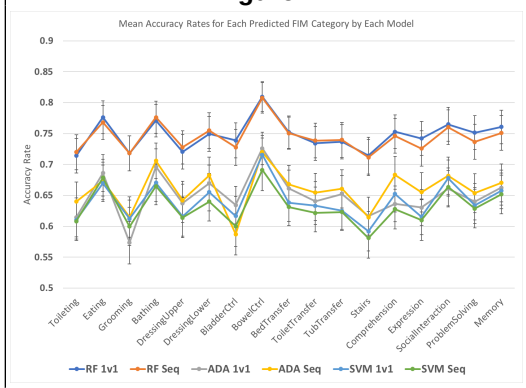


Figure 2:

Mean Accuracy Rates for Each Predicted FIM Category by Each Model

RF=random forsest; ADA = Adaboost; SVM = support vector machine; 1v1: one-vs.-one multinomial classification; Seq = sequential binary classficiation

## Learning Objectives

- To evaluate extent to which modern statistical methods and machine learning algorithms can precisely predict individual clinical outcome using large datasets

- To assess the feasibility of creating modern statistical models to ultimately provide each patient with their own specific functional outcome after traumatic brain injury.

## References

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