Machine Learning Algorithms for Predicting In-Hospital Mortality Following Traumatic Brain Injury: Analysis from the National Trauma Databank

Jad Zreik, BS; Anshit Goyal, MBBS; Archis R. Bhandarkar, BS; John Atkinson, MD; Terry C. Burns, MD, PhD; Mohamad Bydon, MD
Disclosures

Nothing to disclose
Introduction

• Traumatic brain injury (TBI) is a leading cause of mortality, and timely surgical management can be critical for high-risk patients

• Machine learning algorithms have been gaining traction as powerful predictive tools that can reduce increasingly complex, high-dimensional clinical data and provide meaningful prognostic information

• Objective: To assess the performance of machine learning algorithms in predicting in-hospital mortality for TBI patients from a national, multi-center registry
Methods

• National Trauma Databank was queried for patients admitted to a trauma center with acute TBI

• Five different machine learning models (generalized linear model, neural network, extreme gradient boosting, random forest, and support vector machine) were evaluated based on performance metrics

• Data was split into an 80/20 training and testing set. 10-fold cross validation repeated 3 times was performed using the training set, following by testing using the testing set
## Results

<table>
<thead>
<tr>
<th>Model</th>
<th>AUC</th>
<th>Accuracy</th>
<th>Kappa</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generalized linear model</td>
<td>0.925</td>
<td>0.882</td>
<td>0.437</td>
<td>0.801</td>
<td>0.888</td>
<td>0.356</td>
<td>0.983</td>
</tr>
<tr>
<td>Neural Network</td>
<td>0.929</td>
<td>0.865</td>
<td>0.407</td>
<td>0.833</td>
<td>0.867</td>
<td>0.325</td>
<td>0.985</td>
</tr>
<tr>
<td>Extreme Gradient Boosting</td>
<td>0.933</td>
<td>0.928</td>
<td>0.532</td>
<td>0.674</td>
<td>0.947</td>
<td>0.495</td>
<td>0.974</td>
</tr>
<tr>
<td>Random Forest</td>
<td>0.925</td>
<td>0.898</td>
<td>0.458</td>
<td>0.742</td>
<td>0.910</td>
<td>0.387</td>
<td>0.979</td>
</tr>
<tr>
<td>Support vector machine</td>
<td>0.926</td>
<td>0.884</td>
<td>0.440</td>
<td>0.796</td>
<td>0.891</td>
<td>0.359</td>
<td>0.983</td>
</tr>
</tbody>
</table>

Performance metrics for each evaluated model
Results

Receiver operating curve and variable importance figures for the highest performing model (extreme gradient boosting)
Discussion

• Models demonstrated excellent predictive performance (all AUC > 0.90)

• The extreme gradient boosting model was identified as the highest performing model

• Glasgow coma scale (GCS) score, oxygen saturation, pupillary response, and age were identified as the most significant predictors of in-hospital mortality for this model
Summary Points

• Machine learning algorithms may have utility as clinical decision support tools for patients admitted with TBI

• Further research is warranted to externally validate the models and assess their utility in a clinical setting
Questions and discussion