Coma Predictor: Prediction of Neurological Trajectories in Non-Neurological ICU Patients

Haoyin Xu[1]; Alisha Kodibagkar[2]; Jacob Desman[3]; Munachiso A. Igboko[4]; Qianqi Huang[5]; Zixuan Wang[6]; R. L. Winslow[7]; J. L. Greenstein[8]; R. D. Stevens[9]

[1,2,3,4,5,6,7,8]Department of Biomedical Engineering, Johns Hopkins University, Baltimore, MD, USA

[9]Department of Anesthesiology and Critical Care Medicine, Johns Hopkins University School of Medicine, Baltimore, MD, USA

Background

Decreased neurological responsiveness is a cardinal manifestation of brain dysfunction, which occurs in ICU patients **without primary neurological disorders**. Brain dysfunction may be treatable or even preventable with limited means to predict responsiveness changes. There is an unmet need for models to **predict responsiveness outcomes in patients admitted to the ICU**.

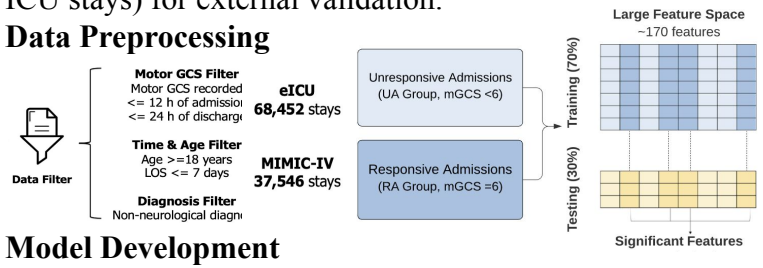
Objectives

1. Predict neurological responsiveness trajectories of non-neurological ICU patients
2. Identify and rank predictive features associated with specific neurological responsiveness trajectories

Methods

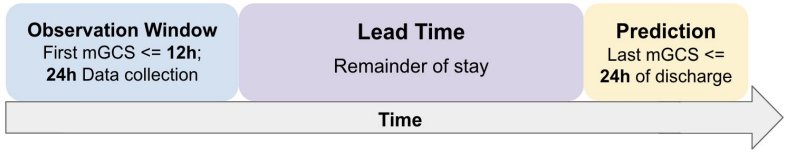
We used the **eICU** database (200,859 ICU stays) as training and testing set; the **MIMIC-IV** database (69,619 ICU stays) for external validation.

Data Preprocessing



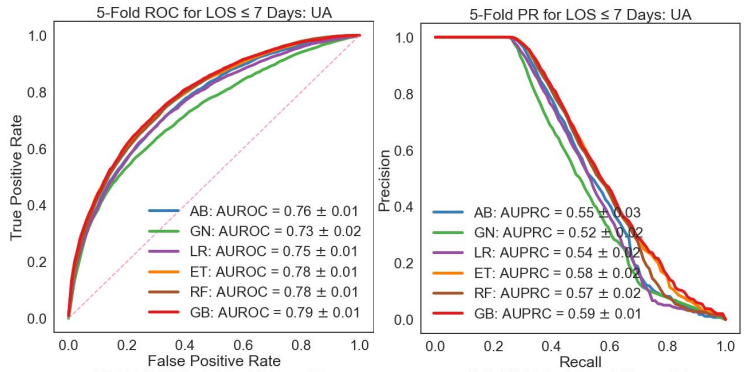
Model Development

Two classifications: **responsive admission** (RA) and **unresponsive admission** (UA) group.

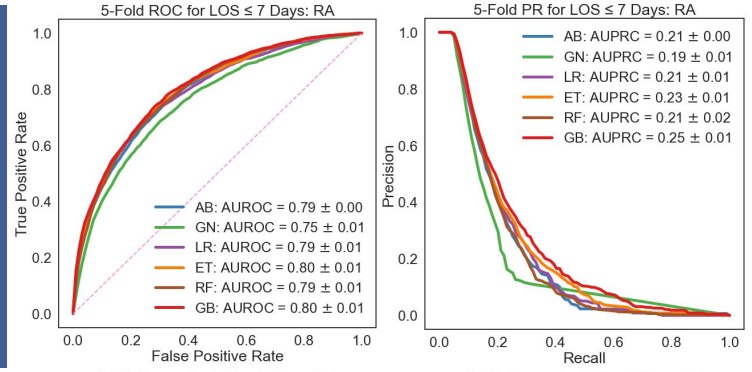


Results 1

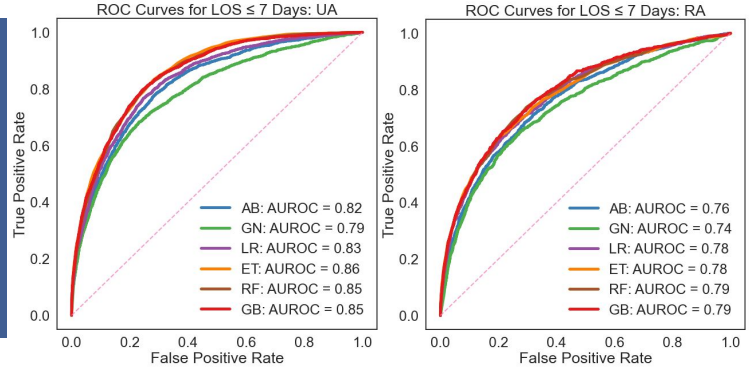
Unresponsive Admission (UA) Group



Responsive Admission (RA) Group

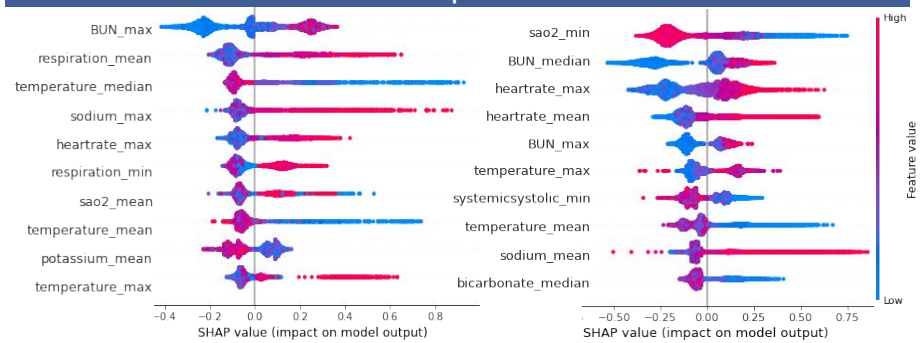


External Validation



Results 2 – Feature Importance

UA & RA Feature Importance SHAP Plots



- The mean (±SD) AUROC for predicting responsiveness was **0.80 (±0.01)** for **RA Group** and **0.79 (±0.01)** for **UA Group**. We chose **gradient boosting** models for best results.
- Top ranked features included physiological signals: **respiratory rate, systemic blood pressure and heart rate**; lab features: **blood urea nitrogen and red blood cell count**.

Conclusions

A machine learning model trained with data collected in the **first 24h after ICU admission** can **accurately predict neurological responsiveness at discharge of patients in ICU for 7 days or less**. This information could be critical in identifying strategies to prevent neurological deterioration or enhance neurological recovery

Future Directions

1. Develop neural network models for prediction and feature importance interpretation;
2. Explore additional features to enhance prediction accuracy

Additional Information

If you have any other questions or comments, welcome to contact us via rstevens@jhmi.edu