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

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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**.

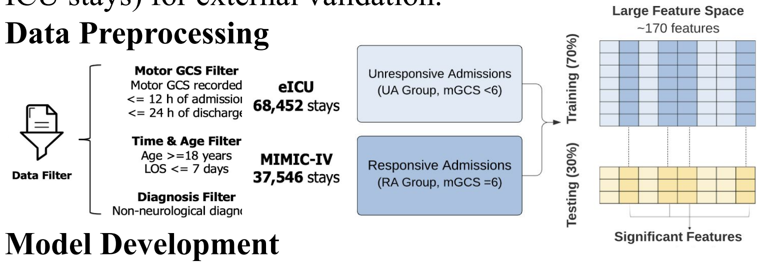
Objectives

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

Methods

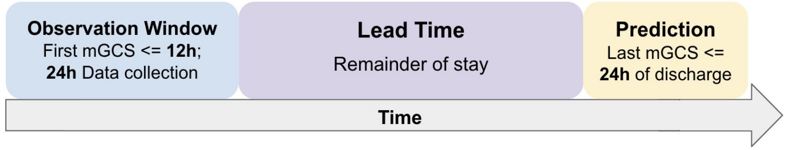
We used the **eICU** database (200,859 ICU stays) as training and testing set; the **MIMIC-IV** database (69,619 ICU stays) for external validation.

Data Preprocessing



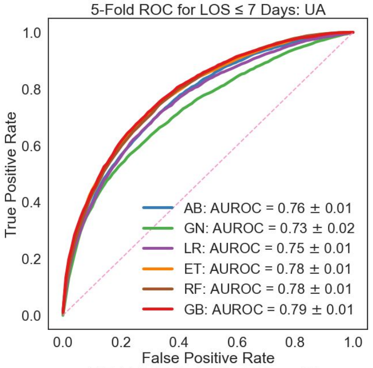
Model Development

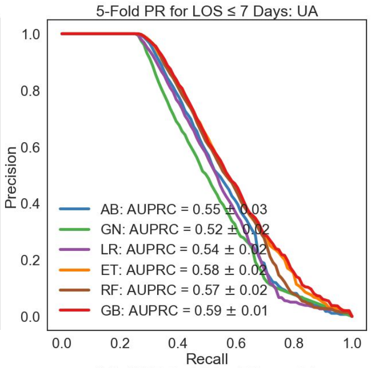
Two classifications: **responsive admission** (RA) and **unresponsive admission** (UA) group.



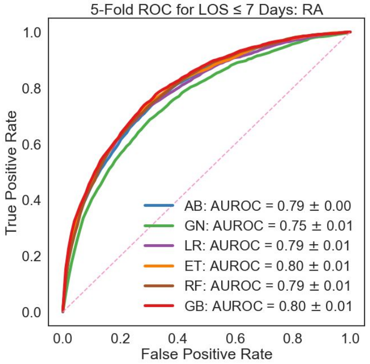
Results 1

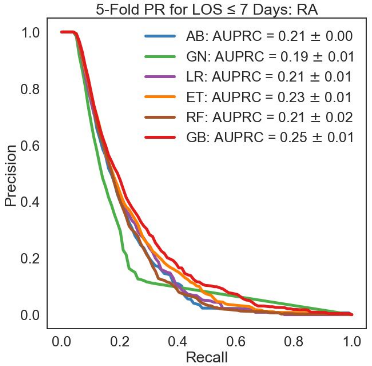
Unresponsive Admission (UA) Group



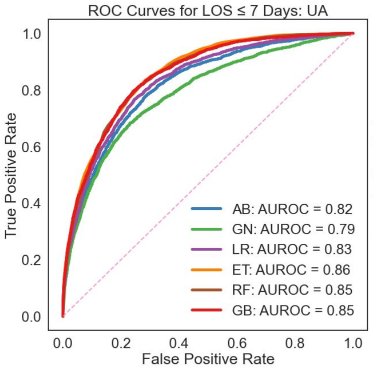


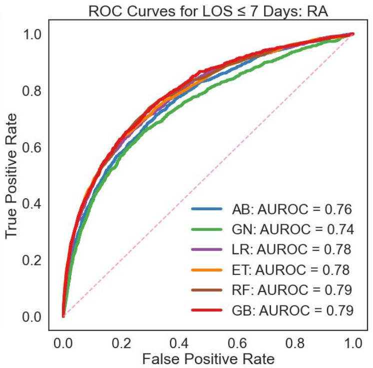
Responsive Admission (RA) Group





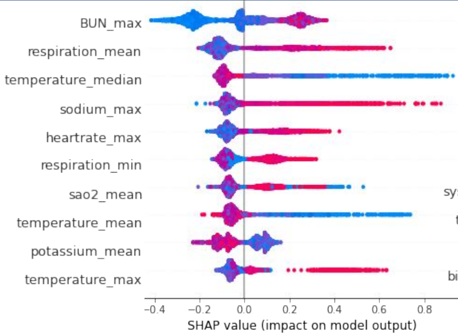
External Validation

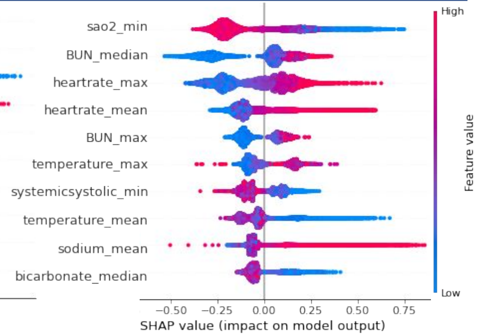




Results 2 – Feature Importance

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

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Background

Loss of consciousness is a medical emergency that requires rapid and precise intervention to maximize the chances of survival, emergence, and neurological recovery. It is commonly associated with a primary neurological disorder, such as stroke or traumatic brain injury; however, impaired consciousness is also frequently seen in critically ill patients **without a primary neurological disorder.**

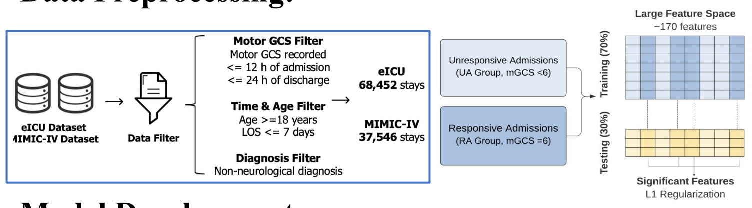
Objectives

1. Use **machine learning methods** to develop models for **coma prediction of non-neurological ICU patients**.
2. Identify **the important clinical variables** contributing to coma onset based on data-driven methods.

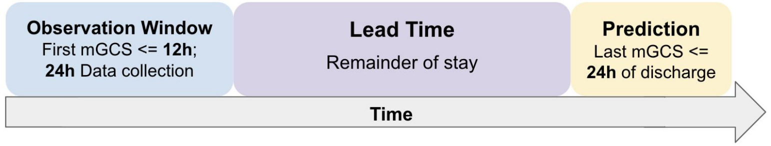
Methods

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

Data Preprocessing:



Model Development:

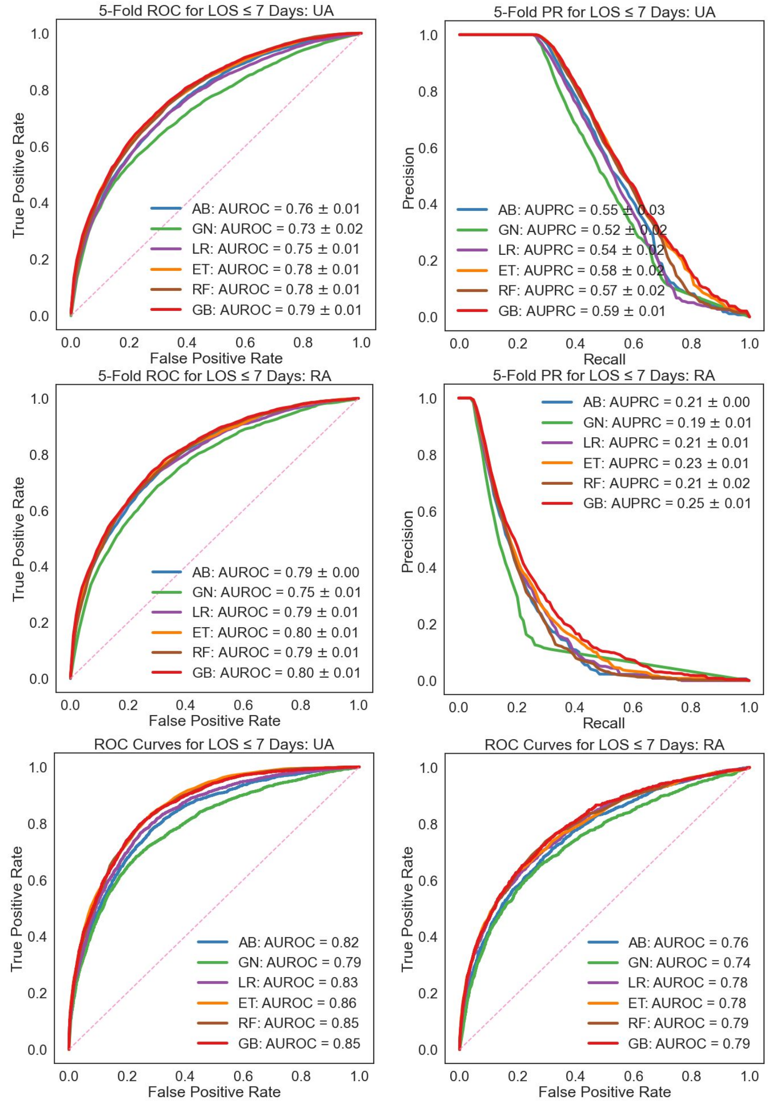


Results

Unresponsive Admission (UA) Group

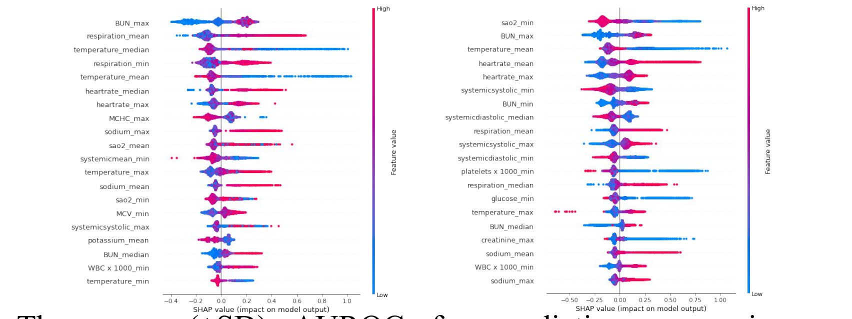
Responsive Admission (RA) Group

External Validation



Result 2 – Feature Importance

UA & RA Feature Importance SHAP Plots



- The mean (±SD) AUROC for predicting responsiveness outcome was **0.80 (±0.01)** for **RA Group** and **0.79 (±0.01)** for **UA Group**. We chose **gradient boosting** models to predict the level of responsiveness at ICU discharge.
- Highly ranked features included physiological signals: **respiration rate, systemic blood pressure and heart rate**; lab features: **blood urea nitrogen and red blood cell count**.

Conclusions

A machine learning model using data collected in the **first 24h of ICU admission** can **accurately predict neurological function at discharge**, which informs strategies to prevent neurological deterioration or enhance neurological.

Future Directions

1. Improve our neural network models for prediction and feature importance interpretation; 2. Include more features such as admission diagnosis.

Additional Information

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