Using Advanced Machine Learning Models to Predict Flow Rate Escalation for Pediatric Patients on High Flow Nasal Cannula

Joshua Krachman[1†], Jessica Patricoski[1,2†], Christopher Le[1†], Jina Park[1†], Ruijing Zhang[1†], Kirby Gong[1], Indranuj Gangan[1], Raimond Winslow[1], Joseph Greenstein[1], James Fackler[2], Anthony Sochet[2,3], Jules Bergmann[2]

[1] Department of Biomedical Engineering and Institute for Computational Medicine, Johns Hopkins University
[2] Department of Anesthesiology and Critical Care Medicine and Division of Health Sciences Informatics, Johns Hopkins University School of Medicine
[3] Division of Pediatric Critical Care Medicine, Department of Pediatrics, Johns Hopkins All Children's Hospital

BACKGROUND

- High flow nasal cannula (HFNC) is commonly used as non-invasive respiratory support in critically ill children.
- Clinical scores, such as the ROX (respiratory rate-oxygenation) index, have been used to predict HFNC failure, but they focus on escalation to mechanical ventilation (MV) and not flow rate escalation.

OBJECTIVE

To evaluate tree-based and neural network machine learning algorithms in predicting HFNC flow escalation and forecasting future flow rates.

INCLUSION & EXCLUSION CRITERIA

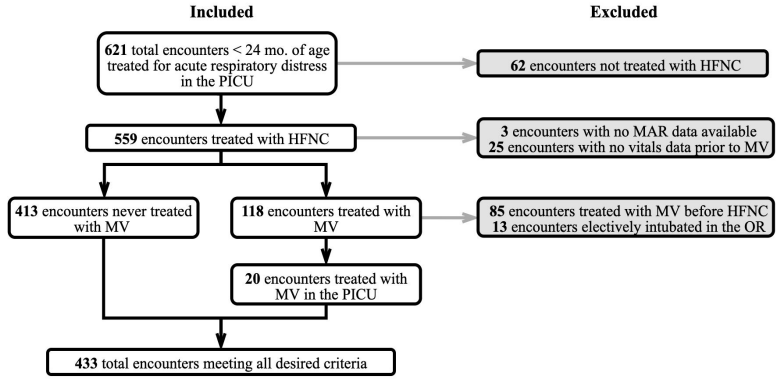

Figure 1. Inclusion and exclusion criteria used to narrow our dataset.

DISCUSSION

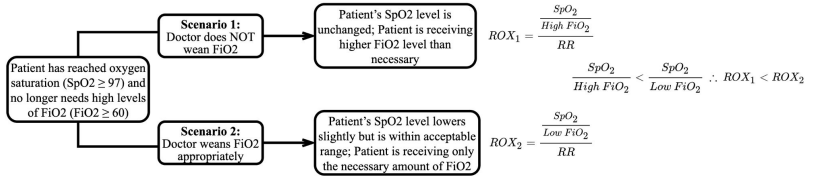

Figure 5. Schematic outlining the role of oversaturation, which explains the poor performance of the ROX index.

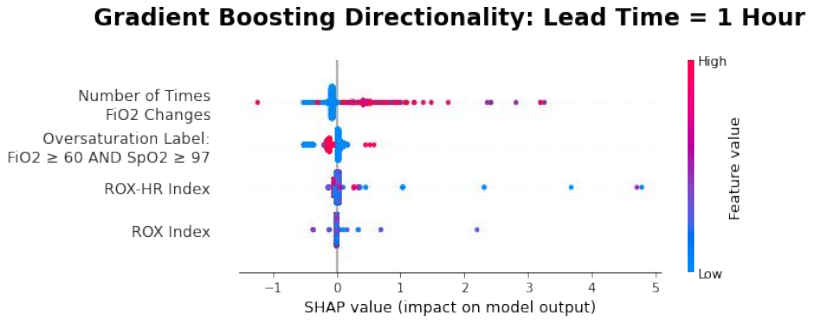

Figure 6. SHAP feature importances, which detail how exclusion of a feature affects model performance, for four synthetic features that rely on clinician intervention.

RESULTS

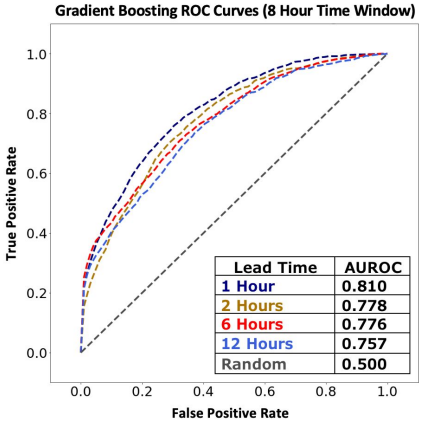

Figure 2. Receiver operating characteristic curves across lead times.

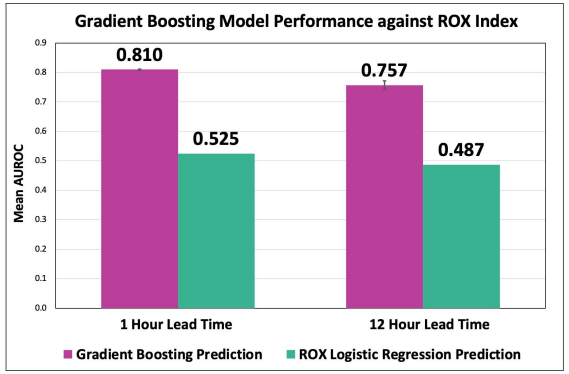

Figure 3. Comparison of our model to ROX index logistic regression baselines.

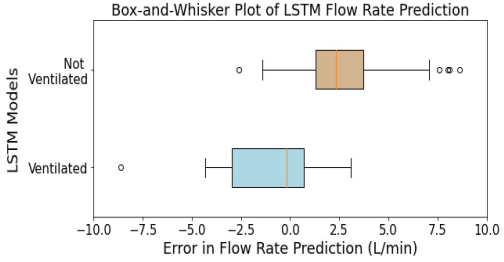

Figure 4. Error distribution of our LSTM in forecasting future flow rates for two subsets of patients separated by eventual escalation to mechanical ventilation.

CONCLUSION

- Our gradient boosting models outperform the ROX index in predicting a patient's increased flow rate on HFNC.
- Our LSTM has potential to forecast future flow rates based on a patient's existing electronic health record and real-time physiologic time series data.