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2024. 10. 31 (Thu) - 11. 01 (Fri) 여수 엑스포 컨벤션센터

Prediction of postoperative vasoplegia after cardiac surgery: machine learning-based analysis

Purpose

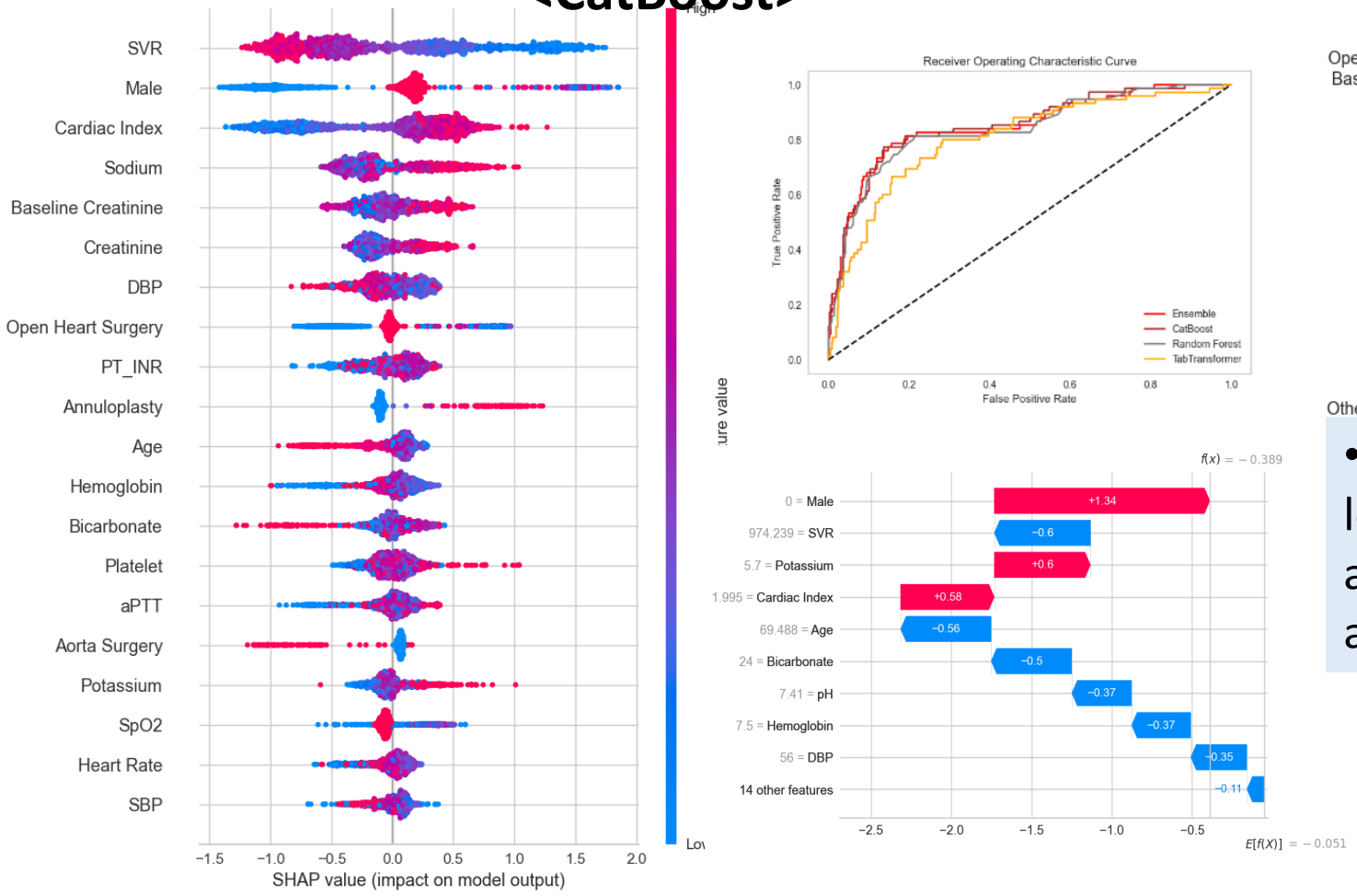
- Vasoplegia is relatively common complication after cardiopulmonary bypass, ranging 5~25%, associated with increased mortality and morbidity after cardiac surgery.
- Thus, anticipating vasoplegia in a selected patient population and adjusting their care accordingly (vs. hypovolemic or cardiogenic shock) are important.
- This study aimed to develop and validate a predictive model for postoperative vasoplegia after cardiac surgery using machine learning techniques based on the data from the Medical Information Mart for Intensive Care (MIMIC-III) database.

Methods

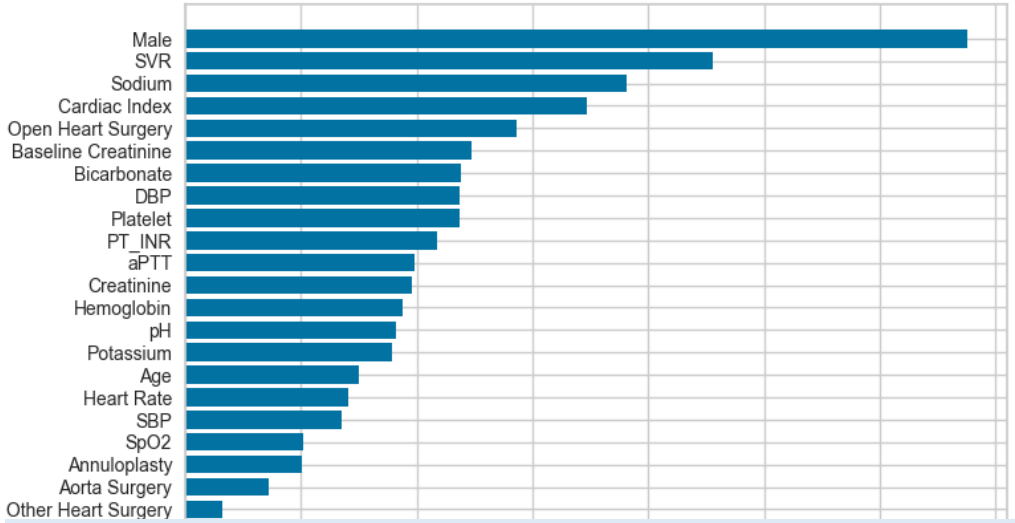
- A total of 60,217 ICU admission -> 4,359 cases involving patients who underwent cardiac surgery upon admission -> **1,441 cases** had SVR, CI and were analyzed. (Training data and test data=7:3)
- **Vasoplegia**: systolic blood pressure <100 mmHg, low systemic vascular resistance (**SVR <800 dynes.s/cm^5/m^2**), a normal or high cardiac index (**CI >2.2 L/min/m^2**), and a normal or reduced central filling pressure despite high-dose vasopressors within the 24hr admission of ICU.
- **Initial vasoplegic status** (**initial CI >2.2L/kg/m^2 and SVR <800 dynes.s/cm^5 at ICU admission**): to facilitate the prediction of future vasoplegia in case that there is no swan-ganz catheter
- Algorithms such as **Extra Trees, Random Forest, Light Gradient Boost, Extreme Gradient Boost, and CatBoost from classic machine learning, as well as TabTransformer from deep learning**

Results

SHAP beeswarm and waterfall plots of prediction model for vasoplegia <CatBoost>



Variable importance of prediction models for vasoplegia



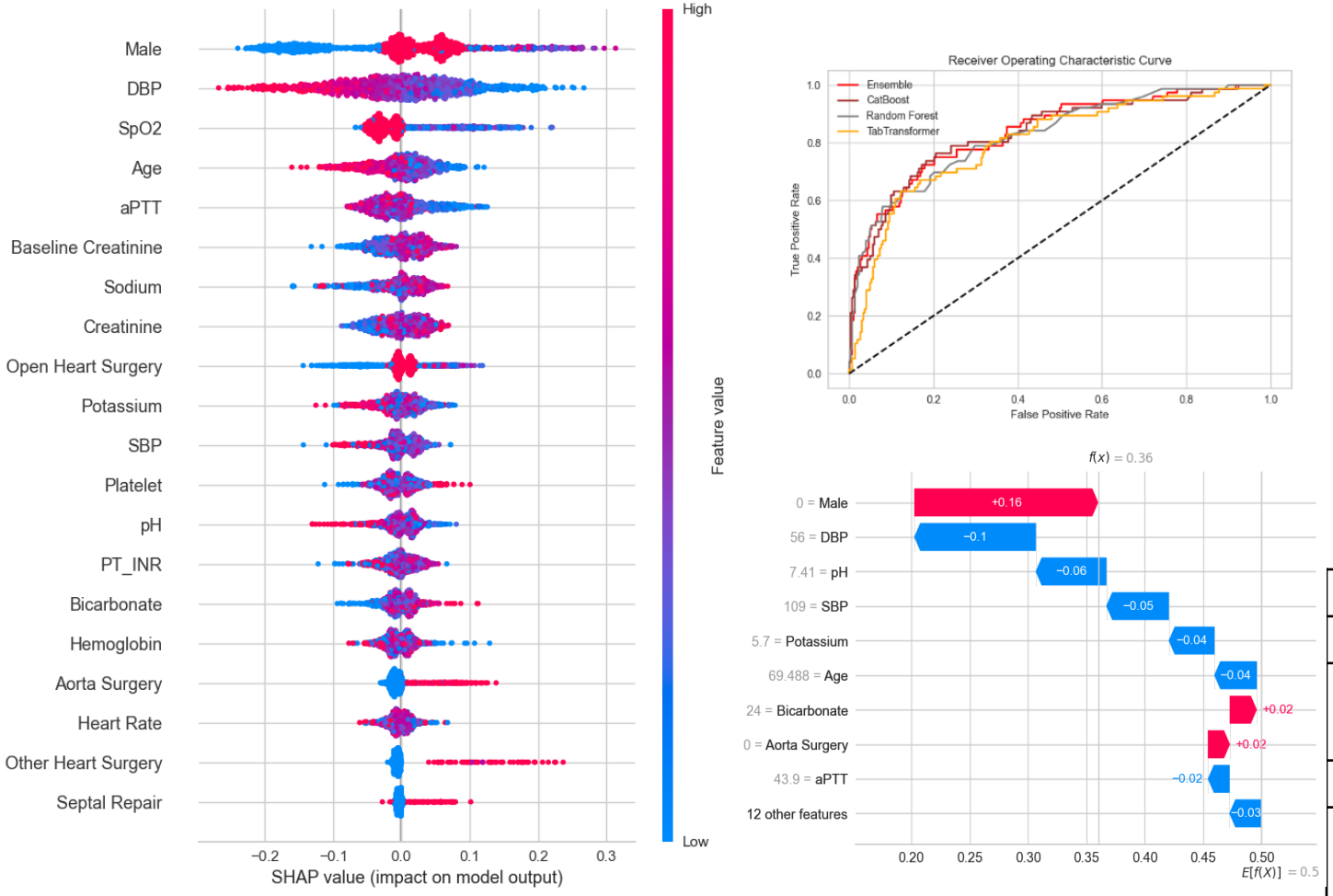
- **Future Vasoplegia :**

low SVR at admission, Male, high CI at admission, high Na^+, base Cr, low DBP, young age

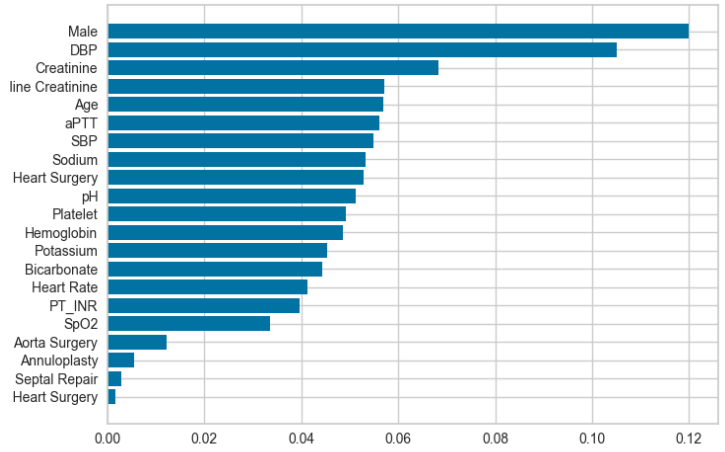
	AUC	Accuracy	F1-score	Recall
Ensemble	0.85	0.873	0.567	0.48
CatBoost	0.853	0.875	0.585	0.507
Random Forest	0.839	0.861	0.552	0.493
TabTransformer	0.805	0.84	0.303	0.2

Results

SHAP beeswarm and waterfall plots of prediction model for initial vasoplegic status <Extra Trees>



Variable importance of prediction models for initial vasoplegic status



- Initial Vasoplegic Status:

Male, high SBP, low DBP, high Cr, Young age

	AUC	Accuracy	F1-score	Recall
Ensemble	0.81	0.829	0.431	0.364
Random Forest	0.803	0.836	0.458	0.39
Extra Trees	0.804	0.852	0.484	0.39
TabTransformer	0.754	0.803	0.309	0.247

Conclusion

- In conclusion, this study successfully developed a vasoplegia prediction model and a predictive model for cases exhibiting initial vasoplegic status (i.e. high cardiac index (CI) and low systemic vascular resistance (SVR) upon initial admission to the ICU) with satisfactory performance using machine learning based analysis.
- Initial high CI and low SVR at ICU admission are important variables to predict future vasoplegia within 48 hours after ICU admission.
- SHAP results from the machine learning model imply that a decline in DBP is a more sensitive indicator than SBP in predicting initial vasoplegic status at ICU admission.