Machine Learning Models Predict Venous Thrombosis After Elective Abdominal Aortic Aneurysm Repair

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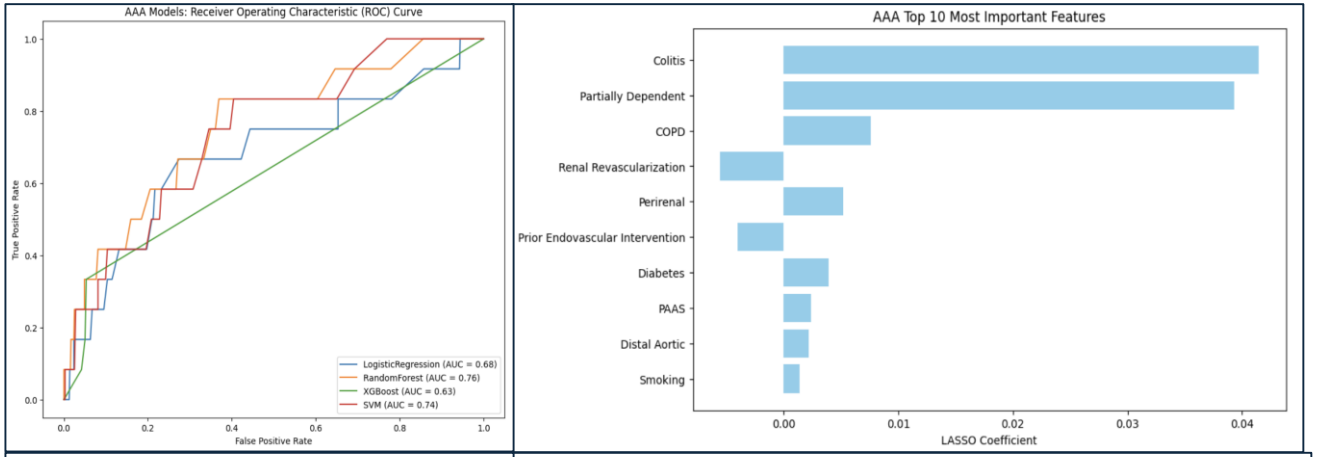
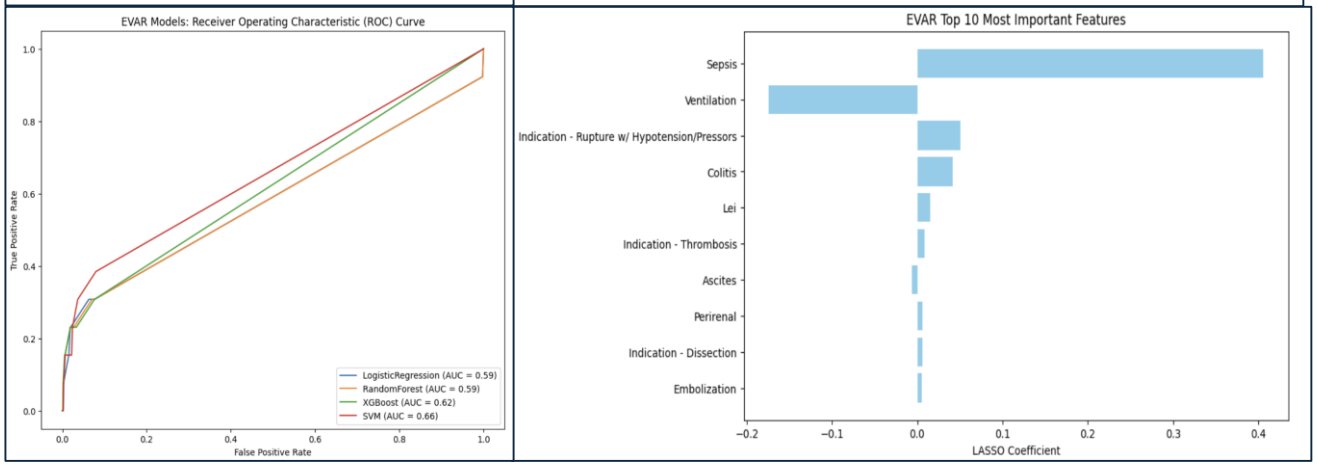
Background: Postoperative venous thromboembolic events (VTE), encompassing pulmonary embolism and deep vein thrombosis, are significant complications following both open aortic repair (OAR) and endovascular aortic aneurysm repair (EVAR).
Objective: To utilize classical machine learning models to predict the occurrence of VTE complications after OAR and EVAR procedures, aiming to enhance patient risk stratification and inform prophylactic strategies.
Significance: Accurate prediction of VTE risks post-aortic aneurysm repair can lead to tailored preventive measures, potentially reducing morbidity and improving patient outcomes in vascular surgery.





Methods

- The National Surgical Quality Improvement Program (NSQIP) database was queried (2012-2022) for OAR and EVAR cases.
- A train:test split of 80:20 and Lasso feature selection for significance were applied to the input data, along with data augmentation via ROSE (Random Over-Sampling Examples) to supplement the small proportion of VTE cases.
- Four classical machine learning models (Random Forest, Support Vector Machine, Logistic Regression, and XGBoost) were created and fine-tuned using a five-fold cross validation with adaptive thresholding.
- Model performance was primarily evaluated on receiver operating characteristic area under the curve (ROC-AUC), along with sensitivity, specificity, and brier score. Data manipulation, machine learning model creation, and model evaluation were all performed in Python 3.10.0.

Results:

- Of 3,631 OAR and 16,099 EVAR procedures, a VTE rate of 1.9% and 0.4% was observed, respectively.
- For OAR, features most associated with postoperative VTE included ischemic colitis, partially dependent functional status, chronic obstructive pulmonary disease, renal revascularization, and peri-renal proximal aneurysm extent. Random Forest was the best performing model to predict postoperative VTE after OAR (ROC-AUC: 0.76, Sensitivity: 0.33; Specificity: 0.96; Brier score: 0.03).
- For EVAR, features most associated with postoperative VTE included sepsis, ventilator independence, indication for surgery of rupture with hypotension or use of pressors, ischemic colitis, and lower extremity ischemia. Support Vector Machine was the best performing model to predict postoperative VTE after EVAR (ROC-AUC: 0.66, Sensitivity: 0.15; Specificity: 0.98; Brier score: 0.05).

Conclusion: Classical machine learning models show promise in the application of predicting postoperative VTE complications after OAR and EVAR operations, with Random Forest and Support Vector Machine being the best models respectively.

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