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REVOLUTIONISING MEDICINE - THE NEW FRONTIER

Contrast Induced Acute Kidney Injury (CI-AKI) in Lower Limb Percutaneous Transluminal Angioplasty: A Machine Learning Approach for Preoperative Risk Prediction

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The Problem: No specific risk models for CI-AKI after Lower Limb Angioplasty

Current CI-AKI Risk Models

- CI-AKI is a common complication of lower limb angioplasty due to administration of iodinated contrast
- Current risk models are based on cardiology cohorts for percutaneous coronary intervention.
- Do not include important variables such as inflammatory parameters and preoperative medications
- None make use of machine learning to improve performance

Study Aim

- To develop accurate preoperative risk models for CI-AKI in lower limb PTA using machine learning methods
- To compare machine learning models with conventional logistic regression.

Study Cohort

- Retrospective cohort of 610 patients from
- Lower limb PTA as an isolated procedure from 2015 - 2020
- Excluded patients <21 years old, preoperative eGFR <15mL/min/1.73 m², no valid pre- or post-operative serum Cr

The Solution: Machine Learning models to Predict CI-AKI after Lower Limb Angioplasty

Study Methods

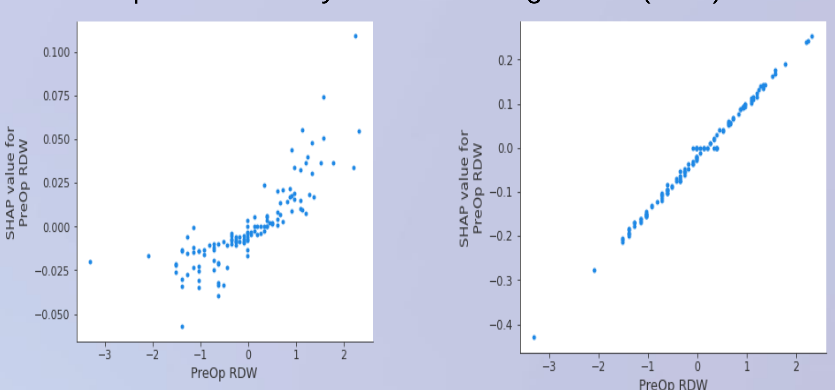
- 80:20 train:test: split
- Inputs:
  - > Demographics: Age, Sex, BMI
  - > Comorbidities: ASA-PS Class, DM, CHF, IHD, CVA
  - > Drugs: ACE/ARB, Diuretics, Statins
  - > General lab measures: Na, K, Cl, Ur, Hb, WBC, RDW
  - > Derived lab measures: eGFR, Neutrophil:lymphocyte ratio
- Output: Presence/absence of postoperative CI-AKI

- Fit conventional logistic regression model
- Fit machine learning models (Logistic Regression with ElasticNet penalty, Random Forests, Gradient Boosting Machines, K-Nearest Neighbours, Support Vector Machines, MultiLayer Perceptron)
- 5 fold cross-validation and grid search for hyperparameter selection
- Evaluation metrics: Area under receiver operating curve (AUROC), area under precision-recall curve (AUPRC), F1 score, sensitivity and specificity
- Variable importance: SHAP plots

Results

Model	AUROC	AUPRC	F1 Score	Sensitivity	Specificity
K Nearest Neighbours	0.905	0.733	0.683	0.70	0.931
Support Vector Machines	0.901	0.766	0.667	0.80	0.882
Random Forest	0.898	0.743	0.615	0.80	0.843
Gradient Boosting Machines	0.866	0.641	0.548	0.85	0.755
Logistic Regression	0.834	0.709	0.538	0.70	0.824
Logistic Regression - ElasticNet	0.823	0.742	0.684	0.65	0.951
MultiLayer Perceptron	0.776	0.559	0.537	0.55	0.902

- 93 patients (15.2%) developed CI-AKI
- All models predicted CI-AKI well
- Best performance by K Nearest Neighbours (KNN)



Nonlinear dependencies captured by machine learning model (Left, KNN) versus classical model (Right, Logistic Regression)

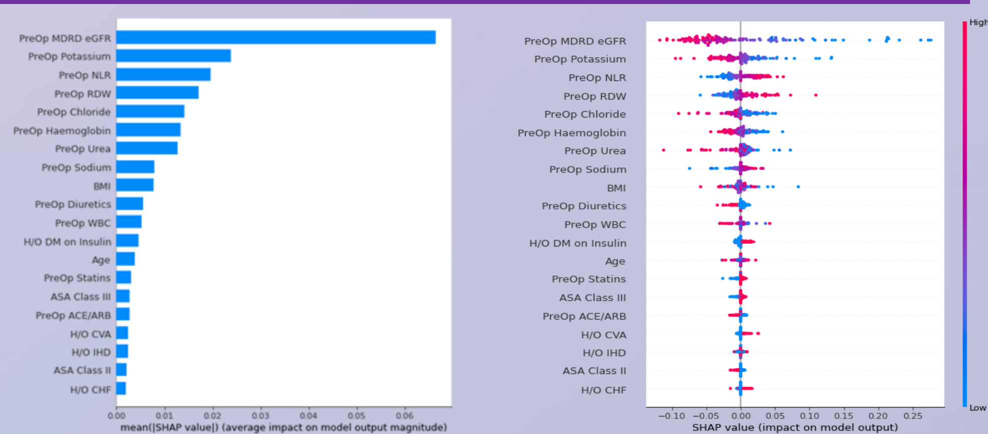


Fig 1A. Important variables in KNN model
Left, Mean SHAP values plot; Right, SHAP summary plot

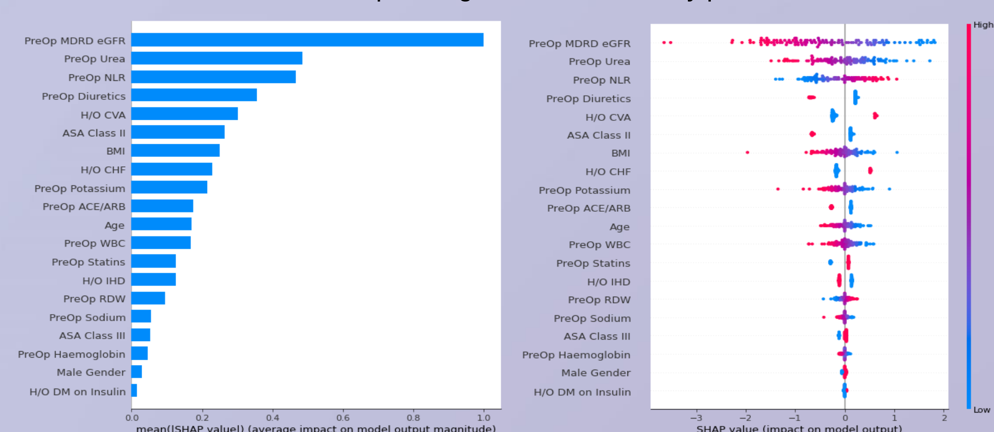


Fig 1B. Important variables in conventional logistic regression model
Left, Mean SHAP values plot; Right, SHAP summary plot

Important variables for machine learning models and classical model are largely in agreement

<u>Conclusion</u>: Machine learning models accurately predict CI-AKI in patients undergoing elective lower limb PTA, using only preoperative variables. Applications include preoperative risk counselling and identifying high-risk patients for monitoring.

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