Predicting long-term cardiac outcomes following kidney transplantation using interpretable machine learning models

Background:

Cardiovascular disease is the leading cause of death in kidney transplant recipients. Despite this, there are few clinical decision support tools that can predict transplant outcomes. This study aims to identify pre-transplant factors that can help predict major adverse cardiovascular events.

Methods:

Using a database of prerenal transplant outcome data, we train and compare twelve different machine learning models for eight cardiovascular outcomes, where one of the twelve models is an ensemble of the other eleven models stacked in multiple layers. Interpretability and robustness is enhanced with feature selection and five-fold cross validation. Model performance was primarily measured with Area Under Curve (AUC).

Results:

For the outcome of cardiovascular death, hospitalization for heart failure, and non-fatal myocardial infarction, the best model had AUCs of 75.9%, 80.4%, and 75.4%, respectively. For cardiovascular death, BNP (p-value<0.001), systolic blood pressure (p-value=0.001), and aspirin use (p-value=0.014) were the three most important features. For hospitalization for heart failure, BNP (p-value<0.001), resting heart rate (p-value<0.001), and diastolic blood pressure (p-value=0.022) were the three most important features. For non-fatal myocardial infarction, BNP (p-value=0.029), aspirin use (p-value=0.001), and pre-transplant triglyceride levels (p-value<0.001) were the three most important features. For five of the eight cardiovascular outcomes, BNP was the most significant feature.

Conclusion:

Pretransplant factors such as BNP, systolic and diastolic blood pressures, aspirin use, and triglyceride levels appear to be important features for cardiovascular outcome prediction following kidney transplantation.

Clinical Implications:

Understanding what pretransplant factors could predict future cardiovascular outcomes in kidney transplant patients could enable early intervention or treatment, ultimately improving kidney transplant outcomes.