Application of Machine-learning to clinical data for prediction of adverse events in patients undergoing transcatheter aortic valve implantation.

Machine learning (ML) is a technique used to give artificial intelligence the ability to learn. ML techniques have been effectively used for prediction and intelligent decision-making in many areas of everyday living, including internet search engines, customized advertising, filtering of spam emails, language processing, finance trending and robotics.

In medicine ML has been successfully employed in biomedical sciences including proteomics, metabolomics, lipidomics, genetics and more recently cardiology, especially cardiovascular imaging. Aside from facilitating image analysis, ML was shown to enhance risk stratification by integrating a set of patient data, to build a combined strong classifier to identify subjects at highest risk of adverse outcomes.

Transcatheter aortic valve implantation (TAVI) is a safe and effective treatment approach for severe aortic stenosis (the most common heart valve disease in the western world in which the outflow of blood from the heart is limited by the progressive narrowing of the valve). This minimally invasive (compared to traditional surgical valve replacement) method is rapidly growing with over seventy thousand procedures performed in the United States in 2019. In contemporary clinical practice prediction of outcome in TAVI recipients is based on risk scores developed for subjects undergoing surgical valve replacement which unfortunately provide very limited prediction in TAVI patients.

Several recent studies have identified particular patients' characteristics associated with adverse outcomes. While such predictors provide only limited prediction when used individually, incorporating all of them in a single model might enhance prediction. XGBoost (a recent implementation of a gradient boosting machine-learning algorithm, which iteratively trains a set of weak learners, to build a combined strong classifier to identify an outcome) is an ideal tool for exploring the feasibility of precise risk stratification in TAVI patients.

In this application by leveraging a nationwide registry of TAVI recipients we aim to develop, test and validate 3 XGBoost models for risk stratification in patients undergoing TAVI:

1. For prediction of death based on baseline (pre-procedural) clinical characteristics
2. For prediction of death based on both baseline (pre-procedural) and peri-procedural clinical characteristics
3. For identification of patients eligible for short hospital stay after TAVI

Impact

This work will result in the development of a practical clinical tool for risk stratification in TAVI recipients. It shall enhance selection of patients for TAVI, facilitate the discussion regarding risk with the patient, enable identification of subjects requiring more intense surveillance following the procedure and (on the other side of the spectrum) distinguish those who are eligible for an early discharge after TAVI.