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Cardiovascular/stroke risk predictive calculators: a comparison between statistical and machine learning models

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Abstract

Background: Statistically derived cardiovascular risk calculators (CVRC) that use conventional risk factors, generally underestimate or overestimate the risk of cardiovascular disease (CVD) or stroke events primarily due to lack of integration of plaque burden. This study investigates the role of machine learning (ML)-based CVD/stroke risk calculators (CVRC$_{ML}$) and compares against statistically derived CVRC (CVRC$_{Stat}$) based on (I) conventional factors or (II) combined conventional with plaque burden (integrated factors).

Methods: The proposed study is divided into 3 parts: (I) statistical calculator: initially, the 10-year CVD/stroke risk was computed using 13 types of CVRC$_{Stat}$ (without and with plaque burden) and binary risk stratification of the patients was performed using the predefined thresholds and risk classes; (II) ML calculator: using the same risk factors (without and with plaque burden), as adopted in 13 different CVRC$_{Stat}$, the patients were again risk-stratified using CVRC$_{ML}$ based on support vector machine (SVM) and finally; (III) both types of calculators were evaluated using AUC based on ROC analysis, which was computed using combination of predicted class and endpoint equivalent to CVD/stroke events.

Results: An Institutional Review Board approved 202 patients (156 males and 46 females) of Japanese ethnicity were recruited for this study with a mean age of 69±11 years. The AUC for 13 different types of CVRC$_{Stat}$ calculators were: AECRS2.0 (AUC 0.83, P<0.001), QRISK3 (AUC 0.72, P<0.001), WHO (AUC 0.70, P<0.001), ASCVD (AUC 0.67, P<0.001), FRS$_{cardio}$ (AUC 0.67, P<0.01), FRS$_{stroke}$ (AUC 0.64, P<0.001), MSRC (AUC 0.63, P=0.03), UKPDS56 (AUC 0.63, P<0.001), NIPPON (AUC 0.63, P<0.001), PROCAM (AUC 0.59, P<0.001), RRS (AUC 0.57, P<0.001), UKPDS60 (AUC 0.53, P<0.001), and SCORE (AUC 0.45,
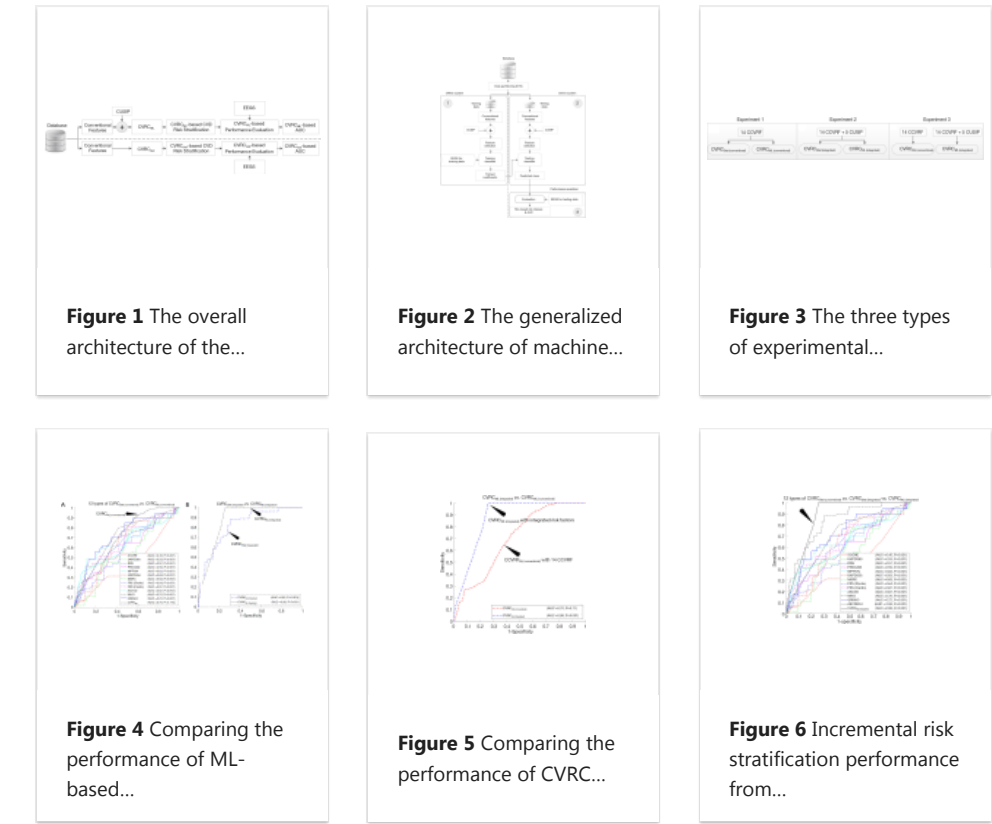
P<0.001), while the AUC for the $CVRC_{ML}$ with integrated risk factors (AUC 0.88, P<0.001), a 42% increase in performance. The overall risk-stratification accuracy for the $CVRC_{ML}$ with integrated risk factors was 92.52% which was higher compared all the other $CVRC_{Stat.}$

Conclusions: ML-based CVD/stroke risk calculator provided a higher predictive ability of 10-year CVD/stroke compared to the 13 different types of statistically derived risk calculators including integrated model AECRS 2.0.

Keywords: 10-year risk; Atherosclerosis; cardiovascular disease (CVD); integrated models; machine learning-based calculator; statistical risk calculator; stroke.

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