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Predicting in-hospital mortality in heart failure patients using machine learning

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ABSTRACT

The age of onset and causes of heart failure differ between high-income and low-and-middle-income countries (LMIC). Heart failure patients in LMIC also experience a higher mortality rate. Innovative ways that can risk stratify heart failure patients in this region are needed. The aim of this study was to demonstrate the utility of machine learning in predicting all-cause mortality in heart failure patients hospitalised in a tertiary academic centre. Six supervised machine learning algorithms were trained to predict in-hospital all-cause mortality using data from 500 consecutive heart failure patients with a left ventricular ejection fraction (LVEF) less than 50%. The mean age was 55.2 ± 16.8 years. There were 271 (54.2%) males, and the mean LVEF was 29 ± 9.2%. The median duration of hospitalisation was 7 days (interquartile range: 4–11), and it did not differ between patients discharged alive and those who died. After a prediction window of 4 years (interquartile range: 2–6), 84 (16.8%) patients died before discharge from the hospital. The area under the receiver operating characteristic curve was 0.82, 0.78, 0.77, 0.76, 0.75, and 0.62 for random forest, logistic regression, support vector machines (SVM), extreme gradient boosting, multilayer perceptron (MLP), and decision trees, and the accuracy during the test phase was 88, 87, 86, 82, 78, and 76% for random forest, MLP, SVM, extreme gradient boosting, decision trees, and logistic regression. The support vector machines were the best performing algorithm, and furosemide, beta-blockers, spironolactone, early diastolic murmur, and a parasternal heave had a positive coefficient with the target feature, whereas coronary artery disease, potassium, oedema grade, ischaemic cardiomyopathy, and right bundle branch block on electrocardiogram had negative coefficients. Despite a small sample size, supervised machine learning algorithms successfully predicted all-cause mortality with modest accuracy. The SVM model will be externally validated using data from multiple cardiology centres in South Africa before developing a uniquely African risk prediction tool that can potentially transform heart failure management through precision medicine.