Machine learning-based prediction of adverse events following an acute coronary syndrome (PRAISE): a modelling study of pooled datasets

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Summary

Background The accuracy of current prediction tools for ischaemic and bleeding events after an acute coronary syndrome (ACS) remains insufficient for individualised patient management strategies. We developed a machine learning-based risk stratification model to predict all-cause death, recurrent acute myocardial infarction, and major bleeding after ACS.

Methods Different machine learning models for the prediction of 1-year post-discharge all-cause death, myocardial infarction, and major bleeding (defined as Bleeding Academic Research Consortium type 3 or 5) were trained on a cohort of 19 826 adult patients with ACS (split into a training cohort [80%] and internal validation cohort [20%]) from the BleeMACS and RENAMI registries, which included patients across several continents. 25 clinical features routinely assessed at discharge were used to inform the models. The best-performing model for each study outcome (the PRAISE score) was tested in an external validation cohort of 3444 patients with ACS pooled from a randomised controlled trial and three prospective registries. Model performance was assessed according to a range of learning metrics including area under the receiver operating characteristic curve (AUC).

Findings The PRAISE score showed an AUC of 0·82 (95% CI 0·78–0·85) in the internal validation cohort and 0·92 (0·90–0·93) in the external validation cohort for 1-year all-cause death; an AUC of 0·74 (0·70–0·78) in the internal validation cohort and 0·81 (0·76–0·85) in the external validation cohort for 1-year myocardial infarction; and an AUC of 0·70 (0·66–0·75) in the internal validation cohort and 0·86 (0·82–0·89) in the external validation cohort for 1-year major bleeding.

Interpretation A machine learning-based approach for the identification of predictors of events after an ACS is feasible and effective. The PRAISE score showed accurate discriminative capabilities for the prediction of all-cause death, myocardial infarction, and major bleeding, and might be useful to guide clinical decision making.

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Introduction

Patients with acute coronary syndrome (ACS) are at high risk for ischaemic and bleeding events, with both being drivers of adverse prognosis.[1] Careful evaluation of these risks plays a fundamental role in the clinical management of each patient, with important implications regarding the choice of optimal medical therapy for secondary prevention.[2–6]

To this aim, several predictive tools have been developed to estimate ischaemic and bleeding risks following an ACS, some of which have potential to support clinical decision making around the optimal duration of dual antiplatelet therapy (DAPT).[7–11] However, the overall accuracy of these scores, along with their generalisability to external cohorts, remains modest, representing an unmet need for individualised patient management strategies.[12,13]

From a clinical standpoint, the poor performance of existing risk scores among patients with ACS might be related to their derivation from unselected percutaneous coronary intervention populations encompassing patients with stable presentation. Moreover, machine learning methods might be able to overcome some of the limitations of current analytical approaches to risk prediction by applying computer algorithms to large datasets with numerous, multidimensional variables, capturing high-dimensional, non-linear relationships among clinical features to make data-driven outcome predictions.[14] The effectiveness of this approach has been shown in several cardiovascular applications, where machine learning was superior to validated traditional risk stratification tools, including prediction of death among patients with suspected coronary artery disease or of heart failure in candidates for cardiac resynchronisation therapy.[15,16] Thus, we sought to develop a machine learning-based risk stratification model integrating clinical, anatomical, and procedural features to predict ischaemic and bleeding

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