Unimodal versus Multimodal deep learning prediction of new onset postoperative atrial fibrillation using preoperative electrocardiograms

Objective: Although new-onset post operative atrial fibrillation (nPOAF) occurs in up to one third of cardiac surgery patients, efforts to reliably screen at-risk patients have been unsuccessful. Deep learning has been used to predict new onset atrial fibrillation in the general population using electrocardiograms (ECG). Thus, we examined whether a multimodal deep learning approach could predict nPOAF in cardiac surgical candidates using ECG data.

Method: Between 2004 and 2022, 4,108 patients without any history of atrial fibrillation (AF) underwent elective coronary bypass, mitral or aortic valve surgery at a single institution. Patients were selected based on a 12-lead ECG read as normal within 30-days of operation and no reported history of AF. Data were allocated to training, validation and testing sets in a 7:1:2 ratio. Multiple studies per patient was admissible for training but not for testing. We leveraged transfer learning using open-source ECG dataset PTB-XL in order to boost the performance of the ECG model. We then compared performance of unimodal tabular and ECG models with multimodal data fusion approaches.

Results
Using STS data elements and preoperative electrocardiogram data, we developed a deep learning framework that fuses these data to predict nPOAF (figure). The incidence of nPOAF over this timeframe was 26.5%. On the hold-out set, a tabular approach demonstrated an AUC of 0.68 (Precision: 0.28, Recall: 0.63) and an ECG-only approach showed an AUC of 0.54 (Precision: 0.28, Recall: 0.72). When examining intermediate and late fusion techniques for multimodal model enhancement, the AUC was 0.64 and 0.63 respectively (Precision: 0.28, Recall: 0.72). All multimodal (NPV: 0.86, Specificity: 0.53), unimodal tabular (NPV: 0.85, Specificity: 0.53) and unimodal ECG (NPV: 0.82, Specificity: 0.56) models demonstrated fair discriminatory value for negative cases:

Conclusions:
The accurate prediction of nPOAF remains challenging and these findings suggest that unstructured pre-operative variables such as rhythm data do not enrich current models. Data augmentation with variables that more accurately reflect pre-operative patient state are needed to improve prediction of this heterogenous condition. Use of artificial intelligence models may have better clinical utility in screening out low-risk patients, which eliminates the need for medical prophylaxis and enables early discharge, thus optimizing healthcare resources.

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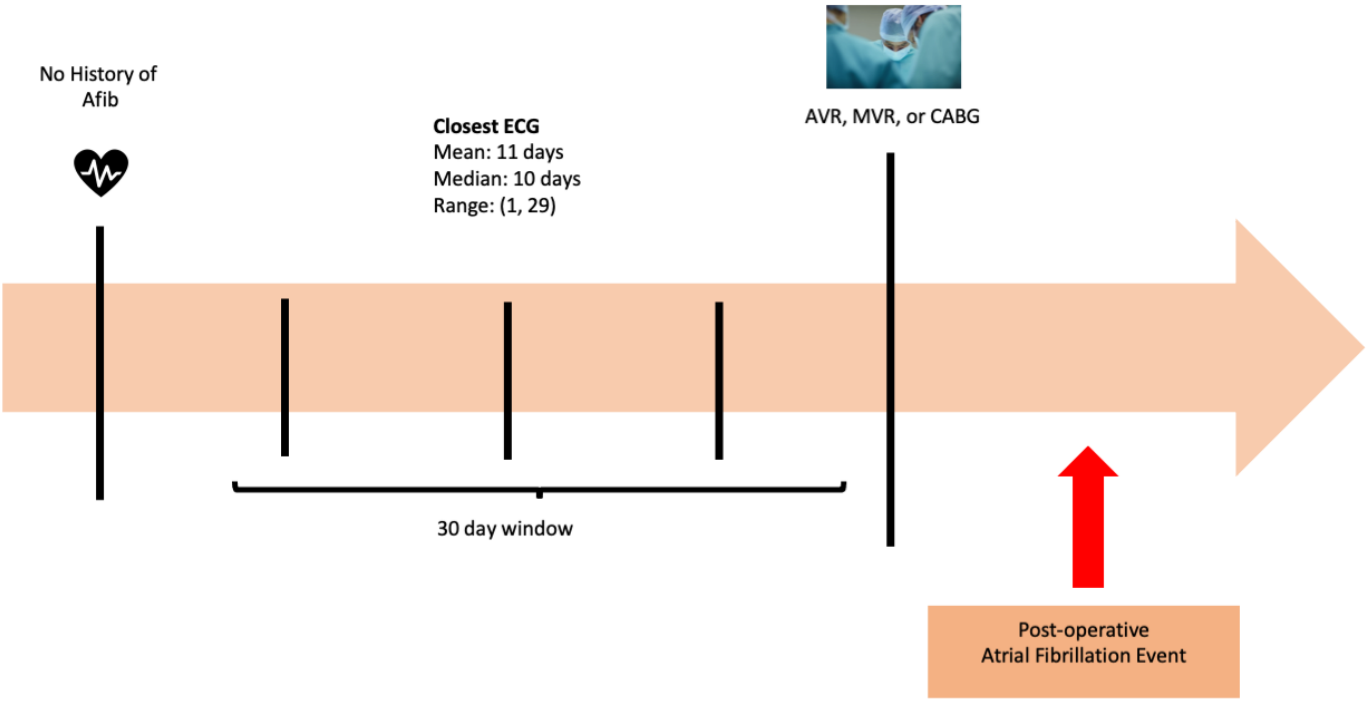
Identified 4,108 patients with normal rhythms preoperatively



Unimodal models compared to multimodal models for POAF prediction