Prediction of atrial fibrillation from normal ECG using artificial intelligence in patients with unexplained stroke

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Topic(s):
Arrhythmias, General – Epidemiology, Prognosis, Outcome

Background: Stroke related to embolic and of undetermined source constitute 20 to 30% of ischemic strokes. Many of these strokes are related to atrial fibrillation (AF), which might be underdetected due to its paroxysmal and silent nature.

Purpose: The aim of our study was to predict AF during normal sinus rhythm in a standard 12-lead ECG to train an artificial intelligence to train deep neural network in patients with unexplained stroke (embolic stroke of undetermined source; ESUS).

Methods: We analyzed digital raw data of 12-lead ECGs using artificial intelligence (AI) recurrent neural network (RNN) to detect the electrocardiographic signature of atrial fibrillation present during normal sinus rhythm using standard 12-lead ECGs. We included 2,585 cases aged 18 years or older with multiple ECGs at our university hospital between 2005 and 2017 validated by crossover analysis of two electrophysiologists. We defined the first recorded AF ECG as the index ECG and the first day of the window of interest as 14 days before the date of the index ECG. We allocated ECGs to the training, internal validation, and testing datasets in a 7:1:2 ratio. We calculated recall, F1 score, and the area under the curve (AUC) of the receiver operating characteristic curve (ROC) for the internal validation dataset to select a probability threshold. We applied this developed AI program to 169 ESUS patients who has been diagnosed and had standard 12-lead ECGs in our hospital.

Results: We acquired 1,266 NSR ECGs from real normal subjects and 1,319 NSR ECGs form paroxysmal AF patients. RNN AI-enabled ECG identified atrial fibrillation with an AUC of 0.79, recall of 82%, specificity of 78%, F1 score of 75% and overall accuracy of 72.8% (Figure). ESUS patients were divided into three groups according to calculated probabilities of AF using AI guided RNN program: group 1 (35 patients with probability of 0-25% of paroxysmal AF), group 2 (86 patients with probability of 25-75% of paroxysmal AF) and group 3 (48 patients with probability of 75-100% of paroxysmal AF). In Kaplan-Meier estimates, Group 2 and 3 (more than 25% of PAF probabilities) tended to have higher AF incidence although it did not reach statistical significance (log-rank p 0.678) (Figure).

Conclusion: AI may discriminate subtle changes between real and paroxysmal NSR and can also be helpful in patients with ESUS to identify if AF is the underlying cause of the stroke. Further studies are needed in order to evaluate their possible use in future prognostic models.
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