中文題目：以心電圖人工智慧預測未來安裝永久性心臟節律器及心血管預後

英文題目：Electrocardiography-based Artificial Intelligence to Predict Future Permanent Pacemaker Implantation and Cardiovascular Outcomes

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Background

In patients with bradyarrhythmias and conduction disturbances, permanent pacemaker implantation (PMI) is widely used to alleviate symptoms of systemic hypoperfusion and prolong their lives. Despite advances in technology, it remains difficult to promptly recognize the population who may need PMI. The prediction of future PMI by convenient and inexpensive tools may assist clinicians to make a proper and timely decision to prevent unfavorable outcomes related to bradyarrhythmias. Therefore, we developed an electrocardiography-based artificial intelligence (ECG-based AI) using deep learning model (DLM) to predict the possibility of PMI within 90 days and long-term prognosis.

Methods

This is a single-center, retrospective, ECG-based AI system study that enrolled 248,573 ECGs from 85,820 patients, and the PMI patients accounted for 3,098 ECGs. All the enrolled PMI patients had at least two chest plain films (CxR): the first one showing no PMI and the last one presenting with PMI. There was at least one ECG in the period between these two CxRs. In addition, the patients with history of PMI or with the first ECGs showing pacemaker rhythm were excluded. The patients were distributed by 5:2:3 ratio in development group, tuning group, and internal validation group, respectively. The ECGs categorized into development and tuning groups were used for DLM training, and the other ECGs were used for internal validation. Furthermore, we enrolled another 26,538 ECGs from a community hospital for external validation. The primary outcome was the performance for AI in predicting PMI within 90 days. We also analyzed further prognostic factors, including future risk of PMI, all-cause mortality, cardiovascular death, new-onset stroke, new-onset coronary artery disease (CAD), new-onset heart failure (HF), and new-onset atrial fibrillation (AF).

Results

In the analysis of prediction of PMI within 90 days, the areas under the receiver operating characteristic (ROC) curves (AUCs) of the DLM in the internal and external validation cohort were 0.883 and 0.919, respectively. Furthermore, in the long-term (up to 8 years) prediction model, the

possibility of PMI is significantly higher in AI-predicted-PMI group (AI-PMI) than that in AI-predicted-no-PMI group (AI-nPMI) with the hazard ratio (HR) of 7.49 and 95% confidence interval (CI) between 5.40-10.39. Additionally, the risks of all-cause mortality (HR 1.91; 95% CI 1.74-2.10) and cardiovascular death (HR 3.53; 95% CI 2.73-4.57) are significantly higher in AI-PMI group than those in AI-nPMI group. Patients of AI-PMI group had more events of new-onset AF, new-onset HF, new-onset stroke, and new-onset CAD than those of AI-nPMI.

Conclusion

The ECG-based AI is a useful screening tool to recognize patients who may undergo PMI within 90 days and to identify patients who carry higher long-term risks of PMI, higher all-cause mortality and higher adverse cardiovascular outcomes, including AF, HF, stroke, and CAD.