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Promoting Sustainable Kidney Health: The Asia-Pacific and Beyond

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Integrating Masked Auto Encoder for Enhanced Chronic Kidney Disease Detection in Electrocardiogram

Jung Nam An[1], Yeongyeon Na[3], Sunghoon Joo[3], Do Hyoung Kim[2], HYUNWOONG CHO[1], Minje Park[3], Yeha Lee[3], Sung Gyun Kim[1]
[1]Department of Internal Medicine-Nephrology, Hallym University Sacred Heart Hospital, Korea, Republic of
[2]Department of Internal Medicine-Nephrology, Kangnam Sacred Heart Hospital, Korea, Republic of
[3]Department of VUNO Inc., VUNO Inc., Korea, Republic of

Objectives : There are no symptoms in the early stages of chronic kidney disease (CKD), it is difficult to recognize the disease, and because laboratory tests are not performed except for screening purposes, kidney function decline is underdiagnosed. In this study, we detected kidney function through a deep learning-based model using pretrained transformer that has learned ECGs.
Methods : Patients in the study, having undergone at least one ECG from 2006 to 2020, had blood lab results within 24 hours. The dataset was split into train, validation, and test sets. The training set included labeled ECG data (with CKD-EPI eGFR blood lab) and unlabeled ECG data, while validation and test sets exclusively comprised labeled ECG data. To enhance performance, a pre-training step reconstructed masked ECG segments using adjacent partial ECG data, employing Masked Auto Encoder (MAE). This step utilized both labeled and unlabeled data, enabling training on the entire train dataset. The primary goals involved binary classifications for predicting eGFR below 60 mL/min and 30 mL/min, achieved through training a Vision Transformer model on standard 10-second, 12-lead ECG input to determine CKD likelihood.
Results : The whole dataset comprises 309,371 labeled ECGs from 199,976 patients. In the test set, utilizing only labeled ECGs yields areas under the receiver operating characteristic curve (AUROC) of 0.8196 and 0.8853 for eGFR below 60 mL/min and eGFR below 30 mL/min. However, applying MAE enhances performance, yielding AUROC values of 0.8701 and 0.9126, respectively, surpassing other baseline methods.
Conclusions : The deep learning model using the 12-lead ECG waveform detected CKD based on CKD-EPI eGFR with high accuracy. The diagnostic performance was improved by fine-tuning using a pretrained transformer. It is expected that the possibility of early diagnosis of CKD will be expanded by screening for decreased kidney function using ECGs-based artificial intelligence technology.