Artificial intelligence-enhanced ECGs may speed heart failure diagnosis and treatment

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When people seek emergency care for shortness of breath, a routine electrocardiogram (ECG or EKG) enhanced by artificial intelligence (AI) is better than standard blood tests at determining if the cause is

heart failure, according to new research published today in *Circulation: Arrhythmia and Electrophysiology*, an American Heart Association journal.

"Determining why someone has shortness of breath is challenging for emergency department physicians, and this AI-enabled ECG provides a rapid and effective method to screen these patients for left ventricular systolic dysfunction," said Demilade Adedinsewo, M.D., M.P.H., lead author of the study and chief fellow in the division of cardiovascular medicine at Mayo Clinic in Jacksonville, Florida.

The left ventricle supplies most of the heart's pumping power, so it is larger than the other chambers and essential for normal function. In left ventricular systolic dysfunction (LVSD), the left ventricle is weakened and must work harder to maintain adequate blood flow to the body.

In a typical year, about 1.2 million people go to emergency departments because they are short of breath. This year, the numbers are far higher because difficulty breathing is one of the hallmark symptoms of a COVID-19 infection. When heart problems are suspected, patients in the emergency department usually have an ECG performed—a quick, 10-second recording of the heart's electrical activity.

"An abnormal ECG raises concern about underlying cardiac abnormalities but are not specific for heart failure," Adedinsewo said.

Emergency department physicians also rely on blood levels of natriuretic peptides. These biomarkers are elevated in the blood when heart failure is present. However, these biomarker levels are also affected by obesity, age, kidney disease, severe infection, high blood pressure in the vessels that bring blood to the lungs (pulmonary hypertension), abnormal heart rhythms and a specific heart failure medication.

To create the AI-enhanced ECG, Mayo Clinic researchers used data on thousands of patients to train computers to distinguish between the ECG patterns of people ultimately diagnosed with LVSD and those without LVSD. In about 10 seconds, standard ECG recordings can be analyzed with the resulting AI software application to identify likely LVSD.

In this study, researchers tested the accuracy of the AI-enhanced ECG to identify LVSD in emergency room patients with shortness of breath compared to the results of biomarker blood tests. They applied the AI-enhancement to the ECGs of 1,606 patients (average age 68, 47% female, 91% white) who had received an ECG and blood testing in the emergency department, later followed by definitive testing using an echocardiogram.

Researchers found:

- AI-enhanced ECG was better than standard blood tests in identifying which patients have severe LVSD (35% or less of blood in the heart pumped out with each contraction), with a performance measure of 0.89 vs. 0.80;
- the AI-enhanced ECG was also good (performance measure 0.85) at identifying patients with less severe but abnormally low pumping ability (50% or less of the blood leaving the heart with each contraction); and
- while several factors can influence blood test results, AI-enhanced ECG performed just as well in men and women and among patients in different age groups.

"AI-enhanced ECGs are quicker and outperform current standard-of-care tests. Our results suggest that high-risk cardiac patients can be identified quicker in the emergency department and provides an opportunity to link them early to appropriate cardiovascular care," Adedinsewo said.

AI-enhanced ECGs are not widely available. In May, the Food and Drug Administration granted emergency use authorization of the AI-enhanced ECG algorithm to screen for LVSD in people with confirmed or suspected COVID-19 disease.

The current study is limited by being a retrospective analysis of previous emergency department visits.

Provided by American Heart Association