Towards an artificial intelligence-augmented, ECG-enabled physical exam

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See Articles page e117

Multiple studies have used artificial intelligence (AI) with convolution neural networks, with input from standard 12-lead ECGs rich in quantitative data, to take this common diagnostic modality into new areas—most notably for event and disease state prediction.[1,2] In *The Lancet Digital Health*, Patrik Bachtiger and colleagues tie into that clinical workflow by using a novel, ECG-enabled stethoscope in a realistic clinical encounter to identify patients with reduced left ventricular (LV) function.[3]

Studies using AI-augmented ECGs to idefntify patients with asymptomatic LV dysfunction marked by a reduced ejection fraction (LVEF) have a clinical purpose.[4–6] Although these previous studies are novel in providing prospective, real-world data, Bachtiger and colleagues take this one step further by integrating the algorithm as part of the auscultatory physical exam. Their study is an independent, external validation of the algorithm, modifying it for a single-lead ECG input rather than requiring the traditional 12-lead ECG. By providing an earlier diagnosis of reduced LVEF, the algorithm would allow patients to start outcome-modifying medical therapies at an earlier stage in the disease.[7] The authors expand the use of this algorithm to a specific clinical context in a prospective multicentre study in London, UK. Eligible patients had presented for a transthoracic echocardiogram, and were examined using an ECG-enabled stethoscope at four standard auscultation positions plus a handheld position. The predicted LVEF was compared against the gold standard of a transthoracic echocardiogram-derived LVEF. By allowing for only one recording attempt per auscultation position and completing the exam in about 2 min per patient or less, the method can be realistically adapted to clinical encounters. Bluetooth transmissions of the ECG recordings and an integrated application providing feedback of the adequacy of the ECG signal quality provide speed and accuracy to the process. The study enrolled 1050 patients (90% with LVEF >40%, 10% with LVEF ≤40%) from diverse backgrounds (51% male, 41% non-White). With the optimal combination of two auscultatory positions, as well as a weighted logistic regression approach, the area under the receiver operating characteristic curve was 0·91 (95% CI 0·88–0·95).

Although this study marks a notable advance for this technology, as highlighted by the authors it is restricted by the use of non-traditional ECG lead positions, which requires additional tools to those that are currently readily available. Additionally, whilst the use of the ECG-enabled stethoscope identified those patients who had a reduced LVEF, it is unknown whether that diagnosis would reliably lead to altered management and improved outcomes. Increased diagnoses might result in overutilisation and increased cost of downstream investigations. Because the use of this AI-augmented algorithm is a screening technique, the correct base population for screening to produce outcomes needs to be determined. Patients in this study were attending for a formal transthoracic echocardiogram, having been referred by clinicians for investigation of symptoms and screening related to heart failure. The use of this technology for patients presenting for primary care versus patients presenting for ECGs or transthoracic echocardiograms would alter the predictive value of the algorithm.

This study has tremendous implications for the future use of AI in cardiovascular care. The combination of the AI-led ECG algorithm and the ECG-enabled stethoscope can be used for point-of-care detection of reduced LVEF. By linking the algorithm to the traditional stethoscope, it opens the possibility of diagnosing reduced LVEF in any patient who undergoes an auscultatory exam, a broader population than those undergoing ECGs. This procedure integrates the AI algorithm at a practical, universal step in the clinical encounter and brings the AI algorithm to patients at an earlier stage in their health care. As this study adapted the algorithm to single-lead ECG inputs, it is expected that other AI algorithms can too be adapted to single-lead ECGs obtained from various methods, including those obtained using a smart watch. In addition to LV function, the hope for future advances is that single-lead ECG inputs into AI algorithms can lead to point-of-care diagnosis and prediction of other arrhythmias, electrolyte imbalances, infiltrative cardiomyopathies, and beyond.

This prospective, real-world study provides a practical application of an AI algorithm integrated in a clinical context that produces a potentially actionable result.

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