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AI-ECG Model Outperforms STEMI Criteria for Identifying ACS Patients With Occlusions

If validated, the technology may help reduce unnecessary cath lab activations and speed needed revascularizations.

by [Todd Neale](#) DECEMBER 08, 2023

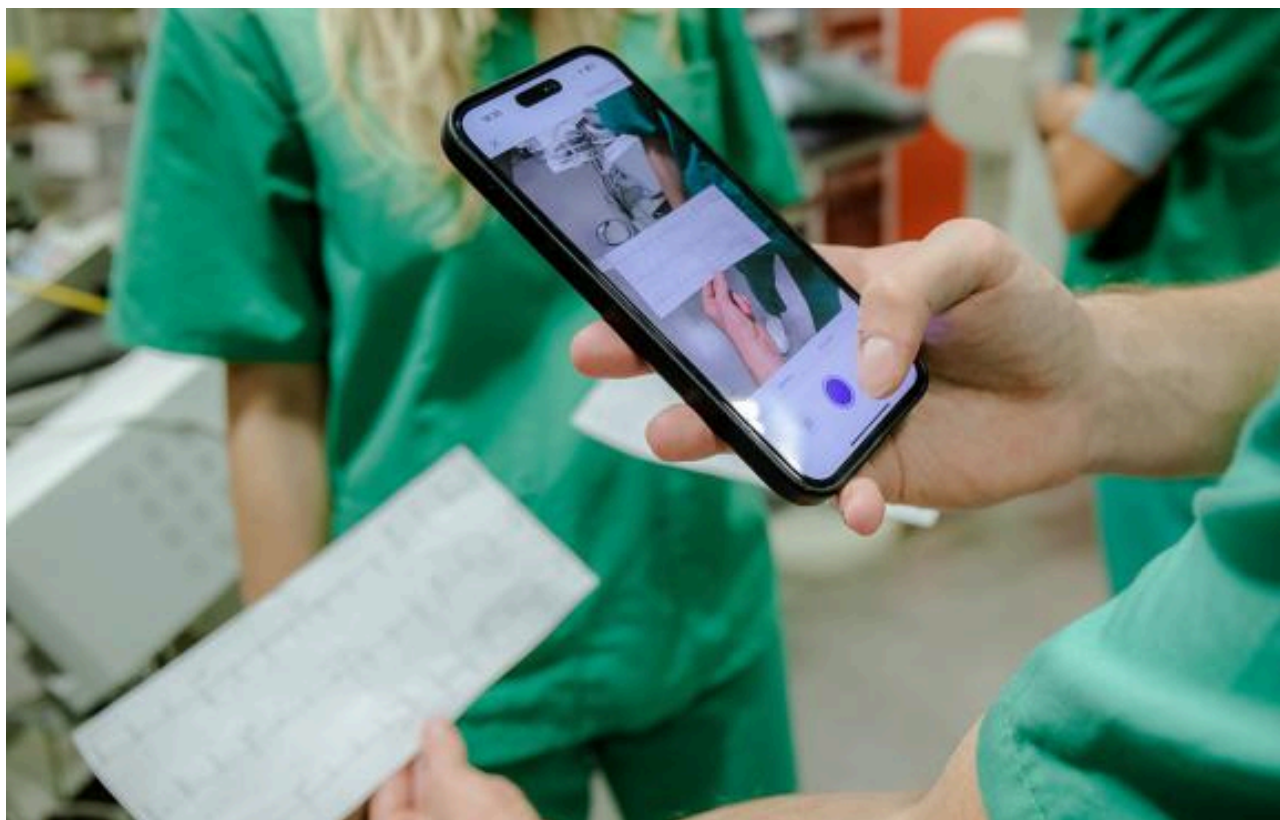


Photo Credit: Robert Herman

An artificial intelligence algorithm for ECG interpretation (AI-ECG) is superior to conventional, guideline-recommended STEMI criteria for identifying patients with chest pain who have an occluded culprit coronary artery that requires immediate revascularization, a retrospective study suggests.

The AI-ECG model—dubbed “Queen of Hearts”—identified occlusion MI with an area under the curve (AUC) of 0.938, higher than the AUC of 0.651 seen with STEMI criteria and similar to the AUC of 0.843 seen when ECG interpretation was performed by two expert readers.

The findings warrant further evaluation of the model in prospective studies to see whether it can improve ACS triage by not relying solely on the presence or absence of ST-elevation on the ECG and ensure speedy revascularization for patients who need it, according to researchers led by Robert Herman, MD (Cardiovascular Centre Aalst, Belgium), who is co-founder and chief medical officer of Powerful Medical, which is developing the AI-ECG algorithm.

“We are able to identify two times more of these patients that are currently missed using just the initial ECG recorded when the patient is hospitalized,” Herman told TCTMD. Clinicians can use the algorithm through the PMcardio smartphone app, which takes a picture of an ECG, digitizes it, and then provides an interpretation.

Use of the AI-ECG algorithm is now being evaluated in pilot studies in a few centers in the United States and Europe, and outcomes will be compared between phases before and after implementation. Aside from the impact on outcomes, the researchers will also be evaluating whether the technology can reduce unnecessary—and expensive—cath lab activations for patients who don’t have an occluded vessel. A randomized trial is planned also.

If all goes well, Herman said the short-term impact of the AI-ECG model is expected to be in reducing false-positive cath lab activations, which would be financially beneficial for health systems.

Over the longer term, it remains to be proven that this approach will reduce adverse clinical outcomes, but, Herman said, “eventually I think the guidelines will change in a way that it will not be STEMI versus NSTEMI anymore, but really change in a way that they focus on the state of the coronary artery versus the ECG manifestation. I think this will reduce the mortality of patients that are currently

missed because they have the same underlying disease, and we just have to prove it through randomized controlled trials.”

Good Performance Across Subgroups

Most patients with ACS present without typical ST-elevation on ECG, and one-third of those with NSTEMI have an occluded culprit coronary artery. This group of patients previously has been shown by Herman’s group to have a **significantly greater risk of mortality** compared with those diagnosed with STEMI, which is believed to be due to delays in invasive management despite their having the same underlying problem.

Herman and his colleagues developed their AI-ECG model—which acts on a single 12-lead ECG—with the aim of addressing this treatment gap. It was developed using 18,616 ECGs from 10,543 patients with suspected ACS who were included in an international database.

For the current study, published in the *European Heart Journal – Digital Health*, the investigators tested the model on 3,254 ECGs from 2,222 patients from Europe and the United States who underwent invasive coronary angiography (mean age 62; 67% men).

Overall, 21.6% were diagnosed with occlusion MI, meaning they had an acutely occluded or flow-limiting culprit artery requiring emergent revascularization. The AI-ECG model identified these patients with an accuracy of 90.9%, a sensitivity of 80.6%, and a specificity of 93.7%. It performed better than conventional STEMI criteria in terms of accuracy (83.6%) and sensitivity (32.5%), but not specificity (97.7%).

The AI-ECG model had similar performance when compared with expert ECG readers, who had an accuracy of 90.8%, a sensitivity of 73.0%, and a specificity of 95.7%.

It stood up well across multiple subgroups defined by presentation, age, sex, and electrocardiographic manifestation, although its sensitivity was lower in patients with left bundle branch block and broad QRS morphology.

Mean time to diagnosis of the occlusion with the AI-ECG model (2.3 hours) was significantly shorter than that for STEMI criteria (5.3 hours; $P < 0.001$) but similar to that when the diagnosis was made by expert ECG readers (2.9 hours; $P = 0.08$).

Prospective Validation a Must

Commenting for TCTMD, Nicholas Mills, MBChB, PhD (University of Edinburgh, Scotland), noted that the current criteria for activating the cath lab are based on the inclusion criteria for the original TIMI trials done about three decades ago, “so I definitely think there is an opportunity for us to evolve our thinking about how we identify patients who’d benefit from emergency angiography.”

He said the current study was well done, adding that the true test of whether this will be transformative in clinical practice will come with prospective validation and implementation studies. In addition, to have an impact, timely intervention for patients who need it will be required.

The fact that diagnostic performance is superior with the AI-ECG algorithm than with standard STEMI criteria isn’t surprising, Mills said. But there remains a question about why these patients with occluded arteries didn’t have ST-elevation on the ECG. It could be, he suggested, that these patients presented late, after the ST-elevation had already resolved and the damage was already done. “So we definitely need prospective studies to understand what impact this sort of technology can have on patient outcomes.”

Mills said it was reasonable to compare the AI-ECG algorithm with STEMI criteria, but he noted that in clinical practice, patients often get taken immediately to the cath lab even if they don’t meet those criteria if an occlusion is suspected. “I would have liked to have seen data based on a more-pragmatic interpretation of the current guidelines to really understand what the gain is from the algorithm,” he said.

Nonetheless, “the opportunity to train AI algorithms in acute cardiology is huge,” Mills said, highlighting the importance of ensuring that the datasets on which they’re trained are reliable and high-quality and that the technologies are easy to implement into practice.

These types of technologies will likely make more of an impact when they incorporate not just information from the ECG, but also information on cardiac biomarkers, like troponin, and on other clinical variables that physicians consider every day, Mills said. “Until we’re doing that—bringing together structured and unstructured laboratory and ECG data in one place—we’re going to struggle to beat

human performance, which is actually very good at determining who needs to go to the cath lab and when.”

There’s great potential, he added, but “I think we’ve got a long way to go to demonstrate to the world that we can implement these technologies and actually make a difference for patients.”

Herman underscored the possible impact their AI-ECG algorithm can have if further studies are successful. He calculated based on the 8.2% excess mortality observed in their prior study among patients with occluded vessels who were missed based on incorrect ECG interpretation and on the number of patients who have an MI with an acute occlusion each year that there are roughly 10,000 excess deaths in the US annually related to this issue.

Therefore, catching these patients through use of this technology “can have one of the biggest impacts in the last 10 years, if you look at mortality and cardiovascular patient management.”



by [Todd Neale](#)

Todd Neale is the Associate News Editor for TCTMD and a Senior Medical Journalist. He got his start in journalism at ... [Read Full Bio](#)

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Herman R, Meyers HP, Smith SW, et al. [International evaluation of an artificial intelligence-powered ECG model detecting acute coronary occlusion myocardial infarction](#). *Eur Heart J Digit Health*. 2023;Epub ahead of print.

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