New AI model could help screen for heart defect

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Investigators from Brigham and Women's Hospital and Keio University in Japan have developed a deep learning artificial intelligence model to screen electrocardiogram (ECG) for signs of atrial septal defects (ASD). This condition can cause heart failure and is underreported due to a lack of symptoms before irreversible complications arise. Their results are published in *eClinicalMedicine*.

"If we can deploy our model on a population-level ECG screening, we would be able to pick up many more of these patients before they have irreversible damage," said Shinichi Goto, MD, Ph.D., corresponding author on the paper and instructor in the Division of Cardiovascular Medicine at Brigham and Women's Hospital.

ASD is a common adult congenital heart disease. It is caused by a hole in the heart's septum that lets blood flow between the left and right atriums. It's diagnosed in about 0.1% to 0.2% of the population but is likely underreported, Goto said. The symptoms of ASD are typically very mild, or in many cases, nonexistent until later in life. Symptoms include an inability to do strenuous exercise, affect the rate or rhythm of the heartbeat, heart palpitations, and an increased risk of pneumonia.

Even if ASD isn't causing symptoms, it can stress the heart and increase the risk of atrial fibrillation, stroke, heart failure, and pulmonary hypertension. At that point, the complications of ASD are irreversible, even if the defect is fixed later. If found early, ASD can be corrected with minimally invasive surgery to improve life expectancy and reduce complications.

There are several ways to detect ASD. First, the largest defects can be found by listening to the heart with a stethoscope. But only about 30% of patients can be discovered this way. Another is by echocardiogram, a time and labor-intensive test that is not a good option for screening. Another test, electrocardiography, or ECG, takes only about a minute, making it possible to use as a screening tool. However, when humans analyze an ECG readout for known abnormalities associated with ASD, there is limited sensitivity for picking up ASD.

To see if an AI model could better detect ASD from ECG readouts, the study team fed a deep learning model ECG data from 80,947 patients over 18 who underwent both ECG and echocardiogram to detect ASD. A total of 857 patients were diagnosed with ASD. The data was collected from three hospitals: two large teaching institutions—one, BWH in the US; and the other, Keio University in Japan, and Dokkyo Medical University, Saitama Medical Center in Japan, a community hospital.

The model was then tested using scans from Dokkyo, which has a more general population and isn't specifically screening patients for ASD. The model was more sensitive than using known abnormalities found on ECGs to screen for ASD. The model correctly detected ASD 93.7% of the time, while using known abnormalities found ASD 80.6% of the time.

"It picked up much more than what an expert does using known abnormalities to identify cases of ASD," Goto said. One limitation of the study is that the model was trained used samples from academic institutions, which deal more with rare diseases like ASD. All the patients used to train the model were being screened for ASD and received an echocardiogram, so it is not clear how well the model would work on a general population, which is why they tested it in Dokkyo. "The model's performance was retained even in the community hospital's general population, which suggests that the model generalizes

well."

The authors also note that even the use of echocardiogram to detect ASD will not find every defect. Some could slip through both the regular screening and the AI model, though these smaller defects are less likely to require surgical closure. "The problem of machine learning is that it's a black box—we don't really know what features it picked up," Goto said. That means we can't learn what features to look for in ECGs from the model, either.

Results suggest that the technology could be used in population-level screening to detect ASD before it leads to irreversible heart damage. ECG is relatively low cost and currently performed in many contexts. "Perhaps this screening could be integrated into an annual PCP appointment or used to screen ECGs taken for other reasons," Goto said.

More information: Deep Learning-Based Model Detects Atrial Septal Defects from Electrocardiography: A Cross-Sectional Multicenter Hospital-Based Study, *eClinicalMedicine* (2023). DOI: 10.1016/j.eclinm.2023.102141. www.thelancet.com/journals/ecl … (23)00318-8/fulltext

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