Detection of potentially deadly atrial fibrillation dramatically improved by new algorithm

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An algorithm developed by Ki H. Chon, PhD, head of the Department of Biomedical Engineering at Worcester Polytechnic Institute (WPI), in partnership with Snehraj Merchant of The ScottCare Corporation, makes it possible for a new heart monitoring system to detect incidents of atrial fibrillation (AF), the most common form of cardiac arrhythmia, far more accurately than previous methods. The algorithm, utilized in the new ScottCare CardioView Dx Suite, detects AF episodes with an accuracy of 95 percent--a dramatic improvement over the previous state of the art--and immediately flags them, obviating the need for a trained technician to spend hours analyzing data.

Atrial fibrillation, which affects about three million Americans, is an independent risk factor for death and a major cause of ischemic stroke, in which blood flow is reduced to part of the brain. Treatments are available that can significantly reduce or eliminate AF, but the condition must first be detected, which is difficult, Chon says.

"Unfortunately, it is notoriously difficult to diagnose," he notes. "AF is often asymptomatic and intermittent. In the vast majority of cases, diagnosis depends upon the presence of symptoms, such as rapid and irregular heart rate, and upon serendipity. Patients may be unaware of their irregular pulse and diagnosis may only be established during a fortuitous visit to a doctor."

In AF, the heart's normal sinus rhythm is disrupted by random electrical impulses in the atria and the pulmonary veins. This results in an irregular heartbeat that may be fleeting or recur intermittently for weeks or even years. While it is often a random phenomenon initially, AF is likely to become chronic, and it significantly elevates the risk for stroke and other complications, including congestive heart failure.

Without careful monitoring and early treatment, AF patients may be at risk of heart failure. But even when patients wear standard Holter or arrhythmia event monitors, which record heartbeats over an extended period of time, accurate detection of this sporadic phenomenon is complicated by the fact that the average human heart beats 72 times per minute. "It is impractical for a trained technician to sort through data on 100,000 heartbeats in each day's recording," Chon says.

Chon's algorithm addresses the need for accurate and automatic detection in two ways: by using a novel technique to detect AF episodes that might otherwise be missed, and by enabling AF to be detected and recorded in real time, eliminating the need for manual detection after the fact.

Previous algorithms have relied upon tracking either the absence of a type of electrical activity in the heart known as the P-wave, or the variability in the timing of the contraction of the ventricle (which produces the tall spikes on an ECG tracing). While absence of P-wave fluctuations are the most telling barometer for AF, motion and noise artifacts can result in AF going undetected. Chon's algorithm, in contrast, combines three different statistical techniques, building upon the unique strengths of each to detect randomness, or markedly increased beat-to-beat variability. It is able to detect AF episodes with an accuracy of 95 percent; previous monitors have had an accuracy of only 70 to 80 percent.

The algorithm enables the TeleSentry mobile cardiac telemetry device and software in the CardioView Dx Suite to analyze the electrical information it detects in real time so it can immediately flag AF episodes, eliminating the need for technicians to spend hours analyzing the data. This is a significant improvement over traditional methods such as Holter monitors, which simply store raw data that must then be downloaded and carefully examined when the monitors are returned to a hospital or other healthcare facility.

"Early detection leads to early intervention, which is the key to saving lives," Merchant said. "That is the motivator for developing and refining algorithms like this. We started with a simple goal of designing an efficient algorithm to accurately detect atrial fibrillation. That led us to complex methods for achieving that goal. This project illustrates how harnessing computing power for rapid execution of complex algorithms is the future of medical diagnostic equipment."

The algorithm was tested repeatedly using data from an independent database provided by MIT before being tested on ScottCare's own patient data, which were collected from a double blind study. "It performed, in all cases, with a very high degree of accuracy," says Chon.

Provided by Worcester Polytechnic Institute