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Wearing the pulse: are smart devices transforming cardiac arrhythmia detection and management?

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Editorial

Technological advances have been shaping our way of living for a long time and have gradually become an irreplaceable part of an individual's daily routine. We have smartphones with the capacity to replace the function of devices that would occupy a whole room, now compressed into an elegant piece of equipment that fits in our pocket. Moreover, other daily accessories, such as timepieces, eyewear and earphones have successfully integrated digital technologies. With an array of technologies that allow collection of physiological data, these devices allow for continuous monitoring and study of our body functions. Data processing and analysis has evolved to a new level with the advent of artificial intelligence and machine learning.

In medicine, devices have been employed for a long time in the diagnostic and monitoring process. The Holter monitor has been effectively used since the 1960s,[1] while Hans Berger recorded the first EEG exactly 100 years ago.[2] The array of devices used in medicine has expanded exponentially, in terms of purpose (diagnostic, therapeutic), areas of application, performance and versatility. However, in the last several decades, the delineation line between a medical wearable device and a daily use accessory has become blurrier. With the implementation of sensor technology, such as accelerometers, photoplethysmographs (PPG), electrocardiographs (ECG), seismocardiographs, ballistocardiographs, we are now able to monitor heart rate and rhythm, blood pressure, physical activity levels and sleep-wake cycles,[3] and even assess fluid status and aid in detecting heart failure decompensation.[4]

The role of medical devices in detection of abnormal heart rhythm is widely recognized. For example, the latest expert consensus from the American College of Cardiology recommends at least 14 days of cardiac monitoring in patients with cryptogenic strokes and consider monitoring in some instances of small- or large-vessel stroke, as well as limited situations of high-risk cardioembolic strokes.[5] Medical grade devices are subject to FDA regulation and post-market surveillance, but they must be prescribed and thoroughly analyzed by a medical provider.[6] Consumer-grade medical devices have been employing the same technologies (ECG and PPG) as their medical-grade counterparts, and some of them have even gained FDA approval.

Apart from Holter, event monitoring, implantable cardiac monitors, other wearable devices, such as chest patches, smartwatches, wrist bands have been employed in the detection of cardiac arrhythmias.

Given all these advances in technology, including new machine learning algorithms with tremendous potential for pattern recognition, as well as widespread access of sensor technology, is it reasonable to assume that we have reached a point where we can efficiently and safely utilize data from consumer grade devices? Furthermore, can we make healthcare related decisions that would lead to similar, or even superior outcomes?

Unfortunately, we are lacking large scale prospective studies which showed improved outcomes after employing consumer grade medical devices.[7] The REHEARSE-AF study employed AliveCor Kardia device, which led to markedly higher rates of atrial fibrillation detection (HR 3.9, 95% CI 1.4 – 10.4, P=0.007), but without significant differences in incidence of stroke/transient ischemic attacks or systemic emboli (HR 0.61, 95% CI 0.22 – 1.69, P = 0.34).[8] Also, one must keep in mind that conducting studies on wearable devices can yield results that have potential biases, such as a "adherer" bias, where users of wearable devices may adhere to other lifestyle measures, with possible better outcomes. On the other hand, those who are suffering from severe symptomatic disease may not be able to use the devices effectively, thus creating barriers to rejecting null hypotheses. Moreover, unlike medical grade medical devices, they can assess the patient's rhythm during rest only, and in an intermittent fashion, while some rhythms, such as a relatively regular atrial flutter, may be difficult to recognize by an analyzing algorithm. Some consumer grade wearables only employ PPG in detection of heart rate, which may result in underestimation of heart rates and result in false negative results.[9] Finally, physician interpretation is always required, which can prove difficult as consumer-grade medical devices offer an avalanche of time and effort taxing data.

Nevertheless, the burden of undiagnosed arrhythmias and other cardiovascular disorders remains high. For example, in a retrospective cohort study from five US claims data sets, the proportion of undiagnosed atrial fibrillation was estimated to be between 11 % - 23 %.[10] Thus, there is an unmet need for better screening methods that could potentially improve outcomes.

Even though consumer grade smart wearable devices are not yet ready to take up the task of identifying abnormal rhythms, with the potential to save time and effort, and eventually lead to better outcomes, we may be on the brink of a revolution. History has shown that it only took several years from Einthoven's invention of the "string galvanometer" in 1903, for the ECG to become compact devices that can be used at bedside.[11]

Perhaps, with the aid of machine learning algorithms and ever improving smart consumer-grade wearable devices, the gap between meaningful and timely detection of cardiac arrhythmias and improvement in outcomes will be filled.

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Conflicts of interest

There is no conflict of interest.

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