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Detecting Atrial Fibrillation Using Smartwatches

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ABSTRACT

The purpose of research: Atrial fibrillation is a globally widespread medical issue. In many cases, atrial fibrillation is paroxysmal, which makes its detection challenging and can delay the implementation of appropriate treatment. The aim of this review is to analyze the latest information on the use of smartwatches in detecting atrial fibrillation.

Research materials and methods: This review draws on data sourced from the current literature and clinical reports from various sources. The search involved the use of keywords like “atrial fibrillation”, "smartwatch," "cardiac arrhythmia, "detecting arrhythmias”, “arrhythmia” and "wearable devices”.

Basic results: The findings indicate that the detection of atrial fibrillation (AF) using commercially available smartwatches demonstrates a very high level of diagnostic accuracy but still has room for improvement.

Conclusions: Atrial fibrillation is a very common problem among patients and the number of sick people increases every year. Detecting these arrhythmias is therefore extremely important to counteract potential, dangerous complications and implement appropriate prevention.

Smartwatches are a promising tool supporting the diagnosis of cardiac arrhythmias and monitoring already diagnosed diseases. Further research and continuous improvement of technologies are needed so that it is possible to use them in everyday medical practice.

Introduction

Arrhythmia, or heart rhythm disorder, refers to a condition where the heart beats irregularly or abnormally. Among cardiac arrhythmias, atrial fibrillation (AF) is the most common, affecting 8.8 million people aged 55 and older in Europe in 2010. Predictions show that this number will increase to more than double to 17.9 million by the year of 2060[1]. Approximately 700,000 people in the United States may have undiagnosed atrial fibrillation[2]. Arrhythmias are associated to 15–20% of all passings, especially cases of sudden cardiac death, displaying the importance of increased focus on these conditions[3].

This is a particularly important problem, since AF can carry a numerous life-threatening complication, especially ischemic stroke, which is five times more frequent in patients with atrial fibrillation than in those without this arrythmia[4]. The diagnosis is not problematic if, in addition to the typical ECG, the patient is symptomatic, but the problem may be atrial fibrillation, which is asymptomatic, and this al happens as well[5]. It is then very important to actively look for this arrhythmia in at-risk. The elementary step for detecting arrhythmias is 12-lead electrocardiography (ECG) which shows a heart rhythm recording in real time of the test being performed. An alternative is ECG holters, where we can monitor the recording for 24, 48 or 72h. The problem becomes atrial fibrillation attacks, which occur infrequently and cannot be captured by these tests.

As technology advances, people are increasingly choosing to use various devices designed to make daily life easier like wearable smart devices, such as smartwatches, capable of assisting in the detection and management of cardiac arrhythmias and sundry health conditions[6,7]. Once, the primary function of watches was to measure time - today smartwatches are much more than that. They are capable of monitoring biometric data such as heart rhythm, pulse rate, sleep pattern, oxygen saturation and blood pressure[8]. Some accessories using

photoplethysmography (PPG) can register patients' electrocardiography (ECG) within a 30-s interval, playing an essential role in monitoring or detecting AF[9,10,11].

Conventional continuous heart monitors or implantable devices improve the detection of atrial fibrillation in high-risk populations[5,12,13,14,15].

How smartwatches work?

Currently, there are more than 100,000 mobile apps on the market targeting users' health and over 400 wearable devices monitoring activities which shows how quickly this business is growing[16]. Smartwatches can monitor the patient's heart rate continuously, in real time, without affecting the patient's comfort in any way[17]. With a single click of the watch, a 30-second rhythm recording is triggered, after which both the watch and the paired phone display the result of the measurement along with possible recommendations such as a doctor's appointment. Such a feature in smartwatches is one of the reasons for the rise in popularity of these devices over the past few years[18].

The essence of the devices' operation is photoplethysmography (PPG) from an optical sensor to analyze heart rate from the skin. The technology described identifies the heart cycle based on the pulsatile pattern of changes in light absorption, which corresponds to changes in blood volume in the vessels beneath the skin surface[19].

Scientific research reports for detection of atrial fibrillation by smartwatches:

A total of 18 studies on the detection of atrial fibrillation, bradyarrhythmias, tachyarrhythmias, and premature contractions were analyzed, evaluating diagnostic accuracy in 424,371 individuals. The signals analyzed by smartwatches were based on photoplethysmography. The overall sensitivity, specificity, and accuracy of smartwatches for detecting cardiac arrhythmias were 100% (95% CI 0.99-1.00), 95% (95% CI 0.93-0.97), and 97% (95% CI 0.96-0.99), respectively. The pooled positive predictive value and negative predictive value for detecting cardiac arrhythmias were 85% (95% CI 0.79-0.90) and 100% (95% CI 1.0-1.0), respectively[20].

One meta-analysis compared the sensitivity and specificity of smartwatches in the context of detecting atrial fibrillation. It showed comparable diagnostic accuracy - smartphones had a sensitivity of 94% and a specificity of 96%, and smartwatches had specificity of 94% and a sensitivity of 93%. In subgroup analyses, the analysis found no difference in diagnostic accuracy between photoplethysmography and single lead electrocardiography[21].

One study compared five smart devices in detecting atrial fibrillation compared to a 12-lead ECG. Their study involved 201 patients, 62 of whom had previously been diagnosed with atrial fibrillation. Sensitivity and specificity for AF detection were similar across all watches: 85% and 75% for the Apple Watch 6, 85% and 75% for the Samsung Galaxy Watch 3, 58% and 75% for the Withings Scanwatch, 66% and 79% for the Fitbit Sense, and 79% and 69% for the AliveCor KardiaMobile, respectively. In terms of patient preference, the Apple Watch ranked highest. I was preferred by 39% of participants[22,23].

In another study, the goal was to provide insight into the percentage of patients for whom anticoagulant therapy would be beneficial if atrial fibrillation (AF) was detected through data from wearable devices. The study utilized electronic health records (EHR) and data from Apple Watch users, including 1,802 individuals. Based on these data, high-risk patients were identified. The analysis used their medical history, Apple Watch usage patterns, and the risk of atrial fibrillation determined by an approved model. The study found that, on average, 0.25% (n = 4.58, 95% CI, 2.0–8.0) of patients could be considered suitable candidates for initiating anticoagulant treatment due to AF detection using the Apple Watch[23,24].

Limits:

Although the contribution of smartwatches to atrial fibrillation detection seems promising, they have many limitations.

Apple Inc. was the first company to receive FDA approval for the automatic detection of AF using an ECG feature on a smartwatch[25]. The increasing number of users with smartwatches capable of self-recording and automatically diagnosing AF has led to a rise in early-stage diagnoses of the condition. Early intervention in AF is more effective, helping to lower the risk of stroke and heart failure[26]. However, the automatic detection of AF in current smartwatches is still not flawless. AF classification is limited to a specific heart rate range, typically between 50 and 120 or 150 beats per minute[27]. Additionally, the Apple Watch (AW) often returns inconclusive results, which can lead to significant delays in diagnosis[28,29].

Smartwatches are mainly popular among the 18-34 age group, with an estimated 40% owning a smartwatch in this age group. Among people aged 35-54, the figure is already 30%. However, when it comes to age 55 upwards, it is only 15%[30], and it is this age group that is most at risk of developing atrial fibrillation. It is also important to remember that not all devices that have the function of performing ECGs have FDA approval and should not be used to monitor heart rate.

The European Society of Cardiology suggests that 12-, single- or multiple-lead ECGs should always be used to diagnose atrial fibrillation to avoid misdiagnoses. This does not include non-ECG wearables and other devices that typically use photopletysmography[28]. ECGs performed by smartwatches often have false-positive results when it comes to diagnosing atrial fibrillation, so the inclusion of anticoagulant treatment, without first confirming the diagnosis, can carry the risk of adverse reactions to anticoagulants, such as bleeding, which can be life-threatening.

Costs are also a significant limitation - wearable devices are not reimbursed in any way, patients must purchase them themselves, which involves costs that not everyone can afford.

Disclosure:

Author Contribution Statement:

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