Abstract

Screening of Atrial Fibrillation Using Wrist Photoplethysmography from a Fitbit Tracker

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Abstract

Background: Atrial Fibrillation is the most common clinically significant cardiac arrhythmia, estimated to affect between 2% (< 65 years of age) and 9% (> 65 years of age) of the U.S. population. Screening and early detection of AF can help prevent associated stroke and cardiovascular disease. Commonly used monitoring devices are limited to short periods (< 4 weeks) and are usually employed in symptomatic subjects. Wrist-worn wearables equipped with photoplethysmography (PPG) could potentially aid in AF screening, as they can be easily worn by most people for extended periods of time.

Objective: This study aimed to investigate the ability of wrist-based PPG to detect the presence of AF in subjects while at rest.

Methods: This study was conducted with the approval of local institutional review boards, and all patients provided written, informed consent. The first dataset consisted of 9 patients with persistent AF and 13 subjects with normal sinus rhythm. For these 22 subjects, PPG and ECG data were collected while sitting stationary for 15 minutes (awake dataset). A second dataset consisted of 10 patients with persistent AF and 27 subjects with no known diagnosis of AF. These subjects were asked to wear a Fitbit wrist-band which recorded PPG and accelerometry data during sleep (sleep dataset, 73 total nights). There was no overlap between subjects in the awake and sleep datasets.

Results: Data were analyzed in overlapping 1 or 5-minute windows. Pulse Rate Variability (PRV) features, PPG morphology features and accelerometer features were extracted for each window. An algorithm was trained on the awake dataset and was validated on the sleep dataset. The performance was 95.7% (98%) sensitivity (Se) and 0.8% (0.8%) False Positive Rate (FPR) for 1 min (5 min) windows. We also investigated the shortest duration of an AF episode that could be detected by using synthesized data. With 1 minute analysis windows, the algorithm was sensitive down to 40-second episodes. Using 5-minute intervals, episodes down to 3 minutes could be reliably detected.

Conclusions: Wrist-bands equipped with PPG sensors can be used to detect atrial fibrillation during sleep or during awake, stationary periods. While reliable detection of short AF episodes can be challenging due to the noisy nature of PPG signals, we have demonstrated that select PPG features can enable accurate detection of AF down to 40 second periods. These findings suggest that wrist-worn devices equipped with a PPG sensor could be used to screen for AF in high-risk subjects or monitor patients post treatment, but are limited to cases where users are not moving or exercising. Additional, larger clinical studies are planned for the future to validate these promising early results and to validate the algorithm's specificity against other forms of arrhythmia.

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KEYWORDS

cardiovascular disease; screening; atrial fibrillation

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