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Entropy-based algorithm for atrial fibrillation detection using photoplethysomgraphic signal recorded by a smart watch

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Background: Atrial fibrillation (AF) is the most common arrhythmia, and its paroxysmal and short duration nature makes its detection challenging. The most important limitation of current smartwatches is that patients need to touch to the sensor of the watch to record signals when patients feel discomfort. We developed a wearable smart watch and evaluated its accuracy to differentiate AF from sinus rhythm, which can continuously detecting heart rhythm without hand touching the device.

Methods and results: A wearable smart watch with PPG sensor and electrocardiogram (ECG) recording function was used for signal acquisition. A total 399 patients with a mean age of 67 years old were enrolled in the study, of whom 237 (81.5%) were male, and 101 have been diagnosed with AF. Pulse wave extracted from the green light spectrum of the signal and ECG were recorded for about 10 minutes for each patient. Pulse-to-pulse intervals (PPI) were automatically identified. All ECG signals were verified by two cardiologists. The correlation between R-to-R interval on ECG and PPI were excellent, with a correlation coefficient $R > 0.99$ ($p < 0.05$). An entropy-based algorithm which combined Shannon entropy of successive difference of PPI and sample entropy of PPI was used to discriminate between AF and sinus rhythm. This method had high sensitivity and specificity (96% and 98%, respectively), the area under receiver operating characteristic curve reached 0.98.

Conclusions: We developed an entropy-based algorithm for AF detection with PPG signal recorded by a wearable smart watch. This algorithm discriminates AF from sinus rhythm accurately. This advance in technology overcomes an important clinical obstacle and can increase the AF detection rate tremendously.