HEALTHCARE INNOVATION TECHNOLOGY LAB (HITLAB)

Comparison Between QT and Corrected QT Interval Assessment by an Apple Watch With the AccurBeat Platform and by a 12-Lead Electrocardiogram With Manual Annotation: Prospective Observational Study

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ABSTRACT

Abnormal prolongation or shortening of the QT interval is associated with increased risk for ventricular arrhythmias and sudden cardiac death. For continuous monitoring, widespread use, and prevention of cardiac events, advanced wearable technologies are emerging as promising surrogates for conventional 12-lead electrocardiogram (ECG) QT interval assessment. Previous studies have shown a good agreement between QT and corrected QT (QTc) intervals measured on a smartwatch ECG and a 12-lead ECG, but the clinical accuracy of computerized algorithms for QT and QTc interval measurement from smartwatch ECGs is unclear. The prospective observational study compared the smartwatch-recorded QT and QTc assessed using AccurKardia's AccurBeat platform with the conventional 12-lead ECG annotated manually by a cardiologist.

A total of 50 participants were included in the study. QT and QTc intervals obtained by a smartwatch coupled with the platform's assessment were comparable to those from a 12-lead ECG.

OBJECTIVES

The objective of this study is to compare smartwatch-recorded QT and QTc intervals assessed using the AccurBeat platform's algorithm with the conventional gold standard procedure that uses a 12-lead ECG annotated manually by an expert cardiologist.

STUDY METHODS

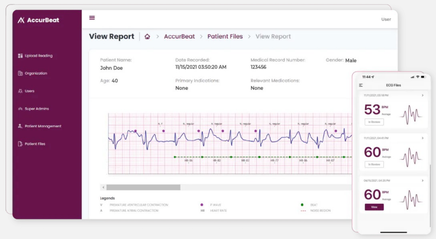
- This study is a single-site observational study to compare QT and QTc intervals assessed using smartwatch-generated data coupled with the platform's algorithm and QT and QTc intervals measured using a 12-lead ECG with manual annotation in healthy individuals.
- ECGs were collected from healthy participants (without any known cardiovascular disease) aged >22 years.
- Two consecutive 30-second ECG readings followed by (within 15 minutes) a 10-second standard 12-lead ECG were recorded for each participant. Characteristics of the participants were compared by sex using a 2-sample t test and Wilcoxon rank sum test.
- Statistical comparisons of heart rate (HR), QT interval, and QTc interval between the platform and the 12-lead ECG, ECG lead I, and ECG lead II were done using the Wilcoxon sign rank test. Linear regression was used to predict QTc and QT intervals from the ECG based on the platform's QTc/QT intervals with adjustment for age, sex, and difference in HR measurement. The Bland-Altman method was used to check the agreement between various QT and QTc interval measurements.

STUDY POPULATION

- Healthy adult participants without known or suspected heart disease were recruited from outpatient primary care and cardiology clinics between January 6 and 19, 2022. This was a convenience sample from the SUNY Downstate cardiology clinic and internal medicine practice.
- The inclusion criteria were selected based on both patient self-report and electronic medical records. The exclusion criteria included any recent illness within 4 weeks and taking any medication irrespective of an indication that is known to prolong the QT interval.

AccurBeat Platform

AccurKardia, a cardiology-focused digital health company has developed a device agnostic platform (AccurBeat) for the analysis of Apple Watch (version 4 or higher)–generated ECGs that leverages an engine built on computational and artificial intelligence (AI) techniques to perform automated analysis of ECGs and support the early detection and diagnosis of arrhythmias.



Solution Development & Evaluation

The AccurBeat (version 1.0) platform includes a native iOS app (used to view the annotated ECG and computerized interpretation of rhythm classification), a clinician web portal (for the review and approval of reports prior to release to patients), a cloud-based application programming interface to access the analytics engine, and the analytics engine itself that annotates the ECG and provides a computerized interpretation of rhythm classification. The analytics engine is based on proprietary methods that leverage a combination of signal processing, image analysis, and AI-based techniques to annotate ECGs and diagnose arrhythmias. The data is normalized, and features are extracted using various signal processing techniques. Once this initial processing is complete, a hybrid architecture combining image analysis with evolutionary computing–based AI is invoked for beat classification, complex feature extraction, and rhythm detection. Following this, an inference engine with established clinical guidelines is used to obtain a diagnosis. Since this study only focused on HR, QT interval, and QTc interval measurements, the output of the inference engine was not applicable to the results of this study. The algorithm was previously tested according to the AAMI ANSI EC57:2012 standard with both publicly available and proprietary databases.

RESULTS

Participant's Characteristics

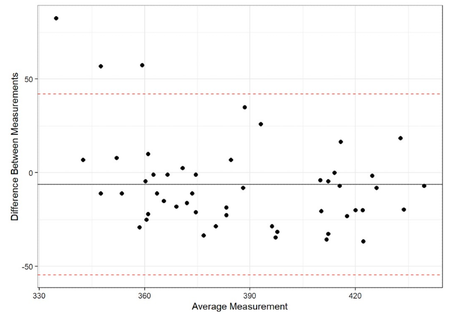
- Out of 50 participants, 32 (64%) identified as female with an average age of 46.18 years.
- No significant age or heart rate (HR) differences were found between sexes.
- However, female patients showed significantly higher QTc interval measurements across devices compared to males.

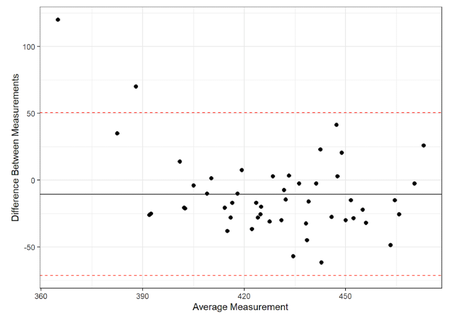
Regression Model Results

- The result of the regression model using the platform measurements to predict the 12-lead ECG measurements indicated that, in univariate analysis, QT/QTc intervals from the platform significantly predicted QT/QTc intervals from the 12-lead ECG, ECG lead I, and ECG lead II, and this remained significant after adjustment for sex, age, and change in HR.

Bland-Altman Analysis

- The Bland-Altman plot results found that 96% of the average QTc interval measurements between the platform and QTc intervals from the 12-lead ECG were within the 95% confidence limit of the average difference between the two measurements, with a mean difference of –10.5 (95% limits of agreement –71.43, 50.43).
- A total of 94% of the average QT interval measurements between the platform and the 12-lead ECG were within the 95% CI of the average difference between the two measurements, with a mean difference of –6.3 (95% limits of agreement –54.54, 41.94).





COMPARISON TO PREVIOUS STUDIES

- QT interval monitoring is crucial for identifying cardiac risks and medication effects, often measured manually or via computerized methods from a 12-lead ECG.
- Wearable technology like smartwatches offers convenience and cost advantages, showing comparable QT values to ECG, especially in lead I and lead II comparisons.
- Age didn't affect AccurKardia's predictive ability, yet QTc interval agreement was less robust due to measurement complexities.
- Variations in acquisition methods, including differences in recording durations, might influence comparison outcomes between smartwatches and ECGs..

CONCLUSIONS

QT and QTc intervals obtained by a smartwatch coupled with the platform's assessment were comparable to those from a 12-lead ECG. Accordingly, with further refinements, remote monitoring using this technology holds promise for the identification of QT interval prolongation.

Limitations

- Sequential, not simultaneous, recordings between smartwatch and ECG may have minor impact.
- Study focused on healthy individuals; results may not apply to those with known heart disease.
- Single investigator for 12-lead ECG; future studies plan multiple investigators to address variability.

Strengths

- Inclusion of racially diverse participants, particularly 50% African American, despite no racial comparisons performed.

Despite limitations, smartwatch-coupled platform shows comparable QT intervals to 12-lead ECG, paving the way for further research involving larger patient samples, cardiac disease inclusion, and multiple investigator assessments for enhanced reliability in remote monitoring.

For more information, visit https://formative.jmir.org/2022/9/e41241/

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