Use of a Smart Watch for QT Interval Assessment in Outpatients with COVID-19

Jason Chinitz[1], Rajat Goyal[1], Donna Chelle Morales[1], Melissa Harding[1], Samy Selim[1], and Laurence Epstein[2]

[1]Southside Hospital
[2]Northwell Health

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Abstract

The COVID-19 pandemic has necessitated rapid implementation of innovative strategies to manage patients remotely, in order to reduce the risk of community and nosocomial transmission. This case demonstrates the use of an Apple Watch to monitor for arrhythmias and QT prolongation in a patient with COVID-19 infection during home isolation.

Case Report

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Jason S. Chinitz MD, FHRS, Rajat Goyal MD, Donna Chelle Morales DO, Melissa Harding PA-C, FHRS, Samy Selim MD, Laurence M. Epstein MD

Southside Hospital

Northwell Health Physician Partners

Bay Shore, NY

Zucker School of Medicine at Hofstra /Northwell

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Address for correspondence

Jason Chinitz, MD

39 Brentwood Road, Bay Shore NY 11706

email: jchinitz@northwell.edu

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Introduction

During the ongoing COVID-19 pandemic, limitations in health care resources and extensive protections against viral dissemination forced novel approaches to previously routine patient management. Patients with COVID-19 infection are at risk for various cardiovascular and arrhythmic complications.[1] In addition, medications indicated to treat COVID-19 infection carry risk of cardiac complications, particularly QT prolongation and ventricular arrhythmia.[2] Several of the most commonly utilized medications at this time,

such as chloroquine, hydroxychloroquine, azithromycin, and famotidine, carry a risk of QT prolongation. This risk is heightened when such medications are used concomitantly, in patients with cardiac comorbidities, or in the setting of acute medical illness such as sepsis.[3]

Hospitalized patients with COVID-19 infection have been monitored for QT prolongation and arrhythmias through the use of serial ECGs, telemetry, as well as ambulatory telemetry monitors.[4] However, limited availability of such resources due to high demand, and precautions set in place to protect health care providers from contact with contagious patients, has precluded standard monitoring even in hospitalized patients. Furthermore, most patients with COVID-19 infection are treated as outpatients, employing self-isolation to reduce the risk of nosocomial and community spread.[5] There is therefore a sudden and dramatic reliance on telehealth and remote ECG monitoring to manage patients at home.

Wearable and "smart" cardiac monitoring devices, such as the Apple Watch series 4 and the AliveCor Kardia system (AliveCor Inc. Mountain View, California), have the ability to record a rhythm strip essentially equivalent to lead I on a standard ECG, and allow for electronic transmission of results. While these devices are validated for their ability to monitor heart rates and differentiate sinus rhythm from atrial fibrillation[6], the accuracy for other ECG interpretation purposes has not been well studied. The waveforms produced have been shown to correlate reasonably well with standard ECG intervals including QTc,[7] and have previously been used to detect drug-induced QT interval prolongation.[8]

As patients with COVID-19 infection continue to overwhelm our global health care system and resources, the ability to remotely monitor patients for cardiac complications of COVID-19 infection, and ensure safety of pharmacologic treatment, has become increasingly important. Currently available wearable cardiac monitoring devices, such as the Apple Watch Series 4, and the Kardia system, may therefore have an important role in the management of patients in this Pandemic.

We report herein a case of a patient with COVID-19 infection who was treated with a QT prolonging medication and was able to be managed remotely with the assistance of a smart device.

Case

A 40 year old female physician with no prior cardiac history presented with fevers, chills, cough and dyspnea. Due to known exposures to patients and close relatives with confirmed COVID-19 infection, she was immediately placed on home isolation and managed by her primary care provider and cardiologist using telemedicine. Due to persistent fevers she was prescribed hydroxychloroquine (400mg bid x 1 day, and then 200mg bid to complete a 5 day course). No baseline ECG was available, however, she was considered at moderate risk for drug-associated QT prolongation (Tisdale Score=7).[3] As such, she used her Apple Watch to record rhythm strips approximately 2-3 hours after each dose of hydroxychloroquine administration, and transmitted these results to her cardiologist (Figure 1). The QTc interval was 441 ms at baseline (measured using Bazett's correction), increased to 476 ms after the 3rd dose, and then returned to baseline at 440 ms after completion of the 5 day course. No arrhythmias were detected during the course of treatment by the Apple Watch. She was able to complete treatment at home, and as her symptoms improved a 12-lead ECG was subsequently performed in the hospital (Figure 2), which confirmed the waveform measurements obtained by the Apple Watch (QTc = 457 ms on ECG) and demonstrated consistency between limb lead measurements (QT interval = 380 ms in both lead I and lead II).

Discussion

The novel Coronavirus has a high transmission rate in the community as well as within health care facilities, forcing a new emphasis on telemedicine and remote monitoring. While telehealth has been effective, this strategy precludes previously standard testing, including ECGs and application of mobile cardiac telemetry monitors. At the same time, cardiac complications related to COVID-19 infection and potential cardiac toxicity associated with common pharmacologic treatment prompts the need for easily accessible cardiac monitoring modalities that do not rely on physical contact or presentation to a health care facility. Remote patient management using smart device-based electrocardiography is therefore a valuable alternative to

previously standard monitoring modalities.

The waveforms provided by smart device-based electrocardiograms have not been vigorously studied for the purpose of QT measurement and no outcome studies based on this strategy have been performed. The rhythm strip obtained by such devices is typically derived from the same vector as lead I of a standard 12-lead ECG; the waveforms are overlaid on standard ECG grids with recordings at 25mm/s and 10mm/mV, allowing QT and RR interval measurements in milliseconds. The corrected QT interval can therefore be derived in the same manner as on a standard 12-lead ECG. A recent validation performed in 129 healthy volunteers showed a reasonable concordance between QTc intervals measured from the Apple Watch and a 12-lead ECG (mean difference -11.67 +- 8.32 ms, r=0.57).(7) In addition, a prior study demonstrated the ability to use a smartphone based heart monitor to accurately detect QTc prolongation in patient receiving QT prolonging medications (bias=4 ms, sd =11 ms compared to 12-lead ECG).[8] Another study found that QTc measurement using a single-lead handheld mobile device is feasible, but the QTc measurement was underestimated (23ms, 95%CI 13-34) when only a lead I rhythm strip was obtained; when a vector analogous to lead II could be recorded, QTc measurements had very close correlation to the maximum QTc interval by 12-lead ECG.[9] Importantly, the change in QTc during treatment with QT prolonging medications has also been correlated with risk of torsades de pointes,[10]indicating that serial measurements using a single lead (such as with a smart device) may provide additional value in risk stratification even when the measured QTc value is imprecise.

Further validation and optimization of recording technique is required before this technology is promoted for routine QT interval assessment. If this approach is adopted, QTc measurement can likely be automated to improve the ease of measurement and reduce measurement error. The lack of multiple contiguous leads obtained by most wearable devices limits the sensitivity of these modalities for detection of QT abnormalities, which may be more pronounced in some leads than others. While lead II is most commonly utilized for QT measurement, the optimal lead for QT measurement does vary, and the use of the same lead for serial assessment is important to interpret QT changes with medication. Lead I is frequently adequate for interpretation, and the QTc measurement from lead I has been shown to differ by an average 7.5 ms from that obtained from lead II.[11] Accordingly, single lead Mobile Cardiac Outpatient Telemetry units have previously been FDA-approved for QTc measurement. Additionally, the quality of the electrogram produced by smart devices may be effected by high skin-to-electrode impedance, which may be variable and impact waveform interpretation; nonetheless, electrogram quality produced by these devices has been generally consistent with other monitoring technologies and well validated for rhythm interpretation. Despite the limitations, the COVID-19 pandemic requires providers to use all resources at their disposal to manage patients safely and minimize the spread of infection, particularly in the health care environment.

Conclusion

Smart monitoring devices such as the Apple Watch Series 4 permits monitoring of heart rhythm, heart rates, and QT intervals, and thereby provide a distinct advantage in the management of patients with COVID-19 infection during home isolation. This case demonstrates one novel approach to patient management under these difficult circumstances.

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Figure 1. Rhythm Strips used for QTc Measurement

Rhythm strips obtained from the Apple Watch during the course of treatment. QT and RR intervals are measured as showed, and QTc calculated using Bazett's formula.

Figure 2. ECG obtained after completion of treatment under home isolation.

Enhancement of leads I and II from 12-lead ECG demonstrating measurement of QT interval (QT = 380 ms, RR = 690 ms, QTc = 457 ms) and consistency of QT measurements between these leads.