A Rare Case of Ciprofloxacin-Induced Bradycardia Recognized by a Smartwatch

Andres Cordova Sanchez, MC1, Moeed Chohan, MD1, Oluwateniola Olatunde, MD1, and Catherine White, MD1

Abstract
Fluoroquinolones are known to cause cardiac side effects. The most common are ventricular arrhythmias and QT prolongation. We present a case of symptomatic bradycardia secondary to ciprofloxacin use in a patient who presented to the hospital after a smartwatch alert for bradycardia. We believe that the integration of wearable technology in the practice of medicine could provide valuable data and improve patient care in different settings.

Keywords
cardiology, bradycardia, ciprofloxacin, wearable device, smartwatch

Introduction
Bradycardia is an uncommon side effect of fluoroquinolones; ciprofloxacin appears to be the less arrhythmogenic of the group.1 The use of commercially available wearable technology may allow us to identify less commonly reported medication side effects. We present a patient with dizziness and lightheadedness on exertion who presented to the hospital after a smartwatch alert for bradycardia.

Case
A-32-year-old female presented 2 days post-hospital discharge after undergoing common bile duct (CBD) dilation via endoscopic retrograde cholangiopancreatography for cholangitis secondary to CBD stent occlusion. Upon discharge, she had been prescribed ciprofloxacin and metronidazole.

She described new onset dizziness upon minimal exertion. Her smartwatch had triggered an alert for a sustained heart rate of less than 40 beats per minute (bpm), prompting her to present to the Emergency Department at an outside hospital. On telemetry, her heart rate (HR) was confirmed to be between 30 and 50 beats per minute (bpm). The patient was subsequently transferred to our hospital for cardiology evaluation.

Upon arrival she was asymptomatic. Her physical examination and vitals were unremarkable besides bradycardia with a HR between 30 and 50 bpm. Initial electrocardiogram (ECG) during this admission showed sinus bradycardia with a HR of 51 bpm and corrected QT (QTc) of 420 ms. ECG performed prior to the initiation of antibiotics showed normal sinus rhythm with HR of 66 bpm and QTc of 438 ms.

The medications given during the procedure 2 days earlier were 1 liter normal saline, 4 mg ondansetron, 160 mg succinylcholine, 100 µg fentanyl, 2 mg midazolam, 4 mg dexamethasone, and 200 mg propofol. The records indicated that her HR remained more than 60 bpm during the admission. At discharge, her blood pressure was 136/78 mmHg, oxygen saturation 94% on room air, HR 65 bpm, she was euvolemic, and only 1 dose of ciprofloxacin had been given.

She was placed on continuous telemetry and ciprofloxacin was replaced with ceftriaxone. Her complete blood count, basic metabolic panel, thyroid stimulating hormone, Lyme serology, urine drug screen, and echocardiogram results returned unremarkable and non-actionable. The following day, her HR improved to 60 to 70 bpm with repeat ECG showing normal sinus rhythm with HR of 75 bpm and QTc of 477 ms.

She was discharged on cefpodoxime and metronidazole to complete her antibiotic therapy for cholangitis.

1SUNY Upstate Medical University, Syracuse, USA

Received October 23, 2021. Revised December 7, 2021. Accepted December 12, 2021.

Corresponding Author:
Andres Cordova Sanchez, MC Department of Medicine, SUNY Upstate Medical University, Rm. 5138, 750 East Adams Street, Syracuse, NY 13210, USA.
Email: cordovaa@upstate.edu
Discussion
The most well-known cardiac side effects of fluoroquinolones include QTc prolongation and torsades de pointes.1 Of the arrhythmias reported in the literature, the majority are ventricular arrhythmias.2–7 Among these studies, there is only 1 case of bradycardia as a side effect.2 It appears that ciprofloxacin has the lowest risk for cardiac side effects, including QTc prolongation and arrhythmias.1
Bradycardia can be secondary to a wide variety of factors. Propofol, succinylcholine, fentanyl, midazolam, dexamethasone, ondansetron were administered during the patients procedure and each of them can cause bradycardia. However, these drugs have a short half-life and bradycardia secondary to any of these would have been expected to happen at the time of administration or shortly after. Volume status can also be implicated in arrhythmias, our patient was euvolemic. Given that other causes of bradycardia were ruled out and that with discontinuation of ciprofloxacin her heart rate normalized, we concluded that ciprofloxacin was likely the cause of her symptomatic bradycardia.

Our patient’s symptoms were somewhat vague. The combination of symptoms and smartwatch notification prompted her presentation to the hospital. Early recognition of bradycardia prevented a potential adverse event.

Wearable technology devices detect heart rate by photoplethysmography (PPG). Using infrared or green light, a PPG device can detect the significant blood flow variations seen in arteries during systole and diastole. The device emits light and a photodetector measures its reflection form the tissue. The amount of reflected light is proportional to intravascular volume variation. PPG can be affected by any movement artifact or pressure changes.8 Muscle contraction,9 Changes in skin temperature,10,11 and darker skin tones12,13 have been identified as causes for inaccuracies when using PPG.

Heart rate monitoring by wearable technology has been reported to have <10% error.14 Variability at rest is reported between 4.5b pm and 22.6 bpm depending on the type of device.15,16 Evidence so far appears to indicate that wearable PPG devices are more accurate at rest than strenuous physical activity. A meta-analysis performed by Zhang et al included 44 studies for a total of 1738 patients and compared HR measurements of 15 brands of commercial wearable PPG devices against measurements from ECG or chest strap and found no statistically significant differences during sleep, rest, treadmill use, post exercise, and daily living activities. However, they found statistically significant differences during resistance training and cycling.17 These devices could provide valuable, easy-to-access information than can later be confirmed by conventional methods. Although it appears that wearable devices allow for acceptable HR readings under certain conditions, several factors have not yet been elucidated and more research needs to be done to fully integrate them into the health care system.

Conclusions
Ciprofloxacin can be a cause for symptomatic bradycardia. Despite having less accuracy than conventional methods, heart rate measurements done by wearable technology are widely available, easily accessible, and could provide valuable information for patient care in different settings.

Author Contributions
A.C.S.: conceptualizing and writing original draft; M.C.: conceptualizing and writing original draft; O.O.: review and editing; C.W.: supervision and review.

Declaration of Conflicting Interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
The author(s) received no financial support for the research, authorship, and/or publication of this article.

Ethics Approval
Our institution does not require ethical approval for reporting individual cases.

Informed Consent
Informed consent for patient anonymized information to be published in this article was not obtained from the patient because our institution does not require informed consent for individual case reports with information anonymized.

ORCID iD
Andres Cordova Sanchez https://orcid.org/0000-0003-3763-3971

References
1. Gorelik E, Masarwa R, Perlman A, et al. Fluoroquinolones and cardiovascular risk: a systematic review, meta-analysis and network meta-analysis. Drug Saf. 2019;42(4):529-538.
2. Zambon A, Polo Friz H, Contiero P, Corrao G. Effect of macrolide and fluoroquinolone antibacterials on the risk of ventricular arrhythmia and cardiac arrest. Drug Saf. 2009;32(2):159-167.
3. Harms H, Prass K, Meisel C, et al. Preventive antibacterial therapy in acute ischemic stroke: a randomized controlled trial. PLoS One. 2008;3:e2158.
4. Chou HW, Wang JL, Chang CH, Lai CL, Lai MS, Chan KA. Risks of cardiac arrhythmia and mortality among patients using new-generation macrolides, fluoroquinolones, and β-lactam/β-lactamase inhibitors: a Taiwanese nationwide study. Clin Infect Dis. 2015;60:566-577.
5. Inghammar M, Svanström H, Melbye M, Pasternak B, Hviid A. Oral fluoroquinolone use and serious arrhythmia: bi-national cohort study. *BMJ*. 2016;352:i843.

6. Lapi F, Wilchesky M, Kezouh A, Benisty JI, Ernst P, Suissa S. Fluoroquinolones and the risk of serious arrhythmia: a population-based study. *Clin Infect Dis*. 2012;55(11):1457-1465.

7. Rao GA, Mann JR, Shoaibi A, et al. Azithromycin and levofloxacin use and increased risk of cardiac arrhythmia and death. *Ann Fam Med*. 2014;12(2):121-127.

8. Castaneda D, Esparza A, Ghamari M, Soltanpur C, Nazeran H. A review on wearable photoplethysmography sensors and their potential future applications in health care. *Int J Biosens Bioelectron*. 2018;4(4):195-202.

9. Boudreaux BD, Hebert EP, Hollander DB, et al. Validity of wearable activity monitors during cycling and resistance exercise. *Med Sci Sports Exerc*. 2018;50(3):624-633.

10. Jeong IC, Yoon H, Kang H, Yeom H. Effects of skin surface temperature on photoplethysmograph. *J Healthc Eng*. 2014;5(4):429-438.

11. Maeda Y, Sekine M, Tamura T. The advantages of wearable green reflected photoplethysmography. *J Med Syst*. 2011;35(5):829-834.

12. Hermand E, Cassirame J, Ennequin G, Hue O. Validation of a photoplethysmographic heart rate monitor: Polar OH1. *Int J Sports Med*. 2019;40(7):462-467.

13. Horton JF, Stergiou P, Fung TS, Katz L. Comparison of Polar M600 optical heart rate and ECG heart rate during exercise. *Med Sci Sports Exerc*. 2017;49(12):2600-2607.

14. Pevnick JM, Birkeland K, Zimmer R, Elad Y, Kedan I. Wearable technology for cardiology: an update and framework for the future. *Trends Cardiovasc Med*. 2018;28(2):144-150.

15. Wang R, Blackburn G, Desai M, et al. Accuracy of wrist-worn heart rate monitors. *JAMA Cardiology*. 2017;2:104-106.

16. Cadmus-Bertram L, Gangnon R, Wirkus E, Thraen-Borowski KM, Gorzelitz-Liebhauser. The accuracy of heart rate monitoring by some wrist-worn activity trackers. *Ann Intern Med*. 2010;166:610-613.

17. Zhang Y, Weaver RG, Armstrong B, Burkart S, Zhang S, Beets MW. Validity of Wrist-Worn photoplethysmography devices to measure heart rate: a systematic review and meta-analysis. *J Sports Sci*. 2020;38(17):2021-2034.