



Case Report

A unique case of bradycardia recognized by wearable technology as first presentation of complete heart block

Daniel L. Overbeek, MD^{a,*}, Emily M. Hogikyan, MD^b, Mallory Davis, MD, MPH^a, Daniel C. McGillicuddy, MD^c^a University of Michigan/St Joseph Mercy Emergency Medicine Residency, United States of America^b University of Michigan Medical School, United States of America^c St Joseph Mercy Ann Arbor, Department of Emergency Medicine, United States of America

ARTICLE INFO

Article history:

Received 1 June 2019

Received in revised form 16 July 2019

Accepted 20 July 2019

Keywords:

Wearable technology

Heart block

Public health

ABSTRACT

Wearable technology has advanced significantly, and the proposed health benefits have been widely touted. Most of the discussion has been surrounding the identification and diagnosis of asymptomatic atrial fibrillation. However, the heart monitoring functions of the wearable technology can also identify other abnormalities as well. We present the first case of wearable technology identified bradycardia diagnosed as the primary presentation of complete heart block. Wearable technology has advanced significantly, but still poses questions regarding its use in screening for rare conditions. One remaining challenge is balancing the desire to screen for rare asymptomatic conditions without overburdening emergency departments with patients responding to alarms on their devices.

© 2019 Elsevier Inc. All rights reserved.

1. Introduction

Wearable technology has expanded significantly in the past few years. With this expansion, there remains disagreement regarding potential health benefits. We present a case of the detection of previously asymptomatic bradycardia by a wearable device with novel heart tracking and electrocardiogram (EKG) technology, diagnosed with complete heart block and successfully treated with pacemaker. This case represents a potential role for wearable technology in the detection of serious cardiac arrhythmias and demonstrates some of the untapped potential of these wearable technologies.

2. Case report

A previously-healthy mid 60s-year-old-woman presented to the Emergency Department (ED) stating that her “Apple Watch” wearable device was alarming due to a low heart rate. The warnings started the day prior and continued the day of presentation. She was asymptomatic at the time but did note that her heart rate was “in the 200s” during her exercise class the day prior, which was unusual for her.

Upon arrival, her heart rate was 37 beats per minute, with a normal blood pressure. EKG on presentation revealed complete heart block. She was taken emergently for placement of a dual-chamber pacemaker. As

in approximately half of cases of complete heart block, no precipitating cause was identified (Fig. 1).

3. Discussion

Complete heart block is an uncommon condition, with a worldwide prevalence of 0.04% [1]. Our patient only presented due to the warnings from her electronic device. American Heart Association guidelines recommend placement of a pacemaker with sustained heart rates of less than 40 in the case of third-degree atrioventricular block [2]. Our patient did have successful placement of an implantable pacemaker with resolution of the bradycardia.

The Apple Watch is a form of “wearable technology”, a category of devices which includes “fitness trackers” and “activity trackers”, such as FitBit, and extends to “smartwatch” devices like the Apple Watch which offer a range of features. These devices have been assessed for their accuracy, usability, and ability to impact health outcomes [3–7]. Regarding heart rate monitoring, accuracy of multiple devices have been tested, with accuracy percentages over 90%. This includes a study by El-Amrawy et al. which analyzed a variety of devices including the Apple Watch, which had a measured accuracy of 99.9% [7].

When a patient is presenting to the ED reporting alarms from an Apple Watch or other wearable technology, after initial stabilization, Emergency Physicians can often access the data from the alarm to supplement the ED EKG and other testing. For the Apple Watch, the corresponding “Health” and “ECG” Apps store data regarding alarm. This data, including rhythm strips when measured, can be accessed on the watch or patient's cell phone. The data does not have a public backup

* Corresponding author at: 1500 E Medical Center Dr, Ann Arbor, MI 48109, United States of America.

E-mail address: danoverbeek@gmail.com (D.L. Overbeek).

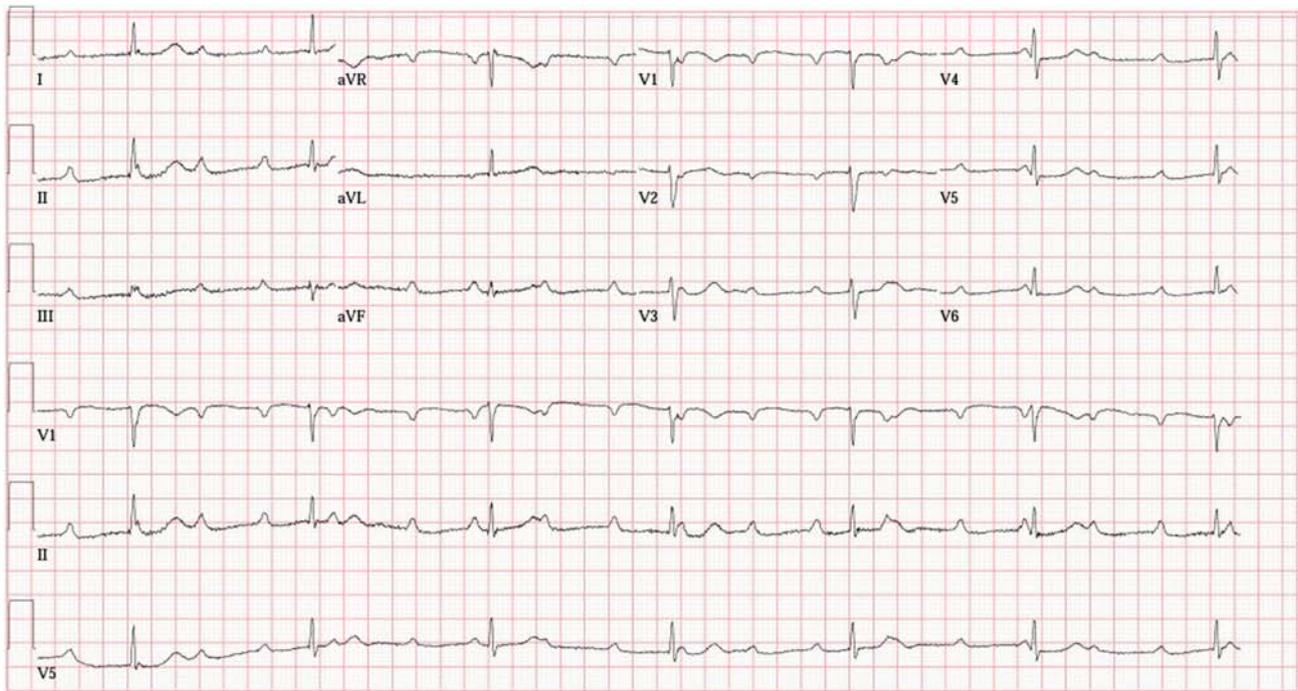


Fig. 1. Presentation EKG.

and cannot be accessed if the devices are not available. If data cannot be accessed and the possibly concerning arrhythmia is no longer present, clinical judgment should be used to determine next steps regarding the possibility of a paroxysmal arrhythmia.

Apple Watch and other fitness trackers use photoplethysmography, monitoring the absorption of specific light wavelengths to measure heart rate. Recent technology also adds two electrodes to the Apple Watch, which can be used to create a one lead rhythm strip, and Apple has implemented technology to interpret that rhythm strip to report on atrial fibrillation. [3]. Users can also elect to be notified of high and low heart rates based on warning levels built into the device, with editable warning ranges [8]. For example, the default setting is to alarm for a heart rate over 120 or under 40 beats per minute.

This technology is currently being trialed in the Apple Heart Study, a prospective, single-arm study initiated in 2018 with preliminary data announced in 2019 [9], seeks to characterize the prevalence of atrial fibrillation in the general population and improve detection rates [3]. However, there are not currently efforts monitor for any other cardiac arrhythmias, including complete heart block.

There have been a variety of responses within the health care and cardiology communities in response to these products [10,11]. The ability to identify early potential problems provides a unique opportunity to determine if interventions in these cases can ward off future complications. The earlier detection of complete heart block likely protected the patient from some morbidity or mortality from her complete heart block, but exact benefits as compared to diagnosis at the time of symptom development are hard to measure.

Apple has sold over 40 million watches alone, and controls approximately half of the smartwatch market. Preliminary data from the Apple Heart Study showed approximately 0.5% of participants received an alarm regarding an irregular pulse [9]. With over 40 million watches sold, this could lead to hundreds of thousands of emergency visits yearly, and more if screening is expanded to include more rare conditions. The importance of accuracy in measurements and selection of appropriate conditions will be critical to manage the increase in health care utilization as a result of the data from wearable technology. Complete heart block is notably less prevalent than atrial fibrillation. Screening for rare conditions will give a much higher rate of false positives, and

these false positives will have an increasing impact on health care utilization [12]. The Apple Heart study reported preliminary positive predictive values between 71% and 84% for atrial fibrillation [9], but this would very likely be lower for conditions with significantly lower prevalence such as complete heart block.

One future goal for providers and technology companies should be to utilize these technologies to improve health literacy among the population. These technologies tend to activate patients regarding their health [13], as many often purchase them as components of a goal to improve their health. Improved health literacy should be a goal, as this has been connected in multiple ways to improved long-term outcomes [14].

4. Conclusion

This case shows early recognition of a life-threatening cardiac arrhythmia using wearable technology. While the condition itself is rare, this case represents an example of the potential benefits of widespread use of wearable technology with enhanced cardiac monitoring. More common conditions such as atrial fibrillation are being actively studied in the realm of wearable technology, and other conditions such as complete heart block will also benefit from further research and tracking. The increased utilization of wearable technology will also represent an important educational issue for both patients and physicians and can be used to improve health literacy and activation.

Declaration of Competing Interest

This work is unfunded.

We do not have any conflicts of interest to disclose. This includes specifically no conflicts or industry relationships with monitoring device manufacturers including Apple.

Acknowledgements

All authors have seen and approved of the final manuscript for publication. The article is the original work of the above authors, and is not under consideration for publication elsewhere.

References

- [1] Kojic EM, Hardarson T, Sigfusson N, Sigvaldason H. The prevalence and prognosis of third-degree atrioventricular conduction block: the Reykjavik Study. *J Intern Med* [Internet] 1999;246(cited 2019 Feb 2):81–6 John Wiley & Sons, Ltd (10.1111). Available from: <http://doi.wiley.com/10.1046/j.1365-2796.1999.00521.x>.
- [2] Tracy CM, Epstein AE, DiMarco JP, Ellenbogen KA, Mark Estes III, Freedman RA, et al. Practice Guideline 2012 ACCF/AHA/HRS focused update incorporated into the ACCF/AHA/HRS 2008 guidelines for device-based therapy of cardiac rhythm abnormalities ACCF/AHA TASK FORCE MEMBERS. *J Am Coll Cardiol* [Internet] 2013;cited 2019 Feb 2(61). <https://doi.org/10.1016/j.jacc.2012.11.007> Available from: doi.
- [3] Turakhia MP, Desai M, Hedlin H, Rajmane A, Talati N, Ferris T, et al. Rationale and design of a large-scale, app-based study to identify cardiac arrhythmias using a smartwatch: the Apple Heart Study. *Am Heart J* January 2019;207:66–75.
- [4] Evenson KR, Goto MM, Furberg RD. Systematic review of the validity and reliability of consumer-wearable activity trackers. *Int J Behav Nutr Phys Act* [Internet] 2015; 12:159 BioMed Central. cited 2019 Feb 2. Available from: <http://www.ijbnpa.org/content/12/1/159>.
- [5] Osborn CY, van Ginkel JR, Marrero DG, Rodbard D, Huddleston B, Dachis J. One drop | Mobile on iPhone and apple watch: an evaluation of HbA1c improvement associated with tracking self-care. *JMIR Mhealth Uhealth* 2017;5(e179) Internet. Available from <http://mhealth.jmir.org/2017/11/e179/>.
- [6] Phan D, Siong LY, Pathirana PN, Seneviratne A. Smartwatch: performance evaluation for long-term heart rate monitoring. 4th Int Symp Bioelectron Bioinformatics. ISBB 2015:2015.
- [7] El-Amrawy F, Nounou MI. Are currently available wearable devices for activity tracking and heart rate monitoring accurate, precise, and medically beneficial? *Health Inform Res* 2015 Oct;21(4):315–20.
- [8] Apple. Apple support: Heart rate notifications on your apple watch [internet]. [cited 2019 Feb 2]. Available from <https://support.apple.com/en-us/HT208931>; 2019.
- [9] Turakhia MP, Perez MV. Results of a Large-Scale, App-based Study to Identify Atrial Fibrillation Using a Smartwatch: the Apple Heart Study. American College of Cardiology: New Orleans; 2019 Available from: https://www.acc.org/-/media/Clinical/PDF-Files/Approved-PDFs/2019/03/15/ACC19_Slides/Mar16_Sat/10amET_Apple-Heart-Study-acc-2019.pdf.
- [10] Fox M. The new Apple Watch has a heart monitor and the FDA approves [internet]. NBC news; 2018 [cited 2019 Feb 2]. Available from <https://www.nbcnews.com/health/health-news/new-apple-watch-has-heart-monitor-fda-approves-n908976>.
- [11] Rowland C. Apple now says its smartwatch tech to detect atrial fibrillation is not for those with atrial fibrillation - the Washington post [internet]. Washington post; 2018 [cited 2019 Feb 2]. Available from https://www.washingtonpost.com/business/economy/apple-now-says-its-smartwatch-app-to-detect-atrial-fibrillation-is-not-for-those-with-atrial-fibrillation/2018/12/06/cb5c46bc-f978-11e8-8c9a-860ce2a8148f_story.html?utm_term=.1db5fc7912b4.
- [12] Dyer O. Sixty seconds on ... Apple ECG. *BMJ* [internet]. British Medical Journal Publishing Group 2018;363(k5364) [cited 2019 Feb 2]. Available from <http://www.ncbi.nlm.nih.gov/pubmed/30567697>.
- [13] CareCentra. Patient engagement expanded via apple smartwatch, mHealth app | welcome to Carecentra [internet]. CareCentra Blog; 2015 [cited 2019 Feb 2]. Available from <https://www.carecentra.com/patient-engagement-expanded-via-apple-smartwatch-mhealth-app/>.
- [14] Berkman ND, Sheridan SL, Donahue KE, Halpern DJ, Crotty K. Low health literacy and health outcomes: an updated systematic review. *Ann Intern Med* [Internet] 2011; 155:97 American College of Physicians. [cited 2019 Feb 2]. Available from <http://annals.org/article.aspx?doi=10.7326/0003-4819-155-2-201107190-00005>.