

Impressions of Older Patients with Cardiovascular Diseases to Smart Devices for Heart Rhythm Monitoring

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Abstract—Atrial fibrillation (AF) is the most common cardiac arrhythmia in the world and AF predominantly affects older individuals. Smart devices, including phones and watches, offer potential as mechanisms to detect AF and facilitate its treatment, but older individuals, as late-adopters of technology, may not perceive smart devices as easy or important to use. Our study focused on assessing impressions of smart devices for heart rhythm monitoring in ambulatory patients presenting to a cardiology practice.

Keywords—Atrial fibrillation, arrhythmia, smartphone, smart watch, monitoring, usability

I. BACKGROUND

Atrial fibrillation (AF) is the most common cardiac arrhythmia worldwide, currently affecting over 6 million Americans, and an equal number of individuals are suspected to have undiagnosed AF based on aging of the US population^[1]. Despite the availability of effective treatments that reduce risk from AF, untreated AF confers a 5-fold risk of stroke, 2-fold risk of heart failure and 50% higher risk of dying, making early detection and treatment imperative to minimize adverse health outcomes^[2,3]. Traditional monitoring methods are cumbersome and costly, resulting in poor adherence. New applications enable periodic or continuous pulse analysis using ubiquitous and familiar smart devices^[4-6]. Advances in hardware, signal processing for motion noise elimination enable accurate AF detection from brief pulse recordings^[7,8]. Ambulatory older patients with cardiovascular disease represent a group at high risk for AF, but these patients are frequently affected by other comorbid psychosocial, cognitive and clinical conditions that might interfere with short or long-term use of smart devices for AF detection. Moreover, older persons may not be comfortable using or sharing information about their heart using smart device-based systems. As part of a larger study evaluating the accuracy of two smart devices for AF detection among older patients presenting for a cardiology visit, we performed a usability assessment.

II. METHODS

A. Study Population

The study enrolled 98 participants between November 2013 and September 2016 at the University of Massachusetts Medical Center. All participants had presented for evaluation of a cardiovascular condition and were approached by research personnel after their clinic visit. Participants were consented and performed a self-evaluation of their heart rhythm using a smartphone application (n=75) running on an iPhone 4S or a

smartwatch application (n=23) running on a Samsung SimBand. A subgroup of the smartphone users (n=17) were asked to take the smart device home and perform a heart rhythm self-assessment 3 times daily for 7 consecutive days. All participants completed a study questionnaire.

B. Study Questionnaire

After completing a heart rhythm evaluation with a smartphone or smartwatch, study participants completed a questionnaire including device usability and acceptability assessments. Key usability domains that were assessed were: overall ease of use, overall importance, privacy concerns, perceived fit into daily life, and stress generated by use. To characterize psychosocial and cognitive status, study participants also completed the Montreal Cognitive Assessment (MoCA), Patient Health Questionnaire 9 (PHQ-9), and the Generalized Anxiety Disorder Scale (GAD 7).

III. RESULTS

A. Participant characteristics

The average of the 98 study participants was 68 years (± 10), 96% of participants were white, and 36% were female. The study cohort included 65 individuals with AF or atrial flutter, 3 with ventricular tachycardia, and 30 subjects with other heart rhythm abnormalities. Participants had a high burden of comorbid cardiovascular conditions. Less than half (41%) of participants reported ownership of a smartphone. Participants were affected by mild cognitive impairment (MOCA = 24 ± 3.4) mild depression (PHQ-9 score of 6), but no evidence of anxiety (GAD-7 score of 5).

B. Usability

Participants reviewed smartphones and watches favorably as heart rhythm monitoring systems, with 78% of participants reporting that the smart devices were “easy” or “very easy” to use. Similarly, 78% found the smartwatch or phone easier to use when compared to “previously used health monitoring devices.” 87% of participants reported that the smart devices were “important” or “very important” to them as a heart rhythm monitor. Participants overwhelmingly reported that the devices would add “little to no stress” to their lives (83%), and that they were comfortable with the privacy of transmitting recordings from a smart device (87%). 74% of participants reported that daily use of the smart devices would fit “well” into their lives. A regression model was used to identify factors associated with a positive impression of smart device usage based on the usability questionnaire and results are documented in Table 1.

TABLE 1. FACTORS ASSOCIATED WITH POSITIVE IMPRESSION OF SMART DEVICE USABILITY

Variable	Incidence Ratio	Std Err	P-value
Age	0.9967	0.0034	0.332
Sex	1.1152	0.0812	0.134
Stroke	1.0542	0.1035	0.591
Dysrhythmia	1.1575	0.0863	0.050
Heart Failure	0.9896	0.0719	0.886

A greater percentage of smart watch users found the devices easier to use (95 % “easy to very easy”) compared the participants who used the smart phone (73% “easy to very easy”). Adherence of at-home smartphone users as defined by actual measurements out of expected measurements was 94%.

IV. DISCUSSION

The National Health Aging Trends Study shows that 25% of seniors over the age of 65 use digital health technology, which is an increase of only 4% from 2011^[9]. With such minimal penetration of health technology in the elderly population, much remains to be elucidated specifically regarding their impressions of smart devices when used for heart rhythm monitoring. Our data shows that more than three out of four (78%) older individuals presenting for a cardiology clinic visit found 2 smart devices, a smartphone and watch, to be easy to use for cardiac monitoring and 78% considered such devices to be easier to use than more traditional cardiovascular monitors. Despite the advanced age of participants in our study, as well as high proportion affected by cardiovascular, psychosocial, and cognitive comorbidities, participants found smart devices easy to use and important to them. Our data also show that participants perceived smart devices to fit easily into their daily lives, as illustrated by the high adherence rate seen among home smartphone users (94%). Regression analysis

using our questionnaire data show that patients with a history of dysrhythmias were 15% more likely to have a more favorable impression of smart devices, further highlighting the importance and potential of smart watches and phones as cardiac monitoring tools in this population.

Overall, older participants appear to have great enthusiasm for smart devices as cardiac rhythm monitoring alternatives. Further development and study of applications for heart rhythm monitoring using smart devices appears warranted among older users at high risk for AF.

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