JMIR Cardio

Electronic, mobile, digital health approaches in cardiology and for cardiovascular health
Volume 3 (2019), Issue 2   ISSN 2561-1011   Editor in Chief: Andrew Coristine, PhD, Scientific Editor at JMIR Publications, Canada

Contents

Original Papers

Original Paper

Assessment of Heart Failure Patients' Interest in Mobile Health Apps for Self-Care: Survey Study

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Abstract

Background: Heart failure is a serious public health concern that afflicts millions of individuals in the United States. Development of behaviors that promote heart failure self-care may be imperative to reduce complications and avoid hospital re-admissions. Mobile health solutions, such as activity trackers and smartphone apps, could potentially help to promote self-care through remote tracking and issuing reminders.

Objective: The objective of this study was to ascertain heart failure patients' interest in a smartphone app to assist them in managing their treatment and symptoms and to determine factors that influence their interest in such an app.

Methods: In the clinic waiting room on the day of their outpatient clinic appointments, 50 heart failure patients participated in a self-administered survey. The survey comprised 139 questions from previously published, institutional review board–approved questionnaires. The survey measured patients' interest in and experience using technology as well as their function, heart failure symptoms, and heart failure self-care behaviors. The Minnesota Living with Heart Failure Questionnaire (MLHFQ) was among the 11 questionnaires and was used to measure the heart failure patients' health-related quality of life through patient-reported outcomes.

Results: Participants were aged 64.5 years on average, 32% (16/50) of the participants were women, and 91% (41/45) of the participants were determined to be New York Heart Association Class II or higher. More than 60% (30/50) of the survey participants expressed interest in several potential features of a smartphone app designed for heart failure patients. Participant age correlated negatively with interest in tracking, tips, and reminders in multivariate regression analysis ($P<.05$). In contrast, MLHFQ scores (worse health status) produced positive correlations with these interests ($P<.05$).

Conclusions: The majority of heart failure patients showed interest in activity tracking, heart failure symptom management tips, and reminder features of a smartphone app. Desirable features and an understanding of factors that influence patient interest in a smartphone app for heart failure self-care may allow researchers to address common concerns and to develop apps that demonstrate the potential benefits of mobile technology.

(JMIR Cardio 2019;3(2):e14332) doi:10.2196/14332

KEYWORDS

mHealth; patient-reported outcome; heart failure; self-care; patient monitoring

Introduction

Background

Heart failure is a complex clinical syndrome characterized by the impairment of the heart's function to fill or eject blood [1,2]. It is a major global health problem with an estimated prevalence of 6.5 million adults in the United States [3] and 37.7 million people worldwide [4]. Every year in the United States, there are approximately 1 million new cases of heart failure and 330,000 heart failure—related deaths [3]. Projections suggest that heart failure's prevalence will increase by 46% between 2012 and 2030 [5]. Its total cost, which includes the expense of health care services, medications, and sick leave, may reach US $69.7 billion by 2030, a 127% increase from roughly US $30.7 billion in 2012 [5].

Several cohort studies have indicated that the prevalence of heart failure increases significantly with age. In the Framingham Study by Ho et al [6], the prevalence was 0.8% in both men and women aged between 50 and 59 years before rising to 6.6% in men and 7.9% in women aged between 80 and 89 years. Similarly, the Rotterdam Study by Mosterd et al [7] showed a prevalence of 1% in the age group of 55 to 64 years, whereas it surpassed 10% in individuals aged 85 years or older. Much like its prevalence, incidence of heart failure is substantially higher in the elderly. In contrast to the annual incidence rates of 0.3% in men and 0.2% in women aged between 50 and 59 years, rates were 2.7% and 2.2%, respectively, in those aged between 80 and 89 years [6]. The cardiovascular health study by Huffman et al [8] that focused on individuals aged 65 years or older approximated an incidence of 19.3 per 1000 person-years.

Owing to the increasing prevalence of heart failure and rising financial implications, forming efficient heart failure prevention and treatment strategies is imperative. Currently, clinicians counsel heart failure patients on evidence-based recommendations outlined in clinical practice guidelines, which include taking prescription drugs, exercising, monitoring daily weight, and restricting sodium intake [9]. However, divergence from these guidelines contributes to hospital re-admission rates that surpass 20% within the first 30 days of discharge [10,11] and approach 50% within 6 months of discharge [12], with a substantial proportion of the 30-day rehospitalizations considered preventable [13].

Objectives

As heart failure patients show poor adherence to self-care behaviors, mobile health (mHealth) has emerged as a potential solution to improve their health outcomes and quality of care. mHealth is defined as the application of mobile technology [14,15], including software apps on mobile devices [16] and wireless sensors such as activity trackers [17]. These technological developments monitor activity and provide reminders of self-care behaviors and heart failure symptoms, which may be difficult for patients to ascertain [16]. Moreover, activity trackers are minimally invasive options that may also be preferable because of individuals' relatively high adherence to wearing them upon recommendation. In a previous study performed by members of our team, adherence rates for wearing activity trackers were observed to be as high as 90% [18]. The purpose of this study was to assess patient interest, specifically needs and preferences, regarding their heart failure self-care and their perceptions regarding a smartphone app integrated with home monitoring sensors. Results were analyzed to achieve the secondary end point of this study, which was to determine the factors that influence their interest.

Methods

Recruitment

From February 2018 to September 2018, study personnel collaborated with internal medicine, cardiomyopathy, and cardiology outpatient clinics to prescreen all patients diagnosed with heart failure at a university-based health system. Heart failure patients aged between 50 and 80 years were eligible to participate in this anonymous study if they were scheduled for an appointment at any of the 3 outpatient clinics. Exclusion criteria included having a cognitive (eg, dementia) disability, being unable to communicate in English, and having visual or auditory impairments to the extent that a smartphone could not be used.

Research personnel contacted potential participants over the phone, provided additional information about the study, and conducted the verbal consent process with those who were interested in participating. In the clinic waiting room, an informational sheet that described the study was given to those who consented to participate. The research team asked the participants to complete the survey before their scheduled appointment and informed them that omitting answers to any questions was permitted. Enrolled subjects received a US $20 gift card.

Upon enrolling in the study, each participant's New York Heart Failure Association (NYHA) classification and ejection fraction (EF) was noted. The NYHA classification categorizes heart failure patients by considering their symptoms during physical activity [19]. EF is a measurement that reports the heart's degree of function by monitoring the percentage of blood leaving the left ventricle when it contracts. These data were recorded to describe the patients' heart failure according to the severity of their symptoms and limitations.

Survey Questions

The survey comprised 15 sections, all written in American English. A total of 4 sections comprised questions relating to sociodemographic information, interest in specific smartphone app features, preferences regarding specific smartphone app notifications, and experience using technology. The section pertaining to interest in specific smartphone app features for heart failure self-care management evaluated the participants' interests using a 5-point Likert scale [20]. It included questions regarding symptom tracking, tips, and reminders (Multimedia Appendix 1). Each participant's responses to questions in these groups were averaged for data analysis. The section concerning notification preferences instructed subjects to indicate how often they would like to receive reminders and information related to heart failure self-care: never, once a day, every 12 hours, every 6 hours, every 4 hours, or every 2 hours (Multimedia

Appendix 1). To determine the participants' experience with technology, 12 *yes or no* questions from the Health Information National Trends Survey were asked (Multimedia Appendix 1) [21].

The remaining sections included questions regarding function, heart failure symptoms, and heart failure self-care behaviors. The participants' function and behaviors were detailed using the following institutional review board–approved questionnaires: Minnesota Living with Heart Failure Questionnaire (MLHFQ), Self-Care of Heart Failure Index (SCHFI), shortened version of the Seattle Angina Questionnaire (SAQ-7), shortened version of the Kansas City Cardiomyopathy Questionnaire (KCCQ-12), Patient-Reported Outcomes Measurement Information System (PROMIS) Global Health, and PROMIS Physical Function short form (SF). Symptoms were measured using a variety of PROMIS questionnaires: Fatigue SF, Anxiety SF, Depression SF, Sleep Disturbance SF, and Social Isolation SF. Scores from these questionnaires represented patient-reported outcomes (PROs), which are reports of a patient's health status directly from the patient. PROs were used to describe the study population because patients were recruited irrespective of the time of their heart failure diagnoses. Along with participants' demographics, MLHFQ scores were of particular interest as they represented heart failure patients' health-related quality of life (HRQOL), which is a factor that might influence their interests in features of a smartphone app.

Scoring

The 21-item MLHFQ is among the most widely used patient-oriented measurements of HRQOL [22]. It accounted for 3 ways heart failure affected the participants: physical, emotional, and socioeconomic. Although there is no scale for the socioeconomic score, physical (0-40) and emotional (0-25) scores were calculated by summation of corresponding responses. Lower scores signified better HRQOL, whereas higher scores signified worse HRQOL in regard to physical and emotional well-being [22]. A total score was also generated by addition of all 21 responses, resulting in a possible range of 0 to 105. Scores were classified as good (<24), moderate (24-45), and poor (>45) HRQOL [22].

SCHFI is a 22-item questionnaire that assesses the patient's ability to care for their heart failure via 3 subscales: maintenance, management, and confidence [23]. For each subscale, the raw score was calculated by summation of corresponding responses. Raw scores were then standardized to a 0 to 100 range, with higher scores indicating better self-care. Management scores were calculated only if heart failure patients acknowledged having trouble breathing or ankle swelling within the past month of taking this survey. For all sections of the SCHFI, scores ≥70 proposed adequate self-care [23].

The SAQ-7 and KCCQ-12 also assessed the HRQOL of patients with respect to angina and heart failure, respectively [24,25]. Scores for both questionnaires were calculated by summation of all 7 and 12 responses, respectively, and by standardization of those values to a 0 to 100 range. Scores were classified as poor (0-24), fair (25-49), good (50-74), and excellent (75-100) HRQOL [24,25].

PROMIS questionnaires are publicly available individual-centered measures of PROs [26,27]. The aforementioned physical and mental health questionnaires were administered to heart failure patients to assess their function and symptoms. Raw scores were computed by addition of all corresponding responses and conversion of those values to *t* scores, which were standardized scores set to a mean of 50 and a standard deviation of 10 [26,27]. Function scores ≥40 were normal, whereas scores <40 denoted moderate to severe adverse health effects. Symptom scores ≤60 were normal, whereas scores >60 represented moderate to severe adverse health effects [26,27].

Statistical Analysis

Before calculating raw scores, questionnaires were examined for completion. For any missing items, the mean of the participant's responses from the same questionnaire was substituted [28]. The cohort was characterized using proportions, means, SDs, medians, and interquartile ranges (IQRs). Summaries of responses and scores, if applicable, for each questionnaire were reported. Linear regression analyses, including multivariate regression analysis, were performed with the participants' age and MLHFQ scores as the independent variables to quantify the linear relationships with their interest in smartphone app features. For all analyses, a significance level of .05, which corresponded to a 95% CI, was used to determine statistical significance.

Results

Demographics

Over the 7-month period, a total of 95 eligible heart failure patients were contacted. Of the 95 qualified patients, 50 consented to participate in this study (Table 1). However, 1 participant only completed the demographics section of the survey.

The participants' mean age was 64.5 years (SD 8.3; range 50-78). Most participants were men (34/50, 68%), of non-Hispanic or non-Spanish origin (40/49, 82%), and white (32/48, 67%). Of the participants, 38% (19/50) had received a bachelor's degree or higher, whereas for 18% (9/50), a high school degree was their highest level of education. As for annual household income, the proportions of individuals whose families earned less than US $50,000 (23/50, 46%) and more than US $50,000 (27/50 54%) were fairly similar. Although 91% (31/45) of the participants were determined to be NYHA Class II or higher, 62% (31/50) had EFs less than 50%. Neither NYHA class nor EF produced statistically significant associations with their interests in potential features of a smartphone app.

Table 1. Demographics of study population.

Characteristic	Value
Age (years; n=50), mean (SD)	64.5 (8.3)
Sex (n=50), n (%)	
Male	34 (68)
Female	16 (32)
Hispanic or Spanish origin (n=49), n (%)	
No	40 (82)
Yes	9 (18)
Race or ethnicity (n=48), n (%)	
White	32 (67)
Black or African American	11 (23)
Asian	5 (10)
American Indian or American Native	0 (0)
Native Hawaiian or other Pacific Islander	0 (0)
Education (n=50), n (%)	
High school	9 (18)
Some college, associate degree, or trade school	22 (44)
Bachelor’s degree	10 (20)
Master’s degree or above	9 (18)
Annual income (US $; n=50), n (%)	
0-25,000	15 (30)
25,001-50,000	8 (16)
50,001-75,000	8 (16)
≥75,001	19 (38)
New York Heart Association class (n=45), n (%)	
I	4 (9)
II	26 (58)
III	15 (33)
IV	0 (0)
Ejection fraction (n=50), n (%)	
≤40%	28 (56)
41%-49%	3 (6)
≥50%	19 (38)

App Interest

More than 60% of the participants were somewhat interested or very interested in a smartphone app that provides information related to symptoms (identification 31/48, 65%, and tips 35/48, 73%), medication or treatment (side effects 33/48, 69%), activity (steps 33/48, 69%, and exercise 31/48, 65%), and sleep (patterns 32/46, 67%, and tips 31/47, 66%; Table 2). On the other hand, more than a quarter of the participants expressed little to no interest in documenting their mood (17/48, 35%) or receiving tips to improve their mood (14/48, 29%). Moreover, 30 participants answered somewhat interested or very interested for both symptom-related statements (Multimedia Appendix 2). Of those 30 participants, 28 (28/30, 93%) owned a smartphone and 10 (10/30, 33%) owned an activity tracker or a smartwatch. Of the 28 participants who expressed interest (somewhat interested or very interested) in both activity-related statements, 26 (26/28, 93%) owned a smartphone and 11 (11/28, 39%) owned an activity tracker or a smartwatch. There were 27 participants who showed interest in both items regarding sleep. Of these, 24 (24/27, 89%) owned a smartphone and 11 (11/27, 41%) owned an activity tracker or a smartwatch.

Table 2. Patients' answers to the Heart Failure Self-Care Management Application Interest questionnaire.

Statement	n	No interest, n (%)	Not very interested, n (%)	Neutral, n (%)	Somewhat interested, n (%)	Very interested, n (%)
Symptom identification, such as noticing swelling in your ankles or legs	48	7 (15)	2 (4)	8 (17)	11 (23)	20 (42)
Providing symptom management tips	48	7 (15)	1 (2)	5 (10)	13 (27)	22 (46)
Providing medication reminders	48	9 (19)	4 (8)	9 (19)	9 (19)	17 (35)
Documenting when you experience side effects from medication or treatment	48	5 (10)	2 (4)	8 (17)	10 (21)	23 (48)
Documenting your level of activity or number of steps	48	6 (13)	4 (8)	5 (10)	9 (19)	24 (50)
Providing reminders to exercise	48	7 (15)	2 (4)	8 (17)	10 (21)	21 (44)
Documenting your sleep patterns	46	5 (11)	3 (7)	6 (13)	10 (22)	22 (48)
Providing tips to get better sleep	47	6 (13)	4 (9)	6 (13)	6 (13)	25 (53)
Documenting your mood	48	9 (19)	8 (17)	8 (17)	7 (15)	16 (33)
Providing tips to improve your mood	48	9 (19)	5 (10)	10 (21)	8 (17)	16 (33)

Reminders

Between 80% and 90% of the participants indicated their desire to receive reminders at least once per day for all but medication reminders, which was 71% (34/48; Table 3). Once a day was the most popular response for the other 5 features. The proportion exceeded 50% for symptom management tips (27/49, 55%), activity or steps (25/49, 51%), exercise reminders (27/49, 55%), and sleep tips (29/49, 59%).

Access to Technology

The majority of participants had access to technology. Only 24 (24/49, 49%) participants owned a tablet, and 44 (44/49, 90%) participants owned a smartphone (Table 4). In addition, high proportions of participants had access to the internet through a cellular network (41/49, 84%) or a wireless network (43/49, 88%). Most participants also had experience using their smartphone (42/44 smartphone owners, 96%) and accessing the internet or their email account(s) (44/49, 90%). Fewer patients had activity trackers and smartwatches as only 14/49 (29%) participants owned one and 9/14 (64%) participants used it regularly. Ownership of an activity tracker or smartwatch was not related to income, as half of them earned a household income that surpassed US $75,001 annually.

Table 3. Patients' answers to Heart Failure Self-Care Management Application Engagement questionnaire.

Statement	n	Never, n (%)	Once a day, n (%)	Every 12 hours, n (%)	Every 6 hours, n (%)	Every 4 hours, n (%)	Every 2 hours, n (%)
Notify you of symptoms	49	9 (18)	20 (41)	8 (16)	3 (6)	4 (8)	5 (10)
Provide you with symptom management tips	49	6 (12)	27 (55)	9 (18)	1 (2)	3 (6)	3 (6)
Provide you with medication reminders	48	14 (29)	12 (25)	9 (19)	4 (8)	3 (6)	6 (12)
Provide you with your level of activity/number of steps	49	5 (10)	25 (51)	3 (6)	4 (8)	6 (12)	6 (12)
Provide you with exercise reminders	49	5 (10)	27 (55)	5 (10)	3 (6)	5 (10)	4 (8)
Provide you with sleep tips	49	8 (16)	29 (59)	6 (12)	2 (4)	0 (0)	4 (8)

Table 4. Patient answers to Health Information Nation Trends Survey.

Question	n	No, n (%)	Yes, n (%)
Do you ever access the internet or World Wide Web or send and receive email?	49	5 (10)	44 (90)
When you use the internet, do you ever access it through a regular dial-up telephone line?	49	48 (98)	1 (2)
When you use the internet, do you ever access it through broadband such as digital subscriber line, cable, or fiber optic service?	49	15 (31)	34 (69)
When you use the internet, do you ever access it through a cellular network (ie, phone and third- or fourth-generation cellular network technology)?	49	8 (16)	41 (84)
When you use the internet, do you ever access it through a wireless network (wireless fidelity)?	49	6 (12)	43 (88)
Do you own a tablet?	49	25 (51)	24 (49)
Do you own a smartphone?	49	5 (10)	44 (90)
If so, do you use your smartphone at least once daily?	43	1 (2)	42 (97)
Do you own a cell phone? (skip if yes answer to smartphone)	5	1 (20)	4 (80)
If so, are you comfortable using the cell phone?	4	1 (25)	3 (75)
Do you own an activity tracker/smartwatch?	49	35 (71)	14 (29)
If so, do you wear it daily?	14	5 (36)	9 (64)

Patient-Reported Outcomes

The median MLHFQ score was 52 (IQR 24-75; Table 5), which corresponded to a poor HRQOL for the average participant. On the other hand, SAQ (median 68, IQR 55-84) and KCCQ (median 61, IQR 47-80) median scores suggested a good HRQOL in relation to angina and heart failure, respectively. The median SCHFI maintenance (median 70, IQR 60-81) and SCHFI confidence (median 72, IQR 50-83) scores revealed adequate ability to perform maintenance behaviors and adequate confidence level for the average participant. Of the 49 participants, 28 (57%) indicated recent breathing complication or ankle swelling (Table 5), which qualified them to complete the management section of the SCHFI questionnaire. Similar to the other section scores, the median SCHFI management score (median 70, IQR 50-85) indicated adequate ability to manage heart failure. Median scores for all PROMIS questionnaires were within the normal range, except for Physical Function SF (median 38, IQR 34-43), which denoted moderate adverse health implications.

In the Heart Failure Self-Care Management Application Interest questionnaire, 67% (32/48) said they were interested in tracking, whereas 65% (31/48) said they were interested in tips and 73% (35/48) said they were interested in reminders (Table 2). Age correlated significantly with interest in each of the 3 features of the smartphone app (*P*=.001, *P*=.002, and *P*=.001, respectively). In contrast to age, MLHFQ scores (Table 5) generated positive correlations with their interests. These correlations were also statistically significant (*P*=.003, *P*<.001, and *P*=.004, respectively). Similarly, when multivariate regression analyses were performed with age and MLHFQ scores, they generated negative coefficients for age and positive coefficients for MLHFQ scores. Moreover, both identifiers achieved statistically significant results with tracking (*P*=.007 and .02, respectively), tips (*P*=.01 and .002, respectively), and reminders (*P*=.007 and .02, respectively).

No relationship between age and frequency of the 6 different reminders (Table 3) was statistically significant: symptoms, symptom management tips, medication reminders, activity/steps, exercise reminders, and sleep tips (*P*=.09, *P*=.26, *P*=.09, *P*=.09, *P*=.13, and *P*=.40, respectively).

Table 5. Patient-reported outcomes.

Questionnaire	n	Median score (IQR)
Minnesota Living with Heart Failure Questionnaire		
Physical score	49	19 (12-32)
Emotional score	48	10 (2-20)
Total score	49	52 (24-75)
Self-Care of Heart Failure Index		
Maintenance	49	70 (60-81)
Management	28	70 (50-85)
Confidence	49	72 (50-83)
Seattle Angina Questionnaire	49	68 (55-84)
Kansas City Cardiomyopathy Questionnaire	49	61 (47-80)
PROMIS[a] Global Health		
Physical	49	42 (35-51)
Mental	49	48 (44-51)
PROMIS Physical Function	49	38 (34-43)
PROMIS Fatigue	49	57 (46-63)
PROMIS Anxiety	49	54 (39-61)
PROMIS Depression	49	52 (41-61)
PROMIS Sleep Disturbance	49	52 (46-60)
PROMIS Social Isolation	49	40 (35-50)

[a] PROMIS: Patient-Reported Outcomes Measurement Information System.

Discussion

Principal Findings

The results indicate that 38 out of 48 survey participants (79%) were interested in at least one of the following features of a smartphone app to assist their heart failure management: symptoms, medication or treatment side effects, activity/steps, and sleep. Consequently, this study suggests the prospect of heart failure patients utilizing a smartphone app to self-monitor their condition while also receiving tips and reminders related to heart failure. Access to and experience with technology should not pose major concerns to its potential, as 43 out of 49 participants (88%) owned a smartphone and had access to the internet.

MLHFQ score and age were 2 factors that correlated the participants' degree of interest. Their responses to questions in this survey and subsequent scores imply that many experienced adverse health outcomes because of their heart failure. The statistically significant positive correlations between their MLHFQ score and interest in tracking, tips, and reminders show that heart failure patients with lower HRQOL express greater interest in a smartphone app for heart failure than those with higher HRQOL. As the MLHFQ is reliable and sensitive to differences in symptom severity [29], heart failure patients with lower MLHFQ scores are likely more prominently afflicted by heart failure. Therefore, their interest in receiving heart failure—related information and reminders may suggest a greater likelihood of utilizing it as an individual-tailored intervention.

Analysis of age was a key aspect of this study because both prevalence and incidence of heart failure increase with age [6,7]. Accordingly, older heart failure patients are the primary target population for any intervention. In contrast to the increase of their interests with MLHFQ score, heart failure patients' interest significantly decreased with age. This result is consistent with and can be explained by previous studies that examined adults' technology usage and attitudes. In those studies, older adults acknowledged the benefits of technological advances but expressed several issues with technology, such as lack of security and reliability as well as inconvenience [30,31]. In addition, they identified low self-efficacy, high anxiety, and increased efforts as reasons for their reluctance to adopt technology [32,33]. As a result, their unfavorable outlook on technology poses a challenge to the prospect of implementing the smartphone app as an intervention. Providing incentives or alternatives, however, could address this challenge for those who may not be interested in mHealth apps.

Questionnaire scores from this survey revealed unexpected results. Both the MLHFQ and KCCQ were intended to quantify patients' HRQOL with respect to their heart failure but revealed contrasting results with statistical significance (P<.001). The MLHFQ generated a median score that corresponded to poor HRQOL, whereas the KCCQ produced a median score that suggested good HRQOL. This discrepancy may be because of the fact that questions in the KCCQ examined a much shorter time frame (2 weeks) than those in the MLHFQ (4 weeks). Furthermore, the KCCQ is primarily concerned with 2 symptoms of heart failure, shortness of breath and fatigue, whereas the MLHFQ is more general. The scores from questionnaires regarding behavior and function produced mixed results, whereas all those regarding symptoms generated scores that fell within the normal range (Table 5). This outcome suggests that the mental health conditions of the participants were in favorable states despite their adverse health effects from heart failure. This finding appears to not align with a previous study that found heart failure patients have higher levels of anxiety than healthy adults, which leads to decreased treatment adherence [34]. The normal mental health of the participants may have influenced their interests in the smartphone app as a self-care strategy.

Limitations and Future Directions

This study was confined to patients from a university-based health system and was limited to those aged between 50 and 80 years. The study population was relatively well educated, which might limit the generalization of our results, although we note that we did not observe any statistically significant correlations across the observed education levels with other variables. There was greater representation of male (34/50, 68%) and white (32/48, 67%) patients in the study cohort (Table 1), which might have generated results that are not applicable to the general population with heart failure. A reason for the disproportionate representation is that this study was limited to English language speakers. Literacy in English was necessary to understand the directions and questions because there was only an English version of the survey. Future study will include translation of this survey into other languages, particularly Spanish. In regard to the results, the statistically significant correlations do not indicate causation. Self-reporting of interest in mHealth may not translate to actual use, adherence, or persistence. Prospective testing of mobile technology apps will be needed along with evaluation of their effectiveness, safety, and value.

Conclusions

This study provides new information on the features that heart failure patients want from a smartphone app to assist them in managing their health. To better contextualize the desired information and features, we sought to correlate survey responses, disease state, and demographics. On the basis of our results, we propose that a smartphone app may be a viable minimally invasive alternative intervention for monitoring heart failure patients because of the generally positive reception, although we note that data in this study were collected from a single site. Participants were interested in all 3 features of the proposed smartphone app—tracking, tips, and reminders. As these are common features of activity trackers and smartwatches, they, along with a smartphone app, may be potential solutions for heart failure patients' self-care needs. Age and MLHFQ scores may be useful predictors in determining whether an heart failure patient is interested in a smartphone app for self-care. These findings suggest that certain populations may be more inclined to utilize mobile technology to manage their treatment and symptoms. We suggest that future mHealth-driven interventions that feature a smartphone app consider first soliciting feedback from their targeted population to better understand patient perspectives on how such technology can be designed to maximize impact. We suggest that this study is a step in this direction.

Acknowledgments

This study was supported by the National Institutes of Health National Heart, Lung, and Blood Institute under grants R56HL135425 and R01HL141773.

Conflicts of Interest

FG consults for Abbott, Amgen, Bayer, Janssen, Medtronic, and Novartis.

Multimedia Appendix 1
Questions in mobile health survey.
[DOCX File , 18 KB - cardio_v3i1e14332_app1.docx]

Multimedia Appendix 2
Ownership of mobile technology among participants interested in mobile health features.
[DOCX File , 52 KB - cardio_v3i1e14332_app2.docx]

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Abbreviations

EF: ejection fraction
HRQOL: health-related quality of life
IQR: interquartile range
KCCQ: Kansas City Cardiomyopathy Questionnaire
mHealth: mobile health
MLHFQ: Minnesota Living with Heart Failure Questionnaire
NYHA: New York Heart Association
PRO: patient-reported outcome
PROMIS: Patient-Reported Outcomes Measurement Information System
SAQ: Seattle Angina Questionnaire
SCHFI: Self-Care of Heart Failure Index
SF: short form

Edited by G Eysenbach; submitted 18.04.19; peer-reviewed by A Miranda, A Gomez-Rexrode, E Muse; comments to author 06.06.19; revised version received 15.07.19; accepted 19.07.19; published 29.10.19.

Please cite as:
Sohn A, Speier W, Lan E, Aoki K, Fonarow G, Ong M, Arnold C
Assessment of Heart Failure Patients' Interest in Mobile Health Apps for Self-Care: Survey Study
JMIR Cardio 2019;3(2):e14332
URL: https://cardio.jmir.org/2019/2/e14332
doi:10.2196/14332
PMID:31758788

Original Paper

Outsourcing the Remote Management of Cardiac Implantable Electronic Devices: Medical Care Quality Improvement Project

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Abstract

Background: Remote management is partially replacing routine follow-up in patients implanted with cardiac implantable electronic devices (CIEDs). Although it reduces clinical staff time compared with standard in-office follow-up, a new definition of roles and responsibilities may be needed to review remote transmissions in an effective, efficient, and timely manner. Whether remote triage may be outsourced to an external remote monitoring center (ERMC) is still unclear.

Objective: The aim of this health care quality improvement project was to evaluate the feasibility of outsourcing remote triage to an ERMC to improve patient care and health care resource utilization.

Methods: Patients (N=153) with implanted CIEDs were followed up for 8 months. An ERMC composed of nurses and physicians reviewed remote transmissions daily following a specific remote monitoring (RM) protocol. A 6-month benchmarking phase where patients' transmissions were managed directly by hospital staff was evaluated as a term of comparison.

Results: A total of 654 transmissions were recorded in the RM system and managed by the ERMC team within 2 working days, showing a significant time reduction compared with standard RM management (100% vs 11%, respectively, within 2 days; *P*<.001). A total of 84.3% (551/654) of the transmissions did not include a prioritized event and did not require escalation to the hospital clinician. High priority was assigned to 2.3% (15/654) of transmissions, which were communicated to the hospital team by email within 1 working day. Nonurgent device status events occurred in 88 cases and were communicated to the hospital within 2 working days. Of these, 11% (10/88) were followed by a hospitalization.

Conclusions: The outsourcing of RM management to an ERMC safely provides efficacy and efficiency gains in patients' care compared with a standard in-hospital management. Moreover, the externalization of RM management could be a key tool for saving dedicated staff and facility time with possible positive economic impact.

Trial Registration: ClinicalTrials.gov NCT01007474; http://clinicaltrials.gov/ct2/show/NCT01007474

(JMIR Cardio 2019;3(2):e9815) doi:10.2196/cardio.9815

KEYWORDS

remote monitoring; telemonitoring; cardiac implantable electronic devices; implantable defibrillators; pacemaker; implantable cardioverter defibrillator; triage outsourcing; follow-up

Introduction

Remote monitoring (RM) management of patients implanted with cardiac implantable electronic devices (CIEDs) (such as implantable defibrillators) enables early detection of clinically relevant events and complications while partially replacing routine follow-up [1-5]. A number of studies have recently demonstrated that RM reduces the total number of in-office visits [4,6], without negative effects on patient outcome [7,8]; some studies have also shown the positive clinical impact of RM [9-12]. Although RM can reduce clinical staff time compared with standard in-office follow-up [13-15], organizational workflow changes and a new definition of roles and responsibilities may be needed to review remote transmissions in an effective, efficient, and timely manner [16]. A model where nurses might have the responsibility for screening the transmission reports and for discriminating the ones that possibly require clinical escalation and where physicians interpret and document the most critical remote reports, may, in fact, rationalize and optimize the in-clinic daily practice, in the sense of a more extensive and differentiated role organization. Considering that most RM data do not require any clinical escalation [1,14], it has been hypothesized that the remote triage may be outsourced to an external remote monitoring center (ERMC) composed of nurses and physicians skilled to interpret CIED data and to troubleshoot CIED-related problems, resulting in the optimization of the time allocation of highly skilled health care professionals [17].

Efficient allocation of health care professionals' time is crucial due to the limited resources available for RM activities today and prospectively in the future, given the patient population growth and accompanying follow-up burden [18]. Outsourcing part of the RM activities could, therefore, have a positive impact on both the health care system and patient care [19].

The aim of this quality improvement project is to evaluate the feasibility of outsourcing the triage of CIED remote follow-up in the management of relevant clinical and technical events in a timely manner. We would like to assess if this approach is safe, effective, and efficient and to evaluate the implications in hospital resource utilization. Our purpose, in other words, is to demonstrate that the proposed triage model consents prompt event management, completeness of remote transmission review, and ability in detecting and prioritizing events (efficacy and safety) and that it might imply a reduction in the use of hospital resources required for daily remote CIED management (efficiency).

Methods

Project Design and Patient Population

From April 2016 to December 2016, an ERMC composed of 1 trained nurse and 1 supporting physician (HTN Spa, Brescia, Italy) performed daily reviews of remote transmissions from 153 CIED patients implanted in the hospital, S Raffaele Giglio Hospital of Cefalù (Italy): 62 single- or dual-chamber pacemakers (IPGs), 15 single- or dual-chamber implantable cardioverter defibrillators (ICDs), and 76 cardiac resynchronization therapy defibrillators (CRT-Ds). The presented experience is included in the validation effort of Medtronic FOCUSON, a service aiming to save time for health care professionals to enable a higher quality of care. The FOCUSON service is built around a highly skilled team that classifies transmitted patient data based on agreed protocol and promptly notifies the physician, allowing efficient and effective patient treatment.

All consecutive patients enrolled in the CareLink network (CLN) in the considered time frame were considered for this analysis. CLN is an internet-based service that provides device-related and physiologic patient data similar to data that formerly required an office visit, together with training and support services. The key component of the CLN is the CareLink monitor, an in-home monitor for patients who have received a Medtronic implanted cardiac device. All patients were included in the ClinicalService project (ClinicalTrials.gov, NCT01007474). This medical care quality improvement project was approved by the medical director and conforms to the principles outlined in the Declaration of Helsinki. Each patient provided informed consent for data collection and analysis. The activity is based on a well-defined legal framework, where the parts agree on responsibility, safety requirements, data ownership, data managing, and compliance and compare current remote management models.

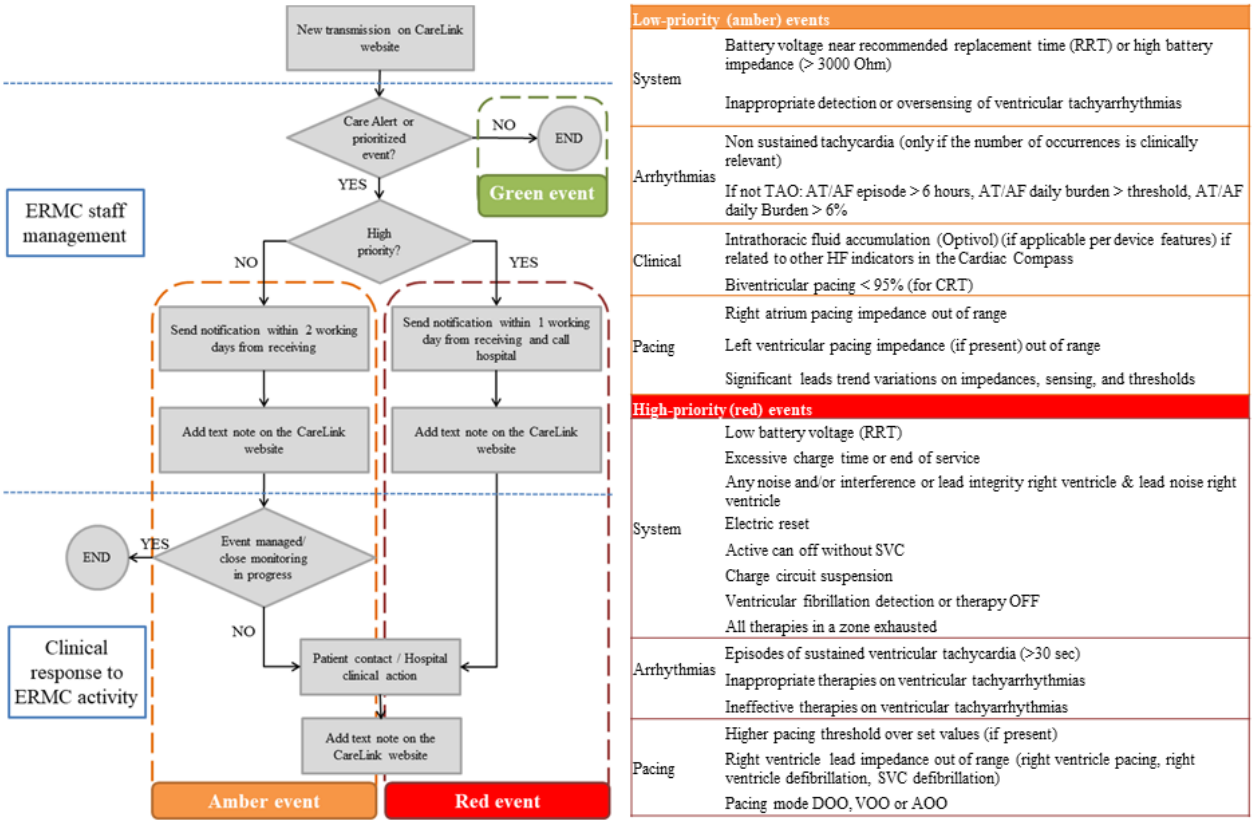
As standard practice before outsourcing, there were 3 physicians performing electrophysiology and ambulatory activities. No nurse was dedicated to the ambulatory service, so RM relied on physicians only. All staff were well trained to manage RM activities, even in the absence of a prespecified shared protocol. Despite RM being considered as an important part of clinical practice, remote follow-up was often carried out in the middle of other activities in free time slots. Patients usually transmitted data 3 times per year, with a specific date scheduled by the physician during the annual in-office visit. These routine, scheduled, remote device interrogations were structured to mirror in-office device checks. Prespecified alerts related to device functionality and clinical events (called CareAlerts) were activated and were able to trigger automatic transmissions, for the purpose of emergency clinical and technical RM of patients implanted with a device with wireless capabilities, but without any check planned for lost transmissions or disconnected monitors.

The New Remote Management Model

External Remote Monitoring Center Staff Management

The patients included in the service were enrolled by the health care provider in CLN, and details from the patient file as well as their identification numbers were recorded. This anonymous patient identification number was used in all formal communications between ERMC and the health care providers. Patients' clinical history (eg, implant indication, cardiomyopathy etiology, and atrial fibrillation history) and relevant information (eg, pacemaker dependency, drug therapy with a special attention to oral anticoagulation therapy, and implanted device and leads details) were available for the monitoring center through the *Comments and Notes* field of the CareLink website. Periodic transmissions were scheduled every 3 months or per individual patient needs (eg, to monitor the evolution of a clinical event or to evaluate the battery status in the presence of battery voltage near recommended replacement time). A shared protocol of transmissions review and reporting was defined in agreement with our hospital staff and the ERMC nurse, and the supporting physicians were accurately trained on its application. A daily check to the CareLink website was mandatory (with exclusion of weekends and bank holidays). The protocol required that all transmissions had to be reviewed by ERMC within 1 working day from when they appear on the CareLink website. A flowchart describing timings, roles, and responsibilities was agreed between the hospital physicians and the ERMC staff (Figure 1).

Figure 1. Remote management flowchart. Green events are all transmissions not reporting device detections listed as low or high priority. In case of missed scheduled transmissions or disconnected monitors, the external remote monitoring center (ERMC) inform the technical team responsible for contacting the patient. RRT: recommended replacement time; TAO: oral anticoagulation therapy; AT/AF: atrial tachyarrhythmia/atrial fibrillation; CRT: cardiac resynchronization therapy; SVC: superior vena cava. DOO, VOO, and AOO are programming modes.



Low-priority (amber) events	
System	Battery voltage near recommended replacement time (RRT) or high battery impedance (> 3000 Ohm) Inappropriate detection or oversensing of ventricular tachyarrhythmias
Arrhythmias	Non sustained tachycardia (only if the number of occurrences is clinically relevant) If not TAO: AT/AF episode > 6 hours, AT/AF daily burden > threshold, AT/AF daily Burden > 6%
Clinical	Intrathoracic fluid accumulation (Optivol) (if applicable per device features) if related to other HF indicators in the Cardiac Compass Biventricular pacing < 95% (for CRT)
Pacing	Right atrium pacing impedance out of range Left ventricular pacing impedance (if present) out of range Significant leads trend variations on impedances, sensing, and thresholds
High-priority (red) events	
System	Low battery voltage (RRT) Excessive charge time or end of service Any noise and/or interference or lead integrity right ventricle & lead noise right ventricle Electric reset Active can off without SVC Charge circuit suspension Ventricular fibrillation detection or therapy OFF All therapies in a zone exhausted
Arrhythmias	Episodes of sustained ventricular tachycardia (>30 sec) Inappropriate therapies on ventricular tachyarrhythmias Ineffective therapies on ventricular tachyarrhythmias
Pacing	Higher pacing threshold over set values (if present) Right ventricle lead impedance out of range (right ventricle pacing, right ventricle defibrillation, SVC defibrillation) Pacing mode DOO, VOO or AOO

With the aim of effectively reviewing transmissions and managing all possible clinically and technically relevant events, a transmission color-code classification was predefined by the hospital physicians to prioritize device clinical and technical conditions. The different types of relevant events related to each color code are represented in Figure 1. Depending on the priority level assigned to the transmission, the flowchart indicated the maximum time to report the permitted and required modality of communication to the hospital. In particular, in case of high-priority events (red transmissions), the hospital was to be informed by email and phone within 1 working day, whereas for low-priority events (amber transmissions), the protocol planned an email communication within 2 working days. No action was required when the transmission did not contain any prioritized event (green transmissions). When transmissions contained data fulfilling more than 1 color code, the transmissions were managed by using the highest priority color code. In case of an actionable transmission (red or amber), a note was added to the related transmission on the CareLink website. Using this method, both the ERMC nurses and physicians and the hospital staff had the same Web-based clinical repository available at patient level. In case of missed scheduled transmissions or disconnected monitors, the ERMC was instructed to inform the technical team responsible for contacting the patient.

Clinical Response to External Remote Monitoring Center Activity

On the basis of the received RM data, the clinical response was at the discretion of the involved clinicians. When the patient had to be contacted, a standardized telephone interview was conducted by the medical staff to evaluate the patient's health condition (worsened dyspnea, increased weight, patient's compliance with the medical therapy, etc). In addition to the interview details, the hospital staff reported all follow-up clinical actions on the CareLink website. In some cases, prioritized events would not require any action, for example, in case of an event already managed with the appropriate therapy (eg, atrial arrhythmias with optimized drug therapy, intrathoracic fluid accumulation, and other events previously known to the staff), or for which clinicians would rather wait to monitor the status of the event.

Research Objectives and Outcome Measures, Efficacy, and Safety

The aim of this health care quality improvement project was to assess if outsourcing the triage of CIEDs' remote follow-up is safe, effective, and efficient to manage relevant clinical and technical events in a timely manner and improve hospital resource utilization. Time to review all transmissions and time to report prioritized events, according to the protocol flowchart, were considered as end points for efficacy and safety.

Efficiency: Comparison With the Benchmark Phase

Efficiency was defined as the ability to improve transmission review and event analysis with reduced hospital resources and was evaluated, in the same recipient of patients, through the comparison with the standard practice of the same hospital in the 6 months preceding the project.

Statistical Analysis

Continuous data were summarized as mean and SD or median and the first and the third quartiles (Q1-Q3), categorical data as counts and percentages. Differences in proportions were compared by applying chi-square analysis. Continuous Gaussian variables were compared by the Student *t* test for independent samples, whereas skewed distributions were compared using the Mann-Whitney nonparametric test. To represent the time distributions, box-and-whiskers plots were used. The transmission rates and their 95% CIs were reported. For the scope of the timing analysis, 45 out of 654 (6.9%) transmissions were excluded, as they occurred outside the review time defined in the protocol. The comparison of the number of transmissions reviewed by ERMC in the monitoring center phase with respect to the benchmark phase was performed by means of a Poisson model. Comparison was performed on the subset of patients included in both the monitoring center and standard practice phases (no differences between those patients and the full population were found). The incidence rate ratio (IRR) was reported together with its 95% CI. Missing data were not inputted into any of the analysis. The rate of transmissions, the detected event, as well as time to review all transmissions and time to report prioritized events were retrospectively retrieved from the CLN database for both the ERMC and benchmark phases. All results will be reported for the whole population and separately by device type, as RM protocol may vary according to patients' treatment indication and to the implanted device.

An alpha level of .05 was considered for each test. All statistical analyses were performed using SAS 9.4 version software (SAS Institute Inc, Cary, NC, USA).

Results

Patients

A total of 153 patients with an implanted CIED were included in the project and followed remotely on the CareLink RM network (Medtronic, Minneapolis, MN) for 8.4 (SD 1.1) months, with a total follow-up period of 107 years.

Demographics and baseline patient characteristics are presented in Table 1. Mean age of inclusion was 68 (SD 11) years, with 73.2% (112/153) male patients. Considering device type, 49.7% (76/153) of patients had a CRT-D implanted, whereas 9.8% (15/153) were implanted with single- or dual-chamber ICDs and 40.5% (62/153) with an IPG (of which only 1 was a CRT-P [cardiac resynchronization therapy pacemaker]).

Efficacy and Safety

Transmission Management

From April 2016 to December 2016, 654 transmissions were recorded and reviewed by ERMC corresponding to 613 (95% CI 568-662) transmissions for 100 patient-years. In particular, CRT-D devices transmitted more than the other CIEDs, with 802 (95% CI 729-882) transmissions per 100 patient-years. Transmissions with prioritized events represented 15.7% of the total transmissions, with 82.5 (95% CI: 66.9-102) amber transmissions and 14.1 (95% CI 8.5-23.3) red transmissions per 100 patient-years (Table 2).

Table 1. Demographics and baseline patient characteristics.

Patient characteristics	Total (N=153)	CRT-D[a] (N=76)	ICD[b] (N=15)	IPG+CRT-P[c] (N=62)
Demographics				
Age at first implant (years), mean (SD)	68 (11)	69 (9)	64 (13)	68 (13)
Male, n (%)	112 (73.2)	55 (72)	15 (100)	42 (68)
Medical history , n (%)				
Ischemic cardiopathy	56 (37)	31 (41)	11 (73)	14 (23)
Acute myocardial infarction	35 (23)	28 (37)	7 (47)	0 (0)
History of heart failure	107 (70.0)	67 (88)	5 (27)	35 (56)
New York Heart Association III-IV	54 (35)	56 (74)	2 (13)	0 (0)
History of ventricular tachycardia/ventricular fibrillation	36 (24)	27 (36)	5 (33)	4 (7)
Ventricular fibrillation/flutter	2 (1)	2 (3)	0 (0)	0 (0)
History of atrial tachycardia/atrial fibrillation	72 (47)	18 (24)	3 (20)	51 (82)
Left bundle branch block	54 (35)	46 (61)	0 (0)	8 (13)
History of stroke/transischemic attack	10 (7)	6 (8)	4 (27)	0 (0)
Diabetes	41 (27)	19 (25)	4 (27)	18 (29)
Medications at baseline[d], n (%)				
Beta-blocker	75 (61)	54 (75)	7 (64)	14 (34)
Diuretic	74 (60)	56 (78)	8 (73)	10 (24)
Antiplatelet	18 (15)	15 (21)	0 (0)	3 (7)
Oral anticoagulants	21 (17)	16 (22)	2 (18)	3 (7)
Amiodaron	4 (3)	4 (6)	0 (0)	0 (0)
Calcio-antagonist	6 (5)	3 (4)	0 (0)	3 (7)
Angiotensin-converting enzyme-inhibitor/angiotensin receptor blockers 2	51 (41)	39 (54)	5 (46)	7 (17)
Digitalis	1 (1)	1 (1)	0 (0)	0 (0)
Implantation time[e], n (%)				
Less than 12 months	29 (20)	26 (36)	2 (13)	1 (2)
12-36 months	59 (41)	43 (59)	7 (47)	9 (16)
More than 36 months	57 (39)	4 (6)	6 (40)	47 (83)

[a] CRT-D: cardiac resynchronization therapy defibrillator.

[b] ICD: single- or dual-chamber implantable cardioverter defibrillator.

[c] IPG + CRT-P: single- or dual-chamber pacemaker + cardiac resynchronization therapy pacemaker.

[d] 124 patients with data about medication at baseline, 72 CTR-Ds, 11 ICDs, and 41 IPGs.

[e] 145 patients with available date of implant, 73 CRT-Ds, 15 ICDs, and 57 IPGs.

Table 2. Rate of transmission, overall and by priority.

Transmission priority	All (n=153, 107 patient-years)	CRT-D[a] (n=76, 53 patient-years)	ICD[b] (n=15, 10 patient-years)	IPG[c] (n=61, 61 patient-years)	CRT-P[d] (n=1, 1 patient-year)
All transmission					
Transmissions, n	654	426	50	176	2
Annual rate of transmissions per 100 patient-years (95% CI)	613 (568-662)	802 (729-882)	504 (382-665)	410 (354-476)	—[e]
No prioritized event (green transmissions)					
Transmissions, n (%)	551 (84.3)	364 (85.4)	40 (80.0)	147 (83.5)	0 (0.0)
Patients with green transmission, n	141	67	14	60	0
Annual rate of transmissions per 100 patient-years (95% CI)	517 (475-561)	648 (585-718)	393 (288-536)	333 (283-391)	—
Low-priority events (amber transmissions)					
Transmissions, n (%)	88 (13.5)	53 (12.4)	9 (18.0)	24 (13.6)	2 (100)
Patients with amber transmission, n	50	28	4	17	1
Annual rate of transmissions per 100 patient-years (95% CI)	82.5 (66.9-102)	94.4 (72.1-124)	88.4 (46.0-170)	54.3 (36.4-81.1)	277 (69.2-1106)
High priority events (red transmissions)					
Transmissions, n (%)	15 (2.2)	9 (2.2)	1 (2.0)	5 (1.7)	0 (0.0)
Patients with red transmission, n	9	5	1	3	0
Annual rate of transmissions per 100 patient-years (95% CI)	14.1 (8.5-23.3)	16.0 (8.3-30.8)	9.8 (1.4-69.7)	11.3 (4.7-27.2)	—

[a] CRT-D: cardiac resynchronization therapy defibrillator.

[b] ICD: single- or dual-chamber implantable cardioverter defibrillator.

[c] IPG: single- or dual-chamber pacemaker.

[d] CRT-P: cardiac resynchronization therapy pacemaker.

[e] Not applicable.

Most of the amber transmissions reported arrhythmia events, whereas two-thirds of the red transmissions presented system issues (Figure 2). Almost all transmissions (99.7%) were reviewed within 1 working day and 86.7% within 24 hours, considering some transmissions occurred outside working hours, as defined in the protocol. Our analysis did not show any predictors of low- or high-priority transmissions, neither considering implanted device type (when compared with the others, IRR for CRT-D was 1.52 [95% CI 0.93-2.50; *P*=.095] and IRR for IPG+CRT-P was 0.63 [95% CI 0.37-1.05; *P*=.078]) nor considering other risk factors (all *P*>.1).

Prioritized Events Communication

Following the protocol, ERMC communicated all high-priority (red) transmissions to the hospital within 24 hours of transmission review, and 96.4% of the amber transmissions were reported within 48 hours. Overall, when we consider the additional time from transmission reception to transmission review and the time from review to communication, 91.7% of red transmissions were reported within 1 working day and 95.4% of amber transmissions within 2 working days (Figure 3).

Prioritized Events Management

Red transmissions required urgent visit or hospitalization in 60% (9/15) of the cases, whereas 92% (81/88) of amber events were managed totally remotely (Table 3). Most of the remotely managed events were related to an already treated arrhythmia or lung fluid impedance-related events.

Figure 2. (A) Distribution of transmission by priority; (B) low-priority detected events; and (C) high-priority detected events. CRT-D: cardiac resynchronization therapy defibrillator, ICD: single- or dual-chamber implantable cardioverter defibrillator, IPG: single- or dual-chamber pacemaker, CRT-P: cardiac resynchronization therapy pacemaker.

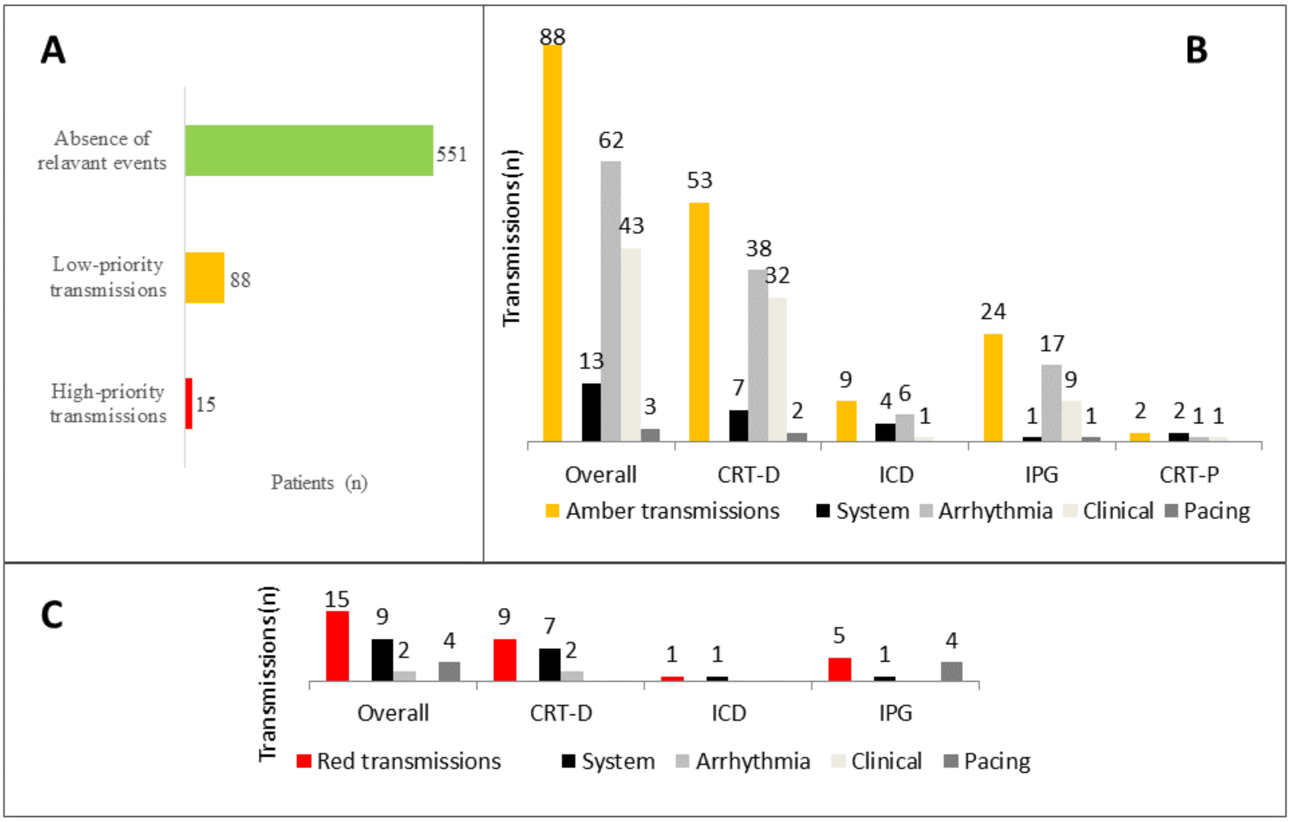


Figure 3. Time from transmission to communication with the hospital.

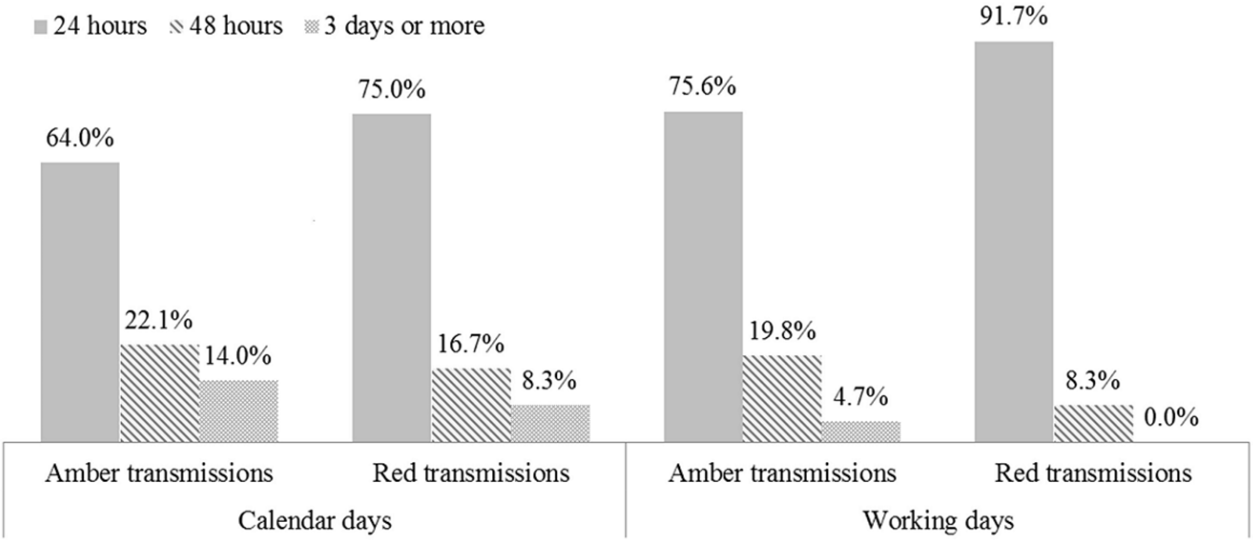


Table 3. Clinical response to reported events.

Clinical response	Total (N=103), n (%)	Amber (n=88), n (%)	Red (n=15), n (%)
Heath care utilization required	16 (15.5)	7 (8.0)	9 (60.0)
Hospitalization for device replacement	7 (6.8)	4 (4.5)	3 (20.0)
Hospitalization for lead revision	2 (1.9)	—[a]	2 (13.3)
Hospitalization for cardiovascular reasons	1 (1.0)	—	1 (6.7)
In-office visit required	6 (5.8)	3 (3.4)	3 (20.0)
Event resolved remotely	87 (84.5)	81 (92.0)	6 (40.0)
New transmission required	17 (16.5)	11 (12.5)	6 (40.0)
Not urgent action[b]	70 (68.0)	70 (79.5)	—

[a] Not applicable.

[b] Event previously managed, monitoring the status of the event. The proportions are calculated on the total number of reported events (103, 88 amber, and 15 red).

Efficiency: Comparison With the Benchmark Phase

Among the 153 patients followed by ERMC, 126 were remotely managed in the hospital from June 2015 to December 2015. In the ERMC phase, the median time to review was significantly reduced from 11 days (Q1-Q3: 4-25 days) to less than 24 hours (Q1-Q3: 0-1 day; Figure 4). During the standard follow-up phase, 21% of the transmissions had not been reviewed after 1 month, whereas during the monitoring center phase, all the transmissions were reviewed within 2 working days (Figure 4).

During the ERMC phase, patients were more compliant to the remote transmissions schedule than in the benchmarking phase, and the total number of annual transmissions per 100 patients increased from 350 to 608, respectively (*P*<.001). Nevertheless, only 78 (21.2%) transmissions required escalation to hospital staff, thus reducing the number of transmissions to review by 75% (IRR 0.25; 95% CI 0.66-0.81; *P*<.001). All data, separated by device type, are reported in Table 4.

Figure 4. (A) Distribution of time from transmission to review, benchmarking phase versus external remote monitoring center (ERMC) phase; and (B) Percentage of reviewed transmissions, benchmarking phase versus ERMC phase. RM: remote monitoring.

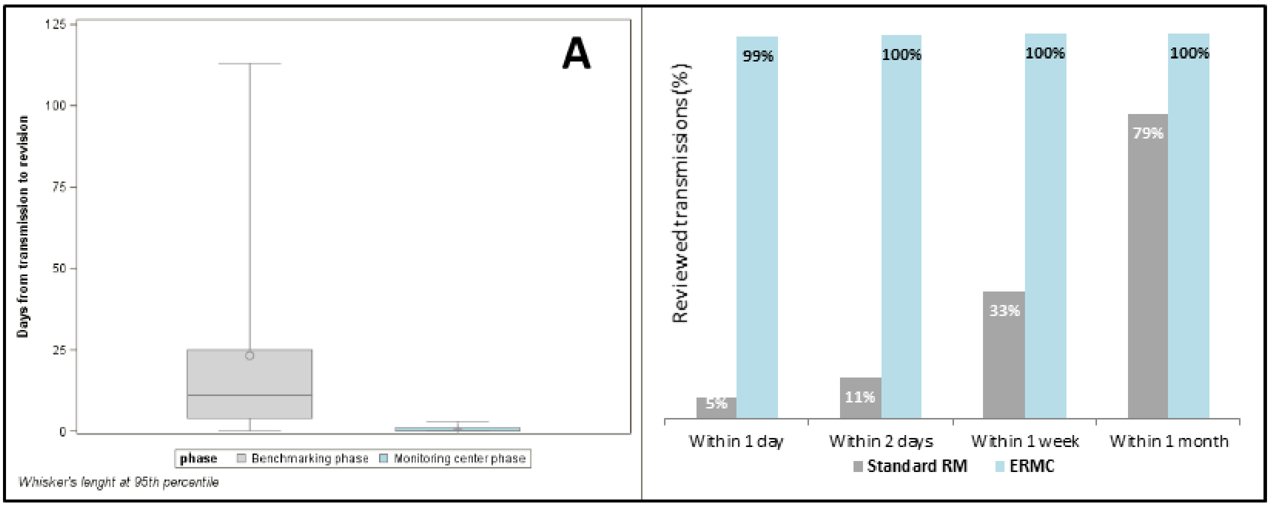


Table 4. Rate of reviewed transmissions, benchmarking phase versus external remote monitoring center phase.

Device type	Benchmarking phase			Monitoring center phase			*P* value
	Total exposure time (years)	Reviewed TX[a], n	Annual rate of hospital physician reviewed TX per 100 patient-years (95% CI)	Total exposure time (years)	Reviewed TX, n	Annual rate of hospital physician reviewed TX per 100 patient-years (95% CI)	
Overall (patients, n=126)	105	368	350 (316-387)	89	78[b]	88 (69-109)	<.001
CRT-D[c] (n=55)	41	214	527 (461-603)	39	42	108 (78-146)	<.001
ICD[d] (n=12)	10	35	366 (263-509)	8	6	75 (28-163)	<.001
IPG[e] (n=58)	54	115	213 (177-255)	41	5	12 (4-28)	<.001
CRT-P[f] (n=1)	1	4	411 (154-1096)	1	0	—[g]	—

[a] TX: transmissions.

[b] 10 (14.7%) were classified as red.

[c] CRT-D: cardiac resynchronization therapy defibrillator.

[d] ICD: single- or dual-chamber implantable cardioverter defibrillator.

[e] IPG: single- or dual-chamber pacemaker.

[f] CRT-P: cardiac resynchronization therapy pacemaker.

[g] Not applicable.

Discussion

Principal Findings

This research showed that externalizing part of RM follow-up is safe, effective, and efficient in supporting a hospital previously challenged to guarantee high-quality standards of RM follow-up in terms of (1) time to review transmissions, both scheduled and unscheduled, to enable timely medical action as necessary; (2) dedicated staff and facility time to perform RM; and (3) patient compliance to RM, measured as the rate of transmissions per year.

Safety and Practicability of External Remote Monitoring Center

The ERMC's staff reviewed and managed all high-priority transmissions within 2 hours and 96.4% of the low-priority events within 2 working days, escalating only 15.7% of all transmissions to hospital staff due to a prioritized event being detected. The frequency of prioritized events was relatively high compared with the 8.2% presented by Cronin et al [14], but a direct comparison is challenging because of different approaches depending on the target population and, above all, because different variables, for example, learning curve, need to be taken into consideration when a third party is involved in the monitoring pathway. Once referred to the hospital staff, 15.5% of escalated transmissions led to a clinical action, in line with the 15.4% reported by Facchin et al [1], showing that ERMC is a precious tool to triage patients implanted with a CIED and to screen relevant events requiring clinical intervention. A total of 84.5% of escalated events did not lead to medical action but were nevertheless essential to hospital staff to monitor the evolution of patient clinical condition with respect to their ongoing treatment and medical history, in line with the definition of prioritized events in the protocol.

Efficiency of External Remote Monitoring Center

It is well known that RM is a valuable tool that is able to support the follow-up of patients with an implanted CIED; however, it requires organizational changes in the hospital workflow to achieve optimal patient follow-up [16]. As such, reducing the time to review remote transmissions to a minimum is an essential aspect to achieve the full benefits of RM for optimal quality of care by enabling fast medical action [20]. Although staff reorganization is essential when aiming for optimal in-hospital RM management, there was no specific RM protocol in the hospital to follow up patients in a systematic way. To avoid bias and to expose all the possible challenges [20] of RM management, an RM protocol was not introduced during the benchmarking phase. In the 6-month period preceding the externalization of RM management, only one-third of the transmissions were processed within 1 week. During the ERMC phase, all transmissions were reviewed within 2 working days, and when a prioritized event occurred, the salient information was promptly communicated to the hospital. This result is comparable with the 2 to 4 days from actionable event onset to related clinical decision required in a number of previous controlled experiences [3,5].

Ensuring patient compliance is another key component to optimal follow-up, especially as patients can get disconnected from the system and may need support to reconnect. Moreover, with time, patient attention can decrease during follow-up and the use of RM may become intermittent. Our data showed that during the ERMC phase, the total number of remote transmissions increased by 74% as the monitoring center also communicated with the technical team to ensure that all patients would remain connected. This can also contribute to avoid variability in care between patients as well as encourage patient engagement in follow-up.

Regarding staff burden, with the escalation of prioritized events only, even with the large increase in the number of transmissions, the proportion of transmissions requiring review was reduced by 75%. If we apply the time to review transmissions (including administrative time) considered in Cronin et al [14], 21 min for prioritized events and 10 min for other transmissions, and the repartition of prioritized or other events found in the ERMC phase (21.2%/78.8%) to the benchmark phase, staff time required to follow up 100 patients would be reduced from 72 to 27 hours per year (62% reduction). Staff burden reduction can have an important organizational impact for the hospital as highly skilled health care professionals may then devote more time to treat more patients in need, thus optimizing patient access to care. It can also contribute to facilitate the implementation of best practice recommendations for follow-up of patients [16] as RM often requires important reorganization that hospitals with limited resources cannot achieve, in the sense of a more extensive and differentiated role organization. The presented research experience has been conducted in a small Italian hospital where cardiologists have to deal with the screening of all remote transmissions. In such a case, the cost of RM triage externalizations would represent an efficient, that is, a cost-saving, alternative and would save cardiologists' time for more important clinical tasks [21].

Limitations

We reported results of a single center experience, sharing the problems with efficacy and efficiency of the RM in a hospital where there was no standard center-specific protocol established for RM apart from the Heart Rhythm Society recommendations. Moreover, our practice may not be the standard of care across different health care systems. Further studies are required to deeply investigate if an ERMC strategy will be recommended in centers with a larger number of monitored patients and with predefined RM strategies.

Due to the limited sample size, we were not able to identify specific subgroups more eligible than others to receive external remote monitoring triage. Future studies could possibly be designated to address the topic.

Once the ERMC phase was completed, we noted that some areas of improvement are still required in the process of externalization of RM, such as refining prioritization of events based on ongoing medical therapy (eg, oral anticoagulant therapy).

Whether the externalization of RM management is able to improve the adherence to guidelines and recommendations and its effects on clinical outcome were not in the scope of this study.

Conclusions

This experience in Cefalù Hospital's cardiology department demonstrated that outsourcing part of the remote follow-up of patients through an ERMC is safe, effective, and efficient compared with standard RM performed at a hospital level. All the transmissions were reviewed within 2 working days and prioritized events were communicated promptly by ERMC, leading to a faster review of important events by hospital staff without the triaging burden. In a scenario of limited resources, such externalization of RM could be a key tool to save dedicated staff and facility time for more crucial patient care activities.

Acknowledgments

The authors wish to thank Dr Gardini (Health Telematic Network Spa, Brescia, Italy) for his efforts in the external remote monitoring center management and Renato Gardelli, Lorenza Mangoni di S Stefano, Emmanuelle Nicolle, Mirko De Melis, and Matthew Cook, all Medtronic Inc employees, for project management activities, data management technical support, and statistical analysis. This research was performed within the framework of the Italian ClinicalService project, a national cardiovascular data repository and medical care project funded by Medtronic Italia, an affiliate of Medtronic Inc. No other funding sources were involved in the research. The authors are responsible for the design and conduct of this research.

Conflicts of Interest

None declared.

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Abbreviations

CIED: cardiac implantable electronic device
CLN: CareLink network
CRT-D: cardiac resynchronization therapy defibrillator

CRT-P: cardiac resynchronization therapy pacemaker
ERMC: external remote monitoring center
ICD: implantable cardioverter defibrillator
IPG: single- or dual-chamber pacemaker
IRR: incidence rate ratio
RM: remote monitoring

Edited by G Eysenbach; submitted 30.01.18; peer-reviewed by A Kollmann, J op den Buijs, SB Golas, M Simons; comments to author 11.07.18; revised version received 05.09.18; accepted 10.10.18; published 18.12.19.

Please cite as:
Giannola G, Torcivia R, Airò Farulla R, Cipolla T
Outsourcing the Remote Management of Cardiac Implantable Electronic Devices: Medical Care Quality Improvement Project
JMIR Cardio 2019;3(2):e9815
URL: https://cardio.jmir.org/2019/2/e9815
doi:10.2196/cardio.9815
PMID:31845898

Original Paper

Characteristics Associated With Facebook Use and Interest in Digital Disease Support Among Older Adults With Atrial Fibrillation: Cross-Sectional Analysis of Baseline Data From the Systematic Assessment of Geriatric Elements in Atrial Fibrillation (SAGE-AF) Cohort

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Abstract

Background: Online support groups for atrial fibrillation (AF) and apps to detect and manage AF exist, but the scientific literature does not describe which patients are interested in digital disease support.

Objective: The objective of this study was to describe characteristics associated with Facebook use and interest in digital disease support among older patients with AF who used the internet.

Methods: We used baseline data from the Systematic Assessment of Geriatric Elements in Atrial Fibrillation (SAGE-AF), a prospective cohort of older adults (≥65 years) with AF at high stroke risk. Participants self-reported demographics, clinical characteristics, and Facebook and technology use. Online patients (internet use in the past 4 weeks) were asked whether they would be interested in participating in an online support AF community. Mobile users (owns smartphone and/or tablet) were asked about interest in communicating with their health care team about their AF-related health using a secure app. Logistic regression models identified crude and multivariable predictors of Facebook use and interest in digital disease support.

Results: Online patients (N=816) were aged 74.2 (SD 6.6) years, 47.8% (390/816) were female, and 91.1% (743/816) were non-Hispanic white. Roughly half (52.5%; 428/816) used Facebook. Facebook use was more common among women (adjusted odds ratio [aOR] 2.21, 95% CI 1.66-2.95) and patients with mild to severe depressive symptoms (aOR 1.50, 95% CI 1.08-2.10) and less common among patients aged ≥85 years (aOR 0.27, 95% CI 0.15-0.48). Forty percent (40.4%; 330/816) reported interest in an online AF patient community. Interest in an online AF patient community was more common among online patients with some college/trade school or Bachelors/graduate school (aOR 1.70, 95% CI 1.10-2.61 and aOR 1.82, 95% CI 1.13-2.92, respectively), obesity (aOR 1.65, 95% CI 1.08-2.52), online health information seeking at most weekly or multiple times per week (aOR 1.84, 95% CI 1.32-2.56 and aOR 2.78, 95% CI 1.86-4.16, respectively), and daily Facebook use (aOR 1.76, 95% CI 1.26-2.46). Among mobile users, 51.8% (324/626) reported interest in communicating with their health care team via a mobile app. Interest in app-mediated communication was less likely among women (aOR 0.48, 95% CI 0.34-0.68) and more common among online patients who had completed trade school/some college versus high school/General Educational Development (aOR 1.95, 95% CI 1.17-3.22), sought online health information at most weekly or multiple times per week (aOR 1.86, 95% CI 1.27-2.74 and aOR 2.24, 95% CI 1.39-3.62, respectively), and had health-related apps (aOR 3.92, 95% CI 2.62-5.86).

Conclusions: Among older adults with AF who use the internet, technology use and demographics are associated with interest in digital disease support. Clinics and health care providers may wish to encourage patients to join an existing online support community for AF and explore opportunities for app-mediated patient-provider communication.

(JMIR Cardio 2019;3(2):e15320) doi:10.2196/15320

KEYWORDS

atrial fibrillation; social media; information seeking behavior

Introduction

Currently, as many as 6 million adults in the United States have atrial fibrillation (AF), and the prevalence of AF is projected to increase to 12 million by 2030 [1]. Both the prevalence and incidence of AF is higher among older adults (ie, aged ≥65 years) compared with younger adults [1], with an estimated prevalence of 1% among adults aged <65 years and 9% among adults aged ≥65 years [2]. Adults with AF are at substantially higher risk of stroke [1], which is 1 of the top 5 leading causes of death in the United States [3].

Treatment with anticoagulants significantly reduces the risk of stroke among adults with AF, but anticoagulants may have significant adverse effects including severe and life-threatening bleeding [4-6] and be difficult to manage (eg, necessity for regular monitoring, dosing changes, and dietary restrictions) [7]. While education and behavioral interventions may improve adherence and persistence with treatment, a recent systematic review did not find that interventions consisting of self-monitoring plus education increased time in therapeutic range compared with usual care [8]. Digital health approaches may be an effective strategy for helping adults with AF manage their disease [9], and pilot studies appear promising [10,11].

Although fewer older US adults aged ≥65 years go online, own mobile devices, and use social media compared with younger adults, technology adoption among older US adults has nearly quadrupled since 2000 [12]. Currently, two-thirds of older US adults are online, 42% own a smartphone, 32% own a tablet computer, and 34% use social media [12]. Previous research indicates that there is interest among older adults with cardiovascular disease to communicate with their health care teams via social media and that greater use of Facebook may be a predictor of greater willingness to participate in online patient support communities [13]. Online support groups for AF exist, and recent research suggests that patients participating in these communities benefit from connecting with others with AF for information and support related to managing their health, including information and support related to the risks and benefits of treatment options, personal experiences, and medication management [14,15].

However, existing literature does not illuminate the characteristics of older adults with AF interested in joining an online support community for AF. Similarly, apps for the detection and management of AF are being developed [16-21], but, similarly, previous research has not examined which older adults with AF would be interested in utilizing this technology to communicate with their health care team. The purpose of this study was to describe, in a cohort of older patients with AF who used the internet, patient characteristics associated with the use of social media and interest in digital disease support. Specifically, we examined the extent to which demographic, clinical, and lifestyle characteristics were associated with (1) Facebook use, (2) interest in an online AF patient support community among older patients with AF, and (3) interest in using a mobile app to communicate with their health care team.

Methods

Study Design and Data Collection

We used data from the Systematic Assessment of Geriatric Elements in Atrial Fibrillation (SAGE-AF) study. Between 2016 and 2018, SAGE-AF enrolled 1244 older adults with AF at high stroke risk from 7 clinical sites in central and eastern Massachusetts or central Georgia. Staff prescreened patients scheduled to attend a clinic visit and sent eligible patients an invitation to participate in the study 1 week before their appointment. Eligibility criteria for SAGE-AF included having a scheduled ambulatory care visit at one of the study practices, electrocardiographic evidence of AF, being aged ≥65 years, and having a CHA_2DS_2VASC risk score ≥2. Exclusion criteria were documentation of an absolute contraindication to oral anticoagulants (eg, recent major bleeding), indication for oral anticoagulants other than AF (eg, venous thromboembolism), inability to demonstrate capacity to provide informed consent as assessed by a capacity instrument that combines direct questions about their understanding of study participation with interviewer observations of the patient [22], not English speaking, planned invasive procedure with high risk for uncontrollable bleeding, current pregnancy, prisoner status, and unwillingness or inability to participate in planned 1- and 2-year follow-up visits at their study sites. Data were collected through a comprehensive geriatric assessment, structured interviews, and abstraction of electronic medical records. Data for this study were derived from the baseline assessment. All participants provided written informed consent. SAGE-AF was approved by the institutional review boards at each study site. Participants received a US $60 gift card after completing the 60-min baseline assessment.

Measures

The baseline interview included questions about the use of technology and social media adapted from the Pew Research

Center [12,23] and interest in digital disease support developed in previous research [24]. Participants reported whether they had gone online or accessed the internet over the past 4 weeks (response options: not at all in the past 4 weeks, less than once a week, once a week, more than once a week but not every day, once a day, or more than once a day). We defined online patients as patients who reported using the internet at least once during the past 4 weeks. Online patients were asked whether they had a Facebook account. Online patients were also asked the following:

> *If we were to create an online community (via a private website or an app) specifically designed for patients with atrial fibrillation, how interested would you be in participating? The community would be held through a private website and/or a secure smartphone/tablet app. You could use this community to ask questions about afib, set activity or diet goals, or report progress on a regular basis.*

We combined no and unsure responses (vs yes) to highlight participants expressing clear interest. Participants were asked if they owned a smartphone (eg, iPhone, Android phone, Windows phone, or Blackberry) or tablet computer (eg, iPad, Samsung Galaxy, Motorola Xoom, or Kindle Fire). Participants who reported owning a smartphone and/or tablet computer were categorized as mobile users. Mobile users were asked “would you be interested in communicating with your doctor or health care team about your atrial fibrillation-related health using a secure smartphone or tablet app?” We combined no and unsure responses (vs yes) to highlight participants expressing clear interest.

Participants self-reported demographics including race/ethnicity, education level, marital status, and living situation during the baseline interview. We abstracted age, height, weight, and medical history variables from patients’ medical records at baseline, including comorbidities (eg, type II diabetes, hypertension, stroke, heart failure, and cancer), whether the patient had newly diagnosed or prevalent AF, use of anticoagulants, and whether the patient’s AF was managed by a dedicated anticoagulation clinic. We calculated body mass index (BMI) from height and weight abstracted from medical records and categorized participants’ weight status as underweight (BMI<18.5 kg/m^2), normal weight (18.5 kg/m^2≤BMI<25 kg/m^2), overweight (25 kg/m^2≤BMI<30 kg/m^2), or obese (30 kg/m^2≤BMI) [25].

Participants were asked “how much difficulty do you have reading ordinary print in newspapers?” and “how much difficulty do you have doing work or hobbies that require you to see well up close, such as cooking, sewing, fixing things around the house, or using hand tools?” (response options: no difficulty at all, a little difficulty, moderate difficulty, extreme difficulty, stopped doing this because of your eyesight, stopped doing this because of other reasons, or no interest in doing this). Participants who reported moderate or extreme difficulty or reported stopping activity because of eyesight for either question were considered to have moderate/extreme/activity-limiting difficulty with reading text. Depressive symptoms were assessed using the Patient Health Questionnaire-9 [26]. This 9-item questionnaire asks participants to self-report the frequency with which they have experienced depressive symptoms over the past 2 weeks (response options: not at all, several days, more than half the days, or nearly every day). We calculated a total score from the sum of responses, with a potential range of 0 to 27 [26]. As few participants reported depressive symptoms in the moderate to severe range, we dichotomized symptoms as minimal (0-4) versus mild or more severe symptomology (≥5) [26]. Symptoms of anxiety were assessed using the Generalized Anxiety Disorder-7 measure [27]. This 7-item scale asks participants to self-report the frequency with which they have experienced symptoms of anxiety over the past 2 weeks (response options: not at all, several days, over half the days, or nearly every day). We summed scores to generate a total score representing symptoms of anxiety, with a potential range of 0 to 21 [27]. As few participants reported symptoms of anxiety in the moderate to severe range, we dichotomized symptoms as minimal (0-4) versus mild or more severe symptomology (≥5+) [27]. The Perceived Efficacy in Patient-Physician Interactions is a 10-item validated, reliable measure of self-efficacy in patient-physician interactions [28], with total scores ranging from 5 to 50 [29]. We categorized scores of ≥45 as high perceived efficacy in patient-provider interactions; this score is equivalent to average responses of very or extremely confident.

Participants were asked to report how much they were bothered by AF based on experiencing heart palpitations (ie, hear fluttering, skipping, or racing), irregular heartbeat (feeling any pause in heart activity), lightheadedness, or dizziness (response options: not at all bothered or I did not have this symptom, hardly bothered, a little bothered, moderately bothered, quite a bit bothered, very bothered, or extremely bothered). We categorized participants as being quite/very/extremely bothered by 1 or more of these 4 symptoms over the past 4 weeks. Participants were asked how satisfied they were with how well their current treatment controlled their AF; responses were categorized as very/extremely satisfied, somewhat satisfied, or mixed satisfied and dissatisfied or somewhat/very/extremely dissatisfied. Participants were asked “in the past month, how much help with the management of your atrial fibrillation have you needed?” (response options: none, very little, some, quite a bit, or very much); responses were dichotomized as none versus any needed assistance.

Participants with Facebook accounts were asked how often they checked their accounts over the past 4 weeks (response options: not at all in the past 4 weeks, less than once a week, once a week, more than once a week but not every day, once a day, or more than once a day); we collapsed response options to not at all, less than once a week, weekly, and daily. Online participants (ie, those who reporting using the internet in the past 4 weeks) were asked how often they used the internet to look for advice or information about their health (response options: not at all in the past 4 weeks, less than once a week, once a week, more than once a week but not every day, once a day, or more than once a day). Online health information seeking was collapsed as not at all, at most weekly, or multiple times per week. Mobile users were asked whether they had any apps related to their health (yes vs no/unsure).

Statistical Analysis

Only online patients (ie, patients who reported using the internet) were asked about the use of Facebook and interest in an online support community for AF. Therefore, these analyses were limited to online patients (ie, patients who reported internet use). Only patients who reported owning a tablet computer and/or smartphone were asked about their interest in using a mobile app to communicate with their health care team. Therefore, analyses examining interest in app-mediated communication were limited to mobile users (ie, patients who have tablet computers and/or smartphones). We additionally excluded participants missing any of the characteristics examined.

We compared demographic characteristics of SAGE-AF participants excluded with characteristics of participants included in the analytic sample using *t* tests for age and chi-squared tests for gender and race/ethnicity. We used logistic regression models to identify crude and multivariable predictors of Facebook use and interest in digital disease support. As marital status and living situation were highly related (only 3 patients who were married or living as married reported living alone), we considered living situation for inclusion in regression models and describe marital status of participants but did not consider this variable for inclusion in regression models. To identify multivariable predictors, we included variables that were associated with the outcome at $P<.10$ and retained variables in the model if the odds ratio (OR) was statistically significant at the .05 level for any level of the variable. We additionally considered study site (Massachusetts vs Georgia) for inclusion in adjusted models. However, as study site was not statistically significant in any of the 3 models and estimated ORs for participant characteristics were very similar to models that did not include study site (data not shown), the final adjusted models did not include study site. Analyses were conducted using SAS 9.4 (SAS Inc, Cary, NC).

Results

Characteristics of the Sample

Seventy percent (875/1244) of the patients enrolled in the SAGE-AF cohort reported using the internet in the previous 4 weeks (online patients). We excluded online patients who lived in a nursing home (n=4) those missing information about Facebook use (n=3), those missing information about interest in an online AF patient community (n=1), those missing information about interest in using a mobile app to communicate with their health care team (n=4), and patients missing information on any of the characteristics examined (n=47), resulting in an analytic sample of 816 online older adults with AF. SAGE-AF participants excluded from the analytic sample were on average 3.7 years older than participants in analytic sample (mean 78.0, SD 7.4 years vs mean 74.2, SD 6.6 years; $P<.001$) and less likely to be non-Hispanic white (73.1% vs 91.1%; $P<.001$); excluded and included participants were similarly likely to be female (50.7% vs 47.8%; $P=.33$).

Online patients were on average aged 74.2 (SD 6.6) years, 47.8% were female, and 91.1% were non-Hispanic white. Almost all (98.9%) had prevalent AF at enrollment. Six out of 10 participants reported seeking health information online; 19.6% of the sample looked online for health information more than once a week during the past 4 weeks, 39.3% at most once per week, and 41.1% not at all. Among mobile users, 29.6% reported using health-related mobile apps. Additional demographic, clinical, and psychosocial characteristics are shown in Table 1.

Characteristics Associated With Facebook Use

Just over half (52.5%) of online patients reported using Facebook. Among Facebook users, 16.4% reported using Facebook less than once a week, 24.3% weekly, and 59.4% daily. Facebook use was more common among women than men (62.6% vs 43.2%; adjusted OR [aOR] 2.21, 95% CI 1.66-2.95) and among patients with mild to severe depressive symptoms (61.2% vs 49.3%; aOR 1.50, 95% CI 1.08-2.10) and less common among the oldest patients (31.9% vs 60.3%; aOR 0.27, 95% CI 0.15-0.48 for patients aged ≥85 years compared with patients aged 65 to 69 years; Table 2).

Table 1. Demographic, clinical, and psychosocial characteristics of older adults with atrial fibrillation (AF) who used the internet (N=816), Systematic Assessment of Geriatric Elements in Atrial Fibrillation (SAGE-AF) 2016-2018.

Participant characteristics	Value, n (%)
Age (years)	
65-69	224 (27.5)
70-74	254 (31.1)
75-84	266 (32.6)
≥85	72 (8.8)
Female	390 (47.8)
Non-Hispanic white	743 (91.1)
Marital status	
Married or living as married	504 (61.9)
Divorced or separated	109 (13.4)
Widowed	162 (19.9)
Single	39 (4.8)
Lives alone	213 (26.1)
Education	
High school/General Educational Development or less	177 (21.7)
Some college or trade school	215 (26.4)
College/some graduate coursework	143 (17.5)
Graduate degree	281 (34.4)
Body mass index	
Underweight	6 (0.7)
Normal weight	141 (17.3)
Overweight	279 (34.2)
Obese	390 (47.8)
History of type II diabetes	197 (24.1)
History of myocardial infarction	145 (17.8)
History of cancer	253 (31.0)
Moderate/extreme/activity-limiting difficulty reading text (eg, newspaper)	119 (14.6)
Elevated depressive symptoms	214 (26.2)
Elevated anxiety symptoms	178 (21.8)
High perceived efficacy in patient-provider interactions	544 (66.7)
Quite/very/extremely bothered by ≥1 of 4 AF symptoms in the past 4 weeks	92 (11.3)
Satisfaction with current AF treatment	
Very/extremely satisfied	637 (78.1)
Somewhat satisfied	97 (11.9)
Mixed satisfied and dissatisfied, or somewhat, very, or extremely dissatisfied	82 (10.1)
Needed help managing AF in the past 4 weeks	118 (14.5)
Anticoagulant management	
Not taking anticoagulant	432 (52.9)
On anticoagulant, managed by anticoagulation clinic	259 (31.7)
On anticoagulant, not managed by anticoagulation clinic	125 (15.3)

Table 2. Use of Facebook in relation to demographic, clinical, psychosocial, and technology use characteristics of online older adults with atrial fibrillation (N=816), Systematic Assessment of Geriatric Elements in Atrial Fibrillation (SAGE-AF) 2016-2018.

Participant characteristics	Uses Facebook		
	Value, n (%)	Crude OR[a] (95% CI)	Adjusted OR (95% CI)
Age (years)			
65-69	135 (60.3)	Reference	Reference
70-74	133 (52.4)	0.73 (0.50-1.04)	0.71 (0.49-1.04)
75-84	137 (51.5)	0.70 (0.49-1.00)	0.67 (0.46-0.97)
≥85	23 (32)	0.31 (0.18-0.54)	0.27 (0.15-0.48)
Sex			
Male	184 (43.2)	Reference	Reference
Female	244 (62.6)	2.20 (1.67-2.91)	2.21 (1.66-2.95)
Race/ethnicity			
Non-Hispanic white	386 (52.0)	Reference	—[b]
Other race/ethnicity	42 (58)	1.25 (0.77-2.04)	—
Living situation			
Lives with others	319 (52.9)	Reference	—
Lives alone	109 (51.2)	0.93 (0.68-1.28)	—
Education			
High school/General Educational Development or less	100 (56.5)	Reference	—
Some college or trade school	124 (57.7)	1.05 (0.70-1.57)	—
College/graduate coursework	68 (47.6)	0.70 (0.45-1.09)	—
Graduate degree	136 (48.4)	0.72 (0.50-1.05)	—
Body mass index			
Underweight	4 (66.7)	2.62 (0.47-14.79)	—
Normal weight	61 (43.3)	Reference	—
Overweight	145 (52.0)	1.42 (0.94-2.13)	—
Obese	218 (55.9)	1.66 (1.13-2.45)	—
History of type II diabetes			
No	319 (51.5)	Reference	—
Yes	109 (55.3)	1.17 (0.84-1.61)	—
History of myocardial infarction			
No	349 (52.0)	Reference	—
Yes	79 (54.5)	1.10 (0.77-1.58)	—
History of cancer			
No	295 (52.4)	Reference	—
Yes	133 (52.6)	1.01 (0.75-1.36)	—
Difficulty reading text (eg, newspaper)			
Not difficult at all/a little difficult	368 (52.8)	Reference	—
Moderate/extreme/activity-limiting difficulty	60 (50.4)	0.91 (0.62-1.34)	—
Depressive symptoms			
Minimal symptoms (0-4)	297 (49.3)	Reference	Reference
Mild to severe symptoms (5+)	131 (61.2)	1.62 (1.18-2.23)	1.50 (1.08-2.10)
Anxiety symptoms			

Participant characteristics	Uses Facebook		
	Value, n (%)	Crude OR[a] (95% CI)	Adjusted OR (95% CI)
Minimal symptoms (0-4)	327 (51.3)	Reference	—
Mild to severe symptoms (5+)	101 (56.7)	1.25 (0.89-1.74)	—
High perceived efficacy in patient-provider interactions			
Less confident (<45)	143 (52.6)	Reference	—
Very/extremely confident (45+)	285 (52.4)	0.99 (0.74-1.33)	—
How bothered by 4 AF [c] symptoms in the past 4 weeks			
At most moderately bothered by any symptoms	370 (51.1)	Reference	—
Quite/very/extremely bothered by ≥1 symptom	58 (63)	1.63 (1.04-2.55)	—
Satisfaction with current AF treatment			
Very/extremely satisfied	322 (50.6)	Reference	—
Somewhat satisfied	62 (64)	1.73 (1.11-2.70)	—
Mixed satisfied and dissatisfied, or somewhat, very, or extremely dissatisfied	44 (54)	1.13 (0.71-1.80)	—
Needed help managing AF in the past 4 weeks			
None	369 (52.9)	Reference	—
Very little/some/quite a lot/very much	59 (50.0)	0.89 (0.60-1.32)	—
Anticoagulant management			
Not taking anticoagulant	231 (53.5)	Reference	—
On anticoagulant, managed by anticoagulation clinic	132 (51.0)	0.90 (0.66-1.23)	—
On anticoagulant, not managed by anticoagulation clinic	65 (52.0)	0.94 (0.63-1.40)	—
Online health information seeking in the past 4 weeks			
Not at all	165 (49.3)	Reference	—
At most once a week	174 (54.2)	1.22 (0.90-1.66)	—
Multiple times per week	89 (55.6)	1.29 (0.89-1.89)	—

[a] OR: odds ratio.

[b] Not included in the adjusted regression model.

[c] AF: atrial fibrillation.

Characteristics Associated With Interest in an Online Atrial Fibrillation Patient Community

Forty percent (40.4%) of online patients reported interest in an online AF patient community. Patients with some postsecondary education (some college or trade school) and those with a bachelor's degree or some graduate education were more likely to report interest in an online AF patient community than patients with a high school education or less (45.1% and 49.0% vs 32.2%; aOR 1.70, 95% CI 1.10-2.61 and aOR 1.82, 95% CI 1.13-2.92, respectively; Table 3). Patients with obesity were more likely to report interest in an online AF patient community than patients who were normal weight (45.4% vs 31.9%; aOR 1.65, 95% CI 1.08-2.52; Table 3). More frequent online health information seeking was associated with greater likelihood of expressing interest in an online AF patient community (55.6% and 43.9% vs 29.9%; aOR 1.84, 95% CI 1.32-2.56 for at most weekly online health information seeking and aOR 2.78, 95% CI 1.86-4.16 for online health information seeking multiple times weekly; Table 3). Finally, online patients who used Facebook daily were more likely to express interest in an online AF patient community than patients who did not use Facebook (50.0% vs 34.8%; aOR 1.76, 95% CI 1.26-2.46; Table 3).

Table 3. Interest in online atrial fibrillation patient community in relation to demographic, clinical, psychosocial, and technology use characteristics of online older adults with atrial fibrillation (N=816), Systematic Assessment of Geriatric Elements in Atrial Fibrillation (SAGE-AF) 2016-2018.

Participant characteristics	Interest in an online AF[a] patient community		
	Value, n (%)	Crude OR[b] (95% CI)	Adjusted OR (95% CI)
Age (years)			
65-69	101 (45.1)	Reference	—[c]
70-74	113 (44.5)	0.98 (0.68-1.40)	—
75-84	98 (36.8)	0.71 (0.49-1.02)	—
≥85	18 (25)	0.41 (0.22-0.74)	—
Sex			
Male	175 (41.1)	Reference	—
Female	155 (39.7)	0.95 (0.72-1.25)	—
Race/ethnicity			
Non-Hispanic white	302 (40.7)	Reference	—
Other race/ethnicity	28 (38)	0.91 (0.55-1.49)	—
Living situation			
Lives with others	250 (41.5)	Reference	—
Lives alone	80 (37.6)	0.85 (0.62-1.17)	—
Education			
High school/General Educational Development or less	57 (32.2)	Reference	Reference
Some college or trade school	97 (45.1)	1.73 (1.14-2.62)	1.70 (1.10-2.61)
College/graduate school	70 (49.0)	2.02 (1.28-3.18)	1.82 (1.13-2.92)
Graduate degree	106 (37.7)	1.28 (0.86-1.90)	1.19 (0.78-1.81)
Body mass index			
Underweight	3 (50.0)	2.13 (0.41-10.99)	2.29 (0.43-12.14)
Normal weight	45 (31.9)	Reference	Reference
Overweight	105 (37.6)	1.29 (0.84-1.98)	1.25 (0.80-1.94)
Obese	177 (45.4)	1.77 (1.18-2.66)	1.65 (1.08-2.52)
History of type II diabetes			
No	246 (39.7)	Reference	—
Yes	84 (42.6)	1.13 (0.81-1.56)	—
History of myocardial infarction			
No	268 (39.9)	Reference	—
Yes	62 (42.8)	1.12 (0.78-1.62)	—
History of cancer			
No	230 (40.9)	Reference	—
Yes	100 (39.5)	0.95 (0.70-1.28)	—
Difficulty reading text (eg, newspaper)			
Not difficult at all/a little difficult	290 (41.6)	Reference	—
Moderate/extreme/activity-limiting difficulty	40 (33.6)	0.71 (0.47-1.07)	—
Depressive symptoms			
Minimal symptoms (0-4)	232 (38.5)	Reference	—
Mild to severe symptoms (5+)	98 (45.8)	1.35 (0.98-1.85)	—
Anxiety symptoms			

Participant characteristics	Interest in an online AF[a] patient community		
	Value, n (%)	Crude OR[b] (95% CI)	Adjusted OR (95% CI)
Minimal symptoms (0-4)	241 (37.8)	Reference	—
Mild to severe symptoms (5+)	89 (50.0)	1.65 (1.18-2.30)	—
High perceived efficacy in patient-provider interactions			
Less confident (<45)	108 (39.7)	Reference	—
Very/extremely confident (45+)	222 (40.8)	1.05 (0.78-1.41)	—
How bothered by AF symptoms in the past 4 weeks			
At most moderately bothered by any symptom	281 (38.8)	Reference	—
Quite/very/extremely bothered by ≥1 symptom	49 (53)	1.80 (1.16-2.78)	—
Satisfaction with current AF treatment			
Very/extremely satisfied	241 (37.8)	Reference	—
Somewhat satisfied	45 (46)	1.42 (0.93-2.19)	—
Mixed satisfied and dissatisfied, or somewhat, very, or extremely dissatisfied	44 (54)	1.90 (1.20-3.02)	—
Needed help managing AF in the past 4 weeks			
None	280 (40.1)	Reference	—
Very little/some/quite a lot/very much	50 (42.4)	1.10 (0.74-1.63)	—
Anticoagulant management			
Not taking anticoagulant	181 (41.9)	Reference	—
On anticoagulant, managed by AC[d] clinic	104 (40.2)	0.93 (0.68-1.27)	—
On anticoagulant, not managed by AC clinic	45 (36.0)	0.78 (0.52-1.18)	—
Online health information seeking in the past 4 weeks			
Not at all	100 (29.9)	Reference	Reference
At most once a week	141 (43.9)	1.84 (1.34-2.54)	1.84 (1.32-2.56)
Multiple times per week	89 (55.6)	2.95 (1.99-4.35)	2.78 (1.86-4.16)
Frequency of Facebook use in the past 4 weeks			
Does not use Facebook	135 (34.8)	Reference	Reference
Less than once a week over the past 4 weeks	24 (34)	0.98 (0.57-1.67)	0.96 (0.55-1.66)
Weekly over the past 4 weeks	44 (42.3)	1.37 (0.88-2.14)	1.32 (0.84-2.08)
Daily over the past 4 weeks	127 (50.0)	1.87 (1.36-2.59)	1.76 (1.26-2.46)

[a] AF: atrial fibrillation.

[b] OR: odds ratio.

[c] Not included in the adjusted regression model.

[d] AC: anticoagulation.

Characteristics Associated With Interest in Using a Mobile App to Communicate With Their Health Care Team Among Mobile Users

A total of 60.2% of online patients reported owning a tablet computer and 58.2% owned a smartphone; 76.7% were mobile users. Among mobile users, 51.8% reported interest in using a mobile app to communicate with their health care team. Women were less likely to express interest in using mobile apps to communicate with their health care team (42.7% vs 60.6%; aOR 0.48, 95% CI 0.34-0.68). Interest in app-mediated communication was more common among individuals who had completed trade school/some college versus high school/General Educational Development (54.4% vs 36.0%; aOR 1.95, 95% CI 1.17-3.22; Table 4). More frequent online health information seeking was associated with greater likelihood of expressing interest in app-mediated communication with their health care team (57.6% and 64.4% vs 38.0%; aOR 1.86, 95% CI 1.27-2.74 for at most weekly online health information seeking and aOR 2.24, 95% CI 1.39-3.62 for online health information seeking multiple times weekly; Table 4). Patients who have health-related apps were more likely to report interest in communicating with their health care team via a mobile app (75.7% vs 41.7%; aOR 3.92, 95% CI 2.62-5.86; Table 4).

Table 4. Interest in using mobile app to communicate with health care team in relation to demographic, clinical, psychosocial, and technology use characteristics of online older adults with atrial fibrillation who owned mobile devices (n=626), Systematic Assessment of Geriatric Elements in Atrial Fibrillation (SAGE-AF) 2016-2018.

Participant characteristics	Interest in using mobile app to communicate with health care team		
	Value, n (%)	Crude OR[a] (95% CI)	Adjusted OR (95% CI)
Age (years)			
65-69	114 (58.8)	Reference	—[b]
70-74	107 (55.7)	0.88 (0.59-1.32)	—
75-84	90 (46.2)	0.60 (0.40-0.90)	—
≥85	13 (29)	0.29 (0.14-0.58)	—
Sex			
Male	192 (60.6)	Reference	Reference
Female	132 (42.7)	0.49 (0.35-0.67)	0.48 (0.34-0.68)
Race/ethnicity			
Non-Hispanic White	292 (51.3)	Reference	—
Other race/ethnicity	32 (56)	1.21 (0.70-2.10)	—
Living situation			
Lives with others	254 (54.0)	Reference	—
Lives alone	70 (44.9)	0.69 (0.48-1.00)	—
Education			
High school/General Educational Development or less	46 (36.0)	Reference	Reference
Some college or trade school	92 (54.4)	2.10 (1.31-3.37)	1.95 (1.17-3.22)
College/graduate school	64 (56.1)	2.25 (1.34-3.78)	1.64 (0.94-2.87)
Graduate degree	122 (56.5)	2.29 (1.46-3.59)	1.58 (0.97-2.58)
Body mass index			
Underweight	1 (33.3)	0.63 (0.06-7.16)	—
Normal weight	43 (44.3)	Reference	—
Overweight	119 (55.9)	1.59 (0.98-2.58)	—
Obese	161 (51.4)	1.33 (0.84-2.10)	—
History of type II diabetes			
No	242 (51.0)	Reference	—
Yes	82 (54.3)	1.14 (0.79-1.65)	—
History of myocardial infarction			
No	270 (52.4)	Reference	—
Yes	54 (48.7)	0.86 (0.57-1.30)	—
History of cancer			
No	226 (52.8)	Reference	—
Yes	98 (49.5)	0.88 (0.63-1.23)	—
Difficulty reading text (eg, newspaper)			
Not difficult at all/a little difficult	277 (51.2)	Reference	—
Moderate/extreme/activity-limiting difficulty	47 (55)	1.18 (0.74-1.87)	—
Depressive symptoms			
Minimal symptoms (0-4)	239 (51.5)	Reference	—
Mild to severe symptoms (5+)	85 (52.5)	1.04 (0.73-1.49)	—

Participant characteristics	Interest in using mobile app to communicate with health care team		
	Value, n (%)	Crude OR[a] (95% CI)	Adjusted OR (95% CI)
Anxiety symptoms			
Minimal symptoms (0-4)	249 (51.6)	Reference	—
Mild to severe symptoms (5+)	75 (52.5)	1.04 (0.71-1.51)	—
High perceived efficacy in patient-provider interactions			
Less confident (<45)	104 (51.2)	Reference	—
Very/extremely confident (45+)	220 (52.0)	1.03 (0.74-1.44)	—
How bothered by AF[c] symptoms in the past 4 weeks			
At most moderately bothered by any symptom	286 (52.1)	Reference	—
Quite/very/extremely bothered by ≥1 symptom	38 (49)	0.90 (0.56-1.44)	—
Satisfaction with current AF treatment			
Very/extremely satisfied	249 (51.0)	Reference	—
Somewhat satisfied	38 (50)	0.96 (0.59-1.56)	—
Mixed satisfied and dissatisfied or somewhat, very, or extremely dissatisfied	37 (60)	1.42 (0.83-2.43)	—
Needed help managing AF in the past 4 weeks			
None	274 (51.3)	Reference	—
Very little/some/quite a lot/very much	50 (54)	1.13 (0.72-1.76)	—
Anticoagulant management			
Not taking anticoagulant	181 (52.6)	Reference	—
On anticoagulant, managed by anticoagulation clinic	110 (55.6)	1.13 (0.79-1.60)	—
On anticoagulant, not managed by anticoagulation clinic	33 (39)	0.58 (0.36-0.95)	—
Online health information seeking in the past 4 weeks			
Not at all	89 (38.0)	Reference	Reference
At most once a week	148 (57.6)	2.21 (1.54-3.18)	1.86 (1.27-2.74)
Multiple times per week	87 (64.4)	2.95 (1.90-4.59)	2.24 (1.39-3.62)
Frequency of Facebook use in the past 4 weeks			
Does not use Facebook	126 (47.4)	Reference	—
Less than once a week over the past 4 weeks	28 (57)	1.48 (0.80-2.74)	—
Weekly over the past 4 weeks	41 (48)	1.04 (0.64-1.69)	—
Daily over the past 4 weeks	129 (57.1)	1.48 (1.03-2.11)	—
Has apps related to health			
No/unsure	184 (41.7)	Reference	Reference
Yes	140 (75.7)	4.35 (2.96-6.39)	3.92 (2.62-5.86)

[a] OR: odds ratio.

[b] Not included in the adjusted regression model.

[c] AF: atrial fibrillation.

Discussion

Principal Findings

In this contemporary community-based cohort of older patients with AF, we found that 70% used the internet and three-quarters were mobile users (ie, owned a smartphone or tablet computer). Among online patients, just over half used Facebook and 40% were interested in an online community for patients with AF. Among mobile users, 52% were interested in using a mobile app to communicate with their health care team. Women, younger patients, and those with elevated depressive symptoms were more likely to use Facebook. More educated patients, patients with obesity, frequent Facebook users, and those engaging in digital activities related to health were more likely to express interest in digital disease support. Men were also more likely to report interest in using a mobile app to communicate with their health care team.

In this sample of older patients with AF who used the internet, 53% reported using Facebook. We found that the oldest patients (aged 75-84 years and ≥85 years) were less likely to use Facebook, similar to national trends in social media use more generally among older adults [12]. Although social media use has increased dramatically among US adults aged ≥65 years in the past decade—from 2% in 2008 to 34% in 2016 [12]—the use of social media is more common among younger cohorts of older adults. In 2016, 47% of older adults aged 65 to 69 years, 41% of those aged 70 to 74 years, 24% of those aged 75 to 79 years, and 17% of those aged ≥80 years reported using social media [12]. The prevalence of Facebook use observed among online patients in our study is similar to these national estimates, considering that online patients represent 70% of the total SAGE-AF cohort. We also found that women were more likely to use Facebook than men, which aligns with data from the Pew Research Center that found that among US adults of any age, 62% of men and 74% of women used Facebook [23].

We found that patients with depressive symptoms were more likely to use Facebook than patients who were not depressed. Although a recent meta-analysis found depressive symptoms to be associated with more frequent social media use [30], the average age among participants in included studies was 22 years, and much less is known about depressive symptoms and social media use among older adults. Another limitation of previous research exploring the relationship between depressive symptoms and social media use is the lack of clarity about the directionality of the association—it may be that negative social comparisons on online social networks result in worsening of mood or it may be that individuals who are feeling depressed seek social support and connection online. In a national study of middle-aged and older women with chronic health conditions, women with depression reported more frequently relying on the internet for help and support than women without depression [31], suggesting that support may motivate Facebook use among older adults with AF with elevated depressive symptoms. Future research could explore how older adults with AF or other chronic health conditions with depressive symptoms utilize Facebook.

We found that 4 in 10 older patients with AF who used the internet were interested in an online AF patient community and that patients with higher education, obesity, more frequent online health information seeking, and daily Facebook use were more likely to express interest in an online AF patient community. In a national study of women with chronic health conditions, only 4% of women aged ≥65 years reported participating in an online discussion group, yet 27% of them said they would be somewhat or very interested in an online course or discussion group and 96% felt that it would be very helpful to get emotional support from people with similar problems [31]. This study extends this research by surveying interest in digital disease support among a contemporary community-based cohort of older adults and provides insights specifically into the interests of patients with AF. Our results indicate that among older patients with AF, those who are already engaged in online activities—online health information seeking and engaging with others via social media—are more likely to be interested in an online patient community. A study of middle-aged and older cardiac rehabilitation patients in Australia found that greater use of Facebook might be a predictor of greater willingness to participate in online patient support communities [13], concordant with our finding that patients who used Facebook daily were more likely to express interest in an online patient community for AF. Although we do have not information on patients’ social media activities, it may be that those who use Facebook daily are doing so to participate in a Facebook group for patients with AF.

In unadjusted analyses, younger patients, those with symptoms of depression or anxiety, patients who were bothered by AF symptoms, and those with lower AF treatment satisfaction were more likely to report interest in an online AF patient community. However, none of these factors were significantly associated with interest in an online patient community after adjusting for other factors, suggesting that this variance was captured by these other variables, such as frequency of Facebook use and online health information seeking. Indeed, in this study, we found that patients with depressive symptoms were more likely to use Facebook, and in previous research, patients who reported difficulty accessing medical care [32] or who reported problems with care coordination or care that was not patient-centered [33] were more likely to engage in online health information seeking or other online activities related to their health.

Recent qualitative research suggests that patients participating in online patient communities for AF find information and support provided through these communities to be helpful [14]. Results suggest that patients with AF make sense of their condition through communicating with other patients with AF online [14]. Members of the AF patient community seek knowledge about living well with AF and use the online community as a medium to discuss their personal experiences and gather information about the risks and benefits of different treatments [14]. Patients also seek information related to medication management in online communities, including concerns about safety and efficacy, dietary restrictions, and side effects [15]. Recent AF management guidelines recommend shared decision making with AF patients [34,35], and online resources are valuable sources of information and support for patients wishing to participate more meaningfully in their AF care. Clinics and health care providers may wish to provide their patients a list of online resources for AF (as seen in [35]) and encourage patients to join an existing online support community for AF, such as the American Heart Association and StopAfib.org’s MyAFibExperience, StopAfib.org’s discussion forum, Atrial Fibrillation Support Forum Facebook group, or the Lone Afib Forum. Given the potential benefits of engaging with other patients with AF and health care providers, clinicians may want to consider barriers to participation among AF patients not already engaging in digital disease management activities when recommending follow-up and disease education plans.

A little more than half of older adults with AF who owned smartphones and/or tablet computers (ie, mobile users) were interested in using a mobile app to communicate with their health care team. Data used in this study were collected before clearance from the Federal Drug Administration for the use of the Apple Watch and Apple Health app for managing AF electrocardiograms (ECGs), and as it becomes more commonplace for patients to send app-collected data to their health care team, interest in using a secure mobile app to communicate with one's health care team may increase. We found that patients with higher education, men, those who engaged in online health information seeking more often, and those with mobile apps related to health were more likely to express interest in patient-provider communication via a mobile app. Studies assessing the usability of health-related apps among older adults [10,20,36], including those for AF [10,20], have enrolled more men than women, supporting the finding that a higher proportion of men are interested in using apps to manage their chronic condition.

Similar to previous research [37], older patients with AF who already had health-related apps were the most likely to express interest in communicating with their health care team via a mobile app—76% of patients who used health-related apps reported interest in app-mediated patient-provider communication. For the 42% of older patients with AF who do not currently use health-related apps but would be interested in communicating with their health care team using a mobile app, training older adults in basic smartphone functionality may aid in learning how to use an app-based intervention [36]. Clinics or health systems could explore using a secure mobile app to connect patients and health care providers, either via a stand-alone app or by using an app to access secure messaging functions of a patient portal.

In unadjusted models, patients aged 75 to 84 years and those aged ≥85 years were less likely to report interest in using a mobile app to communicate with their health care team. However, this age difference was no longer statistically significant after adjustment for the other factors examined, perhaps older adults were less likely to engage in online health information seeking, which was strongly associated with interest in app-mediated patient-provider communication. A study using data from the California Health Interview Survey found that compared with adults aged 60 to 74 years, those aged ≥75 years had 0.37 times the odds of engaging in online health information seeking [38], and in another study, patients in their 70s were less likely to use their health plan's patient portal or send messages to their health care team through the platform [39]. Similarly, in unadjusted models, daily Facebook users were more likely to express interest in using an app than patients who did not use Facebook, but this difference was not significant in adjusted models, perhaps because of the overlap in patients who were high users of social media and those who had health-related apps or engaged in online health information seeking.

Although numerous apps related to the detection or management of AF exist, recent reviews have found that these apps vary in quality [40] and accuracy [21]. A recent review of 102 apps for patients with AF available on from Apple or Google Play found that the majority of the apps included information about AF and AF detection, and a quarter to a third of apps included symptom journals or medication reminders, and 1 app included a patient support community [40]. A quarter depended on an additional device [40]. The review did not report which apps included functionality allowing patients to communicate directly with their health care teams. Unfortunately, the review found that less than a fifth of apps (16% of apps from Apple and 13% from Google Play) included scientifically validated content [40]. Results of pilot studies of apps to help patients manage their AF appear promising [10]. In addition to including evidence-based AF information and behavioral strategies, apps to help patents with AF manage their health and communicate with their health care team should be developed to meet the user interface and functionality needs of older patients with AF [19,37].

Strengths and Limitations

This study has additional strengths and limitations. The SAGE-AF cohort was contemporary and geographically diverse, and participants were enrolled from cardiology, primary care, and electrophysiology clinics, and the cohort focused on older patients who are often excluded from studies on technology. Although our sample had limited racial/ethnic diversity—91% of participants were non-Hispanic white—this is similar to the demographic composition of Medicare beneficiaries with incident AF (91% white) [41]. We did not collect information that would allow us to calculate patients' financial resources relative to the federal poverty line, yet technology and social media are more common among adults with higher socioeconomic statuses [12,23]. The baseline interview did not include detailed questions about patients' online activities, including what type of health information they sought online, participation in Facebook groups, and the use of specific health-related apps, and thus, we do not know whether patients used digital resources related to the management of their AF. We found frequent Facebook use, online health information seeking, and having health-related apps were related to interest in digital disease support; future research could explore associations between seeking information related to AF symptoms, treatment, or self-management or using health apps specifically related to AF and interest in digital disease support.

Conclusions

A recent Cochrane systematic review of 11 trials concluded that the evidence was insufficient to infer that existing educational or behavioral interventions increased time in therapeutic range for patients with AF [8]. Given the complexity of medication adherence and other self-management activities between clinical encounters, digital health approaches may be an effective avenue for promoting adherence to medication and other lifestyle recommendations, including daily physical activity. A recent review of mobile health (mHealth) approaches to AF care summarized the use of technology for ECG or rhythm monitoring, heart rate monitoring, recording patient-reported symptoms and environmental factors, and medication adherence [9]. They also note challenges in mHealth research, including the need to demonstrate cost-effectiveness, increased workload for engaging with patients online, and reimbursement models for such care [9]. Although future research and policy work are needed to overcome these challenges, findings from this study indicate that many older patients with AF are interested in participating in an online patient community for AF and communicating with their health care team via a secure mobile app. Future research should explore these modalities for providing care to older patients with AF and supporting patients with their self-management activities, including symptom tracking and medication management.

In summary, we found that among patients aged ≥65 years with AF, 53% used Facebook, 40% were interested in an online AF patient support community, and 52% of mobile users were interested in using a mobile app to communicate with their health care team. Patients already engaged in online activities were more likely to express interest in these digital disease support modalities. However, even among the subgroup with the lower rate of expressed interest in these digital disease support modalities—patients aged ≥85 years—25% were interested in an online support community and 29% of mobile users were interested in using a mobile app to communicate with their health care team. Given the trends in technology adoption by generational cohorts [42], interest in digital disease support among older adults with AF is only likely to increase in the coming years. Additional research is needed on how to most effectively leverage social media and mobile apps to help older adults with AF manage their health. Understanding the characteristics of older online patients with AF who use social media and would be interested in digital tools to connect with other patients and communicate with their health care team can inform tailored behavioral interventions to help older patients with AF manage their health.

Acknowledgments

SAGE-AF was supported by the National Institutes of Health (NIH) grant number R01HL126911. Additional support for DDM was provided by NIH grants U54HL143541, R01HL126911, R01HL137734, R01HL137794, R01HL135219, R01HL141434, and National Science Foundation grant NSF-12-512.

Conflicts of Interest

AK has received research grant support from Pfizer through its Independent grants for Learning and Change, Pfizer and Bristol-Myers Squibb through its American Thrombosis Investigator Initiated Research Program, and from Bristol-Myers Squibb through its Independent Medical Education Grants. DDM has received research support from Apple, Bristol-Myers Squibb, FLEXcon, Samsung, Pfizer, Philips, Biotronik, and Boehringer Ingelheim. DDM has received consulting fees or honoraria from Bristol-Myers Squibb, Pfizer, Samsung Electronics, and FLEXcon.

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Abbreviations

AF: atrial fibrillation
aOR: adjusted odds ratio
BMI: body mass index
ECG: electrocardiogram
mHealth: mobile health
NIH: National Institutes of Health
OR: odds ratio
SAGE-AF: Systematic Assessment of Geriatric Elements in Atrial Fibrillation

Edited by N Bruining; submitted 01.07.19; peer-reviewed by A Dahl, E Da Silva, H Lee; comments to author 15.08.19; revised version received 28.08.19; accepted 31.08.19; published 14.11.19.

Please cite as:
Waring ME, Hills MT, Lessard DM, Saczynski JS, Libby BA, Holovatska MM, Kapoor A, Kiefe CI, McManus DD
Characteristics Associated With Facebook Use and Interest in Digital Disease Support Among Older Adults With Atrial Fibrillation: Cross-Sectional Analysis of Baseline Data From the Systematic Assessment of Geriatric Elements in Atrial Fibrillation (SAGE-AF) Cohort
JMIR Cardio 2019;3(2):e15320
URL: http://cardio.jmir.org/2019/2/e15320/
doi:10.2196/15320
PMID:31758791

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JMIR Publications
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