

Heart Failure Patients' Use of and Attitudes Toward the Internet and Mobile Health for Self-Care

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A thesis

submitted in partial fulfillment of the
requirements for the degree of

Master of Public Health

University of Washington

2023

Committee:

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Program Authorized to Offer Degree:

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Abstract

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Heart failure is a complex clinical syndrome that is mentioned in approximately 1 in 8 death certificates in the United States. Adherence to heart failure self-care behaviors is critical to minimize complications and prevent hospital readmissions. Mobile health technologies offer promising opportunities for enhancing self-care by enabling remote tracking and providing timely reminders. We sought to investigate three characteristics of heart failure patients with respect to their personal health information seeking behavior: (1) extent to which they use the internet to search for heart failure information; (2) extent to which they are familiar with mobile health apps and devices; and (3) perceptions they have about using an activity tracker or smartwatch to assist them in managing their heart failure self-care. Fifty heart failure patients were asked about their internet and mobile health usage. The structured interview included questions adapted from the Health Information National Trends Survey. More than 50% of the

patients reported using the internet to search for heart failure information in the past 12 months, experience using health-related apps, and thoughts that an activity tracker or smartwatch could help them manage heart failure. Qualitative analysis of the structured interviews revealed six themes: trust in their physicians, alternatives to mobile health apps, lack of need for or knowledge about mobile health devices, financial barriers to activity tracker and smartwatch ownership, benefits of tracking and reminders, and uncertainty of their potential due to lack of knowledge. Trust in their doctors was a major factor for heart failure patients who reported not searching for health information on the internet. While those who used mobile health apps and devices found them to be useful, patients who did not use these devices were generally unaware of or unknowledgeable about them. Patient-provider discussions about the potential uses of mobile health apps and devices with respect to heart failure self-care may impact their usage.

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Introduction

Background

Heart failure is a complex chronic condition in which the heart's function to fill or eject blood is impaired [1,2]. With an estimated prevalence of 6 million adults, it is a serious public health concern in the United States [3]. The incidence of heart failure among those aged 55 years and older in 2014 was approximately 1 million. In 2019, heart failure was the underlying cause of death for 86,177 individuals and contributed to 337,599 deaths. Heidenreich et al. project the prevalence of heart failure to increase to more than 8 million adults by 2030, a 46% increase from 2012, with the United States population growth [4]. They also suggest that the total cost of heart failure, which includes direct and indirect costs, is expected to increase by 127% between 2012 and 2030 reaching \$69.8 billion.

Heart failure not only has adverse consequences on quality of life but also increases the risk of mortality despite comprehensive treatment and management guidelines. Symptoms of heart failure include dyspnea, paroxysmal nocturnal dyspnea, and fatigue as well as lethargy [5,6]. Arrhythmias, such as atrial fibrillation and ventricular arrhythmias, and thromboembolism, such as stroke and deep venous thrombosis, are complications of heart failure that can lead to sudden death [5]. One study indicates that health-related quality of life in heart failure patients is a strong predictor of both all-cause death and heart failure hospitalizations [7]. Hospitalization among heart failure patients is particularly concerning as it has substantial financial implications related to health care expenditures. It constitutes 79% of the lifetime costs of heart failure care [8]. Moreover, there are approximately 1.25 million hospitalizations with a primary diagnosis of

heart failure per year, which costs the United States hospitals \$13.6 billion annually, making it the fifth most expensive treated condition [3,9].

Currently, lifestyle risk factors for heart failure include physical inactivity, obesity, and smoking [10]. Many reports have highlighted the importance of patient education as one of the strategies to improve the overall quality of care of heart failure patients [11-14]. Physicians advise physical activity, weight management, smoking cessation, and medication adherence to heart failure patients as part of their self-care regimen following their diagnosis [11]. However, 83% of all heart failure patients are hospitalized at least once, and 43% are admitted to the hospital at least four times [15]. Hospital readmission rates surpass 20% within the first 30 days of discharge and approach 50% within 6 months of discharge [16-18]. Reduction of complications and subsequent hospital readmissions may be facilitated by development of patient behaviors promoting heart failure self-care. By focusing on patient education to address patients' lack of health information and comprehension, as well as adherence to prescribed self-care, it is estimated that 30-day readmissions due to heart failure may be reduced by up to 75% [19,20].

With the rise in internet and mobile device usage, there have been significant increases in patients' use of the internet to find health information and mobile apps to manage health. Around one-third of patients used the internet to look for health information in the early 2000s [21,22]. Between 2008 and 2017, the proportion of American adults who looked for health information was greater than two-thirds [23]. Patients, particularly those with poorer health status [24,25], have also become more active consumers of health information [21,26,27]. Online health information has often influenced patients to consult physicians and ask them about the

information they have come across on the internet [28]. While past research studies have explored mobile device usage of the general United States population [29,30], there is limited literature on both health-related internet and mobile device use among patients with chronic conditions such as heart failure.

Objectives

Forming strategies that prevent heart failure and improve care efficiency is essential to decrease the prevalence of heart failure and its significant health care expenditures. Many studies have researched various home monitoring interventions such as home visits from nurses, websites, telephone services, and wireless sensors [31-34]. However, few have investigated heart failure patients' behaviors related to internet and mobile health usage. The purpose of this study was to assess heart failure patients' use of the internet and mobile health devices with respect to their heart failure self-care as well as patients' perceptions regarding these devices. We sought to investigate three main questions:

- (1) to what extent do heart failure patients use the internet to search for heart failure information?
- (2) to what extent are heart failure patients familiar with mobile health apps and devices?
- (3) what are the perceptions of heart failure patients about using an activity tracker or smartwatch to assist them in managing their heart failure self-care?

To answer these three questions, I performed a qualitative data analysis of structured interviews from a prior study (mHealth for Heart Failure: Predictive Models of Readmission Risk and Self-care Using Consumer Activity Trackers) with heart failure patients from a university-based

health system. We drew from two established models of information seeking behavior, the Berry Picking Model and Sense Making Theory, to hypothesize that heart failure patients seek health information from a variety of internet and mobile health resources. The Berry Picking Model considers the information search process to be a dynamic process that generally does not employ a specific strategy. Instead, Bates indicates that individuals gather relevant information in pieces through multiple searches [35]. The Sense Making Theory describes an individual's tendency to seek new information due to an information gap, while also emphasizing how people use the acquired information to make connections with existing knowledge [36].

Methods

Study Design

This qualitative study was part of a multi-method study that comprised qualitative interviews and quantitative surveys about heart failure patients' use of and attitudes toward the internet and mobile health [37]. This research study was designed to function as a bridge to our larger study that seeks to utilize a novel mobile app to issue adherence reminders (e.g., medication, exercise, and weight monitoring) and allow patients to monitor their heart failure self-care [38]. The purpose of this study was to determine the feasibility of conducting a future study that uses device data to predict hospital readmissions by demonstrating that subjects have experience or interest in using mobile health apps and devices. Our ultimate goal is to allow heart failure patients to download an app from an app store that adapts to their individual characteristics and allows them to manage heart failure more effectively.

Recruitment

In collaboration with the internal medicine, cardiomyopathy, and cardiology outpatient clinics, study personnel prescreened all patients diagnosed with heart failure (ICD-10: I50) at a university-based health system between February 2018 and September 2018. Patients who were between 50 and 80 years of age and were scheduled for an appointment at any of the three outpatient clinics were eligible for the study. The exclusion criteria included having a known cognitive disability (e.g., dementia), inability to communicate in English, and having visual or auditory impairments to the extent that one could not use a smartphone.

Eligible patients were contacted over the phone prior to their appointments and were provided additional information about the study. The verbal consent process was conducted over the phone in English with patients who were interested in participating. Each participant's New York Heart Association (NYHA) classification, which place heart failure patients into one of four categories based on their physical activity limitations [39], and their ejection fractions, which measure the percentage of blood leaving the left ventricle with each contraction, were reported upon enrollment in the study to describe the severity of their heart failure. Enrolled subjects received a \$20 gift card for completing the interview.

Data Collection

Participants were asked about their internet and mobile health usage based on questions adapted from the Health Information National Trends Survey (HINTS), which was formulated by the National Cancer Institute to assess access to and use of health information [40]. Our structured interview focused on internet access and usage (Appendix 1). It also included questions that

asked about participants' smartphone, tablet, and activity tracker ownership and use. In total, the interview guide consisted of 32 questions: 7 main, 19 follow-up, and 6 probing questions. Interviews were recorded using a digital voice recorder. The interviewers also wrote patient responses on paper to prevent loss of information from potential recording errors.

Data Analysis

Recorded interviews were manually transcribed using Microsoft Word. For qualitative data analysis, interview transcripts were imported into Dedoose 9.0.90, a qualitative data analysis software application. Handwritten interview notes were analyzed for interviews that were either missing recordings or difficult to transcribe due to poor audio quality of the recordings.

Data analysis was informed by the grounded theory approach, which derives the codes and codebook from the data [41,42]. Handwritten interview notes that included words and phrases taken by the interviewers (EL and KA) were used to generate the codes and codebook. The first three interviews were coded by AS and CWA after which any discrepancies were resolved through a consensus discussion. Remaining transcripts were coded by a single researcher (AS).

Through conceptual analysis of the data, general trends and patterns were identified. Potential relationships among the codes were also examined to determine themes across the categories of information. Emergence of patterns in the data facilitated grouping codes into themes. These themes were conceptualized to represent participants' collective experiences and perspectives through their own words.

Results

Demographics

Structured interviews were conducted with 50 heart failure patients (Table 1). Forty-five eligible heart failure patients declined to participate in this study. The interviews took between 2-15 minutes. Thirteen interviews were missing recordings, and poor audio quality prevented transcription of 7 interviews. Neither the recording nor the notes were found for one interview.

The average age of the participants was 64.5 years (Table 1). The majority of the participants were male (68%), of non-Hispanic or non-Spanish origin (82%), and white (67%). A high school degree was the highest level of education for 18% of the participants, whereas 38% had received a bachelor's degree or higher. More participants had annual incomes that exceeded \$50,000 (54%) than those that did not (46%). Most of the participants were determined to be NYHA Class II or higher (91%), while 62% had ejection fractions less than 50%.

Table 1. Demographics of study population.

Characteristic	Values
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 (\$; 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)

Internet Use and Website Type

Twenty-six of the 49 participants reported using the internet to look for heart failure information in the past 12 months (Table 2). Search engines (54%, e.g., Google, YouTube) were the most common type of website used followed by commercial websites (27%, e.g., WebMD), academic websites (23%, e.g., Mayo Clinic, American Heart Association), patient resources (12%, e.g., patient portal), and government websites (4%, e.g., MedlinePlus, National Institutes of Health). Google was the most mentioned search engine for heart failure information ($n = 13$), while WebMD was the most mentioned website ($n = 6$).

Table 2: Types of websites used by participants.

Website type (n=26)	Values, n (%)
Commercial website	7 (27)
Academic website	6 (23)
Government website	1 (4)
Search engine	14 (54)
Patient resources	3 (12)

Half of the participants (13/26) who reported using the internet to look for heart failure information recalled using heart failure-related terms, such as symptoms (Table 3). Management of heart failure was another common category as four participants looked for information about medications (e.g., Entresto) and two looked for information about monitoring devices (e.g., CardioMEMS, Kardia device). Around a quarter of the participants (6/26) performed web searches related to procedures and treatments (e.g., pacemaker, defibrillator, stem cell therapy).

Table 3: Categories of information searched by participants.

Category of information (n=26)	Values, n (%)
Heart failure-related medical terms	13 (50)
Medication	4 (15)
Monitoring device	2 (8)
Procedures/Treatments	6 (23)

Trust in their physicians. Qualitative analysis revealed one overarching theme related to web searches, or lack thereof. Nearly a third of the participants (7/23) who expressed not looking for heart failure information on the internet in the past 12 months attributed it to trusting their doctors. When asked about why he has not used the internet to look for heart failure information, one participant responded, “I guess I have faith in my doctors” (PID: 17).

Trust in their doctors to provide recommendations was an important factor as it allowed a couple participants to circumvent the existence of conflicting information on the internet. During his interview, one participant explained,

I trust the doctors who tell me what [I] need to do and what [I] need to look at. And so, I listen to them. That's the only difference. [There are] only different opinions [on the internet], and it makes it more confusing and scary (PID: 9).

Another participant provided similar comments:

I don't [look for heart failure information on the internet] because there's too much controversy. I prefer to go directly to like a doctor or something like that. I mean, I have in the past. You know, it's been way back. But you know, one researcher says one thing, and the other researcher says something else. Then you really don't know. Being a patient, you really don't know how to put that together. So, I would prefer to go directly to a medical doctor who can decipher it and explain it to me (PID: 26).

In addition to recommendations, physicians often provide educational materials and resources that are intended to support patients manage their diseases. As each physician or group of providers individually compiles disease-specific information together, the materials and resources may differ between hospitals and may not provide answers to all questions patients have outside of their appointments. However, the trust some participants have in their doctors allowed these materials and resources to become reliable sources of information outside of the hospital: “They gave me a booklet, and I go [to the clinic] about every month” (PID: 27). As a result, web searches for heart failure information were thought to be unnecessary for these participants:

I've gone to [the patient portal] to look at different information and messages on there. I haven't done any research (PID: 88).

Mobile Health App and Device Use

Of the 49 participants, 25 described using health-related apps (Table 4). Eleven of the 25 reported having experience using fitness tracking apps (e.g., Fitbit, Garmin). Ten stated using the preinstalled health apps (e.g., Apple Health, Samsung Health) on their smartphones. Nutrition, heart-related, and patient portal apps were used by 16%, 12%, and 16% of the participants, respectively. Two of the 4 participants who were unaware of health-related apps prior to their interviews expressed interest in learning more about such apps and how to use them.

Table 4: Type of health-related app used by participants.

Type of health-related app (n=25)	Values, n (%)
Nutrition	4 (16)
Physical activity	11 (44)
Health	10 (40)
Heart-related apps	3 (12)
Nutrition + Physical activity	4 (16)
Patient portal	3 (12)
Unaware of apps	4 (16)

Alternatives to mobile health apps. There were participants who opted to forgo mobile health apps and use different strategies to track their nutrition and physical activity instead. Many of these alternative methods to fitness and diet tracking focused on paper logs: “I use a spiral notebook for my daily weight, blood pressure, and all” (PID: 11). It was particularly common for tracking nutrition as one participant mentioned, “we write it down on paper, and we look at it” (PID: 13), and another said, “the food and stuff like that I do those manually” (PID: 26).

Lack of need for or knowledge about mobile health devices. Thirty-six participants stated they did not own an activity tracker or smartwatch, and 16 of them indicated that they did not see the need to own one. One participant said, “I haven’t really had the need for it” (PID: 81), while one other revealed, “I never thought I needed one” (PID: 77). Two different participants used the same words to describe how their physical inactivity contributed to their lack of interest: “I’m not that active” (PID: 84; PID: 11). The latter elaborated on her reasoning:

I just have not [moved into] maintaining that kind of documentation because I can’t—I don’t walk well, and there’s not much to track (PID: 11).

Two other participants used the same words in providing a reason for their lack of activity tracker and smartwatch ownership by indicating that they “don’t wear a watch” (PID: 33; PID 39). Another participant who reported not owning any watches explained his lack of interest in watches meant that he has “no interest whatsoever” in owning activity trackers or smartwatches (PID: 17). There were also a few participants who were not knowledgeable about activity trackers or smartwatches and their functions: “I don’t know anything about them” (PID: 69); and “I’m just now hearing about it” (PID: 94).

Financial barriers to activity tracker and smartwatch ownership. The cost of activity trackers and smartwatches was an inhibiting factor for multiple participants. One participant complained, “I think they are expensive, and I don’t want to spend money on it” (PID: 66). Despite the variety of available activity trackers and smartwatches, financial barriers prevented them from owning the devices: “I looked into all of that, but they’re very expensive and I can’t afford it” (PID: 77).

Perspectives on Activity Trackers and Smartwatches

Twenty-seven of the 49 participants thought that an activity tracker or smartwatch could help them manage heart failure (Table 5). On the other hand, 12 participants did not think that they could help them. Five answered with a maybe or possibly, while 5 others expressed that they were unsure.

Table 5: Potential of activity trackers and smartwatches to help manage heart failure.

Response (n=49)	Values, n (%)
Yes	27 (55)
Maybe/Possibly	5 (10)
Unsure	5 (10)
No	12 (24)

Benefits of tracking and reminders. Just under half of those (13/27) who thought that an activity tracker or smartwatch could help them manage heart failure alluded to their specific activity tracking features such as steps. One participant who owns a Garmin activity tracker said,

I don't get in as many [steps] as [my doctors] would like to see me get in, but [it] kinda makes me look at it to say, 'Okay, can I get up and walk for a few minutes?' (PID: 58).

Their ability to track heart rate and provide exercise reminders was mentioned by 7 and 5 participants, respectively. Among those who mentioned exercise reminders, one participant who owns a Fitbit activity tracker mentioned,

Just tracking my day-to-day to see if, when I'm behind on things and tries to give me a little more umph to do more. And each week, it gives me an overall assessment of what I did for that week, which day was bad. So, it just tries to help me with my activity (PID: 27)

Similar experiences were noted by another participant who owns a Fitbit activity tracker:

I like it that [it reminds] me ... It's a great thing to just try to motivate you. Now, I highly recommend that baby bigtime (PID: 78).

Uncertainty of their potential due to lack of knowledge. A total of 10 participants did not answer the question about whether activity trackers and smartwatches could help manage heart failure with a “yes” or “no.” Several participants among the 10 who answered otherwise alluded to needing more information about the devices to determine whether they can be helpful. Lack of familiarity with activity trackers and smartwatches were apparent in several responses:

I really couldn't answer that question ... I don't like really know what it could do for me.

What it's good for. What you use it to do (PID: 33); and

I don't know. Someone has to school me on it (PID: 69).

On the other hand, one participant who answered that an activity tracker or smartwatch could help said, “If someone tells you how to use it and what you're looking for and stuff, it could be helpful” (PID: 9).

Discussion

Principal Findings

The number of participants who had used the internet to search for heart failure information in the past 12 months (26/49) was similar to the number of those who had not (23/49). Thirty percent of the participants who had not recently used the internet to search for heart failure information explained that they trust their doctors to provide specific recommendations and resources for their treatment and management of heart failure. Older adults and patients with

chronic conditions have been known for their trust in providers for health information and reliance on them for medical decision-making, particularly those who do not use the internet for health information [43-45]. Furthermore, the participants' information seeking behaviors are consistent with and can be explained by another study that found heart failure patients rely heavily on their providers for heart failure information [46]. These results support the Sense-Making Theory that describes the impact an information gap has in driving people's propensity to gain new knowledge, since most of the participants sought information to better understand heart failure.

Contrary to a previous national study that reported commercial websites are the most used type of website among people surveyed using the HINTS [47], participants in this study most commonly used search engines (Table 2). This finding along with their use of various heart failure-related medical terms support the Berry-Picking Model (Table 3). The lack of a search strategy development or utilization among the participants is consistent with the model's consideration that information searches are not satisfied by a single search or set of documents. Instead, people's information needs and consequently their queries are modified over time through a process of selecting bits of information across multiple searches.

Similar to internet use for heart failure information, the proportions of participants who have and have not used mobile health apps were nearly equivalent: 25/49 and 24/49, respectively. One of the main findings concerning mobile health apps is that participants who do not use mobile health apps to track their nutrition and physical activity may utilize other methods such as paper logs as they are more comfortable and familiar with doing so. Though not specifically mentioned

in our interviews, lack of technological skills and perceived ability as well as violation of privacy may have been barriers to their use [48]. In regard to mobile health devices, several participants were not interested in owning mobile health devices or were unaware of their existence, which is in concordance with results from a previous study that investigated patient preferences for mobile health resources [49]. For those who have considered purchasing an activity tracker or smartwatch but did not have one at the time of their interviews, the cost of activity trackers and smartwatch was a barrier that discouraged them from owning one. As some health insurance programs offer free or discounted activity trackers, information about these programs may help patients overcome the financial barrier.

Current guidelines for secondary prevention after heart failure diagnosis include physical activity [11]. We found that more than half (27/49) of the participants thought that an activity tracker or smartwatch could assist them in managing their heart failure self-care (Table 5). Most of the participants who owned an activity tracker or smartwatch spoke positively of their experience. They cited their ability to track physical activity and send reminders that encourage physical activity. On the other hand, there were a few participants who had not heard of activity trackers or smartwatches and did not know how it could help them manage heart failure. Activity trackers have the potential to promote heart failure self-care and decrease disease severity by providing a method to monitor and encourage physical activity [50-52]. However, Andersen et al. also found that activity tracker data may stimulate fear, uncertainty, and anxiety [51]. Patient-physician discussions about activity trackers and smartwatches may improve patient knowledge about those mobile health devices and how they can help monitor heart failure.

Limitations and Future Directions

Enrollment in this study was restricted to patients from a university-based health system and those between 50 and 80 years of age. Results may not be applicable to the general population with heart failure as the study sample was relatively well educated and information on heart failure patients who declined to participate in this study was not collected. Generalization of our results may also be limited due to the high percentage of interview recordings that were missing or of poor quality and skewed demographics such as the greater proportion of male (68%) and white (67%) patients in the study sample (Table 1). English proficiency was crucial to comprehend the directions and questions as qualitative interviews were only conducted in English, so the study was confined to English language speakers. This exclusion criterion may explain the disproportionate representation. Future studies should include translation of this interview guide into other languages, particularly Spanish. Another limitation of the study is that it was conducted prior to the coronavirus disease 2019 (COVID-19) pandemic. Follow-up studies should be conducted to determine any changes in patients' behaviors regarding internet use for heart failure information as well as mobile health app and device use.

Conclusions

This study has demonstrated that participants are generally familiar with conducting searches on the internet and the functions of mobile health apps and devices. However, there are many factors that influence their decision to search for health information on the internet and use mobile health apps and devices. Both participants who have and have not engaged in those activities alluded to the importance of understanding their value prior to doing so. One major factor in influencing their self-care regimen was their relationships with their doctors. Owing to

the participants' trust in their expertise, many participants relied on recommendations and resources from their doctors. These findings suggest that discussions about mobile health apps and devices in regard to heart failure self-care between patients and physicians may influence patient perspectives and ultimately use.

References

1. Coronel R, de Groot JR, van Lieshout JJ. Defining heart failure. *Cardiovasc Res*. 2001;50(3):419-422. doi:10.1016/s0008-6363(01)00284-x
2. Jessup M, Abraham WT, Casey DE, et al. 2009 focused update: ACCF/AHA Guidelines for the Diagnosis and Management of Heart Failure in Adults: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines: developed in collaboration with the International Society for Heart and Lung Transplantation. *Circulation*. 2009;119(14):1977-2016. doi:10.1161/CIRCULATIONAHA.109.192064
3. Tsao CW, Aday AW, Almarzooq ZI, et al. Heart Disease and Stroke Statistics-2022 Update: A Report From the American Heart Association [published correction appears in *Circulation*. 2022 Sep 6;146(10):e141]. *Circulation*. 2022;145(8):e153-e639. doi:10.1161/CIR.0000000000001052
4. Heidenreich PA, Albert NM, Allen LA, et al. Forecasting the impact of heart failure in the United States: a policy statement from the American Heart Association. *Circ Heart Fail*. 2013;6(3):606-619. doi:10.1161/HHF.0b013e318291329a
5. Watson RD, Gibbs CR, Lip GY. ABC of heart failure. Clinical features and complications. *BMJ*. 2000;320(7229):236-239. doi:10.1136/bmj.320.7229.236
6. Inamdar AA, Inamdar AC. Heart Failure: Diagnosis, Management and Utilization. *J Clin Med*. 2016;5(7):62. doi:10.3390/jcm5070062
7. Johansson I, Joseph P, Balasubramanian K, et al. Health-Related Quality of Life and Mortality in Heart Failure: The Global Congestive Heart Failure Study of 23 000 Patients

From 40 Countries. *Circulation*. 2021;143(22):2129-2142.

doi:10.1161/CIRCULATIONAHA.120.050850

8. Dunlay SM, Shah ND, Shi Q, et al. Lifetime costs of medical care after heart failure diagnosis. *Circ Cardiovasc Qual Outcomes*. 2011;4(1):68-75.
doi:10.1161/CIRCOUTCOMES.110.957225
9. Liang L, Moore B, Soni A. National Inpatient Hospital Costs: The Most Expensive Conditions by Payer, 2017. In: *Healthcare Cost and Utilization Project (HCUP) Statistical Briefs*. Rockville (MD): Agency for Healthcare Research and Quality (US); July 14, 2020.
10. Del Gobbo LC, Kalantarian S, Imamura F, et al. Contribution of Major Lifestyle Risk Factors for Incident Heart Failure in Older Adults: The Cardiovascular Health Study. *JACC Heart Fail*. 2015;3(7):520-528. doi:10.1016/j.jchf.2015.02.009
11. Heidenreich PA, Bozkurt B, Aguilar D, et al. 2022 AHA/ACC/HFSA Guideline for the Management of Heart Failure: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines [published correction appears in *Circulation*. 2022 May 3;145(18):e1033] [published correction appears in *Circulation*. 2022 Sep 27;146(13):e185] [published correction appears in *Circulation*. 2023 Apr 4;147(14):e674]. *Circulation*. 2022;145(18):e895-e1032.
doi:10.1161/CIR.0000000000001063
12. Feltner C, Jones CD, Cené CW, et al. Transitional care interventions to prevent readmissions for persons with heart failure: a systematic review and meta-analysis. *Ann Intern Med*. 2014;160(11):774-784. doi:10.7326/M14-0083
13. Scalvini S, Giordano A. Heart failure. Optimal postdischarge management of chronic HF. *Nat Rev Cardiol*. 2013;10(1):9-10. doi:10.1038/nrcardio.2012.161

14. Giamouzis G, Kalogeropoulos A, Georgiopoulou V, et al. Hospitalization epidemic in patients with heart failure: risk factors, risk prediction, knowledge gaps, and future directions. *J Card Fail.* 2011;17(1):54-75. doi:10.1016/j.cardfail.2010.08.010
15. Dunlay SM, Redfield MM, Weston SA, et al. Hospitalizations after heart failure diagnosis: a community perspective. *J Am Coll Cardiol.* 2009; 54(18):1695–702.
10.1016/j.jacc.2009.08.019
16. Keenan PS, Normand SL, Lin Z, et al. An administrative claims measure suitable for profiling hospital performance on the basis of 30-day all-cause readmission rates among patients with heart failure. *Circ Cardiovasc Qual Outcomes.* 2008;1(1):29-37.
doi:10.1161/CIRCOUTCOMES.108.802686
17. Krumholz HM, Merrill AR, Schone EM, et al. Patterns of hospital performance in acute myocardial infarction and heart failure 30-day mortality and readmission. *Circ Cardiovasc Qual Outcomes.* 2009;2(5):407-413. doi:10.1161/CIRCOUTCOMES.109.883256
18. Krumholz HM, Parent EM, Tu N, et al. Readmission after hospitalization for congestive heart failure among medicare beneficiaries. *Arch Intern Med.* 1997;157(1):99–104.
19. Windham BG, Bennett RG, Gottlieb S. Care management interventions for older patients with congestive heart failure. *Am J Manag Care.* 2003;9(6):447-461.
20. Tsuyuki RT, McKelvie RS, Arnold JM, et al. Acute precipitants of congestive heart failure exacerbations. *Arch Intern Med.* 2001;161(19):2337-2342. doi:10.1001/archinte.161.19.2337
21. Murray E, Lo B, Pollack L, et al. The impact of health information on the internet on the physician-patient relationship: patient perceptions. *Arch Intern Med.* 2003;163(14):1727-1734. doi:10.1001/archinte.163.14.1727











22. Wagner TH, Baker LC, Bundorf MK, et al. Use of the Internet for health information by the chronically ill. *Prev Chronic Dis*. 2004;1(4):A13.
23. Finney Rutten LJ, Blake KD, Greenberg-Worisek AJ, et al. Online Health Information Seeking Among US Adults: Measuring Progress Toward a Healthy People 2020 Objective. *Public Health Rep*. 2019;134(6):617-625. doi:10.1177/0033354919874074
24. Houston TK, Allison JJ. Users of Internet health information: differences by health status. *J Med Internet Res*. 2002;4(2):E7. doi:10.2196/jmir.4.2.e7
25. Flynn KE, Smith MA, Freese J. When do older adults turn to the internet for health information? Findings from the Wisconsin Longitudinal Study. *J Gen Intern Med*. 2006;21(12):1295-1301. doi:10.1111/j.1525-1497.2006.00622.x
26. McMullan M. Patients using the Internet to obtain health information: how this affects the patient-health professional relationship. *Patient Educ Couns*. 2006;63(1-2):24-28. doi:10.1016/j.pec.2005.10.006
27. Wong C, Harrison C, Britt H, et al. Patient use of the internet for health information. *Aust Fam Physician*. 2014;43(12):875-877.
28. Bujnowska-Fedak MM, Węgierek P. The Impact of Online Health Information on Patient Health Behaviours and Making Decisions Concerning Health. *Int J Environ Res Public Health*. 2020;17(3):880. doi:10.3390/ijerph17030880
29. Carroll JK, Moorhead A, Bond R, et al. Who Uses Mobile Phone Health Apps and Does Use Matter? A Secondary Data Analytics Approach. *J Med Internet Res*. 2017;19(4):e125. doi:10.2196/jmir.5604









30. Bach RL, Wenz A. Studying health-related internet and mobile device use using web logs and smartphone records. *PLoS One*. 2020;15(6):e0234663.
doi:10.1371/journal.pone.0234663
31. Morcillo C, Valderas JM, Aguado O, et al. Evaluación de una intervención domiciliaria en pacientes con insuficiencia cardíaca. Resultados de un estudio aleatorizado [Evaluation of a home-based intervention in heart failure patients. Results of a randomized study]. *Rev Esp Cardiol*. 2005;58(6):618-625.
32. Zan S, Agboola S, Moore SA, et al. Patient engagement with a mobile web-based telemonitoring system for heart failure self-management: a pilot study. *JMIR Mhealth Uhealth*. 2015;3(2):e33. doi:10.2196/mhealth.3789
33. Wakefield BJ, Holman JE, Ray A, et al. Outcomes of a home telehealth intervention for patients with heart failure. *J Telemed Telecare*. 2009;15(1):46-50.
doi:10.1258/jtt.2008.080701
34. Suh MK, Chen CA, Woodbridge J, et al. A remote patient monitoring system for congestive heart failure. *J Med Syst*. 2011;35(5):1165-1179. doi:10.1007/s10916-011-9733-y
35. Bates MJ. The design of browsing and berrypicking techniques for the online search interface. *Online Review*. 1989;13(5):407-424. doi.org/10.1108/eb024320
36. Dervin B. An overview of sense-making research: Concepts, methods and results to date. Paper presented at the annual meeting of the International Communication Association, Dallas, TX, May. 1983.
37. Sohn A, Speier W, Lan E, et al. Assessment of Heart Failure Patients' Interest in Mobile Health Apps for Self-Care: Survey Study. *JMIR Cardio*. 2019;3(2):e14332.
doi:10.2196/14332








38. Sohn A, Speier W, Lan E, et al. Integrating remote monitoring into heart failure patients' care regimen: A pilot study. *PLoS One*. 2020;15(11):e0242210.
doi:10.1371/journal.pone.0242210
39. Criteria Committee of New York Heart Association. In: *Nomenclature and Criteria for Diagnosis of Diseases of the Heart and Great Blood Vessels. Ninth Edition*. Dolgin M, editor. Boston: Little, Brown & Co; 1994.
40. Nelson DE, Kreps GL, Hesse BW, et al. The Health Information National Trends Survey (HINTS): development, design, and dissemination. *J Health Commun*. 2004;9(5):443-84.
doi:10.1080/10810730490504233
41. Glaser B, Strauss A. *The discovery of grounded theory: strategies for qualitative research*. Chicago: Aldine Publishing Company; 1967.
42. Lingard L, Albert M, Levinson W. Grounded theory, mixed methods, and action research. *BMJ*. 2008;337:a567. doi: 10.1136/bmj.39602.690162.47
43. Marrie RA, Salter AR, Tyry T, et al. Preferred sources of health information in persons with multiple sclerosis: degree of trust and information sought. *J Med Internet Res*. 2013;15(4):e67. doi:10.2196/jmir.2466
44. Chaudhuri S, Le T, White C, et al. Examining health information-seeking behaviors of older adults. *Comput Inform Nurs*. 2013;31(11):547-553.
doi:10.1097/01.NCN.0000432131.92020.42
45. Hall AK, Bernhardt JM, Dodd V. Older Adults' Use of Online and Offline Sources of Health Information and Constructs of Reliance and Self-Efficacy for Medical Decision Making. *J Health Commun*. 2015;20(7):751-758. doi:10.1080/10810730.2015.1018603

46. Ivynian SE, Newton PJ, DiGiacomo M. Patient preferences for heart failure education and perceptions of patient-provider communication. *Scand J Caring Sci.* 2020;34(4):1094-1101. doi:10.1111/scs.12820
47. LaValley SA, Kiviniemi MT, Gage-Bouchard EA. Where people look for online health information. *Health Info Libr J.* 2017;34(2):146-155. doi:10.1111/hir.12143
48. Ahmad NA, Mat Ludin AF, Shahar S, et al. Willingness, perceived barriers and motivators in adopting mobile applications for health-related interventions among older adults: a scoping review. *BMJ Open.* 2022;12(3):e054561. doi:10.1136/bmjopen-2021-054561
49. Gordon NP, Crouch E. Digital Information Technology Use and Patient Preferences for Internet-Based Health Education Modalities: Cross-Sectional Survey Study of Middle-Aged and Older Adults With Chronic Health Conditions. *JMIR Aging.* 2019;2(1):e12243. doi:10.2196/12243
50. Mercer K, Giangregorio L, Schneider E, et al. Acceptance of Commercially Available Wearable Activity Trackers Among Adults Aged Over 50 and With Chronic Illness: A Mixed-Methods Evaluation. *JMIR Mhealth Uhealth.* 2016;4(1):e7. doi:10.2196/mhealth.4225
51. Andersen TO, Langstrup H, Lomborg S. Experiences With Wearable Activity Data During Self-Care by Chronic Heart Patients: Qualitative Study. *J Med Internet Res.* 2020;22(7):e15873. doi:10.2196/15873
52. Alharbi M, Straiton N, Gallagher R. Harnessing the Potential of Wearable Activity Trackers for Heart Failure Self-Care. *Curr Heart Fail Rep.* 2017;14(1):23-29. doi:10.1007/s11897-017-0318-z

Appendix 1: Structured Interview

1. Check survey response: “When you use the Internet, do you ever access it through a wireless network (Wi-Fi)?” [page 8]	No	Yes
 1.a If no , why not?		
 1b. Does expense play a role in your decision not to?		
2. In the past 12 months, have you used the Internet to look for heart failure information for yourself?	No	Yes
 2a. If yes , where and what?		
 2b. If no , why not?		
3. Check survey response: “Do you own a tablet?” [page 8]	No	Yes
 3a. If yes , are you comfortable using the tablet?	No	Yes
 3b. If no , why not?		
 3c. If yes , how comfortable? What do you do?		
4. Check survey response: “Do you own a smartphone?” [page 8]	No	Yes
 4a. If yes , are you comfortable using the smartphone?	No	Yes
 4b. If no , why not?		
 4c. If yes , how comfortable? What do you do?		

5. Check survey response: “Do you own a tablet?” && “Do you own a smartphone?” [page 8]		No	Yes
	5a. If yes to both, which do you prefer?	Smartphone	Tablet
6. Check survey response: “Do you own a tablet?” &&/OR “Do you own a smart phone?” [page 8]		No	Yes
	6a. If yes , do you use any software applications or "apps"?	No	Yes
	6b. If yes , do you use a fitness tracking/health app?	No	Yes
	6c. If yes , do you use a food or diet tracking app?	No	Yes
	6d. If yes , do you use the app store?	No	Yes
	6e. If yes , have the apps on your smartphone or tablet related to health helped you achieve a health-related goal such as quitting smoking, losing weight, tracking your diet or increasing physical activity?	No	Yes
	6f. If yes , have the apps on your smartphone or tablet related to health helped you make a decision about how to treat an illness or condition?	No	Yes
	6g. If yes , have the apps on your smartphone or tablet related to health led you to ask a doctor new questions, or to get a second opinion from another doctor?	No	Yes

7. Do you own an activity tracker/smartwatch?	No	Yes
 7a. If yes , what do you use it for?		
 7b. If yes , how often do you sync it?		
 7c. If yes , what brand of tracker/smartwatch do you own?		
 7d. If yes , how long have you had it?		
 7e. If yes , what things do you like the most about the activity tracker/smartwatch? What things do you like the least about the activity tracker/smartwatch? → Other thoughts?		
 7f. If no , why not?		
 7g. If yes or no , do you think an activity tracker/smartwatch could help you manage heart failure?	No	Yes