Mobile technology and health apps: Patient and provider experiences in cardiac rehabilitation

by

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A thesis submitted in conformity with the requirements for the degree of Doctor of Philosophy
Institute of Health Policy, Management, and Evaluation
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Abstract

This study focused on the use of mobile health and wellness applications (apps) in chronic disease management. There are over a hundred thousand health apps available for download on public app stores. These include apps in key areas for chronic disease management such as exercise and diet. However, there is little evidence on patient use of health apps to support self-management of chronic conditions. Therefore, the study objective was to describe cardiac rehabilitation patient and provider experiences with health apps and perceived impact on self-management and the patient-provider relationship.

An exploratory mixed methods design was used to gain an understanding of patient and provider perspectives and experiences. The study was conducted in a cardiac rehabilitation program in Ontario, Canada. A quantitative survey (n=242) focused on patient demographics and technology use profiles. Patient interviews (n=30) and a provider focus group (n=8) were conducted to explore perspectives on mobile technology and health app use as a part of self-management and the patient-provider relationship.

Results from this study describe an aging patient population with a range of cardiac diagnoses and co-morbidities. Ninety-two percent of patients in this study used mobile technology and 50% of those with mobile technology were using health apps.
Most patients and providers felt that health apps can support chronic disease management, particularly with respect to tracking progress against exercise and diet goals. Patients and providers also felt that they needed more support in using health apps and integrating them into care processes. This included the need for education on how to use apps as well as access to information on app accuracy and how to choose or recommend health apps given the large number available. Participants also emphasized the desire for health apps to connect patients and providers during and after the rehabilitation program. Health apps were mostly used by patients in the study in the absence of provider recommendations and without connectivity between patients and providers. Findings highlighted the need for health care practices to leverage and support health apps as a part of care during rehabilitation and post-discharge for patients self-managing in the community.
Acknowledgements

When I started my PhD the most popular advice I received from others was to embrace being a student and allow myself to become immersed in all things academic. I felt this was sage advice and promptly cleared all distractions from my schedule. Upon completion of my dissertation I find myself reflecting on my PhD years as a whirlwind of academic immersion, meeting my husband, having a baby and becoming a co-founder in a new business venture. It would seem I did not take that sage advice to heart! However, the path that I chose filled me with a deep gratitude for the amazing people in my life that believed in me and knew (even when I did not) that I could complete this PhD journey.

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Chapter 1
Introduction

1.1 Study Problem

This study fits within the context of an aging population, increased prevalence of chronically ill patients and a health system focus on promoting self-management in the community. This context illuminates the need to better support self-management and the ways in which patients seek and use self-care supports. While there is a growing body of research on internet use for information seeking and self-management support, there is less information about these behaviours with respect to mobile technology and applications. In this age of technology and electronic access to information, it is important for healthcare providers to understand patient behaviours with respect to use of mobile technology for information seeking and health behaviour change.

Self-care for chronic disease patients often includes the need to manage general health and wellness aspects of life, such as diet, exercise, sleep, and weight gain/loss. This is especially true in cardiac populations (the focus of the present study) where diet and exercise are key priorities in self-management care. There are a multitude of health and wellness mobile applications available for public download and use. However, we do not know how patients with chronic conditions are actively seeking and using these applications as a part of their self-management care.

The current study examined health and wellness application (i.e., “health app”) use in patients with cardiac conditions in a rehabilitation program in Ontario, Canada. For the purposes of this study, health apps included apps used on mobile devices such as smart phones or tablets, and apps that are used in wearable devices (such as Fitbit). Specifically, the study described use of these apps and perceived impact of app use on self-management and the patient-provider
relationship. Results from this study help set the stage for understanding use of health apps within a cardiac rehabilitation population and how we can better support patients with cardiac illness and other chronic illnesses in choosing and using apps as a part of their self-management. By gaining insight into current use of health apps, we can understand how to better engage patients in self-management supported by health apps.

1.2 Research Objectives

Overall research objective: To describe patient and provider experiences with mobile technology and health app use and perceived impact on self-management and the patient-provider relationship.

This overall objective includes the following specific objectives.

- Objective 1: To describe the general demographic and mobile technology use profile of this patient population (age, gender, level of education, household income, diagnoses, technology use, and health app use).
- Objective 2: To describe the types of health apps that patients are using or are interested in using.
- Objective 3: To explore patient and provider perceptions on how health apps influence self-management.
- Objective 4: To describe factors that motivate patients to use health apps.
- Objective 5: To describe patient and provider perceptions on barriers in the use of health apps.
- Objective 6: To explore patient and provider experiences and perceptions on how health apps influence patient-provider relationships.
Objective 7: To describe patient and provider perspectives on “ideal” future state of health apps.

Data was collected on the perspectives of three groups of participants: two patient groups with different degrees of mobile app use experience and one provider group. Specifically, these groups included cardiac patients that used health apps (i.e., health app use group), cardiac patients that did not use health apps (i.e., non-health app use group), and providers in cardiac rehabilitation.

The study of experiences from these three groups allowed for a thorough description of current health app use and perceived influences on self-management and the patient-provider relationship. It allowed for the emergence of themes that describe similarities and differences between the groups thereby contributing to knowledge on how we can best support chronic care patients through the use of health apps.

1.3 Relevance of the Research:
This study provides a description of mobile technology and health app use in patients with cardiac conditions, from the perspectives of patients and providers. Knowing what apps patients are currently using and their perceived impact on self-management and the patient-provider relationship can inform providers how to best support self-management in this emerging era of mobile technology and access to health apps. This research is especially relevant due to the current health system focus on self-management in the community, particularly for an aging population with increasing prevalence of chronic diseases. Improved management of health and wellness (i.e., positive health behaviours) can potentially improve self-management of chronic conditions, thereby reducing burden on the health system.
Chapter 2
Review of the Literature

Mobile technology use in healthcare is a new field and there is limited research on patient use of mobile apps for health and wellness and perceived impact on self-management of chronic conditions. There are however, related areas of research that help to set the stage for the current research within this context. Since the current study sought to describe patient use of apps for health and wellness, the concept of information seeking and self-initiated seeking of health apps is of particular importance, especially in relation to self-management and health decision-making behaviours. Previous research in the field of information seeking has focused on the patient-provider relationship and trust in different sources of information. Therefore, these areas of knowledge will be described as part of the background research for the current study.

There are also comprehensive bodies of knowledge on chronic disease, patient variables that impact information seeking, decision-making, self-management, internet information sources for healthcare, patient trust in information sources, and the role of the patient-physician relationship in information seeking. There are studies describing the number and type of health apps that are available to patients, and there is early stage research on patient use of these apps in relation to self-management behaviours. The following sections in this review of the literature describe previous research in more detail.

2.1 Chronic Disease

In Canada, as in much of the world, the number of people living with chronic conditions is increasing as the population is aging and as people with chronic diseases are living longer. In fact, by 2050 seniors are expected to make up 27% of the population. Today, more than 88% of adults in Canada have at least one chronic condition. Twenty-five percent between the ages of 65 and 79 have four or more conditions and more than one third of those 80 and older have four
or more conditions (Butler-Jones, 2010). In fact, only 24% of seniors in Canada account for 40% of documented healthcare use. These are mainly seniors with three or more chronic health conditions (Canadian Institute for Health Information, 2011).

With a focus on high users of the healthcare system, in Ontario only 1% of the population accounts for 34% of costs to the healthcare system and 10% of the population accounts for 79% of these costs (Commission on the Reform of Ontario’s Public Services, 2012). The top 1% are mostly patients with chronic disease including heart failure, chronic obstructive pulmonary disorder (COPD), and myocardial infarction (Wodchis, 2013). Patients with high morbidity in chronic disease (higher number of conditions and lower reported health status) are also more likely to experience unnecessary declines in health and result in increased burden on the healthcare system (Burgers, Voerman, Grol, Faber, & Schneider, 2010).

2.2 Cardiac Illness / Disease

In particular, more than two million Canadians have heart disease and it is the second leading cause of death (more than 33,600 deaths per year) in Canada (Government of Canada, 2015; Public Health Agency of Canada, 2016b). Risk factors for cardiac illness include health and wellness behaviours such as smoking, lack of exercise, poor diet, being overweight or obese and poor stress management (Government of Canada, 2015; Public Health Agency of Canada, 2016b; World Health Organization, 2015). With the large burden of cardiac illnesses, these behaviours are a main area of focus for health systems with respect to prevention, treatment and self-management of cardiac conditions. The Centre for Chronic Disease Prevention focuses on the importance of prevention and protective factors such as diet and exercise in its 2016-2019 Strategic Plan (Public Health Agency of Canada, 2015).
In focusing on chronic disease management for cardiac patients, it is important to consider secondary prevention programs or cardiac rehabilitation programs. These programs provide education and self-management activities for patients following a cardiac event. They focus on reducing risk factors and preventing further cardiac complications by targeting areas such as diet, exercise, smoking cessation, medication adherence, and psychosocial support (Heren et al., 2011).

When looking at cardiac disease profiles, it has been found that patients with lower socio-economic status, lower income, lower education and patients that are female are more likely to suffer from cardiac illnesses (Biswas, A., Oh, P., Faulkner, G. & Alter, D., 2016; Kubota, Y., Heiss, G., MacLehose, R., Roetker, N. & Folsom, A. (2017); Manrique-Garcia et. al., 2011;). However, it has been found that patients with these profiles are less likely to access in-person cardiac rehabilitation (Grace, S., Turk-Adawi, K., Santiago de Araujo Pio, C., Alter, D., 2016; Lemstra, M., Alsabbagh, W., Rajakumar, R., Rogers, M. & Blackburn, D., 2013). These findings indicate that cardiac rehabilitation is not reaching a significant portion of the cardiac patient population that is eligible for, and should receive rehabilitation care.

In considering difficulties with access to in-person rehabilitation, studies have found that exercise-based cardiac rehabilitation is effective in reducing cardiovascular mortality and hospital admissions (Heren et al., 2011). In the context of patients self-managing in the home, researchers have found that home-based and centre-based cardiac rehabilitation programs have the same outcomes in a number of measures such as subsequent cardiac events, exercise capacity, blood pressure and cholesterol levels (Dalal, Zawada, Jolly, Moxham, & Taylor, 2010). However, in-person cardiac rehabilitation programs can have low participation rates due to patients not wanting to participate in group activities, long distances for patients to travel to the
appointments, inability to participate due to work schedules, lack of parking and language barriers (Neubeck, Freedman, & Clark, 2012). One study focusing on cardiac rehabilitation in Canada found that only 34% of patients eligible for cardiac rehabilitation participate. This study also found contributing factors to low participation rates were due to the need to travel to rehabilitation classes, as well as low patient perceived need for rehabilitation and lack of physician referrals (Grace, Bennett, Ardern, & Clark, 2014). These factors point to a need for improved accessibility of programs and for support in the home via telephone, web and mobile apps. In this light, the Centre for Chronic Disease Prevention cited the harnessing of technology as one key area of focus in its 2016-2019 strategic plan. This plan notes that citizen expectations regarding access to data and technology are evolving and the health system needs to explore technology that can assist chronic patients in engaging in healthy behaviours (Public Health Agency of Canada, 2015).

As mobile technology vendors move forward into the development of such apps, an understanding of the patient perspective and motivational factors are essential in creating apps that are validated, effective and user-friendly. One study exploring the development of an app to support physical activity in sedentary adults found that participants preferred apps that can track progress towards goals, track physical activity, are flexible in being able to record and monitor different activities, have user-friendly interfaces and can integrate a music feature (Rabin & Bock, 2011). Studies have also found that patients find personalized information to be motivating as well as having social elements such as chat forums or tips from other patients. Studies have also found that patients want the ability to connect with providers (Neubeck et al., 2012).
Some apps have started to use rewards as a feature to motivate physical activity and healthy eating. These rewards might involve receiving badges for task completion and/or positioning of participants on leader boards to create a competition. There is little evidence to date on the impact of rewards as a part of cardiac self-management using apps (Neubeck & Freedman, 2015). However, it is these types of motivating factors that must be considered when supporting cardiac rehabilitation and self-management in the home.

A related body of work that is gaining traction is that of financial incentives for healthy behaviours. One example in Canada, the Carrot Rewards app was released in March 2016. Starting in the province of British Columbia and spreading to Ontario, Newfoundland and other provinces, this app rewards people for healthy behaviour through loyalty points with programs such as Aeroplan, PetroPoints, Scene and MoreRewards. This app works by rewarding people for the number of steps they take that is monitored by a variety of step counters (Public Health Agency of Canada, 2016a). Evaluations of this app were pending at the time of the current study.

A 2013 review of apps in cardiac care revealed that the majority of apps are heart monitors and medical calculators. Other apps include ECG education/interpretation, cardiology news/journals, blood pressure tracking, heart rate monitoring and CPR instruction (Martínez-Pérez, De La Torre-Díez, López-Coronado, & Herreros-González, 2013). While there are many general health and wellness apps available, there are fewer apps that have been developed specifically for cardiac rehabilitation with respect to self-management and promotion of healthy behaviours (Neubeck & Freedman, 2015)
2.3 Patient Variables that Impact Chronic Disease and Information Seeking

Factors that are often associated with chronic disease and multimorbidity include older age, female gender, low socioeconomic status, former daily smokers, physical inactivity and obesity (Marengoni et al., 2011; Rosella et al., 2014). The current study focused on self-initiated use of health and wellness apps (i.e., apps that patients chose to use rather than those used as part of a healthcare program), therefore there are certain factors to consider that may influence the ways in which patients seek, understand and act on information. These include the aforementioned demographic variables as well as level of literacy, economic and social resources, and the level of physical and/or cognitive impairments (Bastian et al., 2011).

Since the field of mobile apps in healthcare is a new area of study, it is important to draw upon findings from research on internet use (a close comparator to mobile use). A study by Mayoh, Bond and Todres (2011) focused on internet use for health information seeking in adults aged 30-89 years (mean and median age of 64) with chronic conditions. They found that as age increased patients were less likely to engage in online information seeking. Also, older patients who did use online information seeking were less likely than their younger counterparts to feel that online information increased their confidence in health decision making, nor did it increase confidence in discussing online findings with health professionals or sharing online findings with others. This study shows a difference with age in online information seeking behaviour and use of information. Other studies also support the findings that older people are less likely to search the internet for health information (Miller & Bell, 2012; Sajid, Shakir, & Baig, 2011; Xie, Wang, Feldman, & Zhou, 2013a) and it has been found that as patients age, trust plays a more important role when using the internet for health information seeking as older patients are less likely to trust online sources (Miller & Bell, 2012).
Interestingly, preliminary results in mobile app research point towards older adults having higher levels of sustained engagement than younger adults. One example was found in a study looking at engagement levels with a new heart disease prevention risk assessment and behavioural change app. Results showed that a higher number of younger adults downloaded the app, however, older adults were more likely to sustain engagement with the app (Goyal et al., 2016). These results support findings from the internet studies that older adults are less likely to trust online sources, however, results also point towards potential for sustained engagement in wellness behaviours once trust is gained in an older population.

On the topic of accessing information, it is important to consider aspects of literacy, health literacy and the ability to read and interpret information. As an example, patients have cited the need for more information to be accessible and written in lay terms that are easy to understand (Liang, Xue, & Chase, 2011; Longo et al., 2010). It has also been found that high information seekers are more likely to be well educated and more involved in decision making than their less educated peers (Protier, Moumjid, Bouhnik, Le Corroller Soriano, & Moatti, 2012). In the movement towards promoting patient engagement in decision-making and self-management, it follows that information and resources need to be easily accessible and understood by patients with different educational backgrounds. It has been found that reader level in health information sites needs to be lowered in order to be easily understood by the general population (Misra, Kasabwala, Agarwal, Eloy, & Liu, 2012).

2.4 Decision Making

Patient engagement in care and in medical decision making is becoming an increasingly important focus for healthcare providers. Engaging patients in decisions about their care involves finding appropriate methods of sharing medical information between providers and
patients to ensure effective communication with a common ground. The communication of medical information between providers and patients is a complex task when considering individual interpretations of information and the complexity of healthcare information. Medical information can be presented to patients for a variety of reasons including explanations, directions, reminders, choices and reviewing progress (Rajwan & Kim, 2010). In the context of the current research study, mobile apps focusing on health and wellness often have an educational component and are used for tracking progress against goals and making decisions regarding self-management.

In considering the impact of available information on patient decision-making, researchers have found that approximately 50% of patients living with chronic disease do not take their medications as prescribed (Lee, Grace, & Taylor, 2006). Conflicting information decreases medication adherence and patients will turn to alternate methods of decision-making when faced with this type of conflict. Researchers have found that when presented with conflicting information, patients will often use rules of thumb (i.e., always take medication with food), trial and error, weighing of benefits versus risks and seeking more information from providers, family and friends (Elstad, Carpenter, Devellis, & Blalock, 2012). This reliance of rules of thumb emphasizes the importance of clearly communicating information to patients and making sure that sources of information are accurate, appropriate and accessible. The importance of accurate, appropriate and accessible information and subsequent information interpretation applies to the use of health apps.

Decision-making and health behaviours have more recently been explored in the context of information seeking on the internet. As an example, the Health Information Wants Questionnaire (HIWQ) was developed to explore preferences in decision making as related to
information seeking. Through use of the HIWQ it has been found that frequent internet users prefer more information on diagnosis, self-care, complimentary medicine and laboratory results. Interestingly, these frequent users also want more decision-making autonomy for self-care, laboratory results, and complimentary medicine, but not for diagnosis (Xie, Wang, Feldman, & Zhou, 2013b). These results support the concept of patients self-initiating information seeking and using technology resources for information to support decision-making. For chronic care populations, understanding these preferences and variations in individual needs is essential in understanding how we can best develop and present healthcare information for ongoing self-management.

2.5 Self-Management in Chronic Care

Definitions of self-management have changed over the last decade and have moved from provider centered definitions involving one-way education for patients to more collaborative concepts (Bodenheimer, Lorig, Holman, & Grumbach, 2002). In a review of self-management studies, the following definition of self-management was created:

The individual’s ability to manage the symptoms, treatment, physical and psychosocial consequences and life style changes inherent in living with a chronic condition.

Efficacious self-management encompasses ability to monitor one’s condition and to effect the cognitive, behavioural and emotional responses necessary to maintain a satisfactory quality of life. Thus, a dynamic and continuous process of self-regulation is established. (Barlow, Wright, Sheasby, Turner, & Hainsworth, 2002, p.178)

This definition highlights the concepts of self-efficacy, engagement, self-regulation, monitoring, and the important role patients play in their own self-management. This definition of self-management is useful in the context of the current study as the focus is patient-driven
seeking of, and use of, health apps to enhance self-management of behaviours that can affect chronic (cardiac) conditions.

There is room for improvement in the area of self-management of chronic conditions. In the U.S. it has been shown that six key illnesses (congestive heart failure, HIV, osteoporosis, hypertension, diabetes and hypercholesterolemia) account for $15 billion in annual avoidable costs due to non-compliance with medications alone (IMS Institute for Healthcare Informatics, 2013). Self-management is complex and can involve taking the right medications at the right time, monitoring symptoms and understanding the influence of life style and behavioural choices such as diet and exercise. Of central importance in self-management is the concept of self-efficacy, in which patients have the skills and confidence to problem solve and to carry out health behaviours that are driven by appropriate patient-driven health goals (Bodenheimer et al., 2002).

Individual self-management needs are likely to change over time in chronic illness as symptoms change or complications arise (Bayliss et al., 2007). Given these complexities and changes in care needs, accurate and relevant information is key for patients in navigating their chronic condition(s). It follows that information seeking behaviour is an important aspect of the self-care pathway as patients learn how to manage their condition and alter care processes if their condition changes. In one example, Bass et al. (2006) looked at internet use of patients eight weeks after a cancer diagnosis and found a significant increase in internet use from time of immediate diagnosis to the eight-week follow-up visit. This study also found positive relationships between internet use and self-efficacy variables. Self-management in chronic disease has entered the internet and more recently the mobile age and health providers should understand how to best guide their patients in information seeking.
The majority of seniors with one or more chronic conditions have reported feeling confident in self-management of medical treatments at home. Eighty-eight percent of patients have reported feeling that they knew how to prevent further problems with their chronic condition, despite only 42% of them having spoken with a health professional in the past year about prevention of decline/complications. With respect to self-management, collaborative care is key in ensuring patient engagement, along with appropriate education in self-management, goal setting and decision-making. However, only 48% of seniors with one or more chronic conditions report having spoken with their primary care provider about goals (Canadian Institute for Health Information, 2011).

Despite self-reported feelings of confidence in self-care, there is room for improvement, especially in understanding medications. Seniors taking five or more medications are more likely to experience side effects requiring care (13%) than those taking one or two medications (6%). Yet, only 48% of seniors report having their medications reviewed by a doctor and only 47% report having medications side effects explained to them (Canadian Institute for Health Information, 2011). Also, as previously described, only 50% of patients living with chronic disease take their medications as prescribed (Lee, Grace, & Taylor, 2006).

Another study supported these findings, comparing patients with multiple chronic illnesses with patients with just one chronic disease. In this study, the former group reported more frequent problems in getting needed information and had more problems with their medications, primarily due to poor communication with providers and poor coordination of care (Parchman, Noël, & Lee, 2005). Likewise, it has been shown that providers should not follow individual disease Clinical Practice Guidelines (CPG’s) when treating patients with multiple co-morbid conditions. The recommendations from individual CPG’s can conflict and result in medication
errors, adverse medication events and self-management contradictions (Boyd et al., 2005).

Similarly, most information sources focus on just one disease or condition. With these findings in mind, it is important to study the number and type of chronic conditions within the context of self-management, especially in a cardiac population that may have co-morbidities. These findings from previous studies also speak to the importance of provider support for patients self-managing in the community.

2.6 Patient Trust in Information Sources

Patient trust in information sources is important to consider when designing healthcare education materials and directing patients to specific information sources. Trust in information sources could depend on factors such as accuracy of information, readability and authorship of the information. When looking at healthcare information websites, there is variability in the quality of information provided. Various studies on specific diseases have found that few websites provide accurate and high quality information and these studies have pointed to a need for regulation or accreditation of health websites. These findings suggest that health providers should recommend specific trusted sites for patients to obtain information (Langille et al., 2010; Sambandam, Ramasamy, Priyanka, & Ilango, 2007; Sullivan, Anderson, Ahn, & Ahn, 2011; Ward & Leach, 2012; Wasserman, Baxter, Rosen, Burnstein, & Halverson, 2014; Yeung & Mortensen, 2012). Furthermore, patients want trusted sites to be recommended by health providers (Rider, Malik, & Chevassut, 2014).

In the study by Mayoh, Bond and Todres (2011), 65% of patients noted that the quality of online health information needed to improve and only 57% of online health information seekers felt they could accurately assess quality of the information found. Participants in this study also noted that source referrals from health professionals would be helpful in locating information of
high quality that can be trusted. This is a concern globally, as shown by a study looking at health information seeking in the general population in Hong Kong. This study demonstrated that 60% of information seekers found health websites to be useful, however, 44% were uncertain about reliability of the information (Yan, 2010). Since the internet allows for access to healthcare information from across the world, it provides a large number of health information sites to patients online. Healthcare practices can vary between countries and this could result in confusion when interpreting information and understanding where the information fits within individual care plans. Providers can help to navigate this plethora of information. For example, it has been shown that patients with diabetes rely on and value their relationship with their healthcare providers when interpreting information (Longo et al., 2010). Information found online can be difficult to interpret and the provider relationship helps patients to navigate information sources and know what can be trusted.

There can be other barriers to online information seeking, in addition to concerns regarding accuracy. For example, there can be concern about information bias, particularly in web sites sponsored by pharmaceutical companies or chat forums that are not moderated by healthcare professionals (Gowen, 2013; Synnot et al., 2014). In the general population, online health information has been found to be most useful if it is authored by health professionals, easy to understand and has up to date information (Yan, 2010).

In thinking about social media tools such as email, twitter, chat forums and texting, patients are mainly concerned with privacy and confidentiality of information exchange (Fisher & Clayton, 2012). Since the app market is a new field within medicine, there is relatively little standardization or review of available tools for validity (Haffey, Brady, & Maxwell, 2013; Stevens, Jackson, Howes, & Morgan, 2014). A study conducted in 2016 reviewed past research
on physician experience in prescribing mobile apps as a part of care. They found that the use of apps that connect patients and physicians could help in symptom monitoring and communication; however, the lack of evidence as to the effectiveness of available apps was a barrier for physicians (Daifi, Bahrami, Kaakeh, & Kaakeh, 2016).

The FDA in the U.S. does regulate certain healthcare apps, mainly those considered part of a medical device (for example, to take blood pressure readings). The criteria for healthcare apps that require regulation will likely expand in coming years and include more clarity on validation of health and wellness apps. Steps are also being taken to validate educational smartphone apps in the United Kingdom where the National Health Service (NHS) has, as of 2013, an NHS reviewed library of healthcare apps. This library ensures that patients know where to find apps they can trust and that have been reviewed by providers to make sure they are clinically safe. The library also serves to help patients self-manage and become more empowered in taking part in their care (IMS Institute for Healthcare Informatics, 2013). This initiative by the NHS is one of the first of its kind, however it would follow that we can expect to see more validations of this nature in other countries in the near future. Details on app rating scales and research on app validation is further explored in Section 2.9 Health and Wellness Mobile Apps.

2.7 Patient-Provider Relationship

In traditional paternalistic models of patient care, providers are seen as the experts who tell patients what to do. However, in the current movement towards collaborative care and a patient-centered approach, patients and providers are seen as partners in disease management, albeit each with a unique lens and skill set (Kaba & Sooriakumaran, 2007). This shift places the patient in the driver’s seat with respect to their care as they become part of the care team and
play an important role in self-management of chronic conditions. In this new era of collaborative care, evidence suggests that providers should strive to teach problem solving skills to patients and empower them to set health goals and track progress towards these goals. In chronic illness, this type of collaborative approach can result in improved clinical outcomes and reduced health system costs for chronic patients (Bodenheimer et al., 2002).

Interestingly, despite the amount of information sources now available to patients through web sites and mobile apps, patients have noted that health professionals are still their main source of health information. However, it has been shown that only 34% of online information seekers felt that health professionals reacted positively to them bringing forward online information during a healthcare visit (Mayoh et al., 2011). A review of studies focusing on the patient-provider relationship found that there are three main reactions from providers that occur when patients come to them with information from the internet. The first is to feel threatened and respond defensively, the second is to collaborate in a discussion about the information, and the third is to guide patients to reliable sources of information (McMullan, 2006). This shows wide variation in providers’ reactions to patients sharing internet information. Consequently, having a high level of health concern or experiencing issues in the physician-patient relationship have been shown to be positively associated with increased health information searching. Therefore, patients that don’t trust their patient-physician relationship may be more inclined to seek internet information.

This points to the importance of the physician-patient relationship in relation to trust and information sharing (Renahy, Parizot, & Chauvin, 2010). When patients discuss information from the internet with their providers, they are more satisfied with their provider if the discussion is taken seriously and the providers show interest in the information (Bylund, Gueguen,
D’Agostino, Li, & Sonet, 2010). It is essential that health providers understand these factors when designing educational tools and providing information seeking guidance, be it via websites or via health apps for patients with chronic disease. It also supports the importance of the patient-physician relationship in information seeking and interpretation.

Patients also tend to be more likely to turn to the internet for information if they are dissatisfied with the level of empathy and quality of time spent with their provider (Tustin, 2010). It has also been found that patients with chronic diseases such as diabetes tend to ask health providers specific questions about self-management such as insulin dose, and they use internet searches for more general health questions (Wilson, 2013). As research focusing on the role of technology in information seeking continues, it will be important to consider provider-supported information seeking versus patient-initiated web or mobile app-based seeking.

2.8 Web 2.0

The way in which patients receive information has changed dramatically in the last two decades as health information is less often communicated in one direction from physician to patient. Instead, health information sources expand beyond the doctor to online information, peer forums, and now mobile apps. Additionally, as described above, patients are engaging in more two-way information exchanges with physicians, rather than one-way passing of information from physician to patient as per older more traditional models of medicine.

With the introduction of Web 2.0 there was a rapid disruption of available information sources as traditional in-person and paper-based methods of communication were complimented by online information sources such as websites, online chat forums and videos. Online information seeking is quickly becoming the most popular and most researched method of information seeking available to patients. A study by Mayoh et al. (2011) showed that in an
adult chronic care population, 60% of patients had used the internet and 75% (of this 60%) of patients had used the internet for seeking health information. The majority of patients found that it was easy to find online health information and only 33% had relied on referrals to locate the information. Therefore, the majority of health information seeking was self-directed. This phenomenon of seeking information on the internet is now often referred to as Consumer Health Informatics (CHI) and entire organizations, educational courses and research centres are dedicated to understanding this new field. While CHI began with a focus on the internet it can now be expanded to other areas of health informatics such as mobile apps and wearables. One of the leaders in this area is Gunther Eysenbach who describes CHI in the following way:

Consumer health informatics is the branch of medical informatics that analyses consumers’ needs for information; studies and implements methods of making information accessible to consumers; and models and integrates consumers’ preferences into medical information systems. (Eysenbach, 2000, p. 1713)

Online information is often used to complement information obtained through other sources such as health provider visits and also to establish a “research partnership” with health professionals (Synnot et al., 2014). Online information is seen by patients as enabling a strengthened dialogue in the patient-provider relationship when, for example, patient questions can be answered online about their condition and treatment and then further informed by the healthcare provider (Bass et al., 2006). Patients often search for information to prepare for a healthcare visit or to validate or challenge a healthcare visit outcome. Qualitative interviews have found that this searching for information addresses patients’ needs for acknowledgement as an individual (as opposed to a health card number), reduces uncertainty, and assists patients in gaining more perspective on their health condition (Caiata-Zufferey, Abraham, Sommerhalder,
& Schulz, 2010). It has been shown that the most commonly sought after online health information is for health improvement, medical treatment, family health and health issues that are difficult to talk about (Leung, 2008).

A study by Gowen (2013) exploring internet health information seeking in young adults with mental illness found that the most common topics researched on the internet were medications, diagnoses, treatment options, access to healthcare, and supports and resources. Motivations for going online for health information were to seek out additional information on top of what was given by their health provider, to seek out community or others in similar situations, to prepare for a healthcare visit, to find information anonymously and to get self-care advice when there was no access to formal health providers. Mental health is important to consider in complex chronic disease populations as chronic care patients often suffer from one or more mental health issues, either as a primary diagnosis or as a condition that is secondary to physical decline/disability (World Federation for Mental Health, 2010).

Online videos such as those found on You Tube can also be sources of information for patients. One recent study described a snapshot of the first 100 videos that appear on You Tube regarding breast reconstruction. The authors found that while these videos do not provide comprehensive information, most are educational and provide some facts about the procedure (Tan, Kok, Ganesh, & Thomas, 2013). You Tube videos are just one of many different ways that the internet can inform (or misinform) patients and this research showed that there is room for improvement in the quality of information provided via videos.

Email as a form of information communication is becoming more widely used in healthcare. Email relies on a two-way communication exchange and is considered to be one method for patients to seek out information. A systematic review conducted between 2000 and
2008 revealed that email usage was variable between providers with 16-72% of health professionals using email to communicate with their patients. This review found that both patients and providers saw the benefits of using email; however, there were concerns about confidentiality and security (Ye, Rust, Fry-Johnson, & Strothers, 2010). Similarly, text messaging can be used for communication and for information exchange in disease prevention and management (Armstrong, 2009). While not as broadly studied as email communication, it would follow that the same concerns regarding privacy and security would apply to text messaging. In a study by Fisher and Clayton (2012), 56% of patients in a family practice said they would like their health providers to use the internet or mobile phone apps for appointment setting, diagnostic test results, prescription notifications, health information and as a forum to ask questions. Even for patients who did not currently use this type of technology, 48% would consider using them if their provider used them.

2.9 Health and Wellness Mobile Apps

Finally, mHealth is a growing field within healthcare involving the use of mobile phone apps and more recently, the inclusion of wearable devices such as smart watches. As defined by the National Institutes of Health (NIH), mHealth is the use of mobile and wireless devices to improve health outcomes, healthcare services, and health research (Slaper & Conkol, 2014).

Health apps are important to consider within the context of self-management and chronic disease. In 2000, a large U.S. study showed that primary risk factors leading to death were tobacco use, poor diet and physical inactivity, and alcohol consumption (Mokdad, Marks, Stroup, & Gerberding, 2004). In Ontario in particular, the leading cause of death is chronic disease (79% of all deaths) with cancer, cardiovascular disease, diabetes and respiratory diseases making up the majority of chronic illness. Interestingly, the risk factors associated with these
four chronic illnesses mimic the leading causes of death found in the large U.S. study: tobacco use, poor diet and physical inactivity, and alcohol consumption (Cancer Care Ontario, 2012).

According to a 2015 study by the IMS Institute for Healthcare Informatics there were more than 165,000 health apps available on the market for Android and iOS platforms. Thirty-six percent in the category of fitness, 17% for lifestyle/stress and 12% in the category of diet and nutrition. Disease specific apps accounted for nine percent of health apps on the market and focused within the areas of mental health, diabetes, and heart/circulatory disease. Approximately 10% of these health apps had the capability to link to a device such as a wearable with the majority of these for fitness.

Interestingly, of the 165,000 health apps available, only 36 apps account for nearly 50% of overall app downloads (IMS Institute for Healthcare Informatics, 2015). When looking at mobile health categories, one study found that fitness apps account for 31% of health apps, medical reference apps come in at 17%, wellness apps at 16%, nutrition apps at 7% and medical condition management apps account for 7% of all health apps. Remaining smaller portions of the health app market are for apps such as those for health records, diagnostics, compliance, reminders, remote consultation and monitoring (Research2Guidance The App Market Specialist, 2014). The most frequently downloaded apps are for fitness and diet, followed by apps for heart rate, period tracking and pharmacy/prescriptions. Of the most popular health apps, 65% connected to social media, thereby pointing to the potential importance of this type of app feature (IMS Institute for Healthcare Informatics, 2015).

The majority of health apps are used to inform or instruct with some used for recording and even fewer for display, guidance, reminders and communication. A small number of apps can be used for mobile monitoring in which patients enter in information for providers to view
and intervene with treatment advice if necessary. However, many of these apps are not for people with multiple chronic conditions as they tend to focus on one disease. As well, the most prevalent chronic conditions are underserved in the apps that are available (IMS Institute for Healthcare Informatics, 2013, 2015).

As more apps for self-management and related health and wellness aspects are entering the market, there is an increasing need to rate apps in order to guide quality assurance, and report app reliability and validity. As mentioned earlier in this review of the literature, the United States Food and Drug Administration (FDA), for example, guides the regulation of medical apps and “exercises enforcement discretion” for other health apps such as those for self-management (U.S. Food and Drug Administration, 2015). Generally, medical apps are those used with a medical device like a blood pressure monitor or a blood glucose monitor. As summarized in a recent article in the Canadian Medical Association Journal, the U.K. the United States (U.S.) and Canada all have medical device regulations for health apps (Kwong 2015).

The National Health Service in the U.K. has a health apps library for government approved apps with ratings of quality. The FDA in the U.S. has an incomplete listing of apps, while Health Canada does not provide a listing nor does it provide easily accessible or clear guidelines as to what constitutes a medical app or how one might rate apps for quality and risk (Kwong, 2015). In the absence of a listing of published apps that physicians can use as a resource, The Canadian Medical Association has published a report for physicians that outlines guiding principles when recommending apps for patients to use. This report stated that only 16.5% of physicians recommend apps to patients, mainly due to a lack of guidance in what to recommend. Guiding principles include that the app is endorsed by a recognized medical or
professional association, that it is usable, reliable, has clear privacy of data and is not in conflict of interest with the physician (Canadian Medical Association, 2015).

Researchers are also looking into ways to rate health apps. A new Mobile App Rating Scale (MARS) was developed by researchers in Australia in order to have a reliable tool that assesses app quality. This particular scale uses four measures to assess app quality: engagement, functionality, aesthetics, and information quality (Stoyanov et al., 2015). Following the development of the MARS scale, another study reviewed health app rating scales and from a review of features in existing scales, formed a checklist for evaluating apps for chronic disease management. The main function of this checklist is to screen chronic disease apps for quality and reliability. Interestingly, the authors note that the majority of items chosen for this checklist come from the MARS scale, with some additional items from other scales. The checklist focuses on engagement of the user, functionality, ease of use and information management (Anderson, Burford, & Emmerton, 2016). There are also websites available for sourcing and evaluating health apps. These include My Health Apps, Happtique, IMS Health AppScript, the National Health Service (NHS) Choices Library, and iMedical Apps (IMS Institute for Healthcare Informatics, 2015; Neubeck et al., 2012). These websites employ a number of strategies for evaluating health apps, including gathering information from the app source or developer, incorporating professional reviews of apps and having user ratings of apps available.

A number of institutions and healthcare organizations are exploring support for providers in prescribing apps. One example is in the NHS where several hospitals are testing app prescriptions in the areas of gestational diabetes and COPD. The intention is to then extend app prescriptions into other patient populations as a part of care (Reynolds, 2017). A second example is in Mount Sinai Health System in New York where the organization has launched an
enterprise-wide platform for prescribing apps. This platform, RXUniverse, supports the prescription of apps by practitioners across many diagnoses and is integrated with the health provider electronic health record (EHR) (Mack, 2016).

In Canada, the mobile phone penetration rate is steadily increasing, and in March 2015, 68% of Canadians owned a smartphone, up from 55% in 2014. More recent 2017 statistics available in the U.S. show that 95% of Americans own a mobile phone, 77% of which are smartphones (Pew Research Centre, 2017). Smartphone users of all ages are downloading and using apps with the highest average use (8.88 apps) by 18-24 years olds with a general decline in use as age increases. Interestingly, there is a slight blip in this trend as those aged 55-64 are using slightly more apps on average (5.30 apps) than those aged 45-55 (5.26 apps). Adults aged 65 and over are using an average of 3.19 apps (Langlois, 2015). In developed nations, a 2014 study by Deloitte found that 35% of adults over 65 own a smartphone, 43% of those 55-64 and 57% of those 45-54 (Deloitte, 2014). The recent statistics available from the U.S. show that 42% of those aged 65 and over have a smartphone and 74% of those aged 50-64 have a smartphone (Pew Research Centre, 2017). These figures speak to an increasing trend in smartphone ownership in older demographics.

In the U.S. in 2012, 19% of smartphone users had at least one health app on their phone with the most popular being exercise, diet and weight loss. Of all the health app downloads, the most popular in order of most frequently downloaded were exercise and heart rate monitoring (38%), diet/food/calorie counters (31%), weight loss (12%), period/menstrual cycle (7%), blood pressure (5%), WebMD (4%), pregnancy (3%), blood sugar/diabetes (2%), medication management (2%), mood (<1%), and sleep apps (<1%). There were also 14% of adults downloading “other” health apps such as those pertaining to hearing, health insurance, brain
trainers, allergy alerts, hypnosis, pharmacy apps, smoking cessation, asthma apps, and symptom/diagnosis guides (Fox & Duggan, 2012). These trends identified in 2012 were similar in a more recent study. This study conducted a survey with 1,604 mobile phone users in the U.S. Findings demonstrated that 58% of mobile phone users had downloaded a health app and that fitness and diet apps were the most commonly used. People using health apps were most likely to use them daily (i.e., frequent use). This study also found that the most common reasons for not downloading health apps were lack of interest, cost and concern about data privacy. Forty-six percent of those using health apps had stopped use at some point primarily due to data entry burden, loss of interest or hidden costs. Those using health apps tended to be younger, with higher incomes and more highly educated (Krebs & Duncan, 2015). This study is especially relevant in the context of the current study and provides insight into similar areas of study focus but with a more general population.

More recently wearable devices have entered the scene with global sales of 4.0 million smart watches and 13.5 million health and fitness trackers in 2014. Activity tracking (such as number of steps or heart rate) has been noted as the primary reason people are purchasing wearable devices (GFK, 2015). Research on the effectiveness of wearables in chronic disease management is sparse as this is a new field of work. However, there are a few early studies that point to positive effects of wearables in chronic self-management and related healthy behaviour promotion. Two recent studies have demonstrated that the use of a Fitbit wearable device to track steps and minutes of physical activity resulted in significant positive changes in health activity behaviours. Interestingly, the researchers found that text prompts and pedometers were shown to be ineffective in changing activity levels (Cadmus-Bertram, Marcus, Patterson, Parker, & Morey, 2015; Wang et al., 2015). Similarly, another study evaluated user experiences with
different types of wearables. This study gave 32 chronic disease patients a different wearable
device for at least three days and then evaluated their experiences. Findings from this study
showed that 73% of the participants had a positive experience with at least one of the wearable
devices and planned to purchase one post-study to help them with fitness tracking. Participants
in this study also preferred the more sophisticated wearables such as Fitbit over simple
pedometers (Mercer et al., 2016).

Studies have shown that the primary reason for using a health and fitness app was for
goal tracking (30% of health and fitness app users), followed by awareness of health issues
(28%), and motivation (27%). Other reasons, each cited by less than 7% of users, include
identifying unhealthy habits, medication adherence, connecting with an expert, and competition
(Statistica (a), 2014). In relating app use findings to patient factors, it has been shown that those
who are younger, those with higher incomes and those with higher levels of education are more
likely to have a health app on their phone (Fox & Duggan, 2012).

Most health apps focus on individual use apps that are publicly available for download. There is,
however, an emerging field in the development of apps that connect patients and
providers. These apps are mainly disease specific and focus on symptom monitoring and
patient-provider communication. Many are still in early phases of research and development and
are testing outcomes in clinical effectiveness, cost effectiveness and patient experience.
Examples of these apps in Canada can be found in areas such as post-surgical monitoring
(Armstrong, Coyte, & Semple, 2015), chronic care (Steele Gray et al., 2016), diabetes care
(Cafazzo, Casselman, Katzman & Palmert, 2012), and cardiovascular disease care (McGillion et
al., 2016; Seto et al., 2012a, 2012b). These apps require provider engagement and integration of
the app into practice, therefore evaluations of validity of app use are of central importance.
Early studies evaluating these types of apps have shown promising results. One example, a multi-country review by Deloitte (2015) of health apps that connect patients and providers illustrated positive results in many areas of healthcare through indicators of clinical outcomes, cost effectiveness and patient satisfaction. In the heart failure population a systematic review of telemonitoring studies found that most studies showed improvements in outcomes such as quality of life and decreased hospitalizations. The studies in this review used heart rate and blood pressure monitoring hardware, with transfer of information via telephone and video visit (Maric, Kaan, Ignaszewski, & Lear, 2009). Another systematic review looked at similar telehealth methods for several different patient populations. Again, results demonstrated that most studies resulted in improvements in clinical outcomes (particularly in heart disease patients) (Dellifraine & Dansky, 2008). Results from these systematic reviews point towards overall effectiveness of telehealth in improving outcomes for patients in the community, however, they focus on acute symptom monitoring rather than wellness behaviours and health goal monitoring.

In Canada, similar studies in a heart failure population have shown that the use of a mobile app for patient and provider monitoring of weight, blood pressure, ECG’s and daily symptoms have demonstrated positive results. These results have shown improvements in quality of life and self-care management in heart failure patients (McGillion et al., 2016; Seto et al., 2012a, 2012b). Many of these early studies focus mainly on supporting patients in monitoring acute symptoms, transferring health record information and conducting virtual visits with providers. Again, they do not support wellness behaviours and monitoring progress against health goals.
There is less evidence to date on supporting healthy behaviours in chronic care patients through health apps that focus on wellness behaviours such as exercise and diet. There are also few studies of this nature that leverage a patient-provider connection for monitoring progress against wellness goals. One early study by Widmer et al. (2014) looked at improving the health of employees that were found to be at risk for heart disease. The study implemented an online and mobile app-based program that identified risks, showed employees what they needed to improve and how to improve (i.e., through health behaviours such as diet and exercise). It also showed results on their risk indicators over time with improvements if any were made. Results from this study demonstrated positive clinical outcomes on indicators such as cholesterol levels, blood pressure, blood glucose and weight. A more recent study by Goyal et al. (2016) focused on prevention of heart disease in a publicly available app that assessed risk and provided wellness activity challenges that were customized based on individual risk factors. The app also provided progress views and rewards in the form of point systems and air mile rewards. Results from this study showed that 85% of participants completed 1-14 challenges over a period of 30 days. Younger people downloaded the app more than older people; however, older people remained engaged with the app for longer periods of time, thereby showing differences in forms of engagement with age. These studies support the use of wellness apps for behaviour change, particularly in people at risk for heart disease. While such studies did not connect patients directly with health providers, they did show potential for supporting positive wellness behaviour change through the use of mobile health apps.
2.10 Conceptual Framework

A variety of models have been used to guide studies in health behaviour, in health technology and in chronic care. With the focus on chronic care and information seeking related to self-care management in the community, the Model for Improvement of Chronic Illness Care (Figure 1), otherwise known as the Chronic Care Model (CCM) is central in current research in this area. This model focuses on elements that need to be in place to shift care to the community. It highlights the importance of interactions between patients and providers to accomplish this shift in care and describes patients as informed and activated in a community that has resources and policies in place to support self-management. It also describes the need for a supportive health system to be in place with elements of decision support, delivery system design and clinical information systems (Wagner, 1998). These aspects describe an ideal model of care for patients living in the community with chronic conditions, with consistent interaction and connection between patients and providers.

![Figure 1. Model for Improvement of Chronic Illness Care / The Chronic Care Model (CCM) (Wagner, 1998).](image-url)
While the CCM describes a structure that health systems can aspire to achieve, it does not fully describe the current situation of care that patients experience in the community. Given results from past studies looking at information seeking, it seems that patients do not always feel that their interactions with providers are consistently productive, especially as information seeking efforts are often met with resistance from providers (Mayoh et al., 2011; McMullan, 2006). Nor do all patients feel fully informed about their care and related self-management such as understanding medications (Elstad et al., 2012; Lee et al., 2006). Also, the CCM does not describe patient-driven behaviours in self-management that are not guided by a provider such as information seeking and use of the internet and mobile health apps.

Since the CCM was introduced, there has been an increased presence of technology and eHealth tools that support self-management and consequently, the need for an adapted version of the CCM that includes technology. As such, the eHealth Enhanced Chronic Care Model was recently introduced (Figure 2) (Gammon, Berntsen, Koricho, Sygna, & Ruland, 2015). The purpose of the eCCM is to show how eHealth tools can be used to aid patients in self-management in chronic care. This model leverages the Data, Information, Knowledge, Wisdom framework of Ackoff (1989) to show how data ultimately translates into improved wisdom and health outcomes. The model also provides eHealth examples under the categories of self-management support, delivery system design, clinical decision support, clinical information systems and eHealth education (Gee, Greenwood, Paterniti, Ward, & Miller, 2015).
The eCCM also places patient-provider interactions as central in an ideal structure for supporting self-management and care in the community. The eCCM, like the CCM, provides a framework that health providers and policy makers can aspire to; however, it does not describe current situations of supports and relationships of care that patients experience in the community. Nor does it describe patient self-directed information seeking and self-management behaviours that occur outside of the patient-provider relationship, such as seeking, downloading and using health apps. The model also does not describe factors that influence patient behaviour such as demographic variables, or socio-economic status. There is an assumption within the model that patient health behaviour is driven by provider interactions.

The CCM and eCCM are focused on provider driven supports and structures that aid in chronic care management. In this age of the internet and mobile technology, patients have a vast
amount of health information at their fingertips, along with tools such as peer forums, healthy behaviour tracking tools, symptom tracking tools and medication management tools. This type of health information is available on the internet and through mobile apps. The CCM and eCCM also do not account for chronic care patients living in the community who may not have access to providers or who choose not to access providers and prefer to manage their care on their own. The CCM and eCCM assume that patients have access to, and want an interaction with providers. However, it is important to consider that even for patients who have this interaction there may be elements of their self-management and care that they conduct without assistance from providers. This notion of self-directed care is supported by definitions of self-management that focus on self-efficacy, patient-driven goal setting and patient monitoring of health behaviours (Barlow et al., 2002; Bodenheimer et al., 2002). It is this aspect of self-directed information seeking and care behaviours combined with patient-provider interactions that influence care, that guide the focus of the current study.

A third model is considered in the context of the current study. This is the Model of Individual and Family Self-Management Theory (Ryan & Sawin, 2009). This model as described in Figure 3, focuses on self-management as it relates to individuals and their families. It is a patient-centred approach to self-management and therefore, useful for the current study on patient use of health apps.
The Model of Individual and Family Self-Management Theory follows a similar flow as Donabedian’s Process-Structure-Outcomes framework for examining health services and evaluating quality of care (Donabedian, 1988). In this way, it describes a linear relationship from contextual variables such as complexity of condition to processes of self-management to outcomes in health status, health costs and quality of life. This theory is useful in the context of the current study as it describes detailed aspects of self-management from a patient-centred perspective. It also describes patient demographic/social variables that can influence self-management.

The CCM and eCCM are suited to being prescriptive models for change in provider practice rather than models that can be used to describe current patient-provider relationships and patient behaviours. Also, the models do not account for patient-driven information and resource seeking. Given the focus of the current study to describe current state from both a patient and provider perspective within the area of self-management of chronic conditions, these models
need to be slightly modified for the current research study to allow for key relationships and elements of focus to be highlighted. While the Model for Individual and Family Self-Management Theory describes many aspects related to self-management from a patient perspective and touches on demographic/social variables, it does not describe other demographic variables such as age, education or income as relevant contextual variables. As described earlier, these variables have been cited as important influencers in information seeking literature and in internet use for healthcare and need to be present in the conceptual framework of the current study. The Model for Individual and Family Self-Management Theory also does not describe access to information technologies and resources as a factor, nor does it provide insight into the influence of the patient-provider relationship on patient decisions regarding self-management.

Given the many relevant aspects of the CCM, the eCCM, the Model of Individual and Family Self-Management Theory, and key influencing demographic variables that are described in the literature, a modified version of the eCCM will guide the current research (Figure 4). Specifically, this modified version maintains the overall structure and flow of the CCM and eCCM, noting the importance of the Community, the Health System and the relationship that can occur between patients and providers. It also brings forward key aspects of the eCCM under the areas of delivery system design, self-management support, clinical decision support, clinical information systems and eHealth education. These areas of the health system are included as they pertain to the use of health apps in chronic disease management. While these areas of the health system impact providers through resourcing, policies and procedures, they may or may not impact patients in the context of health app use. Patients can use health apps that are downloaded from public app stores or they can use health apps that providers recommend and sometimes provide. Therefore, areas of the health system such as eHealth Education, may or
may not impact patients. The current study seeks to illuminate current state of health app use and experiences from patient and provider perspectives, therefore, the modified conceptual framework allows for consideration of patients using health apps for self-management either with or without health system influence.

Figure 4. Modified eHealth Enhanced Chronic Care Model

The modified model does not assume that patients are informed and activated, nor does it assume that providers are prepared and proactive (as per the CCM and eCCM). As such these descriptors are not a part of the modified model. Instead, the modified model provides a foundation from which the research can explore these elements through the lens of patient and
provider experiences. Aspects of patients feeling informed or providers feeling prepared with respect to the use of health apps can be explored in order to describe current state.

This modified version of the eCCM also includes the element of patient variables such as age, gender, income and education and places these at the community level as they exist independently of the health system. The modified model allows for a focus on exploring patient and provider experiences with health apps that are available in the community (i.e., available for public download from app stores). As such, health apps are also placed within the community context of resources as they are available to patients without provider interaction. By placing health app resources and patient variables at the community level, it allows for the study of patient experiences with health apps that are publicly available for use.

This model also draws on elements from the CCM and eCCM that allow for the study of how health apps might influence self-management. Self-management and resulting outcomes can be patient-driven through use of publicly downloadable health apps or they can be as a result of patient-provider interactions. The modified model allows for study of health apps and self-management that patients choose to engage in without providers. It also allows for study of health apps and self-management that are influenced by the patient-provider relationship. To date, there is little evidence on patient use of health apps and if such use is self-motivated or motivated through patient-provider relationships. There is also little evidence on patient perceptions on the use of health apps for self-management of chronic conditions. The current study will provide insights into these areas of the modified conceptual model.

The modified conceptual framework supports the study objectives. First, it fits with the study objective of describing the patient population demographic variables and technology/health app use. It also supports the study of health apps in the context of self-
management of chronic conditions. In modifying the CCM and eCCM so that patient driven self-management behaviour can be studied, the modified model allows for exploration of health app use that is purely patient driven, as well as health app use that is influenced by the patient-provider relationship. Finally, the modified model emphasizes patient and provider experiences, thereby supporting the study of motivators and barriers in health app use. The emphasis on patient and provider experiences also allows for an exploration of “ideal” future state of health apps.

A limitation of this “Modified CCM” is that while it attempts to show many of the possible contributing factors related to chronic care and self-management within the context of eHealth, it is likely missing some factors. The current study will illuminate certain parts of the model and provide details on specific elements and relationships between different parts of the model. A second limitation is that each of the elements within the model bring a certain complexity especially in terms of understanding what elements interact with others and the eventual impact on outcomes. Describing cause-effect relationships within a model with a number of interacting elements can be difficult and it is therefore, acknowledged as a limitation in this new model. The current study will provide insight into some aspects of these interactions as will be described in Chapter 4 Results and in Chapter 5 Discussion.
Chapter 3
Design and Methods

3.1 Research Design

In order to meet the overall research objective of describing mobile technology and health app use in patients with cardiac conditions, this study used an exploratory mixed methods design with a quantitative survey (Appendix B), qualitative telephone interviews and a qualitative focus group (Appendix F). The focus of this study was to gain insight into patient and provider experiences in an area that has received little attention to date. This type of mixed methods study design allowed for a description of patient and provider perceptions and experiences with respect to health app use and with respect to the influence of health apps on self-management and the patient-provider relationship. The study also allowed for a description of factors that motivate patients to use health apps, perceived strengths and weaknesses of these apps and the ways in which patients and providers currently use or would want to use these apps.

As this was a relatively new area of study, a survey was used to inform research objectives that were quantitative in nature. Data from the patient survey was analyzed to show descriptive results on the patient population demographic profile, along with a profile of patient mobile technology and health app use. Multiple logistic regression was used to explore possible influences of demographic variables on mobile technology and health app use. Qualitative patient interviews and a provider focus group were conducted to allow for new concepts and themes to emerge from the data through an inductive analysis approach. These qualitative parts of the methodology were guided by a grounded theory approach in order to allow for theory to emerge from the data. A description of patient and provider perspectives leveraged a constructivist philosophy in data collection and analysis through open coding of qualitative data, followed with categorization and formation of themes based on concepts that emerged from the
This study collected survey, interview and focus group data simultaneously and then employed triangulation methods of analysis to combine, compare and contrast results from each of the three data sources (Creswell, 2014; Patton, 2015; Strauss & Corbin, 1998). The approach for data analysis for the quantitative and qualitative parts of this mixed methods study are further described in the Section 3.7 Data Analysis.

3.2 Description of the Patient Survey

The objective of the patient survey (Appendix B) was to collect data on the demographic profile of the patient population, as well as information on mobile technology and health app use. Where possible, existing standard questions from previous research studies were used. Twelve of the 27 questions asked on the survey were taken from existing surveys. Specifically, questions 3, 4, 5, 14, 26 and 27 were taken from a standard population survey from the Pew Research Centre (Fox & Duggan, 2012). Questions 6, 9, 11, 12, and 13 were taken from a health apps use survey (Krebs & Duncan, 2015). The remaining questions were developed specifically for the purposes of the current study. These included questions on mobile device use, and questions on communication of health app results with healthcare providers and demographic variables including cardiac diagnosis and co-morbidities. To note, the demographic question on gender used response options commonly associated with sex (male and female). Only two response options were chosen to keep the survey as simple as possible, though it should be noted that future iterations could include more response options for defining gender. For the questions on diagnosis and co-morbidities, response options were informed by conversations with the cardiac program Senior Clinical Director and Medical Director (Cournoyea & Oh, 2015). Regarding custom questions on health app use, response options were based on current technologies that are available for use (for example, cellphone, smartphone, tablet, and
wearables). The custom questions on communication of health app results with providers were customized based on the research objective of exploring the patient-provider relationship in the context of health app information sharing. All custom questions were reviewed by researchers at the TRI Cardiac Rehabilitation Program to ensure they were written in an unbiased and clear format.

It should be noted that there was a survey formatting error that was caught after the first 70 surveys had been completed. This formatting error caused 19 missed responses on question 13 and 42 missed responses on question 14 (see Appendix B for a copy of the survey questions). This error resulted in 8% (n=19) of the total survey returns to miss question 13 and 17% (n=42) to miss question 14. The survey formatting was corrected for participants 71 through 242.

3.3 Description of the Patient Interview Guide / Provider Focus Group Guide

The patient interviews and the provider focus group sought to describe patient and provider perspectives on health app use, benefits and barriers to health app use, motivating factors in using health apps, possible influence of health apps in self-management of chronic disease, health apps within the context of the patient-provider relationship, and “ideal” future state of health apps. Since the objectives of the interviews and focus group were the same, but from two different perspectives (patients and providers), the interview and focus group questions were captured in the same guide (Appendix F). This allowed for questions to be asked in a similar way with both patients and providers, thereby supporting comparison of responses during the qualitative analysis. Some questions were unique to either patients or providers and these are noted in the guide. The guide was formatted to enable a semi-structured format for interviews and for the focus group, thereby ensuring that research objectives were explored while also allowing for the emergence of new themes within the topic area.
3.4 Definitions

Throughout the study and specifically on the patient survey, during patient interviews and during the provider focus group, the following definitions were used.

*Mobile apps* were defined during data collection as “a software program (application) that is used on a small wireless (mobile) device such as a smartphone, tablet or smart watch. It does not include application use on desktop or laptop computers”.

*Health apps* were defined during data collection as “any mobile health and wellness app that patients feel aid in their health and wellness. This can include but is not limited to fitness, diet, exercise, healthy behaviours (smoking cessation, alcohol limitation, sleep, etc.), and mental health apps such as those for relaxation, meditation, depression and anxiety. They can also include wearable devices that collect information on heart rate, steps, blood pressure, etc.”

3.5 Sampling and Data Collection

This study took place at the Cardiac Rumsey Centre, Toronto Rehabilitation Institute (TRI), University Health Network (UHN) in Toronto, Ontario, Canada. The TRI has a large cardiac prevention and rehabilitation outpatient program that provides care to over 1,500 people each year. It is a six month program organized by weekly in-person classes with a focus on exercise, nutrition, medical care and psychosocial care (Toronto Rehabilitation Institute, 2015). This type of approach in cardiac rehabilitation is typical of most programs in Canada as 90% of programs offer education, exercise support, and risk identification/modification, 80% offer medical assessments and 70% offer screening for depression (Grace et al., 2014).

The patient survey was distributed to patients in 47 rehabilitation classes between July 11th and Sept 7th, 2016 and between January 16th to 27th, 2017. There was a total of 533 patients
attending these 47 classes. Approximately 396 patients were approached and 242 agreed to complete a survey.

This sample size was determined to be adequate based on the multiple logistic regression analysis that would use survey results. Minimum sample size was calculated based on a widely accepted rule of having a minimum of 10 observations per independent variable. While this minimum of 10 is widely cited, the higher the number of observations the better, such as 20 or 30 per independent variable (Hosmer, Lemeshow, & Sturdivant, 2013; LeBlanc & Fitzgerald, 2000). The multiple logistic regression analyses used in this study had four independent variables (gender, age, household income and level of education). Therefore, the study survey sample of n=242 met the minimum criteria threshold.

The survey was distributed in the main waiting area/lobby of the TRI Rumsey Centre prior to the start of each class. Survey distribution was a two-week process as recommended by the Cardiac Rehabilitation Program Manager and was performed by the Researcher with support from a Research Assistant to ensure all classes during the survey period could be approached. Classes were only approached if they were beyond their eighth week of rehabilitation, as requested by the Cardiac Rehabilitation Program Manager. This was to ensure that patients would not feel overwhelmed by new information and other research that occurs during the first eight weeks. During the first week of the two-week survey process, the Researcher was briefly introduced to patients by the Cardiac Rehabilitation Supervisors at the beginning of each class and the following week (week two) the Researcher approached patients in the lobby as they waited for class to begin. Surveys could not be distributed during class so as not to take away from class time and scheduling.
The study was described to patients in-person (using the Survey & Interview Information Letter in Appendix A as a script) with time given for questions. Patients were also given a copy of the Information Letter. Patients agreeing to participate then completed a survey (Appendix B) while waiting for class to begin and handed it in to the Researcher in the lobby. It took patients 5-10 minutes to complete a survey. A few patients chose to take the survey and complete it during class or at home, in which case the Researcher would either collect these surveys the following week or patients would leave them at reception for the Researcher to pick up. Sample size for this study was calculated as both a percentage of the total attending class and as a percentage of the number of patients approached as it was not possible to approach all patients using this method. This was mainly due to some patients arriving just in time or late for class and is described further in Chapter 4 Results of this study.

Once patients had completed the survey, and handed it in to the researcher, they were asked if they would like to be contacted to discuss participating in a telephone interview. At that time, it was explained that only a small number of patients would be randomly selected for interviews. If they agreed to being contacted, the Researcher collected their name and phone number along with a rating of their technology use on an interview sign-up sheet (Appendix C). This rating of technology use was used to select patients for interviews for each of the two interview groupings: cardiac patients who use health apps (i.e., health app users); cardiac patients who do not use health apps (i.e., non-health app users)

Approximately 207 patients were asked if they would be interested in signing up for a telephone interview and 104 patients signed up as interested. Again, there were limitations in the number that could be asked to participate in interviews due to recruitment taking place in the lobby as most would leave for class as soon as they had finished their survey. Forty-six of the
104 patients were randomly selected and contacted for interviews. Three of which were not interested in participating, two had phone numbers that were out of service and 11 were unable to be reached. This study used open coding that was conducted as interviews were transcribed throughout data collection. Therefore, interviewees were contacted until saturation of themes was reached. In total, 30 interviews were conducted between August 24th 2016 and February 23rd, 2017 (15 with health app users and 15 with non-health app users).

Interviews took place over the telephone to support patient convenience in participating. The mean interview time was 24 minutes with a range from 11 minutes to 57 minutes. All interviews were tape recorded and transcribed to allow for a grounded theory approach in analysis through coding, categorization and formation of themes with coding occurring throughout the interview process. The Researcher took notes during interviews to supplement the transcriptions. Interviews followed an interview guide approach that was semi-structured in nature (Appendix F). This allowed for the study objectives to be covered during each interview; however, this approach also allowed for the Researcher to modify the sequence and wording of questions as each interview progressed. Additionally, this approach enabled the Researcher to explore new but related topics that arose during the interviews, as transcription and coding was occurring after each interview. This type of semi-structured approach supported a thorough study of the patient experience and supported a constructivist grounded theory approach in allowing themes to emerge from the data.

Eight providers participated in a 47-minute focus group on February 21st, 2017. This group was made up of Cardiac Rehabilitation Supervisors and Exercise Leaders. Invitation to participate was sent through an email to 27 providers two weeks in advance of the focus group. The email contained an information letter for providers (Appendix D). This sample of providers
receiving the email was chosen because provider schedules could not be fully predicted in advance and a portion of the 27 invited would not have been on site at the TRI Rumsey Centre the day of the focus group. The focus group guide found in Appendix F, follows the same semi-structured format as described above for patient interviews. The provider focus group was tape recorded and transcribed to allow for a constructivist grounded theory approach in analysis through coding, categorization and description of emerging themes. The study sample of patients and providers is further described in Chapter 4 Results.

For the patient survey, all patients eligible for participation were approached in order to obtain a representative sample. For the patient interviews, this study used purposeful sampling to allow for focus on cardiac patients that have used health apps, and those that have not used health apps. The provider focus group was also a purposeful sample as it focused on providers that work frequently with patients in the cardiac rehabilitation program (i.e., Cardiac Rehabilitation Supervisors and Exercise Leaders). Purposeful sampling is common in qualitative methodology as it allows researchers to focus on the study of key characteristics of a population that form the main objective of the study (Patton, 2015).

In general, there are no set rules for sample size in qualitative inquiry. However, as a general rule, when using grounded theory with purposeful sampling, an average of 8-30 participants is widely accepted as a valid sample size and more importantly, interviews are conducted until saturation of themes is reached (Patton, 2015). To note, it is acknowledged that grounded theory often uses theoretical sampling with a constant comparative approach in analysis (Strauss & Corbin, 1998). This approach in sampling was not used in the current study as approximate sample size was determined in advance in order to predict data collection timelines and data collection scheduling with the TRI Rumsey Centre Cardiac Rehabilitation
Program. Having a sample of 15 patients per each of the two patient groupings (health app users and non-health app users) allowed for saturation of themes through open coding.

Regarding the two groupings of patient interviews (health app users and non-health app users), it should be noted that the original study intent was to have three groupings with the third group being patients that did not use mobile technology. However, only 20 patients (of a total survey sample of 242) did not own a mobile device and only three of these patients signed up for interest in interviews. Therefore, it was not possible to obtain a large enough sample of patients without mobile devices to have the third grouping. Instead, these patients were added to the non-health app user grouping.

3.6 Eligibility Criteria and Consent to Participate

This study was focused on outpatients with one or more cardiac conditions including: ischemic heart disease, myocardial infarction, bypass and stent procedures, angioplasty, heart failure and valvular heart disease. Specifically, eligibility criteria for participation were:

- Adult patients (18 years of age and older)
- Able to speak and understand English
- Physically and cognitively capable of participating in a telephone interview
- Physically and cognitively able to complete a survey

All providers working at the TRI Rumsey Centre Cardiac Rehabilitation Program were eligible for participation in the study, as they were over 18 years of age, able to speak and understand English and were physically and cognitively capable of participating.

This study used an implied consent process whereby participation implies consent. This type of consent was recommended by the UHN Research Ethics Board and the University of Toronto Research Ethics Board. The study was reviewed and approved by these two ethics
boards prior to start of data collection. Implied consent was recommended because the patient survey, patient interviews, and provider focus group did not have identifying information attached to results and there was minimal risk in participating. Patients and providers received letters describing the study that were reviewed with them prior to survey distribution and prior to the start of telephone interviews and the focus group (Appendix A and Appendix D).

3.7 Data Analysis

As described above, this was an exploratory mixed methods study with the objective of describing patient and provider experiences with mobile technology and health app use and perceived impact on self-management and the patient-provider relationship. Figure 5 illustrates the quantitative and qualitative parts of this study and how each data source (patient surveys, patient interviews and provider focus group) was analyzed. This method follows work by John Creswell that outline methods for comparing quantitative and qualitative results in convergent parallel mixed methods designs (Creswell, 2013, 2014). Specifically, the quantitative patient surveys were analyzed using descriptive statistics and multiple logistic regression analyses that explored the influence of patient demographic variables on mobile technology and health app use. The qualitative patient interviews and provider focus group were analyzed using a grounded theory constructivist approach through coding of transcripts that allowed for the researcher to identify the emergence of categories and themes (Strauss & Corbin, 1998).

As Figure 5 illustrates, the results from the survey, interviews and focus group were then compared to identify commonalities and differences between the results from each data source. This comparison was accomplished through the approach of using a joint display of data (Creswell, 2014). A joint display of data is one method of comparing quantitative and qualitative results in convergent parallel mixed methods. It merges two sets of data through the
use of a visual display such as a graph or table. This visual display notes the main results and themes from the quantitative and qualitative analyses and identifies the source of each key finding (i.e., from the surveys, the interviews and/or the focus group). The visual display allows for the researcher to identify commonalities and differences in results from the different sets of data. Figure 6, shown in Chapter 4 Results, illustrates an overview of the joint display of data created for the current study analysis. Once these separate data sets were compared, it allowed for interpretation and discussion of results in relation to findings from the review of the literature. These are fully explored and discussed in Chapter 5 Discussion.

Figure 5. Overview of study data collection and analysis process
Results from the survey were summarized using Microsoft Excel to provide an overall description of the Cardiac population at TRI with respect to demographic variables, and use of mobile technology and health apps. This provided context for the qualitative results that explored patient and provider experiences with health apps, self-management and the patient-provider relationship. Multiple logistic regression was conducted using IBM SPSS Statistics to describe possible influences of demographic variables on mobile technology use and health app use. Multiple logistic regression was chosen for these analyses because the dependent variable for each analysis was dichotomous and independent variables were categorical. The goodness of fit statistic used in this study and cited in Chapter 4 Results, is the Nagelkerke $R^2$ statistic for this regression analysis. This statistic was chosen as it is an adaptation of the Cox and Snell statistic that rescales the upper and lower bounds to zero and one thereby allowing for simplified understanding of the approximation of total variance in the data that the regression model accounts for (Nagelkerke, 1991; ReStore National Centre for Research Methods, 2011).

The following multiple logistic regression analyses were conducted:

- Dependent variable of owning a mobile device with independent variables of gender, age, household income and level of education
- Dependent variable of use of a cellphone with independent variables of gender, age, household income and level of education
- Dependent variable of use of a smartphone with independent variables of gender, age, household income and level of education
- Dependent variable of use of a tablet with independent variables of gender, age, household income and level of education
- Dependent variable of use of a wearable with independent variables of gender, age, household income and level of education
- Dependent variable of health app use with independent variables of gender, age, household income and level of education
The qualitative analysis used transcribed data from the patient interviews and the provider focus group. The purpose of the qualitative analysis was to describe patient and provider experiences with health apps and patient and provider perceptions of influence of these apps with respect to self-management and the patient-provider relationship. Each interview was audio recorded and transcribed in Microsoft Excel on a continuous basis to allow for analysis throughout the interview process and identification of saturation of themes. Prior to coding and analysis of each transcript, identifying information was removed. Microsoft Excel was chosen as the software program for transcription and analysis as it can handle large amounts of data and allows for multiple levels of coding and categorization by using columns and sorting features (De Felice & Janesick, 2015; Meyer & Avery, 2008). Specifically, each interview was transcribed by using excel rows to separate each sentence. i.e., the interviewer voice on one row, then the participant voice on the next row, and so on. Columns were used to show if each sentence was from the interviewer, a health app user or a non-health app user and columns were used to identify and sort codes, categories and themes. The provider focus group was also audio recorded and transcribed in a similar format using Microsoft Excel. Transcriptions were checked against audio recordings to ensure accuracy. Once the analysis was complete, filler words such as “um” and “uh” that did not add to context or meaning of the conversation were removed from quotes used in the results section of this study.

Analysis followed a grounded theory constant comparative method with open coding, axial coding and selective coding. Transcriptions were coded by first identifying concepts within the data. Axial coding then allowed for categories to be formed and selective coding involved the generation of themes from analysis of the categories and the dimensions that existed within and between the categories (Strauss & Corbin, 1998). A separate Microsoft Excel file
was used to bring together the codes, categories and themes from the interviews and the focus group transcriptions. This document served as an analysis guide and allowed for comparisons across different categories and themes. The analysis guide also noted which interviews had quotes that supported each code, thereby allowing for quick reference as to frequency of a code being quoted and also origin of the quote (i.e., from a health-app user, from a non-health app user, or from the provider focus group). The constant comparative approach used in this analysis ensured that codes were identified consistently and that similarities and differences between patient experiences and between patient and provider experiences were identified (Patton, 2015; Strauss & Corbin, 1998). Since the methodology followed a semi-structured interview approach, the categories and themes were linked to the main objectives of the study to answer the research objectives. Appendix I outlines the codes, categories and themes that emerged from the data.

Due to the nature of qualitative research using a grounded theory constructivist approach, it was important to acknowledge the Researcher as a participant in the analysis holds views or makes assumptions that could influence coding and emergence of themes due to personal knowledge and biases, i.e. reflexivity (Creswell, 2014). In the current study, the Researcher kept notes on personal knowledge and potential biases throughout data collection and analysis and strived to maintain as objective lens as possible when forming codes, categories and themes. These notes included items such as thoughts on older people potentially not using mobile technology, and thoughts on providers and potential lack of willingness to adopt technology in practice. It should be noted that the Researcher also has experience in co-designing and developing mobile healthcare apps and thoughts related to these previous experiences were also noted. This included notes on working with seniors that had experience using mobile apps and those that had no experience using mobile apps. While these items were noted as potential areas
of bias, the diversity of experiences (i.e. having worked with both app users and non-app user in the past) supported the Researcher in taking a neutral stance and allowing the data to speak to categories and themes, particularly those pertaining to current use of health apps.

To further reduce bias in the qualitative analysis, several transcripts were reviewed by two external researchers. The external reviewers first reviewed transcripts that were not coded, then compared their coding with the study Researcher’s coding. Following this independent review, the Researcher met with the two reviewers to discuss the codes and the merging categories and themes. This process allowed the Researcher to identify potential areas of bias in the analysis and to change coding where appropriate to reduce these areas of bias.
4.1 Overview of Presentation of Results

As described in the objectives and methods sections of this research, this was a mixed methods study with the overall objective of describing patient and provider experiences with mobile technology and health app use and perceived impact on self-management and the patient-provider relationship. This description is best presented with survey, interview and focus group results described together within each emergent theme. Presenting results in this way supports the philosophy of triangulation and merging results in mixed methods studies.

The first section 4.1 of the results describes participants in the study with respect to survey return rates, interview participation and demographic information. From there, the results section describes findings organized by topics/themes from the patient survey combined with themes that emerged in the patient interviews and rehabilitation provider focus group.

Figure 6 illustrates the main themes and sub-themes within each section of the results. Section 4.3 describes the theme of patient health app use, Section 4.4 describes health apps and self-management, Section 4.5 describes health apps and the patient-provider relationship, Section 4.6 describes technology use and assumptions, and Section 4.7 describes patient and provider views on the future of health app use. Finally, broader contextual themes that describe a shifting landscape will be presented in the results. These contextual themes are explored in Section 4.8 and describe a shifting landscape in emerging technologies, provider practices and patient health app use. As seen in Figure 6, the source of information within each sub-theme is noted for patient surveys (S), patient interviews (I), and provider focus group (FG).
Figure 6. Joint display of data of themes and sub-themes that emerged from the patient surveys (S), patient interviews (I), and provider focus group (FG)

Throughout the Results section, qualitative results from the patient interviews and the provider focus group note the origin of each quote. For example, quotes from the focus group are noted as (FG). There were 30 interviews in total so each interviewee was assigned a number from 1 to 30. Interview health app users were noted as IA and interview non-app users were noted as IN. For example, the first interviewee was a health app user and is noted as IA1. Health app users were patients using health apps on their mobile device and/or using a health wearable, such as Fitbit. As described in the Chapter 3 Methods, Appendix H lists the groupings of interviewees as health app users and non-health app users and notes their assigned numbers
Appendix I illustrates a detailed view of the codes, categories, and themes used in the qualitative analysis.

As previously described, health apps in the analysis and results of this study include health apps used on mobile devices such as smartphones or tablets, and health apps that are used through wearable devices (such as Fitbit). The focus of this study was on health app use with respect to apps on a mobile device such as a smartphone or tablet and wearable devices. In most sections of the results, health apps refer to either a health app on a mobile device or a wearable. When study data allowed for separation of results by health apps on mobile devices and wearables, this separation in results is illustrated for the purpose of adding detail to the overall description of health app use in this population. It was not the intention of the study to provide a detailed comparison of all results between mobile apps and wearables.

4.2 Demographic Profile of Participants

Patient Surveys

Patients in 47 classes at the TRI Rumsey Cardiac rehabilitation program were asked to participate in the survey on mobile technology use. As shown in Table 1, 242 of the 533 patients that attended these classes, chose to complete a survey. This resulted in a response rate of 45%. Not all patients attending classes were approached and invited to complete a survey or sign up for interest in an interview. The main reason for not approaching some patients was that they arrived late (or just in time) for class and study recruitment took place in the lobby prior to class. Also, there were circumstances where some patients required assistance with the survey due to forgetting their reading glasses or other limitations. In these cases the researcher sat with the patient and read the survey and responses to them. This would result in missing other patients as they entered the waiting area in the lobby. Another reason for not being able to approach
patients occurred when multiple patients arrived at once and the researcher could not speak with each of them in time before the class started. For these reasons, the return rate was also calculated based on number of patients approached (Table 1). It is an estimate of number approached as the exact number of approached patients was gathered for approximately 50% of the classes. Based on estimated number approached, the survey response rate was 61%.

Table 1. *Survey return rate and interview sign up rate*

<table>
<thead>
<tr>
<th>Return Rates Based on Total Class Attendance:</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Survey Returns</td>
<td>242</td>
<td>45%</td>
</tr>
<tr>
<td>Total Interview Interest Sign Ups</td>
<td>104</td>
<td>20%</td>
</tr>
<tr>
<td>Total Attendees in Classes (47 classes in total)</td>
<td>533</td>
<td></td>
</tr>
<tr>
<td>Return Rates Based on Total Patients Approached:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Survey Returns</td>
<td>242</td>
<td>61%</td>
</tr>
<tr>
<td>Total Interview Interest Sign Ups</td>
<td>104</td>
<td>50%</td>
</tr>
<tr>
<td>Total Approached in Classes: for surveys (47 classes in total)</td>
<td>396</td>
<td></td>
</tr>
<tr>
<td>Total (Estimated) Approached in Classes: for interviews</td>
<td>207</td>
<td></td>
</tr>
</tbody>
</table>

**Patient Interviews**

Of the 533 patients attending classes, 104 (20% of those attending class, or 50% of those approached) signed up for interest in a telephone interview (Table 1). As per Table 2, of the 104 that signed up as interested, 40 (38%) were health app users (i.e., had a health app on their smartphone or tablet, and 13 (13%) were using wearable devices like a Fitbit or Garmin watch. Therefore, a total of 53 (51%) were using a health app or wearable. There were 19 (18%) patients using a health app on their mobile device and also using a wearable. For participants not using health apps or wearables, 35 (34%) had smartphones or tablets, and 5% had no smartphone or tablet. There were 11 participants (11%) that did not fill in the technology use section of the interview sign up form.
Table 2. Health app use profile of patients signing up as interested in an interview

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health app users</td>
<td>40</td>
<td>38%</td>
</tr>
<tr>
<td>Smartphones or tablets but no health apps</td>
<td>35</td>
<td>34%</td>
</tr>
<tr>
<td>Wearable devices but no health apps on smartphone or tablet</td>
<td>13</td>
<td>13%</td>
</tr>
<tr>
<td>No smartphone or tablet</td>
<td>5</td>
<td>5%</td>
</tr>
<tr>
<td>Unknown (tech section of sign up form not complete)</td>
<td>11</td>
<td>11%</td>
</tr>
<tr>
<td>Total number of patients signed up as interested in an interview</td>
<td>104</td>
<td></td>
</tr>
</tbody>
</table>

A total of 46 patients that signed up as interested in interviews were contacted to participate. Three of the 46 contacted, decided not to participate, two of the 46 had a phone number that was out of service, and 11 of the 46 were not able to be reached after two phone call attempts. A total of 30 patients participated in interviews. Eleven of the 30 were female and 19 were male. All interviewees had experienced at least eight weeks of cardiac rehabilitation at the TRI Rumsey Cardiac Rehabilitation Program prior to being contacted for an interview. Seventeen interviewees had graduated from the cardiac rehabilitation program at the time of the interview, eight were in the last month of the program, four were mid-program and one interviewee had ongoing rehabilitation due to their condition as a heart transplant patient. Data on age was not collected upon interview sign-up or as a part of the interviews as it was felt that this question might seem too personal, however, eight patients chose to mention their age during the interview and it ranged from 28 years to 81 years old. Four of these eight patients were in their seventies, thereby providing an indication that the age range of the interview sample was consistent with the age range of participants that completed a survey (as will be described further in Table 5).

For the patient interviews, there was an even split between health app users (n=15) and those not using health apps (n=15). This split was purposeful in the sampling of interviewees so
that equal representation of health app users and non-health app users could be explored. Table 3 shows a more detailed breakdown of health app use amongst the interviewees. This table shows that only three patients did not have a smartphone or tablet, 12 patients had a smartphone or tablet but no health apps, six patients had a wearable device but no health apps on their mobile device and nine patients had health apps on their mobile device. Of the nine patients with health apps on their mobile device, five were also using a wearable. Regarding the three patients with no smartphone or tablet, it was originally considered in the proposal stage of this thesis that a larger sample of those without a mobile device would be interviewed. However, only five of the 104 interview sign ups fit this description, two of which were unable to be contacted for an interview. Therefore, the groupings of patients interviewed naturally fit into two categories: those using health apps or wearables and those not using health apps or wearables. The mean interview time was 24 minutes in length and median interview time was 22 minutes. Interviews ranged in length from 11 minutes to 57 minutes.

Table 3. Health app use profile of patients that participated in an interview

<table>
<thead>
<tr>
<th>Patients using health apps or wearables (n=15)</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health app users</td>
<td>9</td>
<td>30%</td>
</tr>
<tr>
<td>Wearable devices but no health apps on a smartphone or tablet</td>
<td>6</td>
<td>20%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patients not using health apps or wearables (n=15)</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smartphones or tablets but no health apps</td>
<td>12</td>
<td>40%</td>
</tr>
<tr>
<td>No smartphone or tablet or wearable</td>
<td>3</td>
<td>10%</td>
</tr>
</tbody>
</table>

Provider Focus Group

There were eight participants in the provider focus group. Seven were female and one was male. Six of the eight participants were Cardiac Rehabilitation Supervisors and two of the eight were Exercise Leaders. Most of focus group participants were Registered Kinesiologists
(n=7) and one participant was not a regulated professional and instead had a degree in Health Sciences. The focus group was 47 minutes in length and was conducted during a lunch hour. Employees were invited to participate through an email invitation to 27 providers two weeks in advance of the focus group. This large sample of providers receiving the email was chosen because provider schedules could not be fully predicted in advance and a portion of the 27 invited would not have been on site at the Rumsey Centre the day of the focus group.

Demographic Profile of Survey Respondents

Examining the demographic profile of the patient population that responded to surveys, there were 162 (67%) male participants and 74 (31%) female participants (Table 4). In Table 5 we can see that the majority of participants were aged 50-69 (57%) and 70-89 (29%). Only one participant was over 90 years old and only three were under the age of 29.

Table 4. Gender of patients that completed a survey

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>162</td>
<td>67%</td>
</tr>
<tr>
<td>Female</td>
<td>74</td>
<td>31%</td>
</tr>
<tr>
<td>No response</td>
<td>6</td>
<td>2%</td>
</tr>
<tr>
<td>Total number of patients surveyed</td>
<td>242</td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Age of patients that completed a survey

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-29</td>
<td>3</td>
<td>1%</td>
</tr>
<tr>
<td>30-49</td>
<td>25</td>
<td>10%</td>
</tr>
<tr>
<td>50-69</td>
<td>139</td>
<td>57%</td>
</tr>
<tr>
<td>70-89</td>
<td>71</td>
<td>29%</td>
</tr>
<tr>
<td>90+</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>No response</td>
<td>3</td>
<td>1%</td>
</tr>
<tr>
<td>Total number of patients surveyed</td>
<td>242</td>
<td></td>
</tr>
</tbody>
</table>
Household income and level of education were also collected as a part of patient demographic information. Looking at household income (Table 6), 40% of participants had an income of over $75,000/year. The rest of the participants were in income categories of less than $30,000/year (17%), $30,000-$49,000/year (14%) and $50,000-$74,000/year (18%). There were 27 participants (11%) that chose not to answer this question.

Table 6. Household income of patients that completed a survey

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than $30,000</td>
<td>41</td>
<td>17%</td>
</tr>
<tr>
<td>$30,000-$49,000</td>
<td>33</td>
<td>14%</td>
</tr>
<tr>
<td>$50,000-$74,000</td>
<td>43</td>
<td>18%</td>
</tr>
<tr>
<td>$75,000 +</td>
<td>98</td>
<td>40%</td>
</tr>
<tr>
<td>No response</td>
<td>27</td>
<td>11%</td>
</tr>
<tr>
<td>Total number of patients surveyed</td>
<td>242</td>
<td></td>
</tr>
</tbody>
</table>

Looking at level of education (Table 7), the majority of participants had college or university degrees (60%). Nineteen percent had some college or university, 11% were high school graduates and 8% had no high school diploma. Six participants (2%) chose not to answer this question.

Table 7. Highest level of education of patients that completed a survey

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No high school diploma</td>
<td>20</td>
<td>8%</td>
</tr>
<tr>
<td>High school graduate</td>
<td>26</td>
<td>11%</td>
</tr>
<tr>
<td>Some college / university</td>
<td>45</td>
<td>19%</td>
</tr>
<tr>
<td>College / university degree(s)</td>
<td>145</td>
<td>60%</td>
</tr>
<tr>
<td>No response</td>
<td>6</td>
<td>2%</td>
</tr>
<tr>
<td>Total number of patients surveyed</td>
<td>242</td>
<td></td>
</tr>
</tbody>
</table>

Patients were also asked about their cardiac condition and other chronic conditions. Specifically, as seen in Table 8, the most common cardiac conditions were high blood pressure
(n=92, 38%), followed by coronary artery disease (n=88, 36%), high cholesterol (n=73, 30%) and heart attack (n=70, 29%). A smaller number of patients had angina (n=33, 14%), arrhythmia (n=31, 13%), valve disorder (n=25, 10%), heart failure (n=19, 8%), and atherosclerosis (n=11, 5%). There were 59 (24%) patients that chose not to respond to this question.

Table 8. Patient survey results on type of cardiac condition experienced

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>High blood pressure</td>
<td>92</td>
<td>38%</td>
</tr>
<tr>
<td>Coronary artery disease (CAD)</td>
<td>88</td>
<td>36%</td>
</tr>
<tr>
<td>High cholesterol</td>
<td>73</td>
<td>30%</td>
</tr>
<tr>
<td>Heart attack</td>
<td>70</td>
<td>29%</td>
</tr>
<tr>
<td>Angina</td>
<td>33</td>
<td>14%</td>
</tr>
<tr>
<td>Arrhythmia</td>
<td>31</td>
<td>13%</td>
</tr>
<tr>
<td>Valve disorder</td>
<td>25</td>
<td>10%</td>
</tr>
<tr>
<td>Heart failure</td>
<td>19</td>
<td>8%</td>
</tr>
<tr>
<td>Atherosclerosis</td>
<td>11</td>
<td>5%</td>
</tr>
<tr>
<td>Other</td>
<td>24</td>
<td>10%</td>
</tr>
<tr>
<td>No response</td>
<td>59</td>
<td>24%</td>
</tr>
<tr>
<td>Total number of patients surveyed</td>
<td>242</td>
<td></td>
</tr>
</tbody>
</table>

Other (as written in the open text response): "failed septum", "a-fibrillation", "sinusitis", "heart transplant" (2 patients), "aortic dissection", “low blood pressure”, “v-tac”, “tumor resection”

(note: patients could choose more than one response)

Table 9 shows the types of cardiac surgeries or procedures that patients had experienced. The most common being angioplasty (n=116, 48%). Other surgeries included bypass surgery (n=37, 15%), valve replacement or repair (n=22, 9%), pacemaker surgery (n=16, 7%) and implantable cardioverter defibrillator (n=13, 5%). Forty-one (17%) of patients had no surgeries and 11 (5%) chose not to answer this question.
Table 9. Patient survey results on type of cardiac surgeries that patients have undergone

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angioplasty and stent</td>
<td>116</td>
<td>48%</td>
</tr>
<tr>
<td>Bypass / coronary artery bypass graft (CABG)</td>
<td>37</td>
<td>15%</td>
</tr>
<tr>
<td>Valve replacement/repair</td>
<td>22</td>
<td>9%</td>
</tr>
<tr>
<td>Other</td>
<td>19</td>
<td>8%</td>
</tr>
<tr>
<td>Pacemaker</td>
<td>16</td>
<td>7%</td>
</tr>
<tr>
<td>Implantable cardioverter defibrillator (ICD)</td>
<td>13</td>
<td>5%</td>
</tr>
<tr>
<td>No surgeries</td>
<td>41</td>
<td>17%</td>
</tr>
<tr>
<td>No response</td>
<td>11</td>
<td>5%</td>
</tr>
<tr>
<td>Total number of patients surveyed</td>
<td>242</td>
<td></td>
</tr>
</tbody>
</table>

*Other (as written in the open text response): "ischemic bowel", "LVAD", "sinus X3", "ablation", "heart transplant" (4 patients), "cardioversion"

(note: patients could choose more than one response)

As seen in Table 10, with respect to co-morbid or other non-cardiac related conditions in this patient population, the most common condition was diabetes (n=43, 18%), followed by anxiety (n=26, 11%), depression (n=19, 8%), stroke (n=19, 8%), chronic obstructive pulmonary disease (n=11, 5%), cancer (n=9, 4%), and kidney disease (n=8, 3%). Of the survey respondents, 112 (46%) did not have any other (non-cardiac) conditions. There were also a number of “other” co-morbid conditions cited in the open text response option (n=38, 16%).
Table 10. **Patient survey results on other (non-cardiac) health conditions experienced**

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td>43</td>
<td>18%</td>
</tr>
<tr>
<td>Anxiety</td>
<td>26</td>
<td>11%</td>
</tr>
<tr>
<td>Depression</td>
<td>19</td>
<td>8%</td>
</tr>
<tr>
<td>Stroke</td>
<td>19</td>
<td>8%</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease (COPD)</td>
<td>11</td>
<td>5%</td>
</tr>
<tr>
<td>Cancer</td>
<td>9</td>
<td>4%</td>
</tr>
<tr>
<td>Kidney disease</td>
<td>8</td>
<td>3%</td>
</tr>
<tr>
<td>Other</td>
<td>38</td>
<td>16%</td>
</tr>
<tr>
<td>No other chronic conditions</td>
<td>112</td>
<td>46%</td>
</tr>
<tr>
<td>No response</td>
<td>10</td>
<td>4%</td>
</tr>
<tr>
<td>Total number of patients surveyed</td>
<td>242</td>
<td></td>
</tr>
</tbody>
</table>

*Other (as written in the open text response): "asthma, breathing with double PE", "restrictive lung disease", "dementia", "obesity", "mental health", "TIA's", "CLL", "TTA", "metastasis", "PAD, BPH, hypertension", "Raynaud's disease", "high stomach acidity", "CFS", "restless leg", "fibromyalgia", "cancer past issue, liver NASH disease", "urinary constriction", "Cushing's disease", "NASH", "brain aneurism", "low iron", "brain injury", "prostate", "hemoglobin high, b12 def", "chronic bile duct diarrhea, bowel pains", "arthritis" (6 patients), "sleep apnea" (4 patients), "GERD" (2 patients), "hypothyroid" (2 patients)

*(note: patients could choose more than one response)*

The patient survey also asked about self-perceived general health (Table 11). Results showed that most patients rated their health in the middle of the scale with 101 (42%) of respondents rating their health as average, 67 (28%) rating their health as very good, and 54 (22%) rating their health as fair. A smaller number of patients rated their health on the lowest end of the scale with nine (4%) citing their health as poor. Similarly, only six (2%) of patients rated themselves at the highest end of the scale as excellent. Five (2%) of patients chose not to answer this question.
Table 11. Patient survey results on self-perceived general health

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>9</td>
<td>4%</td>
</tr>
<tr>
<td>Fair</td>
<td>54</td>
<td>22%</td>
</tr>
<tr>
<td>Average</td>
<td>101</td>
<td>42%</td>
</tr>
<tr>
<td>Very good</td>
<td>67</td>
<td>28%</td>
</tr>
<tr>
<td>Excellent</td>
<td>6</td>
<td>2%</td>
</tr>
<tr>
<td>No response</td>
<td>5</td>
<td>2%</td>
</tr>
<tr>
<td>Total number of patients surveyed</td>
<td>242</td>
<td></td>
</tr>
</tbody>
</table>

4.3 Description of the Cardiac Rehabilitation Patient Population with Respect to use of Mobile Technology and Health Apps

This section of the results focuses on further describing the patient population with respect to mobile device use and more specifically, health app use. Results in this section came from the patient surveys, patient interviews and the provider focus group. This section also contains findings from multiple logistic regression analyses of survey results that describe the influence of demographic variables (age, gender, income, education) on the independent variables of mobile device use, type of mobile device used and health app use.

4.3.1 Mobile Device Use

To more fully describe the technology use profile of the cardiac rehabilitation patient population at the Rumsey Centre, survey participants were asked to complete questions on mobile technology and health app use. Table 12 shows that 222 (92%) of patients completing the survey own a mobile device and 20 (8%) do not own a mobile device. Mobile device was defined as any mobile device including cell phones, smartphone, tablets and wearables.
Table 12. Patient survey responses on whether they have a mobile device and use a health app

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have a mobile device</td>
<td>222</td>
<td>92%</td>
</tr>
<tr>
<td>Do not have a mobile device</td>
<td>20</td>
<td>8%</td>
</tr>
<tr>
<td>Number of patients that use a health app (of those that have a device)</td>
<td>111</td>
<td>50%</td>
</tr>
<tr>
<td>Total</td>
<td>242</td>
<td></td>
</tr>
</tbody>
</table>

A logistic regression analysis was conducted to explore possible influence of age, gender, household income and highest level of education on mobile device ownership. Table 13 summarizes these results and shows that age and income had a significant overall effect on mobile device ownership (p=0.046 and p=0.045 respectively). Within the age categories these results showed that the age group of 50-69 year olds had 4.29 times larger odds of owning a mobile device than the reference group of 70-89 year olds (p=0.0010). The age group of 30-49 year olds was approaching a significant difference from the 70-89 year olds with p=0.080 and an odds ratio of 6.94. These results suggest that younger patients had a greater odds of owning a mobile device than older patients. Within the variable of household income, the category of income <$30,000/year had 0.12 times lower odds of owning a mobile device than the reference group of those with a household income of $75,000+/year (p=0.0080). The category of income $50,000-$74,000/year had 0.18 times lower odds of owning a mobile device than the reference group of those with a household income of $75,000+/year (p=0.025). These results suggest that those with lower household incomes had lower odds of owning a mobile device than those with a high household income. The income category of $30,000-$49,000/year showed no significant difference than the category of $75,000+/year. Gender and level of education showed no significant effect on the odds of owning a mobile device. These results had a relatively low power due to the small number of responses answering “no” they do not own a mobile device.
(n=20) as seen in Table 12. The Nagelkerke $R^2$ statistic for this regression analysis was 0.19, showing that the model is explaining approximately 19% of the variance, with the Chi-Square model omnibus test of model coefficients significant at $p=0.035$. Given the small number of responses answering “no”, simple logistic regression analyses were conducted with the dependent variable of age and each independent variable of gender, age, household income and level of education. Results from these simple regression analyses supported those found in the multiple logistic regression analysis in Table 13, with younger patients showing greater odds of owning a mobile device than older patients and patients with lower household incomes having lower odds of owning a mobile device than those with a high household income.

Table 13. *Multiple logistic regression results looking at the influence of demographic variables (gender, age, household income and level of education) on mobile device ownership*

<table>
<thead>
<tr>
<th></th>
<th>$\beta$</th>
<th>Sig.</th>
<th>Odds Ratio</th>
<th>Lower CI 95%</th>
<th>Upper CI 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>0.45</td>
<td>0.46</td>
<td>1.57</td>
<td>0.48</td>
<td>5.15</td>
</tr>
<tr>
<td>Age: (reference variable) 70-89 years</td>
<td></td>
<td>0.046*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age: 30-49 years</td>
<td>1.94</td>
<td>0.080</td>
<td>6.94</td>
<td>0.79</td>
<td>60.94</td>
</tr>
<tr>
<td>Age: 50-69 years</td>
<td>1.46</td>
<td>0.010**</td>
<td>4.29</td>
<td>1.42</td>
<td>13.00</td>
</tr>
<tr>
<td>Income: (reference variable) $75,000+/ year</td>
<td></td>
<td>0.045*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income: &lt;$30,000/year</td>
<td>-2.15</td>
<td>0.0080**</td>
<td>0.12</td>
<td>0.024</td>
<td>0.57</td>
</tr>
<tr>
<td>Income: $30,000-$49,000/year</td>
<td>-0.98</td>
<td>0.26</td>
<td>0.38</td>
<td>0.067</td>
<td>2.08</td>
</tr>
<tr>
<td>Income: $50,000-$74,000/year</td>
<td>-1.72</td>
<td>0.025*</td>
<td>0.18</td>
<td>0.040</td>
<td>0.80</td>
</tr>
<tr>
<td>Education: (reference variable) college degree</td>
<td></td>
<td>0.95</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education: no high school</td>
<td>-0.34</td>
<td>0.69</td>
<td>0.71</td>
<td>0.14</td>
<td>2.73</td>
</tr>
<tr>
<td>Education: high school graduate</td>
<td>0.32</td>
<td>0.71</td>
<td>1.38</td>
<td>0.25</td>
<td>7.70</td>
</tr>
<tr>
<td>Education: some college</td>
<td>-0.054</td>
<td>0.94</td>
<td>0.95</td>
<td>0.25</td>
<td>3.57</td>
</tr>
</tbody>
</table>

*Note: Age categories of 19-29 years and 90+ years are not included as the sample for these categories was too small for the analysis  
* $p<0.05$, ** $p<0.01$*

Looking at Table 14, of those with a mobile device (n=222), 145 (65%) had a smartphone, 92 (41%) had a tablet, 54 (24%) had a wearable and 82 (37%) had a cellphone.

Fifty-four of these 82 patients with a cellphone also noted on the survey that they had a
smartphone, tablet or wearable. Twenty patients chose “not applicable” and two chose not to respond to that survey question. It should be noted that for this question, participants could choose more than one response.

Table 14. Patient survey responses on type of mobile device used (for those using a mobile device)

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smartphone</td>
<td>145</td>
<td>65%</td>
</tr>
<tr>
<td>Tablet</td>
<td>92</td>
<td>41%</td>
</tr>
<tr>
<td>Cellphone</td>
<td>82</td>
<td>37%</td>
</tr>
<tr>
<td>Wearable</td>
<td>54</td>
<td>24%</td>
</tr>
<tr>
<td>Not applicable</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>No response</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Total with a mobile device</td>
<td>222</td>
<td></td>
</tr>
</tbody>
</table>

(note: patients could choose more than one response)

The following four tables show multiple logistic regression results that explore possible influences of age, gender, household income and highest level of education on use of cellphones (Table 15), smartphones (Table 16), tablets (Table 17), and wearables (Table 18).

Table 15 shows that patients 30-49 years old had 0.24 lower odds of using a cellphone than the reference category of 70-89 year olds (p=0.02). Patients with a household income <$30,000/year had 4.15 larger odds of using a cellphone than those with a household income of $75,000+/year (p=0.0040). Patients with a lower education (no high school diploma) had 6.71 larger odds of using a cellphone than those with a college or university degree (p=0.015). These results suggest that younger patients had lower odds of owning a cellphone (i.e., without smartphone technology) than older patients and patients with very little education had higher odds of owning a cellphone than those with a college or university degree. The variable of gender did not show a significant influence on using a cellphone. The Nagelkerke R² statistic for
this regression analysis was 0.26, showing that the model is explaining approximately 26% of the variance, with the Chi-Square model omnibus test of model coefficients significant at p<0.001. As described above, it should again be noted that 54 of the 82 patients with a cellphone also had a smartphone, tablet or wearable. Therefore, this analysis of influence of demographic variables on cellphone use was not for those only owning a cellphone and results might have been influenced by patients in the sample that owned multiple types of devices. An analysis of cellphone only was not conducted as the n-size was too small for multiple logistic regression for those owning a cellphone only (n=28).

Table 15. *Multiple logistic regression results looking at the influence of demographic variables (gender, age, household income and level of education) on use of a cellphone*

<table>
<thead>
<tr>
<th></th>
<th>β</th>
<th>Sig.</th>
<th>Odds Ratio</th>
<th>Lower CI 95%</th>
<th>Upper CI 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>.38</td>
<td>0.30</td>
<td>1.46</td>
<td>0.71</td>
<td>3.02</td>
</tr>
<tr>
<td>Age: (reference variable) 70-89 years</td>
<td></td>
<td></td>
<td>0.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age: 30-49 years</td>
<td>-1.42</td>
<td>0.02*</td>
<td>0.24</td>
<td>0.072</td>
<td>0.82</td>
</tr>
<tr>
<td>Age: 50-69 years</td>
<td>-0.71</td>
<td>0.06</td>
<td>0.49</td>
<td>0.23</td>
<td>1.03</td>
</tr>
<tr>
<td>Income: (reference variable) $75,000+/ year</td>
<td></td>
<td></td>
<td>0.0070**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income: &lt;$30,000/year</td>
<td>1.42</td>
<td>0.0040**</td>
<td>4.15</td>
<td>1.58</td>
<td>10.95</td>
</tr>
<tr>
<td>Income: $30,000-$49,000/year</td>
<td>0.79</td>
<td>0.095</td>
<td>2.20</td>
<td>0.87</td>
<td>5.57</td>
</tr>
<tr>
<td>Income: $50,000-$74,000/year</td>
<td>-0.35</td>
<td>0.49</td>
<td>0.71</td>
<td>0.26</td>
<td>1.89</td>
</tr>
<tr>
<td>Education: (reference variable) college degree</td>
<td></td>
<td></td>
<td>0.041*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education: no high school</td>
<td>1.90</td>
<td>0.015*</td>
<td>6.71</td>
<td>1.45</td>
<td>31.12</td>
</tr>
<tr>
<td>Education: high school graduate</td>
<td>1.00</td>
<td>0.070</td>
<td>2.69</td>
<td>0.92</td>
<td>7.85</td>
</tr>
<tr>
<td>Education: some college</td>
<td>0.37</td>
<td>0.41</td>
<td>1.45</td>
<td>0.60</td>
<td>3.49</td>
</tr>
</tbody>
</table>

*Note: Age categories of 19-29 years and 90+ years are not included as the sample for these categories was too small for the analysis
* p<0.05, ** p<0.01*

Table 16 shows multiple logistic regression results exploring the influence of demographic variables on smartphone use. These results show that with respect to gender, women have 0.36 lower odds than men of owning a smartphone (p=0.0060). The variable of age also shows influence of smartphone use, with those aged 30-49 years old having 4.95 larger odds
(p=0.013) and those aged 50-69 years old having 3.61 larger odds (p=0.0010) of using a smartphone than those 70-89 years old. Results also showed that those with only a high school education had 0.19 lower odds of owning a smartphone than those with a college or university degree (p=0.0040). These results suggest that women in the cardiac rehabilitation population had lower odds of owning a smartphone than men, and younger patients had higher odds of owning a smartphone than older patients. Also, those with only a high school diploma had lower odds of owning a smartphone than those with college or university degrees. Interestingly, those with no high school diploma showed no difference than those with a college or university degree. The Nagelkerke $R^2$ statistic for this regression analysis was 0.28, showing that the model is explaining approximately 28% of the variance, with the Chi-Square model omnibus test of model coefficients significant at p<0.001.

Table 16. Multiple logistic regression results looking at the influence of demographic variables (gender, age, household income and level of education) on use of a smartphone

<table>
<thead>
<tr>
<th></th>
<th>β</th>
<th>Sig.</th>
<th>Odds Ratio</th>
<th>Lower CI 95%</th>
<th>Upper CI 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>-1.02</td>
<td>0.0060**</td>
<td>0.36</td>
<td>0.18</td>
<td>0.74</td>
</tr>
<tr>
<td>Age: (reference variable) 70-89 years</td>
<td>0.0050**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age: 30-49 years</td>
<td>1.60</td>
<td>0.013*</td>
<td>4.95</td>
<td>1.40</td>
<td>17.53</td>
</tr>
<tr>
<td>Age: 50-69 years</td>
<td>1.28</td>
<td>0.0010**</td>
<td>3.61</td>
<td>1.67</td>
<td>7.79</td>
</tr>
<tr>
<td>Income: (reference variable) $75,000+/ year</td>
<td>0.21</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income: &lt;$30,000/year</td>
<td>-0.66</td>
<td>0.19</td>
<td>0.52</td>
<td>0.19</td>
<td>1.38</td>
</tr>
<tr>
<td>Income: $30,000-$49,000/year</td>
<td>-0.42</td>
<td>0.40</td>
<td>0.66</td>
<td>0.25</td>
<td>1.75</td>
</tr>
<tr>
<td>Income: $50,000-$74,000/year</td>
<td>0.58</td>
<td>0.92</td>
<td>1.79</td>
<td>0.61</td>
<td>5.31</td>
</tr>
<tr>
<td>Education: (reference variable) college degree</td>
<td>0.028*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education: no high school</td>
<td>-0.91</td>
<td>0.19</td>
<td>0.40</td>
<td>0.10</td>
<td>1.57</td>
</tr>
<tr>
<td>Education: high school graduate</td>
<td>-1.68</td>
<td>0.0040**</td>
<td>0.19</td>
<td>0.060</td>
<td>0.58</td>
</tr>
<tr>
<td>Education: some college</td>
<td>-0.37</td>
<td>0.44</td>
<td>0.70</td>
<td>0.28</td>
<td>1.74</td>
</tr>
</tbody>
</table>

Note: Age categories of 19-29 years and 90+ years are not included as the sample for these categories was too small for the analysis

* p<0.05, ** p<0.01
Looking at Table 17, the multiple logistic regression analysis that explores the influence of demographic variables on tablet use, significant results only occurred with respect to the independent variable of gender. Results showed that women have 3.08 larger odds of using a tablet than men (p=0.0010). Variables of age, income and education did not show significant results with respect to influence on tablet use. The Nagelkerke $R^2$ statistic for this regression analysis was 0.11, showing that the model is explaining approximately 11% of the variance. This low result suggests that there may be other factors influencing the odds of patients using a tablet. Also, the Chi-Square model omnibus test of model coefficients was not significant at p=0.083 for this regression analysis. Given these values of the Nagelkerke $R^2$ and the Chi-Square, and that gender is the only significant variable in the model, it can be suggested that the independent variables in this regression model explain very little of the variance.

Table 17. Multiple logistic regression results looking at the influence of demographic variables (gender, age, household income and level of education) on use of tablet

<table>
<thead>
<tr>
<th></th>
<th>β</th>
<th>Sig.</th>
<th>Odds Ratio</th>
<th>Lower CI 95%</th>
<th>Upper CI 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>1.12</td>
<td>0.0010**</td>
<td>3.08</td>
<td>1.55</td>
<td>6.09</td>
</tr>
<tr>
<td>Age: (reference variable) 70-89 years</td>
<td>-0.017</td>
<td>0.97</td>
<td>0.98</td>
<td>0.35</td>
<td>2.80</td>
</tr>
<tr>
<td>Age: 50-69 years</td>
<td>-0.039</td>
<td>0.91</td>
<td>0.96</td>
<td>0.48</td>
<td>2.00</td>
</tr>
<tr>
<td>Income: (reference variable) $75,000+/ year</td>
<td>0.19</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income: &lt;$30,000/year</td>
<td>-0.81</td>
<td>0.086</td>
<td>0.44</td>
<td>0.18</td>
<td>1.12</td>
</tr>
<tr>
<td>Income: $30,000-$49,000/year</td>
<td>-0.48</td>
<td>0.29</td>
<td>0.62</td>
<td>0.25</td>
<td>1.52</td>
</tr>
<tr>
<td>Income: $50,000-$74,000/year</td>
<td>-0.80</td>
<td>0.082</td>
<td>0.45</td>
<td>0.18</td>
<td>1.11</td>
</tr>
<tr>
<td>Education: (reference variable) college degree</td>
<td>0.68</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education: no high school</td>
<td>0.69</td>
<td>0.29</td>
<td>1.99</td>
<td>0.56</td>
<td>7.10</td>
</tr>
<tr>
<td>Education: high school graduate</td>
<td>0.40</td>
<td>0.45</td>
<td>1.49</td>
<td>0.53</td>
<td>4.14</td>
</tr>
<tr>
<td>Education: some college</td>
<td>0.17</td>
<td>0.70</td>
<td>1.18</td>
<td>0.51</td>
<td>2.76</td>
</tr>
</tbody>
</table>

*Note: Age categories of 19-29 years and 90+ years are not included as the sample for these categories was too small for the analysis*

*p<0.05, **p<0.01*
Table 18 describes the influence of demographic variables on use of a wearable mobile device, such as a Fitbit or Garmin. This multiple logistic regression result shows that patients with an income of <$30,000/year had 0.053 lower odds of using a wearable than those with an income of $75,000+/year (p=0.0060). Patients with a high school diploma had 2.71 larger odds of using a wearable device than patients with a college or university degree (p=0.095).

Therefore, these results suggest that those with the lowest household income had lower odds of using a wearable than those with the highest household income and those with a high school diploma had higher odds of using a wearable than patients with higher levels of education.

There were no significant effects with respect to gender or age. The Nagelkerke $R^2$ statistic for this regression analysis was 0.19, showing that the model is explaining approximately 19% of the variance, with the Chi-Square model omnibus test of model coefficients was significant at p=0.003.

Table 18. Multiple logistic regression results looking at the influence of demographic variables (gender, age, household income and level of education) on use of a wearable

<table>
<thead>
<tr>
<th></th>
<th>β</th>
<th>Sig.</th>
<th>Odds Ratio</th>
<th>Lower CI 95%</th>
<th>Upper CI 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>-0.26</td>
<td>0.54</td>
<td>0.77</td>
<td>0.34</td>
<td>1.76</td>
</tr>
<tr>
<td>Age: (reference variable) 70-89 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age: 30-49 years</td>
<td>0.96</td>
<td>0.12</td>
<td>2.60</td>
<td>0.78</td>
<td>8.68</td>
</tr>
<tr>
<td>Age: 50-69 years</td>
<td>0.45</td>
<td>0.45</td>
<td>1.02</td>
<td>0.65</td>
<td>3.76</td>
</tr>
<tr>
<td>Income: (reference variable) $75,000+/ year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income: &lt;$30,000/year</td>
<td>-2.95</td>
<td>0.0060**</td>
<td>0.053</td>
<td>0.0070</td>
<td>0.43</td>
</tr>
<tr>
<td>Income: $30,000-$49,000/year</td>
<td>-1.074</td>
<td>0.059</td>
<td>0.34</td>
<td>0.11</td>
<td>1.04</td>
</tr>
<tr>
<td>Income: $50,000-$74,000/year</td>
<td>-0.88</td>
<td>0.082</td>
<td>0.41</td>
<td>0.15</td>
<td>1.12</td>
</tr>
<tr>
<td>Education: (reference variable) college degree</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education: no high school</td>
<td>-0.76</td>
<td>0.50</td>
<td>0.47</td>
<td>0.053</td>
<td>4.21</td>
</tr>
<tr>
<td>Education: high school graduate</td>
<td>1.00</td>
<td>0.095*</td>
<td>2.71</td>
<td>0.84</td>
<td>8.76</td>
</tr>
<tr>
<td>Education: some college</td>
<td>0.011</td>
<td>0.98</td>
<td>1.01</td>
<td>0.35</td>
<td>2.96</td>
</tr>
</tbody>
</table>

Note: Age categories of 19-29 years and 90+ years are not included as the sample for these categories was too small for the analysis

* p<0.05, ** p<0.01
As Table 19 shows, for those using a mobile device (n=222), they were also asked what they used their device for. The majority of patients were taking pictures with their device (n=189, 85%), using email (n=178, 80%), using the internet (n=172, 77%) and texting (n=170, 77%). One hundred and thirty patients (59%) were using their mobile device to look up health information on the internet. Twenty respondents noted the question as “not applicable” and eight chose not to respond to that survey question.

Table 19. Patient survey responses on what their mobile device is used for (with patients using a mobile device)

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pictures</td>
<td>189</td>
<td>85%</td>
</tr>
<tr>
<td>Emails</td>
<td>178</td>
<td>80%</td>
</tr>
<tr>
<td>Internet</td>
<td>172</td>
<td>77%</td>
</tr>
<tr>
<td>Text</td>
<td>170</td>
<td>77%</td>
</tr>
<tr>
<td>Internet for health Info</td>
<td>130</td>
<td>59%</td>
</tr>
<tr>
<td>Not applicable</td>
<td>20</td>
<td>9%</td>
</tr>
<tr>
<td>No response</td>
<td>8</td>
<td>4%</td>
</tr>
<tr>
<td>Total with a mobile device</td>
<td>222</td>
<td></td>
</tr>
</tbody>
</table>

(note: patients could choose more than one response)

While the survey did not focus on computer use, all interviewees noted that they were using a computer at home for searching the internet and using email. In the focus group, providers noted that they have been seeing an increase in patient technology use, especially health apps.

[Health apps] being used an awful lot more than it used to these days. (FG)

Tracking more things and using it more ...to make [their] lives more simpler I guess and easier. (FG)
4.3.2 Health App Use

This section describes results that relate to the objective of describing the types of health apps that patients are currently using and exploring patient and provider perceptions on health app use. Table 20 shows that the total number of patients using health apps was n=111. This was 50% of those responding that they own a mobile device (n=222), and 46% of the total number of patients that completed a survey (n=242). Health apps were defined on the survey form as “any mobile app that patients feel aid in their health and wellness. This can include but is not limited to fitness, diet, exercise, healthy behaviors (smoking cessation, alcohol limitation, sleep, etc.), and mental health apps such as those for relaxation, meditation, depression and anxiety. They can also include wearable devices that collect information on heart rate, steps, blood pressure, etc.”

Table 20. Patient survey responses on health app use

<table>
<thead>
<tr>
<th>Health App Use</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients using a health app</td>
<td>111</td>
</tr>
<tr>
<td>Percent patients using health app that &quot;have a device&quot;</td>
<td>50%</td>
</tr>
<tr>
<td>Percent of all patients (with or without device) using health apps</td>
<td>46%</td>
</tr>
</tbody>
</table>

Table 21 shows the multiple logistic regression results looking at the influence of demographic variables on health app use for patients who own a mobile device. These results show that age has an overall effect (p=0.0040), specifically with those aged 30-49 years having 4.49 larger odds (p=0.0060) and those aged 50-69 years old having 3.69 larger odds (p=0.0010) of using health apps than patients aged 70-89 years old. Income also showed that those with a household income of <$30,000/year having 0.36 lower odds of using health apps than those with a household income of $75,000+/year. These results suggest that younger patients had higher odds of using health apps than older patients, and those with a low household income had lower
odds of using health apps than patients with a high household income. The Nagelkerke $R^2$
statistic for this regression analysis was 0.18, showing that the model is explaining
approximately 18% of the variance, with the Chi-Square model omnibus test of model
coefficients significant at $p=0.002$.

Table 21. *Multiple logistic regression results looking at the influence of demographic variables*
(*gender, age, household income and level of education*) on health app use

<table>
<thead>
<tr>
<th></th>
<th>$\beta$</th>
<th>Sig.</th>
<th>Odds Ratio</th>
<th>Lower CI 95%</th>
<th>Upper CI 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>-0.45</td>
<td>0.21</td>
<td>0.64</td>
<td>0.32</td>
<td>1.28</td>
</tr>
<tr>
<td>Age: <em>(reference variable)</em> 70-89 years</td>
<td></td>
<td>0.0040**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age: 30-49 years</td>
<td>1.50</td>
<td>0.0060**</td>
<td>4.49</td>
<td>1.53</td>
<td>13.16</td>
</tr>
<tr>
<td>Age: 50-69 years</td>
<td>1.30</td>
<td>0.0010**</td>
<td>3.69</td>
<td>1.75</td>
<td>7.78</td>
</tr>
<tr>
<td>Income: <em>(reference variable)</em> $75,000+/ year</td>
<td></td>
<td>0.075</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income: &lt;$30,000/year</td>
<td>-1.022</td>
<td>0.036*</td>
<td>0.36</td>
<td>0.14</td>
<td>0.93</td>
</tr>
<tr>
<td>Income: $30,000-$49,000/year</td>
<td>-0.92</td>
<td>0.056</td>
<td>0.40</td>
<td>0.15</td>
<td>1.02</td>
</tr>
<tr>
<td>Income: $50,000-$74,000/year</td>
<td>-0.058</td>
<td>0.90</td>
<td>0.94</td>
<td>0.40</td>
<td>2.23</td>
</tr>
<tr>
<td>Education: <em>(reference variable)</em> college degree</td>
<td></td>
<td>0.32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education: no high school</td>
<td>-0.42</td>
<td>0.52</td>
<td>0.66</td>
<td>0.18</td>
<td>2.36</td>
</tr>
<tr>
<td>Education: high school graduate</td>
<td>-0.22</td>
<td>0.68</td>
<td>0.80</td>
<td>0.28</td>
<td>2.32</td>
</tr>
<tr>
<td>Education: some college</td>
<td>0.66</td>
<td>0.14</td>
<td>1.94</td>
<td>0.80</td>
<td>4.68</td>
</tr>
</tbody>
</table>

*Note: Age categories of 19-29 years and 90+ years are not included as the sample for these categories was too small for the analysis
* $p<0.05$, ** $p<0.01$

Patients using health apps were asked in the survey questions to list the type of health
app(s) they were using. Table 22 lists the survey responses to this question and shows that the
most common type of health app used was for fitness with 88 (79%) of patients selecting this
response. Following this, 30 (27%) of patients were using diet apps, 22 (20%) were using sleep
apps, and 21 (19%) were using apps for monitoring blood pressure. Fewer patients (less than 10)
were using apps for medications, mood, diabetes/blood sugar monitoring, and smoking cessation.
Table 22. Patient survey results on type of health apps being used

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fitness</td>
<td>88</td>
<td>79%</td>
</tr>
<tr>
<td>Diet</td>
<td>30</td>
<td>27%</td>
</tr>
<tr>
<td>Sleep</td>
<td>22</td>
<td>20%</td>
</tr>
<tr>
<td>Weight loss/control</td>
<td>21</td>
<td>19%</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>19</td>
<td>17%</td>
</tr>
<tr>
<td>Medication management</td>
<td>8</td>
<td>7%</td>
</tr>
<tr>
<td>Mood</td>
<td>5</td>
<td>5%</td>
</tr>
<tr>
<td>Diabetes / blood sugar</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>Smoking cessation</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
<td>7%</td>
</tr>
<tr>
<td>Don't know</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td><strong>Number of patients that use a health app</strong></td>
<td><strong>111</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Other (as written in the open text response): *"meditation", "breathing", "lab reports", "UHN Rehab Workbook", "SpO2"

(note: patients could choose more than one response)

Patient interviews showed similar health app usage with the majority of interviewees with health apps using them for tracking walking, running and biking.

*As far as health goes, the biggest thing for me was trying to figure out what the distances are for when I'm walking. (IA9)*

*So, it does the steps, converts it into the kilometres, and that’s primarily what I've been using. (IA14)*

*Well, I wear it all the time so it’s just monitoring how much I walk. (IA16)*

Similarly, interviewees who were not using health apps also cited exercise apps as something they would be most interested in.

*One thing I wanted that you don't get in a tablet, that I could have gotten on the cell phone was steps…. and then, so you know it can do the distance on the cell phone, so you know how many steps you do per day. (IN8)*

*I mean my number of paces in a day might be useful. It could give me an indication of whether I am actually sort of sitting there and or am I doing nothing in my sort of everyday routine as of exercise to compliment my day. (IN23)*
I think that [walking] app is a handy one so I will tell one of my kids to download it for me. Because that would certainly be of help and I think the counting [steps] could be helpful. (IN27)

Providers echoed this in observing that the majority of apps they noticed patients using were for exercise.

And then I found too that sometimes that when we give our prescriptions in miles I would have a number of people ask how many steps is that? If they're checking their steps. (FG)

Tracking exercise progress was of particular interest for app users and non-users. Interviewees mentioned tracking daily progress and also tracking against goals.

That's what I find the biggest benefit about the apple phone and that. So that you can kind of see where you were at and last week you didn't do much or last week you did, type of thing. So I try to keep up on it. (IA21)

....going slightly further and at a certainly shorter time and not so quite short of breath that sort of thing. If I could see that, I think that would be immediate motivation. I think that is an immediate satisfaction from the patients point of view. (IA28)

Heart rate was also noted as an important health app feature, especially as related to exercise.

Patients noted.

I find it hard to record my heart rate especially because my heart rate's pretty, like, post-exercise its pretty high so it's hard to count that many in 10 seconds. So, I find on my Fitbit where it monitors, it gives me my heart rate, I find that really useful. (IA2)

So, I want to make sure that I do exercise, is my heart rate right in the range, have I maintained the time and things like that. (IN5)

Like my Garmin, my heart rate monitor is so, so useful when I go mountain biking because it's just on your wrist and that's it. (IA21)

Providers also spoke about the importance of tracking heart rate and had noticed patients using mobile apps and wearables to check heart rate.

They're using a device for their heart rate, they favor the device. (FG)
Related to tracking progress, patients (both health app users and non-users) spoke about the use of visualizing results, and noted that they liked graphs as a visual output.

*So if you saw that on a chart then that would be positive reinforcement to what you're doing.* (IN10)

*.....some kind of graphic, probably a graph summary month by month...see where I'm going, see if I'm increasing, decreasing, maintaining it.* (IN13)

*....it makes a graph for you and also as to what you have eaten after the end of each meal you can write down and it's specific.* (IA28)

Following exercise, patients mentioned health apps for diet, weight loss, tracking calories, tracking sodium content and recipes as the next most frequently used apps.

*I mean it would tell you how many calories you've eaten in each meal. And then, the beginning of it you put in your weight, how much you want to lose.* (IA28)

Providers echoed the use of diet apps by their patients.

*Track what they eat, exercise, track your weight, [patients] track a lot of stuff.* (FG)

Following exercise and diet apps, the most frequently mentioned apps during interviews were those for blood pressure, sleep and health educational information.

*When asked specifically which apps they were using, survey respondents cited Fitbit as the most frequently used (n=19, 17%), then Apple Health (n=17, 15%) and S Health (n=11, 10%) (Table 23). Between three and seven percent of patients were using Map My Walk/Ride/Run, My Fitness Pal, Medisafe, Lose It, and Cardiograph. Thirteen (12%) of patients with health apps did not know the name of what they were using.*
Table 23. *Patient survey results on the name of the health app being used*

<table>
<thead>
<tr>
<th>Response Options (all open text response)</th>
<th># Patients Citing Each</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fitbit</td>
<td>19</td>
<td>17%</td>
</tr>
<tr>
<td>Apple Health / iHealth</td>
<td>17</td>
<td>15%</td>
</tr>
<tr>
<td>S Health</td>
<td>11</td>
<td>10%</td>
</tr>
<tr>
<td>Map My Walk/Ride/Run</td>
<td>7</td>
<td>6%</td>
</tr>
<tr>
<td>My Fitness Pal</td>
<td>7</td>
<td>6%</td>
</tr>
<tr>
<td>Medisafe</td>
<td>4</td>
<td>4%</td>
</tr>
<tr>
<td>Lose It</td>
<td>3</td>
<td>3%</td>
</tr>
<tr>
<td>Cardiograph / Cardio</td>
<td>3</td>
<td>3%</td>
</tr>
<tr>
<td>Withings</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>Heart Rate</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>Garmin</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>LG Health</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>Apple Watch</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>Instant Heart Rate</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>Argus, Calm, Brainwaves, Runner, Dynacare Labs, Polar, Noom, Mio Go, Take My Pulse, Simply HIIT, Stress Check, Wildflowers, Companion for Band, 37 Bracelet, Rhythm Health, Treadmill, Google pedometer, Runmeter, Fitonomy, Symple, U A Record, Weight Diary, Fitness, Treksee, Steps, Stairs, Miles, Tap a Lap, Heart Monitor, Med Helper, Sleepbot, Nike Run Club, Bernstein</td>
<td>1 (i.e., these apps were used by one patient each)</td>
<td>1%</td>
</tr>
<tr>
<td>Patients that &quot;don't know&quot; what they use</td>
<td>13</td>
<td>12%</td>
</tr>
<tr>
<td>Number of patients that use a health app</td>
<td>111</td>
<td></td>
</tr>
</tbody>
</table>

Survey respondents were also asked how frequently they used their health apps (Table 24). Frequent use was more common with 56 (50%) patients using them once per day and 24 (22%) using them a few times per week. Only six (5%) used health apps once per week, five (5%) used them once per month, and four (4%) used them less than once per month.
Table 24. *Patient survey results on frequency of health app use*

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once per day</td>
<td>56</td>
<td>50%</td>
</tr>
<tr>
<td>Few times per week</td>
<td>24</td>
<td>22%</td>
</tr>
<tr>
<td>Once per week</td>
<td>6</td>
<td>5%</td>
</tr>
<tr>
<td>Once per month</td>
<td>5</td>
<td>5%</td>
</tr>
<tr>
<td>Less than once per month</td>
<td>4</td>
<td>4%</td>
</tr>
<tr>
<td>No response</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>Number of patients that use a health app</td>
<td>111</td>
<td></td>
</tr>
</tbody>
</table>

With respect to the length of time that patients had been using health apps, the majority of survey respondents had been using health apps for less than six months (n=54, 49%) and 31 (37%) had been using them for over six months (Table 25). The cardiac rehabilitation program is six months long and may have contributed to interest in and use of health apps pertaining to areas that are of focus in the program such as exercise and diet. As will be described in detail in Section 4.5, results from this study show that providers in this program generally do not recommend apps, therefore, possible influence from the program might be as a result of program educational focus on areas such as fitness and diet.

Table 25. *Patient survey results on length of time having used a health app*

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1 month</td>
<td>11</td>
<td>10%</td>
</tr>
<tr>
<td>1 month to 6 months</td>
<td>43</td>
<td>39%</td>
</tr>
<tr>
<td>6 months to 1 year</td>
<td>14</td>
<td>13%</td>
</tr>
<tr>
<td>More than 1 year</td>
<td>27</td>
<td>24%</td>
</tr>
<tr>
<td>No Response</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>Number of patients that use a health app</td>
<td>111</td>
<td></td>
</tr>
</tbody>
</table>
4.4 Health Apps & Self-Management

This section describes patient motivations to use health apps (for patients using apps), and motivations to engage in healthy behaviours (for patients not using apps). Following a description of motivations, is a description of barriers to using health apps and the related topic of trust (and distrust) in health apps particularly as pertains to accuracy and privacy of information. Finally, the theme of paper versus apps for health tracking is explored from both patient and provider perspectives.

4.4.1 Overview of Health Apps and Self-Management

The patient survey asked all respondents whether they felt that health apps can help in managing chronic illness. Results show that 156 (64%) said yes apps can help, 11 (5%) said no they cannot help, and 69 (29%) said they didn’t know (Table 26).

Table 26. Patient survey results on whether health apps can help in managing chronic (for example, cardiac) illness

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>156</td>
<td>64%</td>
</tr>
<tr>
<td>No</td>
<td>11</td>
<td>5%</td>
</tr>
<tr>
<td>Don't Know</td>
<td>69</td>
<td>29%</td>
</tr>
<tr>
<td>No Response</td>
<td>6</td>
<td>2%</td>
</tr>
<tr>
<td>Total number of patients surveyed</td>
<td>242</td>
<td></td>
</tr>
</tbody>
</table>

The patient survey also asked those that are using health apps whether they felt that the app(s) had improved their health (Table 27). Results show that 35 (32%) of patients felt that their health had improved very much with use of the health app and 50 (45%) felt that their health had improved a little bit or the health app was somewhat helpful. Combined, these results show that 85 (78%) of patients that had used health app felt that it had helped to make an improvement on their health. Eight patients (7%) felt that the health apps(s) were either of no
help or had made their health worse. Four (4%) of the patients chose not to answer this survey question.

Table 27. Patient survey results on whether patients using health apps felt that use helped improve their health

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health very much improved</td>
<td>35</td>
<td>32%</td>
</tr>
<tr>
<td>Health a little bit improved / somewhat helpful</td>
<td>50</td>
<td>45%</td>
</tr>
<tr>
<td>Health made worse / no help to health</td>
<td>8</td>
<td>7%</td>
</tr>
<tr>
<td>No response</td>
<td>4</td>
<td>4%</td>
</tr>
<tr>
<td>Number of patients that use a health app</td>
<td>111</td>
<td></td>
</tr>
</tbody>
</table>

(note: patients could choose more than one response)

These results were echoed during the patient interviews and in the provider focus group. The majority of patients that were using a health app noted that they felt it had helped to improve self-management of their condition.

“Well, yeah it just helps me you know, I track everything from my weight loss. (IA1)

Garmin products are really, really good, and this Fenix is a phenomenal device. So, I wear it all the time, like I even wear it to sleep because it monitors my sleep, monitors my resting heart rate. It does, yeah it's an onboard real health and fitness tracker for me. So yeah, it's phenomenal. (IA6)

I guess it helped me in terms of pacing myself to try to get back to a point I felt I was before. Yeah. I guess it was useful in terms of the process to retraining myself. (IA30)

Providers also spoke about health apps being useful for patients in self-managing their condition.

And then I found too that sometimes that when we give our [exercise] prescriptions in miles I would have a number of people ask how many steps is that? If they're checking their steps. (FG)

Whatever works for that patient. It's hard enough to exercise as it is and if they've found something that works for them that's great. (FG)
4.4.2 Motivations to Use Health Apps

Discussion on motivations was a central part of the patient interviews and provider focus group. For health app users the discussion focused on motivations to use health apps and for non-app users the discussion focused on motivations to exercise and engage in health and wellness activities. For health app users, the most common motivation for using health apps was to be able to track progress and monitor against health goals.

*It really measures my progress. And I love that because that, that’s the motivator right? (IA6)*

*....and goal setting ... keeping active I don't know you can kind of see it there black and white. Oh jeez, that was a bit of lazy week last week or whatever. (IA21)*

Providers also noted that tracking against goals and reaching goal milestones was motivational for patients.

*....they really do like the that sort of weekly report, of here is your most active day, your average, you know getting the badges [badge icon rewards on the app for reaching a certain number of steps]. (FG)*

Patients noted the benefit of health apps that interpret results automatically. This type of app feedback is similar to the motivation noted above of gaining badges (icons that reward) within the app when patients achieve certain milestones.

*....they sort of explain it. They tell you whether its normal or abnormal and so forth. So, you get a better understanding of where you're at. (IA9)*

Another common motivation to use health apps was simply to be healthy through healthy behaviours such as exercise and good diet. Related to this, there was motivation due to the dislike and fear of being unhealthy, and ultimately the fear of declining in health.

*For myself personally, the motivation is for me to get healthier so I don’t have to visit that [health] system again as a patient. (IA1)*

*I think basically, initially the way I started and when I started, I was going through a very severe change in my life. I found myself to be not in a very healthy state, a very*
I was a totally different person from what I knew myself to be and that was very uncomforting, very unnerving so I wanted to get back on track as quickly as I could. (IA3)

So, what motivated me? It was literally life and death for me. If I was to continue with the high sodium I would have just accelerated the heart failure which would have accelerated the potential for me to die. (IA14)

Some patients also found the social component of health apps to be motivational, especially the factor of receiving praise from others for wellness efforts. Also, the ability to connect with others and show results. Providers also noticed patients using the social features of health apps.

I'm linked with two friends so there is a social element a bit of competitive and motivational component with that. (IA2)

I have posted to Facebook and it will show the actual route, it will show my map where I walked, a trail. Even if I go around the same block three times...yeah you can post it and say oh you know I did that and then people can say oh yeah great job. (IA18)

I find that people have commented that the social element is motivating. (FG)

These latter two quotes also speak to the notion of competition as a part of the social aspect of health apps and note that this feeling of competition between peers can be motivational. Others also mentioned competition as a positive feature.

.... its pushing each other in a way, like comparing with one another. (IA9)

There is a bit of like my neighbour does it too so you know, in the summer maybe more than in the winter, you know we kind of challenge each other or whatever.....bug each other a little bit, like you know I did 20,000 steps today, how much did you do type of thing. (IA21)

However, some patients noted that competition was not motivational.

I really don’t care that some guy did the same ride as I did in like four minutes where I did it in 12. (IA1)
Similarly, one patient that had mentioned the usefulness of competition also noted that sometimes it is not motivating. It seems that the aspect of competition might be an individual preference and even something that can be motivating sometimes but not at other times.

*It's sort of helpful. It can be demoralizing or it can be you know...cause like you run a race and if you win its very nice and if you don’t, you don’t like it.* (IA2)

Patients interviewed that were not using health apps were asked about motivations to engage in healthy behaviours and lifestyles. Even though they were not using health apps, knowing what motivates patients to engage in healthy behaviours might inform ways in which health might be useful. This group of non-health app users mostly spoke of the motivation of being and feeling healthy, as well as the desire to prevent further health decline.

*Well the walking makes me feel good for one thing. I guess it’s a physiological thing, if I walk a couple miles or more I get this great endorphin rush and it feels good.* (IN15)

*Well basically I want to stay healthy, I want to enjoy my old age.* (IN27)

*Oh, it's always the fact that you know, if you do it you reduce your chances of having a second heart attack by 50% period.* (IN29)

Similarly, motivation related to regret of not engaging in healthy behaviours in the past.

*....so, I could tell a good story, but I should have looked after myself better in my youth.* (IN13)

Following the motivation to be healthy, the motivations of socializing and family involvement was also noted during the interviews as influencing healthy behaviours.

*Sometimes you see somebody else and you just chat a little bit. Sometimes you can tell they're cardiac patients, and so on and so forth.* (IN7)

*I still have a fairly young family. You know there's a wedding next year, my son, you know both of my sons are still living at home, obviously my husband....so motivation is being able to function as a family.* (IN19)
Other motivations that were mentioned by one or two interviewees included wanting to look better, having personal health goals and the desire to get outside and be active.

### 4.4.3 Barriers to Using Health Apps

In order to more fully understand health app use and what motivates some people but not others, gaining an understanding of barriers to using health apps (and using mobile technology in general) was discussed during the patient interviews and provider focus group. The most common category of barriers was one of confusion. This was mentioned by both health app users and non-health app users. For example, patients spoke about feeling confused with respect to apps having too many features, too much information and being complicated to use.

*I've looked at them and there's too many buttons. (IA12)*

*... but it had a lot of options that went above and beyond what anyone would use...you know like all technology were all using ten or fifteen percent of the capability...I thought it was going to be too cumbersome. (IN13)*

*As long as they're not too complicated. The problem with some is there's too many things on it or too technical...hard to suss things out. It becomes too overwhelming and you know, you get frustrated. (IN17)*

Also, confusion in knowing what technology and what app to use and feeling that there are too many to choose from. Patients and providers brought this up in discussion.

*I couldn't find anything. There may be something out there because there's thousands of apps. (IN13)*

*There were so many that I kept downloading to see which is the one that I would prefer, and then I had to go. (AI8)*

*There is just so many different ones out there. (FG)*

The category of annoyance regarding mobile technology and apps also emerged. This category emerged mainly as annoyance with having to be connected to a device too frequently and apps requiring too much work.
The rest of it is just, you know, a time burner. And you know that may be appropriate for some people but I'm still working and I don't have a lot of time to play with these things. Technology really burns your time if we let it. (IN13)

I'm not great, I did that on a different app watching calories and food. But that just takes way too much time. (IA21)

I don't walk around with my phone in my hand. I just don't want to be married to it anymore than we already are. (IN29)

Following items that patients found confusing or annoying about mobile technology and apps, financial concerns were the next most common barrier. However, it should be noted that of the patients citing financial concerns only one of these patients did not own any mobile devices. Therefore, most patients noting this theme already owned a mobile device of some kind and were speaking about financial concerns with respect to themselves purchasing another or more expensive devices.

I've been interested in it but I've never thought the out pay of cash was, you know, that price is pretty high. (IN17)

For me, I think smartphone would be kind of an expensive toy. (IN24)

Yes, they're nice. Very nice. I can't afford one right now. (IN26)

There were also a number of interviewees that noted that financial concerns would be a barrier for others but not for themselves.

I think some people are aware of the Garmin watch, I don't know, it was a fairly inexpensive model. I got it for $125 on Amazon. But you know a lot of people wouldn't be interested in spending that amount of money either, or the money on a Fitbit. (IA11)

There were also barriers related to usability that patients found unappealing. For example, some patients found that mobile device screens were too sensitive and mistakes were made when using the touch screens.

.....it's so sensitive that sometimes your finger or hand barely grazes the surface and you've got five or six letters that you didn't write. (IN19)
Or screen size was too small.

... as far as reading the text that comes up on a smartphone it is just too small. My eyesight isn't exactly that good. (IN23)

I've always text messaged but for looking things up I find it very small. (IN27)

Some patients also found that wearables with a chest strap were not comfortable to use.

I did not like the thing that went on my waistband. In fact, I gave it back still in the package. (IA18)

But you know it [chest strap] takes a little adjusting to so I've only used it a few times so far. (IA30)

Others had experienced malfunctions with their device or health app.

They had all sorts of problems with communication between the GPS and the cadence trackers, and that kind of thing. I would have never ending frustrations trying to get them to communicate with one another. (IA6)

Well unfortunately it's [Fitbit] falling apart. I've got to get it replaced. (IA14)

Following these barriers and concerns, fewer patients noted barriers such as having low phone memory, limited data plans, trouble remembering to use the app, or needing to charge the device.

Patient survey results echoed some of the barriers that emerged in the patient interviews. As seen in Table 28, the main reasons for not using health apps were that patients didn’t know about them (n=35, 27%), didn’t own a mobile device (n=28, 21%), or were not interested in them (n=27, 21%). The response options of not owning a device or not being interested could be related to items discussed in the interviews such as disinterest due to the time needed to use them or other annoyances such as having to be on a device frequently. Survey results also showed that 15 patients (11%) also cited that health apps are “too complicated to use”. This result supports findings from the interviews as noted above. The survey result of thirteen patients (10%) responding that they don’t trust apps with their data also supports interview results and is
described further in the following Section 4.4.4 on health app trust. Finally, a smaller number of patients noted cell plan data as a barrier while fewer noted that they don’t need a health app and that their health is fine.

Interestingly the response option of “cost too much” was only selected by three patients (2%). Financial concerns did emerge as a common theme in the interviews as described above, however, as previously stated this theme was mentioned mainly by patients that already owned a mobile device and were thinking of a different device. Or it was mentioned as a perceived barrier for others but not for oneself.

Table 28. Patient survey results on reasons for never having used a health app

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Didn't know about them</td>
<td>35</td>
<td>27%</td>
</tr>
<tr>
<td>Don't own a mobile device</td>
<td>28</td>
<td>21%</td>
</tr>
<tr>
<td>Not interested in health apps</td>
<td>27</td>
<td>21%</td>
</tr>
<tr>
<td>Too complicated to use</td>
<td>15</td>
<td>11%</td>
</tr>
<tr>
<td>Don't trust apps with my data</td>
<td>13</td>
<td>10%</td>
</tr>
<tr>
<td>Use too much of cell plan data</td>
<td>11</td>
<td>8%</td>
</tr>
<tr>
<td>Health is fine, don't need</td>
<td>5</td>
<td>4%</td>
</tr>
<tr>
<td>Cost too much</td>
<td>3</td>
<td>2%</td>
</tr>
<tr>
<td>Other</td>
<td>27</td>
<td>21%</td>
</tr>
</tbody>
</table>

Number of patients never used a health app 131

Other (as written in the open text response): "not downloaded yet", "my phone is to phone out and receive calls I'm not interested in apps on my cell phone", "don't use apps", "too many to choose", "just got the device", "can't use on my phone", "forgot", "never felt the need", "haven't taken the time to", "have pedometer, finger pulse oximeter, blood pressure monitor", "blackberry too old", "lack of patience to deal with", "I would use if I used my smartphone for more purposeful", "just did not use any", my blackberry is predominantly just a work device - for office work", "didn't monitor my health generally or exercise"

(note: patients could choose more than one response)
The patient survey also asked patients if they had discontinued using health apps and if so what was/were the reason(s). Table 29 shows that 45 (19%) of patients had discontinued using a health app. In Table 30 the most common reason was that patients had lost interest in the app (n=45, 19%), followed by the app taking too much time (n=16, 36%). The latter result seems consistent with the interview results presented above that health apps can be too much work to use or that patients do not want to be on their mobile devices that frequently. With respect to the survey result of lost interest, this could be due to many reasons, possibly some of those cited above in the interviews such as health apps being complicated or annoying to use.

Table 29. Patient survey results on number of patients that discontinued using a health app

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>45</td>
<td>19%</td>
</tr>
<tr>
<td>No</td>
<td>178</td>
<td>74%</td>
</tr>
<tr>
<td>No response</td>
<td>7</td>
<td>3%</td>
</tr>
<tr>
<td>Total number of patients</td>
<td>242</td>
<td></td>
</tr>
</tbody>
</table>

Table 30. Patient survey results on reasons for discontinuing use of a health app (if applicable)

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lost interest</td>
<td>22</td>
<td>49%</td>
</tr>
<tr>
<td>Takes too much time</td>
<td>16</td>
<td>36%</td>
</tr>
<tr>
<td>Hidden costs</td>
<td>4</td>
<td>9%</td>
</tr>
<tr>
<td>Other</td>
<td>18</td>
<td>40%</td>
</tr>
<tr>
<td>Patients that have discontinued using a health app</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Other (as written in the open text response): &quot;better easier app&quot;, &quot;no real use to me&quot;, &quot;Fitness Pal&quot;, &quot;replaced by watch&quot;, &quot;ADHD&quot;, &quot;health change had to stop&quot;, &quot;no longer on diet&quot;, &quot;use treadmill more than walking&quot;, &quot;too complicated&quot;, &quot;inconsistent results&quot;, &quot;did not like it&quot;, &quot;am not supposed to do exercise at the moment&quot;, &quot;had a Fitbit, will get a new one&quot;, &quot;replaced phone and did not download the app again on new one&quot;, &quot;question the accuracy&quot;, &quot;inaccurate data&quot;, &quot;not sure what to do&quot;, &quot;just wish they were simpler to access; and that I had an unlimited data plan; I like working out in the gym but cannot afford that long term&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(note: patients could choose more than one response)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Providers had specific concerns with respect to patient use of health apps that were different from the concerns of patients. A common theme during the provider focus group was that use of health apps depends on the patient. i.e., different patients want and need different apps (or for some, they do not want apps at all).

*Because it depends what the patient wants too. If their desire is to input their data and just have it a method of tracking and that’s what motivates them. Some of the people have said that they would rather have a newsletter with just tips. (FG)*

*.... some of them are just not interested they just want us to do it. Highlight their route [for walking], print it and be done with it. (FG)*

Computer literacy was also noted as a barrier in the provider focus group. This is consistent with the concept that emerged during the patient interviews that health apps can be confusing to use. Providers also noted barriers specific to the care they provide in the cardiac program and that some health apps may not compliment this care. For example, they wanted health apps to be more customizable to patient goals, and to enable patient-provider communication.

*The individualized piece because I think when you get a Fitbit it automatically sets your goal at 10,000 but for some people they realize that’s not realistic and reset their goals but some people won’t know how to reset their goals. (FG)*

*Putting stuff into the app but you're not really getting feedback. But you can set goals and whatever it is you want but to get that personal feedback [from a provider] “yeah that’s what I would like you to do” or “good job” or “this is what my expectation is” or whatever, you aren't going to get that from just using an app. (FG)*

*.... and people have said you know without a person or the actual health coach, how do I know it’s right for me or how do you get that feedback. (FG)*

Providers also mentioned that even with the use of health apps, there is still a need for in-person contact in the context of cardiac rehabilitation.

*So, there is a study .... on diabetes and apps in McMaster and she [the researcher] said one of their outcomes from feedback that you miss the person, its great the app can do everything and enter everything but you're not there. So, the personal contact is lost and people do rely on that and value that as well. (FG)*
4.4.4 Health App Trust

As shown in the survey results in Table 28, 10% of patients not using health apps cited that they did not trust apps with their data. This theme also emerged during the patient interviews and provider focus group, specifically concerning trust in app accuracy, and trust in app privacy. A related theme also concerns efforts that some patients are taking steps to validate apps. With respect to trust in app accuracy, there were a number of health app users that felt concerned about accuracy.

I'm skeptical whether it’s doing a great job......on my sleep quality, if my sleep quality is as poor as this app is telling me it is, I shouldn't be upright. (IA2)

If you are not walking but you do some move with the phone, how the phone is assessing that is the main thing? If it’s just by motion, how accurate is it? If you are not moving, just moving in one space how does the phone know exactly what you are doing? And for these applications, in healthcare the main thing is accuracy. (IN4)

Well I know Garmin's and Fitbits aren't accurate at taking your pulse so what's the point? (IN13)

Providers also felt that app accuracy was important, especially as it pertains to the safety of health apps in giving the right information to patients that are self-managing a chronic condition such as cardiac illness. Providers also encouraged patients to validate the accuracy of their apps against other sources of information such as having heart rate checked by a provider or doing a manual check of heart rate to compare with output from their wearable.

I walked in the zoo for four hours and I got 1000 steps and I was like there's no way. It was because I was pushing a stroller. (FG)

Really always double check to make sure that they're taking their pulse correctly and explaining that they [wearables] might not be one hundred percent accurate. (FG)

I find that a number of my patients don’t feel that it is very reliable and that their heart rates are higher. Where and what range I'm not sure, but I kind of gather over 120 approximately. Might be sort of where they question the accuracy of the heart rate read out that they get. (FG)
Interestingly, there were also a number of patients that felt their health apps were accurate enough. Therefore, it would seem that there is a split in health app user opinions on accuracy.

_When I was on the stress test...I would be checking with them what the heart rates were. And I'd be checking with my watch, and we were within a beat per minute, two beats per minute. So, it was pretty accurate._ (IA6)

_...the physios or nurses do the heart rate pulse manually, just to check that the Apple watch was on track. And it's been pretty close, there's been no time where it's been way off._ (IA25)

Results from this study show that patients want to know the accuracy of their apps and they often take steps to validate accuracy such as comparing their health apps with other measurements. Similar to differing views on accuracy, there were also differing views on app privacy of information. There were some health app users and non-users that felt concerned about the privacy of their information.

_...it was at Sunnybrook and you know, he was able to go into a record that said oh I see you haven't been in the hospital very much but I found one procedure you had this many years ago at Mount Sinai. So, it’s not even a hospital associated with Sunnybrook but obviously there's some sort of centralized database with that information. I wouldn't like it if my fitness information made it into that._ (IA2)

_...the information doesn't stay on your wrist and the information goes to Google and the insurance companies can have access to it. So that's wrong, that's why I won't wear one [Fitbit]._ (IA28)

Other patients that were health app users and non-users were not concerned about privacy of information. Providers did not mention privacy as a concern.

_I don't see an issue if someone comes across that I'm exercising and how that would be problematic so, like I think that's an older generation kind of view to be like scared of the information being shared but I don't think big brother is watching._ (IA3)

_I'm just uploading my data to the app and yeah that's probably being stored in the cloud. But I don't, you know, really have a confidentiality issue around that._ (IA6)
So, I haven't worried about the reliability and the confidentiality. Do I care if the world knows my heart beat? (IA25)

### 4.4.5 Paper Versus Apps for Health Tracking

One theme that emerged during the patient interviews and provider focus group was one of paper versus apps for health tracking and monitoring progress (such as exercise or diet tracking). Within this overall theme, there were app users that felt that tracking with an app was better than using paper and there were non-app users that were tracking on paper, though felt that having it electronically in an app might be better. There was also a common sentiment across app users and non-users that sometimes people can learn how to do things the right way (such as exercise) and then they don’t need to track at all, it simply becomes part of everyday routine.

In discussions that focused on the benefits of using apps as opposed to pen and paper (mostly noted by app users and by observations from providers) the following thoughts were captured.

*I did not measure my steps the way most people did in the program I just found it too irritating. So, every week I would just say I did 5,000 steps this day, 8,000 steps that day, and I was taking it off my Fitbit. (IA18)*

*We're supposed to fill in these sheets and hand them in when we come in for our weekly appointments. It would be good if there was an app that could collect all the data and then just make it available through email. (IA25)*

*So, I suppose I can put the information into excel, and you know, form my own graphs and things like that which I used to do at work. But I certainly don't want to do that anymore, I want an app to do it. (IA28)*

*.... and now they seem to come in before class and they're sitting down with their phones and writing everything down on their journals from their week. (FG)*

There were also non-health app users that were using pen and paper to track their health.

*I keep track for the dietitian, I'm keeping a food diary but it's in paper form. (IN10)*

*Actually, I still am using the [paper] charts. What I did was made copies and I'm still doing that. (IN19)*
Well, you know I tracked, you know I should just put it altogether really because I track my blood pressure, my sugar. And walking. So I'll have to put it all together... because at the moment I've got pieces of paper on the kitchen table. (IN26)

Providers spoke of the benefit of using apps but were concerned that apps would not cover the needed care practice elements that are currently captured on paper. They also felt that it can be difficult to merge different modalities of information because they are currently receiving both paper and electronic information from patients.

We still have a paper-based diary, like tracking system of what they do at home. And I've had patients say “can I give you my Fitbit log instead”... we will say maybe in conjunction [with the paper form] because it doesn’t give us all the information. (FG)

Instead of a diary they like to email whatever they can download from the gadget, it is extra work dispersing and translating information when it’s done for numerous people. (FG)

Finally, there were discussions that highlighted the sentiment that people can just learn to do the things the right way and then they don’t need to track progress on paper or on an app. This was noted by both app users and non-users.

I felt pretty confident about what I was doing, I still like, I had to go on a low sodium diet prior to the transplant and then I became diabetic after the transplant so I used some technology to guide me in those areas but now I feel like I'm more conscious of what I'm doing. (IA14)

I used it from January until September or October and by then I could pretty much guess how many steps I had taken in a day. (IA18)

4.5 Health Apps and the Patient-Provider Relationship

Section 4.5 begins with a description of overall experiences with health apps in the context of the patient-provider relationship. Following this description, barriers in patient-provider engagement with respect to health app use are explored.
4.5.1 Overall Experiences with Health Apps and the Patient-Provider Relationship

The patient survey had a section of questions on sharing health app results with providers. The first of these questions asked patients that are using health apps if they had discussed the apps with their providers (Table 31). The majority of these patients (n=72, 65%) responded that they had not discussed their health app with providers. Twenty-four (22%) of patients had discussed their health apps with providers.

Table 31. Patient survey results on whether patients using health apps have discussed them with their healthcare providers

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>24</td>
<td>22%</td>
</tr>
<tr>
<td>No</td>
<td>72</td>
<td>65%</td>
</tr>
<tr>
<td>No response</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Number of patients that use a health app</td>
<td>111</td>
<td></td>
</tr>
</tbody>
</table>

All survey respondents (health app users and non-users) were asked if they felt providers would want them to share health app results. The majority of patients responded that they did not know (n=157, 65%) (Table 32). Sixty (25%) of patients felt that providers would want them to share results and 21 (9%) of patients felt that providers would not want them to share health app results.

Table 32. Patient survey results on whether patients feel that providers want patients to share health app results

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>60</td>
<td>25%</td>
</tr>
<tr>
<td>No</td>
<td>21</td>
<td>9%</td>
</tr>
<tr>
<td>Don't Know</td>
<td>157</td>
<td>65%</td>
</tr>
<tr>
<td>No Response</td>
<td>4</td>
<td>2%</td>
</tr>
<tr>
<td>Total number of patients surveyed</td>
<td>242</td>
<td></td>
</tr>
</tbody>
</table>
When asked if they would want to share results with providers, Table 33 shows that the majority of patients said yes, they would want to (n=116, 48%). Thirty-eight (16%) of patients said they would not want to share results, and 78 (32%) responded that they didn’t know if they would want to.

Table 33. *Patient survey results on whether patients would want to share health app results with their healthcare providers*

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>116</td>
<td>48%</td>
</tr>
<tr>
<td>No</td>
<td>38</td>
<td>16%</td>
</tr>
<tr>
<td>Don't Know</td>
<td>78</td>
<td>32%</td>
</tr>
<tr>
<td>No Response</td>
<td>10</td>
<td>4%</td>
</tr>
<tr>
<td>Total number of patients surveyed</td>
<td>242</td>
<td></td>
</tr>
</tbody>
</table>

### 4.5.2 Provider Engagement in Patient Health App Use

Patient interviews and the provider focus group also discussed views on sharing health apps and health app results with providers, primarily within the context of the patient-provider relationship. During these discussions, participants noted both positive experiences and barriers that they had faced when sharing health apps with providers. Experiences related to the patient-provider relationship when sharing health apps centred around providers engaging patients, providers giving technical support to patients using health apps, and provider receptivity when patients shared their health apps and results.

There were limited patient experiences with providers recommending health apps, and interviewees spoke more about positive experiences when providers recommended websites or had engaged in email communication with patients.

*One of the guys at Toronto rehab, he gave us a website that seemed to be pretty good. He said it’s sensible so that’s probably the one I use now.* (IA12)
And they’ve given us information on diet and exercise and websites we can look at. (IA16)

.... they often prefer to be reached by email and I find they respond much more promptly. Within the same day not only do they respond but they also have the results for me and we can communicate two or three times about those results. Whereas before on the phone it would take back and forth calling. The doctors are much more amenable to using the e mail. (IN19)

Providers brought up a web-based learning tool they are using with some patients and noted it as a step in the right direction with respect to using technology as a part of the cardiac rehabilitation program.

We use a learning management system where there is a toolbox and there is an exercise there we use. And so, I review what the patient does and look over all their emails. (FG)

I think having Cardiac College [a web-based learning tool] is a huge step. It's the center of something and a place they can trust. (FG)

On the topic of patients using technology, providers noted that they were receptive to providing technical support to patients and did not mind providing this support even though it is not an expectation within their job role. They also noted that patients were reaching out to them to ask for technical support.

Sometimes, they'll bring in Polar’s and they won’t know how to use those and ask for help with them. (FG)

They just need help with the initial set-up. Once they get it set-up, they get their son or grandson to set it up to the computer then they're good and they don't have to worry about that part. (FG)

We did that for one of the groups where we actually hired a guy to come in and brought in a bunch of laptops and it was for the grad programs. What to click on, what not to, how to read emails, how to go to website all that stuff. (FG)

Only a few patients mentioned sharing health app results with providers, thereby supporting the survey results illustrated in Section 4.5.1. A few patients that were not using apps also noted that they had shared health and wellness information they were
tracking on paper with their providers. However, when asked if they would feel comfortable sharing results from a health app, the majority of patients responded that yes, they would feel comfortable. This was consistent for both health app users and non-health app users.

I don’t mind sharing information about myself that will help me. There's no harm in me saying anything about my performance. If I tell my doctor that I feel something that has gone wrong then I can get advice from him. If I say nothing then I will get nothing. (IN23)

Yeah, like the more information they can have the better. So yeah, I have no issue if I had to share that with my GP or anything. (IA30)

On the topic of sharing health apps results, providers spoke about patients wanting a history of their paper record of health activity tracking.

Nowadays you see “I forgot to take a picture of December twenty-fourth [tracking results] to have in my diary”. Then I would check through the box and get it and scan it for them. So, they seem to be more interested and if that's what's going to help them, then so be it. (FG)

Providers also spoke about patients wanting to keep in touch with them post-graduation from the rehabilitation program.

I love hearing from people from 20 years ago, do you remember me? Yes, I do, I really do! (FG)

Whether it's formal because we do have formal things, education, on track, testing. And informal if you're in the neighborhood poke your head and say hello, getting emails every six months, come and say hi. I like that kind of thing. (FG)

Looking at providers engaging patients directly in health app use, only four of the interviewees had experienced a provider recommending an app.

I have never used any health applications but I've heard about it in the program at UHN. (IN5)

I have been put on to a couple of [apps] by my doctor, she put me on. (IA21)

For two of these four patients, they felt they needed more direction than what was provided.
I don’t think she mentioned any particular apps but she did suggest that it might be helpful. (IA3)

Well a lot of the visits with the doctor were "oh yeah use my fitness pal" or "oh yeah use Cleveland's hospital website"...no one actually sat and showed me the app or the website and how to use it. (IA14)

Most interviewees stated that providers had not mentioned health apps.

I don't think we've had a class on that or just to say, you know, like suggest you could try doing this. And like even getting a fit band. Nobody recommended that or said do that because it would be beneficial for you.... they don't push any technology per say that I can remember. (IN10)

Providers noted feeling hesitant to recommend apps. A couple of providers in the focus group had provided some recommendations but this was not consistent across providers and they were unsure which apps to recommend. Providers seemed more comfortable recommending websites than apps. This is consistent with the finding noted above that patients interviewed had little experience with providers recommending apps, however they could speak to providers recommending websites.

More apt to recommend a website so if it’s something like a government website like Eat Right Ontario I would recommend a lot. I don’t know if they have an app yet. You're connected to a dietitian it’s not in my scope of practice to give diet advice outside of Canada's food guide. But if they want more information, they want a menu plan then that's a great service right. (FG)

This hesitation to recommend apps is echoed in the categories that emerged specifically as barriers in patient-provider engagement and health app use as described in the next section.

4.5.3 Barriers in Patient-Provider Engagement and Health App Use

From the patient perspective, common barriers related to using health apps were mainly centred around feeling that providers were dismissive and uninterested in this type of discussion. This sentiment was felt during patient-provider conversations about health app use and also during conversations about general health and wellness. In particular, this barrier seemed to
emerge mainly during interactions with primary care or specialist physicians but not with rehabilitation providers. Also, most patients using health apps had not shared them with providers.

*I may have mentioned it when I was with a cardiologist. Especially with the Fitbit, I do remember talking with him about the Fitbit. “Oh, cool”. That was all he said. "Oh cool". (laughing). (IA1)*

*I sort of say I've been doing this and this kind of thing. And my GP isn't interested. He doesn't really care what I do. He said that's up to you and your cardiologist to manage. He's really, you know, like he, he's just not really interested. (IN10)*

*I would just be afraid I was bothering them that's it. I don’t know whether they would want me communicating. (IN24)*

Patients also mentioned that bringing up general health or health app conversations can be difficult due to provider availability and appointment restrictions.

*Even though I'm his patient um, I can't do a walk-in and you can only discuss one thing at a time.... like "well okay but we can't talk about this today, you have to come back and make another appointment and come back again tomorrow or the next day” or that kind of thing. (IN10)*

One patient brought up an example where the provider did engage him in app use conversation, however, it resulted in a negative patient-provider experience.

*.... my doctor he saw my phone and he said give me your phone and he just went on and said look at this. And he went into the area and said this is how much you're walking, your sleep etc. I didn't have much choice and he looked around and got information. I think I was a little bit embarrassed about how low the steps per day was. So, did it help him? I think it helped prove his point better than it made me feel. (IA2)*

Conversely, rehabilitation providers in the focus group felt that they welcomed patients sharing app results. These findings could be due to differences in patient versus provider perspectives or due to differences in experiences with primary care and specialist physicians versus with rehabilitation providers.
One guy was handing in diaries regularly which was 2.5 miles every week and he recently got a Fitbit and he was adding that he was doing 6-7,000 steps. So, I said that's great, try to get that up to 10,000 because I knew he was doing 2.5 miles still anyways and he liked this new gadget. (FG)

I'm happy as long as they hand it in whether it's on their Fitbit or diary we're getting some information that they're active, motivated and they're handing in something. (FG)

In general, patients preferred to wait for providers to engage them in the health app conversation and felt that they would wait until it was brought up by a provider.

I would feel comfortable but since it's never been requested I don't see the point of forcing that on them. (IN19)

If it's required I probably will. But at this point they haven't asked me for it. (IA20)

But, would I walk in and voluntarily say to them have this if you want? Nope, not going to happen. (IN29)

When providers did engage in app use conversations with patients, it was found that they would sometimes indicate that health apps (especially wearables) are not accurate, thereby discouraging patients to use them.

Well I know Garmin's and Fitbits aren't accurate at taking your pulse so what's the point? I first learned that at the program at Rumsey and I looked into it further and she was absolutely correct. That was the other reason I got rid of the Garmin. (IN13)

A lot of people even my doctors and even a couple of the rehab girls were saying that the Garmin's things pick up a lot of interference so sometimes you can get a real spike that your heart rate went way up but it actually didn't. (IA21)

The majority of patients interviewed also pointed out that they acknowledged that providers have a heavy workload and this made it difficult for them to engage in health app use. Patients were sympathetic towards provider workloads.

....talking everything over with my cardiologist, I'm positive that that's not something, he's so busy because he's a surgeon too. (IN10)
Well it’s a lot more data for them to read too you know…. yeah, a lot of time. Our healthcare system is under distress right now anyway. (IA11)

I don’t think most doctor’s have time to read all that stuff. (IA18)

As previously mentioned, providers also noted that when patients use health apps it can add to their workload because it does not fit with current care processes. Providers were also hesitant to be seen as promoting certain apps over others and were concerned about the accuracy and validity of apps. As mentioned in the above section, providers generally felt more comfortable recommending trusted websites from reputable sources.

That’s why it’s so hard to recommend as staff, I don’t know if we really do have this concrete list that we recommend we aren’t really promoting them that way. Not that it wouldn’t be a good idea to have a few and mention them and have them in our Power Point or in our book. (FG)

I find that the websites are easier to tease out what's research based rather than the apps you don't know the creator of the apps. but usually when you see the websites you see that its done by the Canadian association. (FG)

There are always new apps and they like to compete with each other and that can be a concern. A month later the top five can be something different. But those ones will still exist right. So, if you still want to know the reliability if you can. (FG)

4.6 Technology Use and Assumptions

During the patient interviews and provider focus group, common barriers that were brought up in conversation were those related to age and older patients having limitations in technology use and ability. This sentiment was mainly stated by patients using health apps. Providers and some patients felt that age was not a determining factor and that many older adults were using mobile technology and health apps. Others felt that age and related technology savviness was shifting with more and more older adults starting to use mobile apps. Although not mentioned as frequently, other barriers related to gender, language and cognitive ability were mentioned during patient interviews and by the provider focus group.
4.6.1 Age as a Determinant in Technology Use

On the topic of age as a factor in determining technology ability and related health app use, it was frequently noted that older people have trouble using technology and apps. Interestingly, this was more frequently cited by patients that were already using health apps. Many of these patients tended to self-identify as younger than other patients not using mobile technology and apps.

*The majority of the people in my class it feels like are older than me, are retired. I'm not saying that everyone who is older is less tech savvy, but there's more of them who are less tech savvy, so that's an issue.* *(IA2)*

*But I can see a lot of maybe older people that you know, technology is maybe not there for them, I'm not sure.* *(IA21)*

The following patients owned a mobile device but were not using health apps and noted that older patients might have difficulty using health apps. To note, patients that did not own a mobile device did not raise age a barrier in technology use.

*And just from my own personal experience, people around my age about maybe closer to half or half way decent now with this kind of technology, but probably half aren't.* *(IN7)*

*I'm seventy-two years old and I don’t think there's a lot of seventy-two year olds out there browsing the app store for apps.* *(IN13)*

Some patients however, felt that age and related technology use is experiencing a shift with more older adults starting to use mobile apps.

*Maybe in the next one or two decades people will be more [technology savvy]...baby boomers...they are changing right.* *(IN4)*

*Now, I'm sure you know as time goes by in another 15 years or so, you know the majority of people my age are going to be much more comfortable with that type of thing. Downloading stuff and so on and so forth and whatever. So, it may be a bit of an issue now, whereas 10-15 years in the future it's not going to be an issue.* *(IN7)*

While providers and a few patients felt that older generations are already tech savvy.
I was surprised a lot of the older people did have smartphones. (IA11)

I mean I’m seventy-two and I’m using a computer all the time. I think even people older than me are using a computer these days. (IA28)

Maybe in the next one or two decades people will be more [technology savvy]...baby boomers...they are changing right. (IN4)

4.6.2 The Influence of Gender, Language and Cognitive ability

Mentioned less frequently, though still relevant within the theme of assumptions related to technology use, are patient and provider views on gender, language and cognitive ability as factors in app use. Gender was mentioned twice by patients during interviews.

Now most of the men are probably computer conversant, but a few ladies that are in my class, I doubt that they do much more than rudimentary computer. (IN10)

You have a lot of guys who can do anything technologically and then you have little old ladies. So, you have to try to keep the technology simple. (IA18)

Language and cognitive ability came up as a barrier during the provider focus group and during several patient interviews.

And I think with a lot of the ESL learners, they wouldn’t jump on the web. They would need someone to show them that you know. (IA14)

It’s the people that don’t speak English or have cognitive issues or might be concerned about not using it correctly. I’ve had people with cognitive impairments that start using the apps that their family sets them up on it and it’s a much more confusing situation for them. (FG)

4.7 The Future of Health App Use

Themes from the previous sections on barriers are also relevant to discussions of the future use of health apps. This is particularly true when considering barriers that would need to be resolved should patients and providers want to increase use of health apps. The following sections describe desired health app features, considerations for practical app use, desired
changes in practice that pertain to health apps, and the type of support that patients and providers need to use health apps.

### 4.7.1 Desired Health App Features

In looking towards the future of health app use, the theme of desired or ideal health app features was asked in the patient survey and came up during patient interviews and the provider focus group. Table 34 shows patient survey results on the type of health app they would be interested in using. Results show that the majority of patients in the cardiac rehabilitation population were interested in using fitness apps (n=111, 46%). Following fitness, the next most frequently cited types of desired apps were those for blood pressure (n=89, 37%), diet (n=72, 30%), weight/weight loss (n=59, 24%), sleep (n=51, 21%), diabetes/blood sugar (n=39, 16%), medication management (n=36, 15%), mood (n=26, 11%) and smoking cessation (n=8, 35). Thirty-nine (16%) of patients were not interested in health apps and eight (3%) of patients did not know what type of app they would be interested in using. These results were consistent with results presented in Table 22 on the types of health apps patients are currently using. Both Table 22 and Table 34 show that the top response is fitness, with the next four responses (differing in order between the two Tables) being diet, blood pressure, sleep and weight loss/control.
Table 34. Patient survey results on the type of health app they are interested in using

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fitness</td>
<td>111</td>
<td>46%</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>89</td>
<td>37%</td>
</tr>
<tr>
<td>Diet</td>
<td>72</td>
<td>30%</td>
</tr>
<tr>
<td>Weight loss/control</td>
<td>59</td>
<td>24%</td>
</tr>
<tr>
<td>Sleep</td>
<td>51</td>
<td>21%</td>
</tr>
<tr>
<td>Not interested</td>
<td>39</td>
<td>16%</td>
</tr>
<tr>
<td>Diabetes / blood sugar</td>
<td>39</td>
<td>16%</td>
</tr>
<tr>
<td>Medication management</td>
<td>36</td>
<td>15%</td>
</tr>
<tr>
<td>Mood</td>
<td>26</td>
<td>11%</td>
</tr>
<tr>
<td>Smoking cessation</td>
<td>8</td>
<td>3%</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>1%</td>
</tr>
<tr>
<td>Don't Know</td>
<td>8</td>
<td>3%</td>
</tr>
<tr>
<td>Total number of patients surveyed</td>
<td>242</td>
<td></td>
</tr>
</tbody>
</table>

Other (as written in the open text response): "need to know of reliable choices available", "I feel overwhelmed at present and may look into it when I feel more on top of things", "would rather do this sort of thing on my laptop, don't really like smaller devices"

(note: patients could choose more than one response)

The patient survey also asked about “ideal” health app features (Table 35). Over half of patients responded that they would want goal setting and educational tools (n=136, 56% and n=126, 52% respectively). Following these two features, symptom monitoring was selected by 108 (45%) of patients, access to the medical record was selected by 89 (37%) of patients, and appointment reminders was selected by 82 (34%) of patients. Sixty-eight (28%) of patients felt that medication tracking was an ideal app feature, 47 (19%) of patients selected messaging with providers as an ideal feature, and 34 (14%) of patients selected peer support forums as an ideal app feature.
Table 35. Patient survey results on “ideal” health app features

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal setting</td>
<td>136</td>
<td>56%</td>
</tr>
<tr>
<td>Educational</td>
<td>126</td>
<td>52%</td>
</tr>
<tr>
<td>Symptom monitoring</td>
<td>108</td>
<td>45%</td>
</tr>
<tr>
<td>Access to medical record</td>
<td>89</td>
<td>37%</td>
</tr>
<tr>
<td>Appointment reminders</td>
<td>82</td>
<td>34%</td>
</tr>
<tr>
<td>Medication tracking</td>
<td>68</td>
<td>28%</td>
</tr>
<tr>
<td>Messaging with providers</td>
<td>47</td>
<td>19%</td>
</tr>
<tr>
<td>Peer support forums</td>
<td>34</td>
<td>14%</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>5%</td>
</tr>
<tr>
<td>Total number of patients surveyed</td>
<td>242</td>
<td></td>
</tr>
</tbody>
</table>

*Other (as written in the open text response): "ease of use", "heart rate", "doesn't have overlapping features", "my BP app is noded for the Withings machine but is huge with stuff that AMS band has", "Medical Alert call", "easy to use", "exercise", "on my cell phone", "exercise tracking", "BP with accurate HR", "being able to download pertinent reports to share with my physicians and print”*

(note: patients could choose more than one response)

Similarly, as was previously discussed in Section 4.3.2, it was also found that interviewees spoke positively about apps that can track against goals and monitor progress. Goal setting and monitoring symptoms and progress was also noted in Section 4.4.2 on patient motivations to use health apps.

When looking at the patient interviews, only three of the non-health app users were not familiar with health apps. The majority of non-health app users were familiar with health apps and many noted having an interest in them.

*I have seen some people wearing like a wrist watch and I have wondered how it works but not used it. (IN5)*

*Like she counts all her laps, and steps and heart on whatever she has. Also, she has a health app yeah, which would be good to have. (IN27)*
4.7.2 Practical App Use

The practical aspect of health app use was highlighted during the patient interviews and provider focus group. Most importantly, was the aspect of simplicity of use. Both health app users and non-users brought this up, as did providers.

*Whatever it is, it’s got to be really simple to operate.* (IA12)

*...but it [health app] had a lot of options that went above and beyond what anyone would use...you know like all technology we’re all using 10 or 15% of the capability...I thought it was going to be too cumbersome. I believe in the KISS theory.* (IN13)

The ability to customize to individual needs was also important and speaks to the desire for apps that can incorporate individual goals rather than setting a standard goal for all users.

*They do let you go from metric to like...to have it miles which is good, and they let you change what settings and what readings it will give you so I like that as well.* (IA9)

*Sometimes you set them up on their program and once they're really comfortable with their Fitbit or whatever then they go wild with it and they change it themselves and they seem to give themselves their own exercise prescription and impress themselves.* (FG)

Also, patients mentioned preferring apps that do not require manual input, especially within the context of using wearables such as Fitbit and Garmin.

*I find it hard to record my heart rate especially because my heart rate's pretty like, post-exercise its pretty high so it’s hard to count that many in 10 seconds. So, I find on my Fitbit where it monitors, it gives me my heart rate, I find that really useful.* (IA2)

*Which is great because then you can walk anywhere and it [Garmin] calculates your distance and your, you know you can do all kinds of things with it.... all I needed to do was do my three miles, 15 minute mile. The GPS watch helped me do that.* (IA11)

Non-health app users also noted the benefits of apps that do not require manual input.
If you’re walking or doing exercise, it gives you your heartbeat and you don’t have to stop and check. (IN4)

It’s convenience so people can know without any hazard, quickly how many calories I have burned, my heart rate or I am able to maintain my [exercise] prescription or things like that. Quickly without doing any calculations. I think that would help people. (IN5)

Related to the topic of individualized options on health apps was discussion on inclusion of competition within these apps. Some felt that competition was motivating.

I do use the function where the Fitbit allows you to compete with two friends or people and you know, share your results and see who has walked more in a week or whatever. So, I've done that with two of my friends. (IA2)

While others did not want aspects of competition.

So, I'm not tracking my results against any others. That doesn't really interest me. (IA6)

My daughter and son in law use it but I think it’s more for people who want to run competitively against other people and stuff like that. That’s not my game so I did not download it. (IN13)

These differing preferences point towards the need for health apps that provide feature options that people can choose to use or not use. This aspect of individualized app features also came through in conversation about individual preferences with respect to amount of time spent using a mobile device or different levels of health and wellness commitment. In general, simplicity of use and convenience were key desired app features.

4.7.3 Desired Changes in Practice

When asked about ideal state regarding health app use and what patients and providers would want in the future, two main themes emerged. The first centred on the desire to connect patients and providers during the rehabilitation program through the use of technology and apps. The second theme spoke to the need for enhanced continuity of care as supported by virtual care post-graduation from the rehabilitation program.
The first theme of connecting patients and providers during rehabilitation care was mentioned by the majority of patients during interviews and by providers during the focus group.

.... the doctor can log on and see your stuff. And that would be fine given the doctor can look at it or a technician or a technologist can look at it and say you know “slow down a bit you're ranking up heart rate too much”, or you know, “go to the next level....” (IA1)

And that ultimately, you'll be able to track, you know your heart rate, your blood pressure, all that type of thing. And provide that type of information off of various sensors with the kind of watch you're wearing to your healthcare professional. And then they can use it as a preventative tool. (IA2)

In discussing the ability to connect patients and providers, many patients mentioned that having a provider monitoring their progress against goals was motivating.

If I was being monitored even more closely than I am now, rather than just handing in that paper sheet every week, I definitely think that my compliance would be higher. (IA2)

You feel more of a responsibility and more that there is someone who is overseeing you and you do feel a responsibility to the person. You should feel a responsibility to yourself but it’s much easier to forgive yourself! (IN19)

Several patients also spoke about making the cardiac rehabilitation lectures available online and available to the public.

Nowadays it’s unbelievable what you can do. So, if there's a virtual way, the thing they do online with the seminars. That could be good for that. You could be in your t-shirt and shorts at home and away you go. (IN17)

A list or website where you can log in and once you are in to the program you get a password of something. You know there's a lot of lectures throughout like on diet, or reading labels or interplay with medications, and stuff like that. So, I sat through those lectures but I didn't take notes and I don't remember quite a bit of it. (IA25)

In some ways I think that should be open to more people, to more public. I have a friend I was telling her of it and she's very much into food and nutrition and she eats so well and she's into labels and then she started to ask me questions. I didn't know that and she would've loved to come. (IA28)
This desire for an enhanced patient-provider connection was especially relevant within the context of moving from paper tracking to more automated app-based tracking.

In terms of specifically Rumsey, they had the red form where you write everything down...they might look at perhaps developing an app where everyone records or reports their results. (IA14)

.... the tracking with Toronto rehab is all done on paper right? That I find I'm doing anyways. Tracking everything I do on my phone because I have my phone while I'm exercising. And then it's like the day of my rehab which is today, I just copy everything from my phone on to the pieces of paper you know. I feel like, it's a little outdated to be doing that. (IA30)

While it was not mentioned during patient interviews as a desired feature, providers brought up the aspect of being able to communicate through an app or website as a potentially useful feature. Providers also mentioned the concept of a virtual health coach for patients that might be receiving rehabilitation via distance.

Sometimes they want a personalized question answered because they expect the staff to know their history.... so, if they had a forum where they can ask a question and the answer is going to be something that is trustworthy. (FG)

During discussions on connecting patients and providers through health apps, patients brought up the desire to be in control of what information is sent to providers.

If at your choice, your discretion obviously.... not everybody wants to share that information. (IA9)

If the information is being spread around I want to be able to say yes, please give it to this doctor or that doctor or I don't know. I'd like it to be at my discretion. (IA28)

It's like an online portal you're controlling it but everyone you grant access to would also be able to have a better idea of your exercising patterns. (IA30)

This theme of wanting more connection between patients and providers during the rehabilitation program was also brought up during conversation on connecting post-graduation from the rehabilitation program. Providers brought up the concept of a virtual coach that could be available both during the program and after graduation. Similarly, this
concept of continuity of care post-graduation was a central theme during the patient interviews.

*I personally would appreciate something, and this is just me. I personally, some kind of little, I don't know what it would be. Some kind of, say even if it were once a week or once every two weeks or whatever. "Are you doing your follow up?" I don't know how you do it, but "this is from the cardiac rehab and we're interested in how things are going and whatever, and hope you're keeping up your program." (IN7)

So, find an app that sends me a message every two weeks or three after I graduate that asks me “hi, how are you doing, remember us?” You know, an email message or something like that. Yeah. So just the nature of “we're still thinking about you and we hope you are keep up with your stuff, keep in touch” that kind of thing. (IA25)

*If you had an app for the person, you could send the results to that for the progression of every three months. That would be a good thing. (IA28)*

Non-health app users spoke about wanting more rehabilitation post-graduation, but not specifically in the context of it being through virtual or app-based care.

*I think some of us would actually pay to still go. There's such a wait list to get in. (IN17)*

*I wish I could redo it a second time but they said I can’t do it again. So, I'm working on that to see if I can do it again…. It’s unfortunate that they will not continue the program on let’s say maybe one day a week for the graduates. (IA20)*

There were also discussions on patients feeling that it can be difficult to stay motivated post-graduation from the program and that continuity of care could help maintain healthy behaviours.

*So, what happens is that when the program’s over, there's a waterfall and they just stop, right? You could see it, like I said with the nutrition [inaudible], and I know from talking to people within the group, they were already cutting back from five days a week to three, two, you know? (IA6)*

*You know almost everybody seems to have a relapse, and I mean relapse in terms of keeping up with the program all the time. (IN7)*

*I guess there’s a lot of people who finish the program who don’t stay motivated so if you keep in touch with each other maybe that could help. (IN17)*
This latter quote also refers to the idea of patients keeping connected with one another post-graduation in order to maintain motivation to continue with their health programs. This sentiment was voiced by others as well.

_I don't use the leader board right now on the Garmin. If my entire alumni group, if we were all on it. Then we might continue to trade that information and we might to continue to say ”hey, how you doing? Are you making your distance?” And then you're prodding one another. (IA6)_

_I've had patients as well at graduation they will seek a way to keep in touch with each other. So, someone will start an email list you know if you want to be in our motivation group they will motivate each other by saying “I'm still doing this how is everybody else doing”, so sometimes they like that social aspect to continue and they wonder if we have a Facebook page. Things like that. (FG)_

Patients also mentioned a desire to be connected with other fitness organizations post-rehabilitation.

_But one of the things I'm going to look at, I do this idea of continuity. And maybe it's a combination of TRI, and then an outside provider like the YMCA or Goodlife. (IA6)_

_I wish they had more in the community. I know they have a couple of pools that are free to people and just the seniors…. (IN26)_

These results point to the importance of continuity of care post-graduation by connecting patients with providers and also connecting patients with each other. Discussions on this topic brought forward the need for a community of care that is built during rehabilitation and continues after the in-person rehabilitation is complete, even perhaps continuing into community based health and wellness programs.

Under the overall theme of ideal future state and desired changes in practice, there was also discussion within the provider group of how care processes would need to change to support more virtual care and use of apps and how this type of change could result in improved practices.

_So, if we're just tracking what people are doing and find out how often they are sedentary would be of interest. It's not something we currently ask them to report but if we're making a wish list (laughs) why not? (FG)_
We can automate…. and have more one-on-one face-to-face time right? (FG)

On the topic of increased use of virtual care and health apps, it is also important to note that a few patients did not feel the need for continuity of care post-graduation from the rehab program, thereby speaking to the importance of understanding individual needs.

.... if I can keep this up and it doesn't get worse then I don’t see any reason to because I haven't had a heart attack yet. I haven't had major surgery so I'm quite happy to go off and carry on the habit, that's up to me. (IN27)

No, I think once I graduate, I would be good to go. (IA30)

4.7.4 Patients Need Support

When discussing ideal future state of health apps, the theme of patients needing support emerged, specifically with respect to patients wanting providers to recommend health apps, the need for technical support and education, and finally the benefit of incentives to use apps for health and wellness. On the first topic of patients wanting app recommendations, this is related to discussions on concerns regarding validity of apps (Section 4.4.4) and confusion around what app to use given there are so many choices on the market (Section 4.4.3). The majority of patients mentioned wanting app recommendations from providers.

They [providers] can motivate the people and give information and say these are available. And help the people to buy these ones and choose. (IN4)

I think that what might be helpful is when people are choosing a specific technology I think they can get lost in terms of deciding on if they want a Fitbit, or do they get a Garmin?....it might be helpful to have a better understanding of what is the best brand or you know what is the best for a recovering heart patient? (IA30)

Providers also wanted to be able to recommend apps but felt that even with recommendations they prefer for patients to choose their own apps. This sentiment points towards helping patients to have the information needed to make informed decisions about health app use.
Patients felt that health apps should be discussed during the cardiac rehabilitation classes as a part of the curriculum.

*If you have a person that has used the apps and like, you have the volunteers that come there and they talk especially in the last four weeks of the class...if you have them come in, or you know explain to them these apps, show them all, you know, on the larger screens in the lecture room, you know the ease of the use and what can be used for them. And I'm sure there's people in there that will go hey that's a great idea.* (IA1)

*I think if one or two sessions can involve, maybe half an hour duration each, they can be added. Just creating awareness and the usefulness of such apps.* (IA3)

*If they [providers] had one or two or however many number of visits or classes that said “okay this would benefit you by wearing this band. It will give you a report and if you can access an app on it be your cell phone or your laptop, if you have one”.* (IN10)

Patients also wanted to engage with other patients and share app experiences and have a mechanism to allow these experiences to inform provider recommendations on health apps to use.

*I think it can be a strong motivator provided it's used the right way .... if you took samples, project them on a screen and showed people and said "okay this is a case study of somebody who went through our program. This is what they did, this is where they were, this is the device they were using to track their progress.* (IA6)

The need for technical support and education on health apps was a common theme during patients interviews and the provider focus group. Technical support was cited as a need from most patients that were not using a health app and also from providers as noted above.

*Maybe make the availability of learning how to use available. Say, where I go every Wednesday, I don't know how. If each person has their own and if I were to bring in my tablet, somebody else brings in something. Maybe, it's just knowing how is a big barrier because many people are not going to go to the library.* (IN8)

*If I had more education and information, I can use some of the apps better. Ok. Like the activity one it just has how many calories do you want to burn? So, I just have to pick a number it wasn't an informed thing where I knew about diet or other situations. I just put in a number to keep pushing and going.* (IA25)
Actually, it might be helpful if you wanted people to use the app, you know was to have a session to how to use it. How to download and use it. I think that's part of it. There's no question that it's tricky. (IN27)

Patients also mentioned a desire for assistance with interpreting results from health apps.

Are they ever going to, to have classes that teach at the patient level, enough knowledge that they would be able to understand it and not panic? (IN10)

.... but with a lot of those people who say it’s too much trouble or I'm not capable or I don't want to do it, if they saw it being used in the healthcare field and became part of it, and someone showed them ok here's what you did. And then a month later say ok here's what you did compared to a month ago. (IN13)

The financial aspect as a barrier to use of health apps was also brought up during the patient interviews as described in Section 4.4.3. Some of these patients felt that health apps should be subsidized within publicly funded healthcare.

The government can subsidize these things for the people who are wanting like, incentives. Then they can buy this one, and it pays the government back because then people are healthy. (IN4)

It shouldn’t cost money because most people if you’re on a pension or something, and money is an issue. (IA12)

Some patients and providers mentioned the incentive of apps that pay or reward healthy behaviours.

So I get stars based on my activity. Every time you go out for ten minutes non-stop you get a star, up to a max of five or something, and if you've done your prescription walk, do your resistance weight lifting they give you these stars for the first six months. Then for the second six months they pay you, they pay you cash. (IA9)

You can lead a horse to water but you can’t make them drink, is really what you're up against. And the issue is to use technology in order to facilitate self-management, then giving them some sort of reward at the end of it, you know a candy or coffee or some sort of recognition. (IN13)

So, Manulife has a new insurance, life insurance program where you get a Garmin watch as soon as you sign up and they do sort of a health screening, self-report questionnaire to find out your vitality age as opposed to your real age and the more activities you do to promote your healthy lifestyle the lower your insurance premium
goes the next year. And you can get a discount at GoodLife. It’s interesting right? (FG)

Also, it was mentioned by one patient that there are apps that donate money towards a charity of choice when you engage in healthy behaviours.

My friend….if she downloads this app and she uses it when she exercises then some company will donate x amount of money to whatever [cause]…. that company group, whatever that she wants it to be donated to. (IN8)

In summary, financial incentives could be direct in terms of subsidizing health app purchases, they could be indirect with praise and feedback for successful results, or they could be through donations to charities that are meaningful to patients. Incentives were not mentioned by all patients as motivating and some felt that even having stars or tokens within the app was incentive enough, without having actual financial reward.

4.7.5 Providers Need Support

Providers also brought up the need for support, particularly with respect to knowing which health apps to recommend. Further, they also wanted support in organizing care processes and resources that would need to change in order to support virtual app-based care.

Provider concerns about knowing what to recommend were described in Section 4.5.3 and included concerns about being seen as promoting certain apps over others. When asked about what they would like in terms of ideal state regarding health apps, providers spoke about having a standard reputable source for health apps that included information on reliability and validity of each app.

If we could be knowing what's out there, it's just doing so much work to scan everything. Seeing what's available out there and seeing what's reasonable. (FG)

What's reliable, we here, we get presented with so many different new ones on the market we don't know which to trust. (FG)
What's reliable. Just a variety of factors but if there was a type and a reliability and there was something we could pick and choose how they use it then we can have confidence it’s safe and secure. (FG)

Providers also wanted to make sure there are adequate resources to support the use of health apps in their care processes and they wanted health apps to match the measures and care processes currently used in practice.

You can't just fire up anything. You do need someone that's going to keep an eye on it and make sure it's reasonable. (FG)

But if it was a sort of app that captured all the things we care about, because we summarize their exercise diary and put it into our charting. Yeah. So, if there was something that captured date, distance and how long it took them. Pre-exercise, post-exercise pulse. Those are the things we care about. Symptoms if any. (FG)

### 4.8 Context: Shifting landscape in emerging technology, provider practices and patient use of health apps

This section of the results speaks to a theme that emerged throughout the study that provided overall context and applies across multiple themes that were previously described. Specifically, this contextual theme speaks to a shifting and changing environment with respect to emerging technologies, healthcare practices, and patient use of health apps and technologies.

Throughout the study participants brought up the concept of technology as continually changing and patient adoption of technology as continually increasing. At the time of this study from August 2016 to February 2017, wearables were one of the newer technologies on the market and results show that fewer patients had wearables (n=54, 24%) than had smartphones (n=145, 65%) or tablets (n=82, 37%) (Table 14). Also, few patients had the older technology of a cellphone (n=82, 37%) and 54 of these 82 also owned a smartphone or tablet. A relatively small number of patients (n=20) did not own a mobile device (Table 12). Similarly, as mentioned earlier in the Results, it was noted in the patient interviews that every patient had a
computer. Most patients that were interviewed spoke about using the internet to search for health information, and this was considered to be commonplace and not a new technology concept among patients.

*As well, if there's any meds that are prescribed or any particular symptom that I'm feeling, I am one of those people. I look it up. Obviously, I try to follow the sites where there recommended by various doctors. (IN19)*

*Yeah, I do research on health matters and whatever comes up. (IA20)*

*Sometimes, I do [look up health information]. But only if I need to. To answer a question I am going to be posing and if I can look it up on the internet then I can sort of avoid having to chase the doctors. (IN23)*

The Apple Watch, is one example of one of the most recent mobile technologies available on the market that is used for health and wellness. Of the patients surveyed, only two (2%) had this type of smart watch (Table 23). As described earlier in the results, wearables are using automated measurement of health activities which is preferred by patients.

Within the context of a shifting landscape surrounding health app use there is also a shifting landscape of provider practices and adoption of mobile technologies. Providers spoke about wanting to leverage existing technologies and incorporate them into practice.

*So, I mean the technology exists. It’s just the matter of taking advantage of it and actually getting rid of the redundancy and the extra work that we have to. (FG)*

Providers also mentioned having a web-based learning management system with which they would like to expand the feature set and capabilities.

*I think having Cardiac College [web-based learning management system] is a huge step. It's the center of something and a place they [patients] can trust. Sometimes they want a personalized question answered because they expect the staff to know their history they aren't going to get that specific question answered by not necessarily certain cardiac college so if they had a forum where they can ask a question and the answer is going to be something that is trustworthy. I've heard that as a request by a patient. (FG)*
As described earlier in the Results, the accuracy of health apps and capability for health apps to fit within practice processes were of key importance within this shifting technology landscape.

*If they get up to the point where they're 95% accurate and technology is at the point that you just throw a Fitbit on somebody and at the end of the week it sends us an email and says "yeah, [patient name] spent six hours and 17 minutes training and there was this many 10 minute blocks and they just sent it to us that way, that would be kind of interesting. (FG)*

These quotes speak to a changing healthcare environment with providers interested in using emerging mobile technologies and health apps, but recognizing that in order to use them effectively these technologies need to be valid and integrated into practice processes. Provider use of technology in practice was similar to technology use by patients in that web sites and web-based systems were being used. However, mobile apps and especially wearables were not being recommended to patients or used in practice.

*Some of the food tracking things I've recommend to certain patients specifically for sodium content which they can track that. I've done that and on the heart rate side I have suggested heart rate monitors. That is as far as I've gone. Not really any wearables. (FG)*

Providers also spoke about continuity of care post-discharge and touched on the concept of supporting patients in the community to continue with their health activities. One example was that of potentially having a health coach post-graduation. This was also a common theme for patients as described earlier in the results. Patients emphasized the desire for a continued connection with care post-graduation from the rehabilitation program and suggested that this connection could be virtual through the use of health apps and a continuation of monitoring against health goals. This theme of a shifting environment will be further explored in the Discussion section as it relates to other themes presented in this study.
Chapter 5
Discussion

The following is a discussion of study findings organized under each research objective. Themes that emerged from this study (Figure 6) fall naturally within the research objectives, including themes of patient health app use, self-management, patient-provider relationships, technology use and assumptions, and the future of health app use. The following presentation of the discussion under each objective includes and identifies findings of each theme in order to maintain consistency in the flow of findings from the results section of this study. Study findings are discussed in relation to previous research conducted in this field.

5.1 (Objective 1) To describe the general demographic and mobile technology use profile of this patient population

The current study demographic profile of this cardiac rehabilitation population had a higher proportion of males than females and an age range mostly between 50 and 89 years old. This profile of the study sample was consistent with the overall patient population attending the TRI Cardiac Rehabilitation Program (Cournoyea & Oh, 2015). Results showed slightly higher proportions of patients with higher household incomes (over $50,000 per year) and higher levels of education (college or university degrees). There was a range in cardiac illness diagnoses and co-morbidities.

This profile of patients attending cardiac rehabilitation also seems consistent with findings from previous studies noting that although those with lower socio-economic status, lower income and lower levels of education are more likely to suffer from cardiac illness, these patients are less likely to attend cardiac rehabilitation (Biswas et al., 2016; Grace et al., 2016; Kubota et al., 2017; Lemstra et al., 2013 & Manrique-Garcia et al., 2011). While the current study profile is likely representative of cardiac rehabilitation patients in general, it also supports
previous research in the field demonstrating that cardiac rehabilitation is not reaching a significant portion of the cardiac patient population that is eligible for, and should receive rehabilitation care. Previous studies have also shown that only 34% of eligible patients in Canada participate in cardiac rehabilitation, mainly due to lack of physician referrals, difficulties with travel to the rehabilitation program, language barriers, scheduling barriers and low patient perceived need for rehabilitation (Grace et al., 2014; Neubeck et al., 2012). With less than half of eligible patients participating in cardiac rehabilitation programs, results from this study may not be generalizable to all cardiac patients.

The eight providers that participated in the focus group were either Cardiac Rehabilitation Supervisors or Exercise Leaders. There was no representation from physicians, nursing, occupational therapy or physical therapy members of the rehabilitation staff. This is consistent with staffing in the rehabilitation program as the majority of staff are either Cardiac Rehabilitation Supervisors or Exercise Leaders (Cournoyea & Oh, 2015); however, the absence of other types of providers is a limitation in drawing conclusions.

With respect to mobile technology use, most (92%) of patients had a mobile device, thereby supporting global population trends with increasing mobile and health app adoption in the market place. Logistic regression results showed that the newer, more sophisticated and expensive mobile technology (smartphones, tablets and wearables) had greater odds of being owned by patients that were younger or that were more educated or that had higher household incomes. These results in mobile technology use contribute to trends seen in previous research on internet use. For example, previous studies on internet use have found that older patients are less likely than younger patients to use the internet for health information seeking (Mayoh et al., 2011; Miller & Bell, 2012; Xie et al., 2013b). Similarly, previous studies have shown that
people with lower levels of education are less likely to seek information and engage in health decision making (Protiere et al., 2012). Statistics on mobile technology use in the general population also support these findings and show that a higher percentage of younger people own mobile technology and that ownership decreases with age (Deloitte, 2014). However, it should be noted that even though older people are using less technology, the adoption rate of mobile technology is increasing each year in older individuals (Deloitte, 2014; Pew Research Centre, 2017). Previous studies have also shown that cost can be a barrier to app use, thereby supporting current study findings on the influence of income on app use (Fox & Duggan, 2012; Krebs & Duncan, 2015; Langlois, 2015). With differences in technology adoption and use associated with demographic variables, the current study supports the need to explore health equity promotion in health services that are delivered virtually. In particular, future studies and health processes improvements could focus on ensuring that all patients have the opportunity to receive equal care regardless of their demographic variables and current use of technology. This could include providing access to technology and education in mobile app use, as well as care options that do not use technology.

As described in Chapter 4 Results section of this study, the logistic regression analyses exploring possible influences of demographic variables on mobile technology and health app use explain a small proportion of results. Therefore, it is important to consider other influencing variables that were not captured in this study. The Nagelkerke R² statistic in the regression analyses ranged from 0.11 to 0.28, thereby indicating that there could be other independent variables influencing the dependent variables on mobile technology and health app use, or may be due to items such as measurement error, possible collinearity or external variables that were not included in the analysis. Efforts were made to minimize measurement error that could have
occurred due to patients misinterpreting the survey questions. Many questions used in the analyses were basic demographic questions on gender, age, income and education, each with simple Likert scale type responses. Similarly, dependent variables were based on whether patients owned a mobile device (yes or no) and if they used health apps (yes or no). Also, the researcher double checked all survey data entry fields to ensure a high level of data entry quality.

In considering collinearity, a main factor to look for is whether the direction of the regression coefficient (as positive or negative) is indicating a direction that is not supported by evidence in the literature. i.e., if the literature points to older people being less likely to use health apps then the analysis should reflect that direction of results in the regression coefficient (Martz, 2013).

There were no discrepancies of this nature in the results. While these rules for collinearity provide a good guide, they are not exhaustive and future studies of this nature could explore possible effects of collinearity in more detail.

Other variables that might influence results should be considered. Reflecting on factors that could influence mobile device ownership and health app use, it might be useful to study results on motivational factors and barriers in app use that were cited by patients. As illustrated in Chapter 4 Results, these could include technical ability and confidence as well as knowledge about what is available for use with respect to health apps and related technologies such as wearables. Other factors that could be considered might be those related to patient motivation to be healthy and to engage in wellness activities. This could relate to motivation to set health goals and track progress and to use health apps that support goal setting and monitoring. One might also consider patient level of trust in mobile technology and health applications especially trust with respect to accuracy and privacy of data. Provider engagement or patient perceived provider engagement might also impact use of health apps, particularly if providers are
recommending or prescribing apps. Or conversely if providers are recommending against use of apps. These variables as described by patients when discussing motivations and barriers could contribute to the variance in the $R^2$ statistic.

5.2 (Objective 2) To describe the types of health apps that patients are using or are interested in using

When looking at the type of health app used, cardiac patients in this study were mostly using apps for fitness, diet, sleep, weight loss/control and blood pressure. This study focused on a cardiac rehabilitation population and it is unknown whether this profile of health app use is specific to this patient population or can be applied more broadly across other chronic populations. There could also be the influence of the design of the rehabilitation program on the types of apps used as the program focused education on these same categories of health. Results from this study showed that 49% of the patients surveyed had started using health apps within the last six months prior to the survey, thereby indicating that they started using them during the six-month rehabilitation program. This could be because the areas of focus in the program may have influenced their interest in health and wellness and related use of health apps.

While these possible influences on health app use in this population are noted, it can also be noted that results do seem to reflect health app use in the general population. One study in particular showed that the most popular app downloaded by the general population are exercise and heart rate apps, followed by diet and weight loss apps (Susannah Fox & Duggan, 2012). Therefore, it is unknown as to whether participation in the rehabilitation program influenced choice in health app use. It should be noted that not all patients were interested in using health apps. Therefore, future directions in health app use in care must also consider equitable care options for those not using this technology.
5.3 (Objective 3) To explore patient and provider perceptions on how health apps influence self-management

A key focus in chronic disease management, and specifically in cardiac disease management, is engaging in healthy behaviours such as exercise and diet. The current study sought to describe patient perceptions on use of health apps for self-management and support of healthy behaviours. Results showed that of all patients surveyed (both health app users and non-users), 64% felt that health apps can help with self-management while 29% didn’t know. For patients that had used health apps, 77% felt that the apps had helped to improve their health. Patient interviews and provider focus group findings supported these results by highlighting the benefits of apps with respect to engaging in healthy wellness behaviours. In the context of using apps as a part of self-management of a chronic condition, these results suggest that health apps may be perceived as beneficial by patients with a cardiac condition. Previous research on the use of wearable devices support these findings and have shown that tracking steps and exercise activities have shown positive outcomes in health activity behaviours (Cadmus-Bertram et al., 2015). Reflecting on definitions of self-management (Barlow et al., 2002; Bodenheimer et al., 2002), findings from the current study support self-management elements of self-efficacy, lifestyle change, management of symptoms and self-regulation based on knowledge of health state.

Findings from the current study on self-management and maintenance of healthy behaviours also show that sometimes patients do not need an app. This was voiced in the context of paper tracking being just as good or better for some patients in supporting self-management. This latter point was discussed by both health app users and non-health app users and some felt that aspects of wellness such as tracking walking distance can be learned and they
did not feel a need to continuously track distance (or steps) using a device. These findings support the need for individualized options in chronic disease management and supporting healthy behaviours. It follows that health providers might consider having different tools available to support patients that want to use mobile apps and support those that choose not to use mobile apps.

5.4 (Objective 4) To describe factors that motivate patients to use health apps

Within the topic of self-management, the current study engaged in an exploration of patient motivation to use health apps. This was explored with the intention of describing factors that motivate health app users and to identify ways in which providers might engage non-health app users. The main motivations that were described by patients included the ability to track progress and monitor against goals, and the motivation to be healthy and prevent declines in health. Previous studies on general population use of health apps have also shown that the primary reason for health app use is to track progress against goals (Statistica (a), 2014). This understanding of motivations contributes to knowledge that providers might leverage to encourage current non-app users to begin using health apps.

Findings from the current study also noted that patients have differing needs and preferences with respect to health app use. These findings point towards the need for individualized options in health apps such as choice to use or not use certain features or choice to set customized health goals. Previous research focusing on self-management of chronic conditions has described the need for care to be individualized as each patient’s care needs can differ. Therefore, care plans should be flexible and change over time as these needs shift (Bayliss et al., 2007). Previous studies have also shown that patients prefer apps that have personalized educational information (Neubeck et al., 2012). Similarly, in the current study, the
aspect of competition within apps was found to be motivating for some and de-motivating for others, thereby also supporting the importance of identifying individual needs and preferences in health app use. It follows that an emphasis on individualized care should be reflected in health apps by providing options on features such as competition and individualized goal setting.

5.5 (Objective 5) To describe patient and provider perceptions on barriers in the use of health apps

In gaining an understanding of what motivates health app use it is also important to understand items that may be de-motivating, or barriers. A main barrier found in this study was that health apps can be complicated and confusing. Certain usability barriers were also discussed, such as small screen size, or touch screens that are too sensitive and that patients can find difficult to use.

Another barrier mentioned, was that some patients found health apps annoying to use, mainly due to the time needed to use them or the feeling that they always needed to be attached to their mobile device. Financial concerns were also raised as a barrier. Interestingly, this barrier was mostly mentioned by patients that already owned at least one mobile device and they were considering purchasing another device, or they were referring to the barrier as something experienced by those around them but not by themselves. A previous study of the general population also demonstrated that apps need to have minimal time requirements/user burden to be sustainable in use and that one of the main reasons for not downloading health apps in the general population is due to the burden of data entry. The same study found that hidden costs in health app use were also a barrier, thereby supporting the finding of financial concerns related to app use (Krebs & Duncan, 2015).
Lack of trust in health apps was also raised as a barrier in the current study. Concerns about trusting apps pertained mainly to accuracy of information presented or recorded in apps and the privacy of this information. Both patients and providers felt that app accuracy was important, especially for taking health measures such as heart rate. Study results showed that there was a divide in trust in accuracy with some finding that health apps were accurate and others finding they were not accurate or feeling concerned about accuracy. Similarly, some patients felt that privacy of information was a concern and a barrier to app use, while others did not worry about the privacy of information. These differences in patient opinions suggest that app accuracy and privacy can be a barrier for some and that a potential first step in addressing this barrier would be to have publicly available information on accuracy and privacy of health apps. This would help those concerned with accuracy and privacy to have the information they need to make informed decisions with respect to health app use. Secondly, it points to the need for continuous improvement in development of health app accuracy and privacy of information and for these items to be a central focus for app developers.

Limited trust in health apps also lead to patients and providers in the current study feeling that they did not know which apps to use or recommend. There are many apps to choose from on the app stores with little information available on app reliability and validity. Patients and providers wanted a list of recommended apps that are appropriate for healthcare settings and specifically for chronic care. Despite the progress being made on validating health apps and creating lists of recommended apps, this type of work is just beginning. Early areas of focus have been more in the realm of health apps that are considered to be medical devices. Regulation and validation of health and wellness apps seems to be a secondary focus for most national governing bodies such as Health Canada and the US FDA (Kwong, 2015; U.S. Food
and Drug Administration, 2015). This is also the case with standard rating systems for healthcare providers to use when evaluating apps that they may want to recommend to patients. The Canadian Medical Association has recently published a set of guidelines for physicians to consider when recommending apps to patients. These guidelines include aspects of usability, reliability, and privacy of data (Canadian Medical Association, 2015). Similarly, researchers are developing and testing scales that can be used to rate app quality with respect to user engagement, functionality, aesthetics and information quality (Anderson et al., 2016; Stoyanov et al., 2015).

Providers spoke of the benefit of tracking through apps yet felt that they were currently experiencing patient use of paper forms as well as the use of health apps. This use of two modalities of tracking results created the barrier of extra work to pull together information into one format. Providers also felt that they would be more inclined to support app-based health tracking if the measures used in apps matched those currently used in practice with the paper forms. These results speak to a shifting environment of health tracking with some using paper-based methods and some using mobile tracking. Providers might feel better prepared to embrace tracking through mobile technology if apps could support current health practice approaches in goal setting and tracking.

5.6 (Objective 6) To explore patient and provider experiences and perceptions on how health apps influence patient-provider relationships

The first concept explored within the theme of the patient-provider relationship and health app use, was that of communication of health app results. Findings from this study revealed that the majority of patients using health apps had not discussed them with providers. Those that had brought up health apps with providers had experienced a lack of receptivity to the
app use conversation, especially when speaking with primary care and specialist physicians.
These results contribute a mobile app perspective that supports previous research findings on
online information seeking and the patient-provider relationship. For example, one previous
study found that only 34% of patients felt providers reacted positively to them bringing forward
information they had found online (Mayoh et al., 2011).

When both health app users and non-health app users were asked if they felt providers
would want them to share results, the majority responded that they did not know. When asked if
they would want to share results almost half of patients said yes and interviews illustrated that
patients felt comfortable sharing results, especially if they knew their provider would be
receptive. However, patients felt that some providers are not receptive to discussions on health
and wellness (mainly primary care and specialist physicians) and that many providers don’t have
the time for these conversations. They also preferred for providers to begin these types of
discussions and engage patients, rather than patients engaging providers. These results suggest
that while patients may want to share health app results with providers, they feel uncertain as to
whether providers will want to engage in that conversation. This uncertainty likely stems from
experiencing different reactions from providers, a concept that is supported in a study by
McMullen (2006) that illustrated three main reactions that can occur with providers when
patients share information from the internet. One is to feel threatened and respond defensively,
another is to collaborate in a discussion about the information, and a third is to guide patients to
reliable sources of information.

Providers participating in the current study focus group felt that they were receptive to
patients sharing apps and app results and felt they were also receptive to helping patients set up
their health apps when they needed technical support. This discrepancy between patient
experiences with lack of provider receptivity versus providers feeling they are receptive might be
because the providers participating in this study were solely rehabilitation providers and did not
represent a sample of providers from other disciplines such as primary care or specialist
physicians. The experiences that patients reported about a lack of receptivity to discuss app use
seemed to be with primary care and specialist physicians. These results might also be because
providers that chose to participate in the focus group could be more engaged and interested in
health apps then providers that chose not to participate.

However, providers noted feeling more comfortable recommending health websites as
opposed to health apps as they felt better informed about website sources and accuracy of
information. They also felt hesitant about being seen as promoting certain apps over others.
This theme is a barrier to health app use as patients also felt that providers were not currently
recommending apps, yet they wanted them to engage in app recommendations. As previously
discussed, more work is needed in the area of health app validation and in the development of
standard resources that provide patients and providers with ratings and recommendations on
health apps.

These results also speak to a shifting environment in healthcare with respect to
paternalistic versus collaborative relationships between patients and providers. Historically,
many providers adopted a more paternalistic approach, whereas current trends in healthcare are
seeing emphasis on a collaborative approach (Kaba & Sooriakumaran, 2007). With current
study results showing that many patients preferred for health app conversations to be initiated by
providers, it seems that some patients might still subscribe to a more paternalistic model of care.
This may be due to a number of reasons; however, one reason to consider is the older average
age of the cardiac population in this study. These patients may feel more comfortable with a more traditional paternalistic model of care and communication.

The current study focused on health apps that patients choose to download and use without connection to a health provider. However, results also illustrated that patients would prefer to be connected with providers. They mentioned the motivation of having a provider monitor their progress against health goals and the benefit of being able to communicate and ask questions, especially pertaining to appropriateness of goals over time. These results show that while individual apps are useful in self-management, health apps would be more motivating and perhaps used by more patients if they also connected patients and providers.

As described in the review of the literature, apps that connect patients and providers are still in early stages of development and research (Armstrong et al., 2015; Cafazzo et al. 2012; McGillion et al., 2016). Results available in evaluations of health apps that connect patients and providers have demonstrated positive results in self-management, clinical outcomes, cost-effectiveness and quality of life (Seto et al., 2012a, 2012b; Taylor, 2015). Many of these early studies focus mainly on supporting patients in monitoring acute symptoms. Results in previous studies in the general population demonstrate positive outcomes in wellness behaviours through the use of apps (Goyal et al. 2016). However, there is little evidence to date on supporting healthy behaviours in chronic care patients using health apps that focus on connecting patients and providers in the monitoring of wellness behaviours.

Previous studies in self-management have demonstrated the importance of establishing an ongoing patient-provider connection. These studies have shown that only 48% of seniors with chronic conditions have spoken with their primary care provider about their goals. Also, only 48% of seniors report having their medications reviewed by a physician, with 47% having
medication side effects explained to them (Canadian Institute for Health Information, 2011). Similarly, from a provider perspective, studies have shown that chronic disease clinical practice guidelines can result in conflicting care guidance for providers and consequently for patients. These conflicts can result in medication errors, adverse medication events and self-management contradictions (Boyd et al., 2005). These types of conflicts support the need for ongoing patient-provider engagement in care, especially when patients are self-managing in the community. The patient-provider relationship is central in effective self-management in chronic care. It follows that to manage chronic illness effectively, patients require ongoing collaborative support from providers, particularly in the areas of goal setting and monitoring progress. The current study supports the use of mobile apps as one way to connect patients and providers in chronic disease management.

5.7 (Objective 7) To describe patient and provider perspectives on “ideal” future state of health apps

In exploring the future of health app use, this study described the desired or “ideal” state of health apps from the perspectives of patients and providers. Features considered to be ideal also mimicked those that were cited as most frequently used by health app users. These included apps for fitness, diet, sleep, weight loss/control and blood pressure. As previously discussed, these results might have been influenced by the cardiac rehabilitation program since these aspects of health and wellness are a focus of the program, though studies on the general population also support these results (Susannah Fox & Duggan, 2012). With respect to app functionality, goal tracking and measuring progress were key features. Especially the ability to input and track individualized health goals such as those established in the rehabilitation
program. As discussed previously, these findings on health goals are similar to those discussed in prior research on health app use in the general population (Statistica (a), 2014).

In discussions about usability of health apps, simplicity was a central theme. Patients and providers felt that health apps need to be simple and easy to use. Related to ease of use was a preference for apps that automatically measure healthy behaviours rather than those that require manual input of information. For example, wearables that automatically count steps/distance and record heart rate. These findings on “ideal” health apps, are also supported by the previously described findings on app barriers where apps can be confusing or require too much manual input. Findings from this study also point to supporting patients’ individual needs and preferences in health app use. This was especially relevant in the context of comfort with technology and technical ability in understanding how to use health apps.

In the context of cardiac rehabilitation and the chronic care experience within this setting, current study findings on “ideal” health apps demonstrated that patients want to be connected with providers and that this connection could be through the use of health apps. Patients and providers felt that health apps could be utilized in the rehabilitation program to track patient progress against goals and to communicate with one another. They felt that health apps could enable a transition from the current paper-based tracking that is used in the program to a more automated electronic system of tracking. Patients in the current study also wanted more continuity of care post-graduation from the program. They wanted to be able to receive feedback from providers on their progress, update goals as needed and keep in touch with other patients. Health app users emphasized that this could be accomplished through the use of an app. Many patients saw this functionality as desirable for post-graduation care to enable them to
stay motivated as they felt that ongoing contact with the rehabilitation providers, even on a less frequent basis, would help to maintain motivation to engage in healthy behaviours.

With respect to health apps that can be publicly downloaded, the concept of connecting patients and providers through health information that is measured on the app would require several considerations. These include how that connection is made, the type of information that is transferred, and how the information integrates into practice, especially if information is coming from different apps. The type of information and presentation of information varies between apps and these differences would need to be reconciled. These points address the concern that providers voiced about having to integrate different sources and types of information into their records. It seems that for health app information sharing between patients and providers to be effective, it needs to be presented to providers in a standard format and in a way that does not increase provider workload.

In thinking about the “ideal” future state of health app use, patients and providers discussed the need for support. For patients, support focused on the need for assistance in choosing apps. Patients wanted providers to recommend valid apps and to include education on app use within the cardiac rehabilitation program. Patients also discussed needing technical support with apps, including support on how to use them and on how to interpret results. Some patients also spoke about the value of incentives in motivating health app use, and healthy behaviours. They spoke of incentives in the form of financial rewards, donations to charities or by having apps that are subsidized through healthcare programs. However, this notion of financial incentives as a motivation was not consistent across patients. Many patients felt that the ability to connect with providers via an app would be the primary motivation to engage in wellness behaviours.
Providers also spoke of the need for support in knowing what apps are valid and what they should be recommending or prescribing. As previously discussed, there are many apps available, most with limited information on validity. This leads to providers having difficulty in knowing what to recommend. Providers in this study were also hesitant to be seen as promoting certain apps over others. This points to the need for organizational support in recommending apps, thereby removing that responsibility from individual providers. It was also noted in the study results that providers may not need to recommend only one type of app. They could provide recommendations on different apps that they know are valid, thereby allowing patients to make an informed decision about which app is best for them. As described previously, the concept of prescribing apps is emerging in some institutions. Examples from the NHS and Mount Sinai System in New York provide insights into early adopters of app prescribing tools and processes within hospitals (Mack, 2016; Reynolds, 2017). Prescribing apps include validation of apps, institutional support in guiding providers on which apps to use/recommend and health system support in enabling apps to be a part of practice.

Providers also emphasized the need for apps and healthcare processes to complement one another. Specifically, when transitioning from current paper based processes to app-based goal monitoring, they would want the apps to record the same measures currently recorded on paper. Also, providers noted that they would need appropriate resources to support health app use. These resources could include supports for patients (technical support, for example), and supports to ensure the technology is valid, up to date, and working properly.

In summary, the use of health apps as a part of practice would require a change in practice processes, organizational support and ultimately health system support. In this era of shifting from paper-based charts to electronic medical records, the use of health apps would need to be
integrated into the larger e-health system. This would allow for integration of various information sources and would support global changes in practice processes and standards of care that would be required in order to effectively use health apps as a part of patient care. In considering the use of health apps post-rehabilitation, this concept also fits within the area of public health as it supports health promotion, prevention and secondary prevention. These policy implications fit within the current healthcare technology environment of shifting care to the community and moving towards virtual web and mobile solutions that support this community based care.

5.8 Conceptual Framework

A modified conceptual framework based on the CCM and eCCM was used to guide study objectives, methods and results (Figure 4). This modified framework guided study methods by providing a description of key components of the research including elements of community resources, individual variables, health system components and patient and provider experiences.

The modified conceptual framework supported study analysis primarily by focusing the analysis on patient and provider health app use and experiences. This study of experiences was central in the research objectives and the framework ensured that this focus was maintained throughout analysis. The framework also supported analysis of individual patient factors that might influence health app use such as demographic variables. Likewise, the framework supported analysis of results describing health apps that patients are currently using or would like to use. In analyses focusing on provider experiences, the conceptual framework aided in maintaining a distinction between elements that exist in the community (i.e., health apps that are available on the market) and elements that are specific to health providers such as delivery
system design, clinical decision support, and clinical information systems. The framework also clearly illustrated the patient-provider relationship as an important element to include in analysis.

The conceptual framework used in this study supported organization and interpretation of results. This was helpful in interpreting findings that link directly to elements in the framework, such as identifying types of health apps on the market that patients are using. It was also helpful in guiding an exploration of how the different elements in the study results interact with each other. One key example is that study results found that most health apps that patients are using are self-sought and downloaded without influence from health providers. This finding supports a modified element of the framework that maintains health app resources at a community level where apps are accessible to patients with or without provider interaction. This modification allows for separation of patients and their self-management (and related health app use) from the patient-provider relationship and helped to guide study results focusing on patient experiences.

There were also new findings from this study that were not highlighted in the modified framework and might be considered in future iterations of the framework and related research. One finding is that patients and providers are making assumptions about technology use and ability based on patient age. As previously discussed, in this era of emerging mobile and wearable technologies with intuitive designs, it will be important to maintain an understanding as to whether these assumptions are correct as technology usability progresses and as user adoption (especially among older generations) continues to increase. Results from the current study also described motivations to use health apps and barriers to use. While these fit within the concepts of patient and provider experiences, the topics of motivations and barriers could be highlighted further in future iterations of the framework.
Results also pointed to a desire for enhanced continuity of care and ideal future state with respect to the use of health apps. These results highlighted the way in which virtual care post-discharge from programs could better support self-management, wellness behaviours and consequently support preventative care. Future versions of the conceptual framework could expand on this concept of post-discharge care.

One aspect to note in the modified framework is that functional and clinical outcomes are shown as resulting from self-management in chronic care. The current study did not have an objective to measure outcomes and it was considered to be out of scope. Therefore, the current study did not provide insight into outcomes and this could be an area for consideration for future work and for expansion of the modified framework.
6.1 Summary of Findings and Implications

The overall research objective of this study was to describe patient and provider experiences with mobile technology and health app use and perceived impact on self-management and the patient-provider relationship. This study used an exploratory mixed methods design with quantitative findings from a patient survey (n=242), qualitative findings from patient interviews (n=30) and qualitative findings from a provider focus group (n=8).

Study results provided insight on patient and provider experiences with mobile apps in a cardiac rehabilitation program. The study contributed to knowledge on mobile technology use in health care and desired future state from both patient and provider perspectives.

Patients in this study represented an aging patient population with a range of cardiac diagnoses and co-morbidities. Results from the current study demonstrated that older patients were using less mobile technology and health apps than younger patients, however adoption among this older demographic seems to be increasing. Most patients in the current study were using mobile technology and half of those with mobile technology were using health apps.

Health apps were felt to support chronic illness management particularly with respect to setting wellness goals and monitoring progress against these goals. Study participants felt that exercise, diet, sleep, weight loss/control and blood pressure apps were most useful in chronic disease management.

In the context of shifting to community-based care, this study demonstrated that a large portion of older chronic care patients are engaging in self-management through the use of health apps that they have chosen to download and use. However, few of these patients received app recommendations from providers, nor were they connected with providers through the health
Apps they were using. Patients voiced that they wanted recommendations on which health apps to use, and to be connected with providers via health apps during the rehabilitation program and post-discharge. Patients also wanted providers and care processes to be linked with health apps for enhanced communication of results and to eliminate paper tracking. To manage chronic illness effectively, patients require ongoing collaborative support from providers, particularly in the areas of goal setting and monitoring progress against goals. The current study supports the use of mobile apps as one way to connect patients and providers in chronic disease management.

Providers are currently experiencing a shift in practice with increasing health system emphasis on community-based care and supporting patient self-management in the home. Virtual care is one method to support care in the community and support higher volumes of patients. Results from the current study indicate that providers would like to move away from paper-based monitoring and shift to electronic and more automated means of supporting patients. However, both patients and providers in the current study voiced the concern of a lack of knowledge on health app accuracy. They felt that having access to this type of information and access to trusted resources on recommended health apps would be important in moving forward with apps that connect patients and providers.

With technology complexity and manual data input as barriers noted in the current study, the introduction of smart technologies and wearables might reduce this barrier. These types of devices are typically designed to be intuitive, easy to use and with automated features (such as a wearable counting steps automatically). Given this evolution of mobile technology and related ease of use, it may be important for providers to continually check assumptions about technology use and variables such as age as a limitation in technology use. For example, technology options that require less manual input might be easier to use for those that feel less comfortable with
technology. In light of supporting chronic patients to self-manage in the home, it will be important to ensure providers continually have accurate knowledge regarding patient technology use and barriers to adoption. Also, providers should maintain up to date knowledge on technologies that are available to support patients and provide greater ease of use.

To support the use of health apps as a part of chronic disease management there will need to be a focus on integrating this type of technology into care processes. Beyond provision of resources to assist in app recommendations or prescriptions, health practices will need to shift from a paper based system to integrated electronic and mobile based care. This type of shift has policy and practice implications in overall e-health processes and standards of care and in public health aspects of health promotion, prevention and secondary prevention. To effectively support patients and providers in the use of health apps as a part of care, health system standards of care need to support the use of apps and integrate this use with overall e-health strategies, and associated electronic systems.

Patients will also need technical support and education in using mobile technology and health apps and this should be a consideration in health system app use. Also, it will also be important to provide patients with options in mobile and in-person care. Some patients do not use, nor do they want to use mobile technologies and apps, and health providers must ensure equitable care options throughout shifts in practice towards virtual care.

Results in the context of the study conceptual framework

The conceptual framework provided a useful guide in the study analysis and interpretation of results. It supported the main objective of describing patient and provider experiences and also guided the study of key elements in the use of health apps. A central study finding that supported modifications that were made to the eCCM model for the current study
was that patients were choosing to seek health app resources in the community without support from providers.

Study findings also highlighted potential new areas that could be illustrated in future iterations of the modified eCCM framework. These include the identification of motivations and barriers in health app use, and the need to continually check assumptions of health app use related to demographic variables such as age. The latter concept is especially relevant in the context of a shifting landscape of technology capabilities and user friendliness and health app use among older patients. Finally, one main aspect of the framework that was out of scope in the current study was that of outcomes as they related to self-management. This aspect could be a potential area of focus for future research and iterations of the conceptual framework.

6.2 Study Recommendations

The following recommendations are presented as a part of the overall study finding that patients and providers feel that health apps can support self-management of chronic conditions by promoting healthy behaviours.

- Health apps should be used as a part of healthcare practice and continuity of care post-discharge, either through recommendations of individually used apps and/or through use of apps that connect patients and providers.

- Health apps recommended or used in practice should include those for fitness, diet, sleep, weight loss/control and blood pressure.

- Health apps recommended or used in practice should have features of goal setting and monitoring progress against goals.

- All health apps either through the public app store or through healthcare institutions should have publicly available results and rating systems on items such as accuracy, validity of use within patient populations and privacy of data.

- Health apps that are developed and used to connect patients and providers should fit practice needs, such as using the correct measures for fitness tracking.
• Patients should be supported in health app use through access to education on technology and health app use.

• Providers should be supported in health app use through practice guidelines and care processes that support and integrate the use of health apps.

• Providers should maintain an understanding of the current state of emerging technologies, and patient adoption of technologies.

• Health policies and processes should support the use of health apps through changes in global standards of care that support use of health apps and through the integration of health apps into the larger e-health strategy and electronic systems.

• Future care that includes the use of health apps should ensure equitable options of care for those that choose not to use them.

6.3 Study Limitations

In mixed methods research, there are limitations with both the quantitative and qualitative parts of the methodology. Specifically, from a quantitative perspective, the current study used multiple logistic regression analyses as a preliminary description looking into the possibility of demographic variables influencing mobile technology and health app use; it was not expected that all variance would be explained. These analyses did show some associations through significant odds ratios; however, the analyses were only able to explain a portion of the variance in the independent variables and that there were likely other influencing factors that were not included in the analysis. Also, the regression analysis looking at the influence of demographic variables on cellphone use was confounded by a high portion of the cellphone use sample also using other mobile devices such as smartphones or wearables. The sample size of patients using cellphones only was too small to conduct a regression analysis on this sample alone (i.e., excluding those that also own a smartphone or wearable). Future studies with a larger sample size and with the research objective of fully flushing out these associations would be needed to draw more finite conclusions. These future studies could include items that were described as
motivating factors or barriers to determine if these variables might influence mobile technology and health app use.

With qualitative research methods there is the potential for researcher bias to influence the interpretation of results. As described in the Methods, to mitigate this risk, the Researcher ensured that qualitative coding, categorization and formation of themes was reviewed by two external qualitative reviewers.

Another limitation that is considered is that the results of this study in a cardiac population may not be generalizable to other chronic populations. In particular, this population was sampled from an outpatient cardiac center in Toronto, Ontario that focuses on areas such as diet and exercise i.e., a focus on the behaviours that might influence patients to seek health apps. While this limitation cannot be mitigated within the current study, it does provide reason to conduct similar studies in other chronic care patient populations and also in populations at different stages in their chronic illness. Results from previous studies have shown that less than half of eligible patients in Canada participate in cardiac rehabilitation (Grace et al., 2014). The current study results show a demographic profile that is consistent with that seen in the TRI Cardiac Rehabilitation Program and in other cardiac rehabilitation programs. The current study patient profile showed patients as having higher income levels and levels of education. As previously discussed, while those with lower socio-economic status, lower income and lower education are more likely to have cardiac illnesses they are also less likely to access cardiac rehabilitation. These findings are consistent in the current study population profile. This presents a limitation with the current study in that while it does represent cardiac rehabilitation patients, it does not represent the general cardiac patient population. It should also be noted that
the study excluded patients that could not speak in English, therefore results may not be
generalizable to non-English speaking patients.

Similarly, the current study included representation by only two provider groups: Cardiac
Rehabilitation Supervisors and Exercise Leaders. While these provider groups are representative
of staff in the cardiac rehabilitation program, they do not represent all provider disciplines that
are engaged in chronic care across other patient populations such as physicians. Also, providers
that chose to participate in the focus group might be more engaged and interested in health apps
than providers that chose not to participate. Again, future studies of this nature could include
broader representation of provider disciplines to determine if similarities and/or differences in
provider experiences exist. The current study was also limited in the amount of provider
engagement in data collection due to their busy work schedules and provider availability. A
focus group was chosen as the best methods for data collection as it was convenient for
providers, and allowed for their perspectives on the topic to be captured. However, one provider
group did not allow for a large sample of providers to participate.

It was noted in Section 4.2 Demographic Profile of Participants, that patients arriving late
for class could not be approached for study participation. Since these patients were not able to
be captured in the study, it is unknown as to whether they may share characteristics that would
be of value in understanding access to the rehabilitation program (such as the use of public
transportation). The current study was unable to capture the experiences of these patients with
respect to mobile technology and health apps. Similarly, with respect to analysis of patient
variables, the categories used to capture patient age in the survey may have been too broad
thereby resulting in a loss of detail in describing mobile technology and health app use with
respect to age. This may have impacted the multiple regression analyses looking at age as a variable in mobile technology and health app use.

6.4 Recommendations for Future Research

As mentioned in the limitations, one area for future research would be to expand this study to include a broader range of patient and provider populations in chronic care. This would allow for comparison of themes and possibly set the stage for generalizations across chronic care that could inform practice in the field of health apps in different areas of healthcare practice. This type of research could be expanded to other cardiac populations to explore whether the current study results are unique to the TRI Cardiac Rehabilitation Program, or if they are more generalizable, specifically with patients that do not access the cardiac rehabilitation program. Further the research could be expanded to other chronic disease populations and to complex chronic populations experiencing multiple conditions. As discussed, less than half of eligible patients participate in cardiac rehabilitation. Therefore, future research could explore health app use in patients that choose not to attend the program and whether a virtual program might result in higher participation rates. Similarly, future research could be expanded to involve broader representation from healthcare providers.

Another recommendation for future research would be to conduct more focused and detailed analyses on the influence of demographic variables and other variables such as those cited by patients as motivating factors or barriers in mobile technology and app use. These types of analyses could help healthcare programs to better predict technology usage in their patient populations and to understand how to best assist patients in using mobile technology and health apps for health and wellness. Similarly, it was not the intention of the current study to provide a detailed comparison of results between mobile app users and those using wearables. Again, this
type of future study and analysis could lend insights into current usage patterns and how healthcare providers can best identify gaps and barriers, and support patients in health and wellness app use through different mobile modalities.

Additionally, further research will be needed to fully understand current models of chronic care and the use of mobile technology and health apps as a part of care. This current study provides a description of patient and provider experiences with mobile technology and health apps, however, it was not the objective of the study to develop and test new models of care using technology. Nor was it the objective of the current study to test existing technologies or develop new technologies such as those that connect patients and providers. Future studies could explore these concepts in more detail. Similarly, future research could focus on outcomes as they relate to self-management and the use of health apps. Potential future studies on outcomes could explore outcomes in the context of patient driven self-management behaviours (such as publicly available health apps) and behaviours that are influenced by the patient-provider relationship (such as prescribed health apps).
References


Burgers, J. S., Voerman, G. E., Grol, R., Faber, M. J., & Schneider, E. C. (2010). Quality and


Appendix A
Patient Survey and Interview Information Letter
**Study Title:** Health and wellness mobile app use in chronic care: What can we learn from the experiences of cardiac patients and providers?

**Principal Investigator:** Dr. Paul Oh, Medical Director, Cardiac Rehab Program

**Co-Investigator:** Sarah Sharpe, PhD Candidate, University of Toronto

**Introduction:**
You are being asked to take part in a research study. The following is a description of the study and you should take as much time as you need before deciding whether or not to participate. You should ask the study staff to explain anything that you do not understand and make sure that all of your questions have been answered before deciding to participate. Before you make your decision, feel free to talk about this study with anyone you wish including your friends, family, and family doctor.

**Background/Purpose:**
We are performing a study to learn about patient and provider experiences with health and wellness apps. Particularly use of apps by patients who have cardiac conditions. This study has two parts and you can choose to participate in one or both parts.

**Study Part 1 - Survey:**
The first part of the study is a survey exploring mobile app use (or non-use) in a cardiac patient population. The purpose of this survey is to understand if and how patients use mobile technology and health and wellness apps. The survey will take 5-10 minutes to complete.

**Study Part 2 – Interviews:**
Following this survey, you will be asked if they would like to sign up indicating interest in participating in an interview. The interview will involve a discussion on your thoughts about using mobile technology and mobile apps. Specifically, we will discuss positive and negative aspects of using health and wellness apps.

There are a limited number of interviews that will take place, so not all patients who sign up will be contacted since the study will look for representation from people who have experience using apps and those who have little or no experience. We will know about your app use experience by the interview sign up sheets. If you are selected for participation in interviews, you will be contacted by telephone by the Researcher, Sarah Sharpe, and she will describe the interview to you, provide an opportunity to ask questions and you can choose if you would like to participate. If you choose to participate, Sarah will then schedule a time that works for you for a telephone interview.

The interview will take up to 30 minutes on the telephone. Interviews will be audio recorded to ensure that the Researcher captures all information provided during the conversation. Audio recordings will be transcribed into a document for analysis and summary of interview results.

**Reimbursement:**
There is no reimbursement for participation in this study.
Risks:
There are no known risks in participating in this study.

Benefits:
There are no direct benefits from participating in the study, however, results from the study will help us to better understand how we can improve health services for patients with respect to the use of mobile technology and health and wellness apps.

Confidentiality:
All results from the study will be anonymous and will be summarized/grouped together so that identifying information will not be reported in results of the study.

Voluntary Participation:
Your participation in this study is voluntary. You may decide not to be in this study, or to be in the study now and then change your mind later. Participation or choosing not to participate will in no way affect your care at UHN/Toronto Rehab.

Rights as a Participant:
By agreeing to participate by completing the survey and/or an interview, you do not give up any of your legal rights against the investigators, sponsor or involved institutions for compensation, nor does this letter relieve the investigators, sponsor or involved institutions of their legal and professional responsibilities.

Conflict of Interest:
Researchers have an interest in completing this study. Their interests should not influence your decision to participate in this study.

Contact Information:
Principle Investigator: Dr. Paul Oh, Medical Director, Cardiac Rehab Program
416-597-3422 x5263, paul.oh@uhn.ca
Co-Investigator: Sarah Sharpe, PhD Candidate, University of Toronto
416-454-7274, sarah.sharpe@utoronto.ca

UHN Research Ethics Board (REB) Contact: If you have any questions about your rights as a research participant or have concerns about this study, call the Chair of the University Health Network Research Ethics Board (UHN REB) or the Research Ethics office number at 416-581-7849. The REB is a group of people who oversee the ethical conduct of research studies. The UHN REB is not part of the study team. Everything that you discuss will be kept confidential.

Thank you for your time in reviewing this information. Please let us know if you have any questions and if you would like to participate in the survey and/or an interview.

Sincerely,
Sarah Sharpe, Co-Investigator and PhD Candidate, University of Toronto
sarah.sharpe@utoronto.ca, 416-454-7274
Appendix B
Patient Survey on Health and Wellness App Use
Health and wellness mobile app use in chronic care: What can we learn from the experiences of cardiac patients and providers?

Thank you for agreeing to participate in this study! The following questions will help us to understand more about patients’ use of mobile technology and apps.

Definitions. Before we begin, a quick note on two terms we will use.
1. Mobile device is any mobile device that can have a software program (application) that is used on a small wireless (mobile) device such as a smartphone, tablet or smart watch. It does not include applications on desktop or laptop computers.

2. Health apps are any mobile app that patients feel aid in their health and wellness. This can include but is not limited to fitness, diet, exercise, healthy behaviours (smoking cessation, alcohol limitation, sleep, etc.), and mental health apps such as those for relaxation, meditation, depression and anxiety. They can also include wearable devices that collect information on heart rate, steps, blood pressure, etc.

First, some questions about your mobile technology use.

1. Do you have a cell phone, smartphone, Blackberry, iPhone, iPad, Tablet or wearable device (like Fitbit)?
   ☐ Yes (If Yes, please go to question 2)
   ☐ No (If No, please go right to question 13)

2. What mobile device(s) do you have? (Check all that apply)
   ☐ Cell phone
   ☐ Smartphone (iPhone, Blackberry, Android smartphone)
   ☐ Tablet (iPad or Tablet)
   ☐ Wearable device (like Fitbit)

3. Have you ever used your mobile device to do any of the following things (select all that apply):
   ☐ Send or receive an email
   ☐ Send or receive text messages
   ☐ Take a picture
   ☐ Access the internet
   ☐ Look for health or medical information online

4. On your mobile device, do you currently have any software applications or “apps” that help you track or manage your health and wellness? (Apps for exercise, diet, sleep, stress, heart rate monitoring, blood pressure, blood sugar, etc.)
   ☐ Yes (if Yes, please go to question 5)
   ☐ No (if No, please go to question 11)
5. What kind of health apps do you currently have on your mobile device? (select all that apply)
   □ Exercise, fitness, pedometer or heart rate monitoring (includes specific types of exercise like running, ab workouts, yoga, etc.)
   □ Diet, food, calorie counter
   □ Weight
   □ Blood pressure
   □ Blood sugar or diabetes
   □ Medication management
   □ Mood
   □ Sleep
   □ Smoking cessation
   □ Other (please specify) ____________________________
   □ Don’t know

6. Which health apps do you currently have on your mobile device?
   □ I have: (List all by name) ____________________________
   □ I don’t know which ones I have

7. How frequently do you use your health app(s)?
   □ At least once per day
   □ A few times per week
   □ About once per week
   □ About once per month
   □ Less than once per month

8. How long have you been using your health app(s)?
   □ Less than 1 month
   □ Between 1 month and 6 months
   □ Between 6 months and 1 year
   □ More than 1 year

9. To what extent do you think health apps have improved your health?
   □ Made worse/didn’t help at all
   □ Just a little bit/somewhat improved
   □ Very much improved

10. Have you ever discussed your health app results with your healthcare provider(s)?
    □ Yes
    □ No

11. Are there any health apps you downloaded and no longer use?
    □ Yes *(if Yes, please go to question 12)*
    □ No *(if No, please go to question 13)*
12. If you have downloaded health apps in the past, but no longer use some of your health apps, what reasons do you no longer use them? (Select all that apply)
   □ Takes too much time to enter data
   □ Lost interest
   □ There were hidden costs
   □ Other reason(s) (please specify): ____________________________

*(all responses from question 12, please go to questions 14-27)*

13. If you have never used a health app, please select the reason(s) why:
   □ I don’t own a mobile device
   □ I’m not interested in health apps
   □ They cost too much to buy
   □ I don’t trust letting apps collect my data
   □ My health is fine and I don’t need one
   □ They would use too much of my cell plan data
   □ They are too complicated to use
   □ I didn’t know about them before
   □ Other reason(s): ____________________________
   □ Not applicable

14. Are you interested in using any of the following health apps? (Select all that apply)
   □ I’m not interested in using any health apps
   □ Exercise, fitness, pedometer or heart rate monitoring (includes specific types of exercise like running, ab workouts, yoga, etc.)
   □ Diet, food, calorie counter
   □ Weight
   □ Blood pressure
   □ Blood sugar or diabetes
   □ Medication management
   □ Mood
   □ Sleep
   □ Smoking cessation
   □ Other (please specify) ____________________________
   □ Don’t know

15. What are the “ideal” features a health app would have that would be useful for you? (Select all that apply)
   □ Educational information
   □ Health goal setting and tracking
   □ Symptom monitoring
   □ Messaging with providers
   □ Appointment reminders
   □ Medication tracking and reminders
   □ Peer support forums (chat forums with other patients)
   □ Access to my medical record information
16. Has a healthcare provider ever recommended that you use a health app?
   ☐ Yes
   ☐ No

17. Do you feel your health providers would want their patients to share their results from health apps?
   ☐ Yes
   ☐ No
   ☐ Don’t know

18. Would you want to share health app results with your providers?
   ☐ Yes
   ☐ No
   ☐ Don’t know

19. Do you feel that health apps can help with management of chronic conditions like cardiac illnesses?
   ☐ Yes
   ☐ No
   ☐ Don’t know

Now, a few questions about you.
20. Your cardiac condition/diagnosis is: (Select all that apply)
   ☐ Coronary artery disease (CAD)
   ☐ Angina
   ☐ Arrhythmia
   ☐ Atherosclerosis
   ☐ Heart failure
   ☐ Heart attack
   ☐ Valve disorder
   ☐ High blood pressure
   ☐ High cholesterol
   ☐ Other: ____________________________

21. You have had the following surgeries: (Select all that apply)
   ☐ Bypass surgery / coronary artery bypass graft (CABG)
   ☐ Angioplasty (such as balloon or stenting)
   ☐ Valve replacement
   ☐ Pacemaker
   ☐ Implantable cardioverter defibrillator (ICD)
   ☐ Other: ____________________________
   ☐ I have not had any surgeries
22. Do you have any other chronic/ongoing health conditions?
    ☐ Chronic kidney disease
    ☐ COPD (chronic obstructive pulmonary disease)
    ☐ Stroke
    ☐ Diabetes
    ☐ Cancer
    ☐ Depression
    ☐ Anxiety
    ☐ Other __________________
    ☐ No, I don’t have any other chronic/ongoing health conditions

23. In general, would you say your health is:
    ☐ Poor
    ☐ Fair
    ☐ Average
    ☐ Very good
    ☐ Excellent

24. Your gender:
    ☐ Male
    ☐ Female

25. Your age:
    ☐ 18-29
    ☐ 30-49
    ☐ 50-69
    ☐ 70-89
    ☐ 90+

26. Your annual household income:
    ☐ Less than $30,000 / year
    ☐ $30,000 - $49,000 / year
    ☐ $50,000 - $74,000 / year
    ☐ $75,000+ / year

27. Your level of education:
    ☐ No high school diploma
    ☐ High school graduate
    ☐ Some college or university but no degree
    ☐ College or university degree(s)

Thank you for taking the time to answer these survey questions!

Please place your survey in the envelope provided.
Appendix C
Sign-Up Sheet for Interviews
(Each patient signed a separate sheet)
**Research Study:** Health and wellness mobile app use in chronic care: What can we learn from the experiences of cardiac patients and providers?

**Sign Up Sheet for Interest in Participating in a Telephone Interview**

Would you be interested in participating in an interview on the topic of using mobile technology such as smart phones and mobile applications/apps as a part of cardiac rehabilitation? Interviews will take place over the telephone. You don’t need experience using mobile technology to participate!

If so, please let me know your name and phone number so I may contact you for an interview. Please note, that just a small number of patients will be contacted for interviews and also that by signing this form, you are not obligated to participate in an interview.

Sincerely,

Sarah Sharpe, PhD Candidate, University of Toronto

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**I am interested in participating in an interview:**

Name:

_____________________________________________________

Phone Number:

______________________________

Please check all technologies that you have ever used or currently use:

☐ A computer at home (laptop or desktop)
☐ Internet service at home
☐ A cell phone (regular cell phone, not a smart phone)
☐ A mobile device (smart phone, iPhone, iPad, tablet)
☐ Any apps on your mobile device (weather, fitness, banking, etc.)
☐ Health and wellness apps on your mobile device. (diet, exercise, smoking cessation, stress reduction, meditation, medication management, sleep improvement, etc.)
☐ Wearable device (like a Fitbit) to monitor steps, heart rate, etc.
Appendix D
Provider Focus Group Information Letter
PROVIDER FOCUS GROUP INFORMATION LETTER

**Study Title:** Health and wellness mobile app use in chronic care: What can we learn from the experiences of cardiac patients and providers?

**Principle Investigator:** Dr. Paul Oh, Medical Director, Cardiac Rehab Program

**Co-Investigator:** Sarah Sharpe, PhD Candidate, University of Toronto

**Introduction:**
You are being asked to take part in a research study. The following is a description of the study and you should take as much time as you need before deciding whether or not to participate. You should ask the study staff to explain anything that you do not understand and make sure that all of your questions have been answered before deciding to participate. Before you make your decision, feel free to talk about this study with anyone you wish including your friends, family, and family doctor.

**Background/Purpose:**
We are performing a study to learn about patient and provider experiences with health and wellness apps. Particularly use of these apps by patients who have cardiac conditions.

**Study Method – Provider Focus Group**
You are being asked to participate in a focus group with your fellow providers. This focus group will involve a discussion on your thoughts about using mobile technology and mobile apps with patients. Specifically we will discuss your thoughts on the use of health and wellness apps in a cardiac patient population.

The focus group will take place during a regularly scheduled meeting on [enter date and location here, currently TBD dependent on final timelines following ethics approval].

The focus group will be up to 1 hour in length during a regularly scheduled meeting. The focus group will be audio recorded to ensure that the Researcher captures all information provided during the conversation. Audio recordings will be transcribed into a document for analysis and summary of focus group results.

**Reimbursement:**
There is no reimbursement for participation in this study.

**Risks:**
There are no known risks in participating in this study.

**Benefits:**
There are no direct benefits from participating in the study, however, results from the study will help us to better understand how we can improve health services for patients with respect to the use of mobile technology and health and wellness apps.

**Confidentiality:**
All results from the study will be anonymous and will be summarized/grouped together so that identifying information will not be reported in results of the study.

**Voluntary Participation:**
Your participation in this study is voluntary. You may decide not to be in this study, or to be in the study now and then change your mind later. Participation or choosing not to participate will in no way affect your employment at UHN/Toronto Rehab.

**Rights as a Participant:**
By agreeing to participate in the focus group, you do not give up any of your legal rights against the investigators, sponsor or involved institutions for compensation, nor does this letter relieve the investigators, sponsor or involved institutions of their legal and professional responsibilities.

**Conflict of Interest:**
Researchers have an interest in completing this study. Their interests should not influence your decision to participate in this study.

**Contact Information:**
 Principle Investigator: Dr. Paul Oh, Medical Director, Cardiac Rehab Program
416-597-3422 x5263, paul.oh@uhn.ca

Co-Investigator: Sarah Sharpe, PhD Candidate, University of Toronto
416-454-7274, sarah.sharpe@utoronto.ca

**UHN Research Ethics Board (REB) Contact:** If you have any questions about your rights as a research participant or have concerns about this study, call the Chair of the University Health Network Research Ethics Board (UHN REB) or the Research Ethics office number at 416-581-7849. The REB is a group of people who oversee the ethical conduct of research studies. The UHN REB is not part of the study team. Everything that you discuss will be kept confidential.

Thank you for your time in reviewing this information. Please let me know if you have any questions. If you would like to participate in the focus group, please show up on [enter date and location here, currently TBD dependent on final timelines following ethics approval].

Sincerely,

Sarah Sharpe, Co-Investigator and PhD Candidate, University of Toronto
sarah.sharpe@utoronto.ca, 416-454-7274
Appendix E
Interview Tracking Form
**Research Study:** Health and wellness mobile app use in chronic care: What can we learn from the experiences of cardiac patients and providers?

Researcher form to track patients and providers to be contacted for participation in interviews, decision to participate and date/time of interview.

 Note: Tables will be extended to accommodate the number of participants approached for consent in order to fulfill sample size requirements.

<table>
<thead>
<tr>
<th>Health App Use Group</th>
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<td>Verbal Implied Consent for Interview (yes/no)</td>
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<td>Date &amp; Time of Interview</td>
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<td>Date &amp; Time of Interview</td>
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</table>
Researcher Interview Guide for Patients / Focus Group Guide for Providers

To Note:
* During patient interviews, for each set of questions, the Researcher will ask questions that apply to the interviewee (i.e., depending on their technology and app experience).

**The interviewer will use probes to gather in depth information and allow for new themes to emerge by using phrases such as “please go on…. “, “tell me more about…. “can you describe more about…. “”, please describe why or why not…. “”, etc.

*** If needed, when patients or providers are not familiar with mobile devices or health and wellness apps, the Researcher will provide a brief description as follows:
1. Mobile device is any mobile device that can have a software program (application) that is used on a small wireless (mobile) device such as a smartphone, tablet or smart watch. It does not include applications on desktop or laptop computers.

2. Health apps are any mobile app that patients feel aid in their health and wellness. This can include but is not limited to fitness, diet, exercise, healthy behaviours (smoking cessation, alcohol limitation, sleep, etc.), and mental health apps such as those for relaxation, meditation, depression and anxiety. They can also include wearable devices that collect information on heart rate, steps, blood pressure, etc.

Interview Guide

Thank you for participating in this interview/focus group. It will take up to 30 minutes (1 hour for focus group) to complete and if at any time you would like to stop or reschedule, please just let me know. I am going to audio record our interview/focus group so that I can remember what you tell me accurately. The audio recording will be transcribed to text and then summarized so your information will be anonymous in all presentations of results.

Are you ready to start? I am going to turn on the recorder now.

As you know, we are here today to talk about your thoughts on using mobile technology and health and wellness apps for patients in cardiac rehabilitation.

A. Experience with technology, mobile technology and health apps
Patients and Providers:
• Tell me about your experience using computers, cell phones and mobile devices
• Tell me about your experience using health apps
• Tell me about what you know about health apps
• Tell me what you think about health apps? Good things about them? Negative things about them?
• Tell me about whether you trust health and wellness apps. Please describe.

Providers:
• How do you feel about your patients using health apps?
• Would / have you recommended health apps to patients? Why or why not?

B. Health apps and influence self-management
Patients and providers:
• Tell me your thoughts on the use of health apps and if they might influence self-management of cardiac conditions?
• Tell me your thoughts on the use of health apps and if they might influence self-management of general health and wellness?

C. Health apps and the patient-provider relationship
Patients:
• How would you feel about telling your provider about health apps you might be using? (For example, if you were tracking your exercise, or diet, or heart rate…)
• How would you feel about sharing your health app results with your provider? (For example, if you were tracking your exercise, or diet, or heart rate…)
• How do you feel about providers recommending health apps to their patients?

Providers:
• How would you feel about patients telling you about health apps they might be using? (For example, if they are tracking your exercise, or diet, or heart rate…)
• How would you feel about patients sharing their health app results with you? (For example, if they are tracking your exercise, or diet, or heart rate…)
• Do you feel that the use of health apps can impact current care processes? Why or why not?
• How do you feel about recommending health apps to patients?

D. Motivations / motivating factors to use health apps
Patients and Providers
• What do you think drives/motivates patients to use health apps?
• What kind of incentives would motivate patients to use health apps?
• Are there certain people in patients’ lives that influence the decision to use a health app? (Friends, family, providers, others?) Please describe how they might be an influence.

E. Barriers to using health apps
Patients and Providers
• What are some barriers to patients using health apps? Please describe why?
• How can we resolve these barriers? What needs to be in place to help patients to use health apps?
Appendix G
Provider Focus Group Participating Disciplines
Research Study: Health and wellness mobile app use in chronic care: What can we learn from the experiences of cardiac patients and providers?

Provider Focus Group Participating Disciplines

List of participating disciplines:

1. __________________________________________________

2. ________________________________________________

3. __________________________________________________

4. __________________________________________________

5. __________________________________________________

6. __________________________________________________

7. __________________________________________________

8. __________________________________________________

9. __________________________________________________

10. ________________________________________________

11. ________________________________________________

12. ________________________________________________
Appendix H
Groupings of Patient Interview Participants
<table>
<thead>
<tr>
<th>Health App Users</th>
<th>Non-Health App Users</th>
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<tbody>
<tr>
<td>IA1</td>
<td>IN4</td>
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<td>IN27</td>
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<td>IA30</td>
<td>IN29</td>
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Appendix I
Codes, Categories and Themes from the Qualitative Analysis
<table>
<thead>
<tr>
<th>Results Section</th>
<th>Theme</th>
<th>Sub-Theme</th>
<th>Category</th>
<th>Examples of Frequently Cited Codes <em>(not a complete list of all codes)</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>4.3</td>
<td><strong>patient health app use</strong></td>
<td>mobile device use</td>
<td>tech use</td>
<td>have a computer, seeing an increase in patient technology use</td>
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<tr>
<td></td>
<td></td>
<td>internet use</td>
<td></td>
<td>look up health information</td>
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<td></td>
<td></td>
<td>tech confidence</td>
<td></td>
<td>self-perceived as tech savvy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>health app use</td>
<td>activity</td>
<td>track walking, track steps, track running, biking, exercise</td>
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<tr>
<td></td>
<td></td>
<td>heart rate</td>
<td></td>
<td>heart rate, ECG via holt monitor</td>
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<td>diet</td>
<td></td>
<td>diaries for eating, track calories, sodium calculator, recipes, weight</td>
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<td>blood pressure</td>
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<td>blood pressure</td>
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<td>sleep</td>
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<td>sleep</td>
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<td>educational</td>
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<td>educational information</td>
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<td><strong>health apps and self-management</strong></td>
<td>health apps and use in self-management</td>
<td>apps and self-management</td>
<td>health apps help self-management</td>
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<td>motivations to use health apps</td>
<td></td>
<td>track progress, programs that interpret results, graphing results</td>
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<td>progress and goals</td>
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<td></td>
<td>health</td>
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<td>app use motivation is to be healthy, getting outside and being active</td>
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<td></td>
<td>social</td>
<td></td>
<td>family, social components motivational, socializing, competitive apps positive, competitive apps negative</td>
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<tr>
<td></td>
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<td>prevention</td>
<td></td>
<td>regret not exercising and being healthy in past</td>
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<td></td>
<td>barriers to using health apps</td>
<td>confusing</td>
<td>confusing / hard to use / too many features, too many apps to choose from, not sure which apps are valid, too much information can be overwhelming</td>
</tr>
<tr>
<td>Results Section</td>
<td>Theme</td>
<td>Sub-Theme</td>
<td>Category</td>
<td>Examples of Frequently Cited Codes (not a complete list of all codes)</td>
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<td></td>
<td></td>
<td>annoying</td>
<td>apps that require too much work, don't want to be on computer or device often, screen / buttons too sensitive, screen too small, apps not customizable</td>
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<td></td>
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<td>cumbersome</td>
<td>apps that require a chest strap, wrist bands uncomfortable, need to charge the device, remembering to use the app</td>
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<td>malfunctions</td>
<td>apps that don't connect properly, mobile device or app not working properly</td>
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<td>requirements</td>
<td>low phone memory, no data plan</td>
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<td></td>
<td>access</td>
<td>financial constraints</td>
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<td>still need in-person connection</td>
<td>need to keep the in-person contact, use of apps depends on the patient</td>
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<td>health app trust</td>
<td>accuracy</td>
<td>apps are accurate, acknowledge apps not perfect, validate accuracy, would be good to know accuracy of each app</td>
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<td></td>
<td>privacy</td>
<td>worried about privacy, not worried about privacy</td>
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<td></td>
<td>paper versus apps for health tracking</td>
<td>benefits of apps versus paper</td>
<td>apps better than paper, diary on phone easier than paper and pen, using the notes section of the phone, providers notice patients using apps to record their prescriptions</td>
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<td>sometimes apps are not needed</td>
<td>can just learn things the right way, pen and paper can be just as good/better, mobile device user tracking on paper, non-app user tracking everything on paper, but still need paper to get all the necessary information</td>
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<tr>
<td>Results Section</td>
<td>Theme</td>
<td>Sub-Theme</td>
<td>Category</td>
<td>Examples of Frequently Cited Codes <em>(not a complete list of all codes)</em></td>
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<td>health apps and the patient-provider relationship</td>
<td>provider engagement in patient health app use</td>
<td>providers engaging patients</td>
<td>provider recommending apps, provider recommending websites, recommend using chest strap for heart rate, emailing with providers positive experience, using a web-based learning management system</td>
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<td>patients engaging providers</td>
<td>patient comfortable sharing results, patient has shared results, providers welcomed patient sharing results, patients stay in touch post-graduation</td>
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<td>providers give tech support</td>
<td>patients ask for tech support, providers don't mind giving tech support</td>
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<td>barriers in patient-provider engagement</td>
<td>patients not wanting to engage providers</td>
<td>not shared apps with providers, patients wait for providers to ask for information, patient doesn't think providers interested, providers not available</td>
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<td>providers telling patients apps / wearables not accurate, dismissive of app use conversation, dismissive of exercise etc. conversation, apps not talked about at the hospital, hesitation to promote apps</td>
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<td>providers need support</td>
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<td>patient acknowledgement of provider constraints</td>
<td>acknowledgement of provider workload constraints</td>
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<td>technology use and assumptions</td>
<td>age as a determinant in technology use</td>
<td>older not tech savvy</td>
<td>older generations not tech savvy, soon older generations will be tech savvy, older generations tech savvy, all generations liking and using technology</td>
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<td>the influence of gender, language and cognitive ability</td>
<td>gender differences</td>
<td>men more tech savvy than women</td>
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<td>cognitive limitations</td>
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<td>linked to &quot;health app use codes&quot; in Section 4.3</td>
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<td>practical app use</td>
<td>ease of use</td>
<td>simple to use, customizable to needs, measures without manual input, automatic indicators</td>
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<td>competition</td>
<td>do not like competitive apps, like competitive apps</td>
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<td>connecting patients and providers</td>
<td>connect patients and providers via apps, patient decides what information sent to providers, virtual health coach during the program</td>
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<td>incentives</td>
<td>provider monitoring (compliance) is motivation to exercise</td>
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<td>interest in virtual education</td>
<td>make lectures electronic and available online, make lectures available for general public, record cardiac lectures so can listen to then when walking</td>
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</tr>
<tr>
<td>Results Section</td>
<td>Theme</td>
<td>Sub-Theme</td>
<td>Category</td>
<td>Examples of Frequently Cited Codes (not a complete list of all codes)</td>
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<td>continuity of care beyond rehab</td>
<td>virtual health coach post-graduation, want more rehab / connection with care after graduation, need to keep patients connected with one another for support and motivation, idea of connecting patients with other fitness organizations post-rehab, don't need more rehab or connecting with care after graduation</td>
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<td>apps can support improvements in care processes</td>
<td>technology can give even more information than what is currently collected, care processes could be more efficient, in-person time better utilized, technology can reduce workload for providers</td>
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<td>patients need support</td>
<td>making informed app choices</td>
<td>discuss apps in cardiac classes, recommend apps that connect patients and providers, make use of experiences other patients have had with apps, providers want patients to choose their own apps / websites</td>
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<td>interest in health apps</td>
<td>non-app user wants to use health apps, non-app user knows about health apps, non-smartphone user can see benefits of smartphones / wearables, non-app user wants to know more, non-app user not familiar with health apps</td>
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<td>education</td>
<td>need tech support, provide tech education, provide education on results interpretation</td>
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<td>Sub-Theme</td>
<td>Category</td>
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<td></td>
<td>incentives</td>
<td></td>
<td>providers should pay for devices and apps for patients, apps that pay / reward when you exercise, apps that donate money when you exercise, incent healthy living by providing health apps</td>
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<tr>
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<td>providers need support</td>
<td>provider resources</td>
<td>providers need guidance on which apps to recommend, if providers use apps with patients they need resources to support then</td>
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<td></td>
<td></td>
<td>care processes</td>
<td></td>
<td>care processes would need to change with use of technology, would like an app that is in the same format as the paper system</td>
</tr>
<tr>
<td><strong>4.8</strong> context: shifting landscape in emerging technology, provider practices and patient use of health apps</td>
<td>linked to themes in above sections</td>
<td>linked to categories in above sections</td>
<td>linked to codes in above sections</td>
<td></td>
</tr>
</tbody>
</table>