

## A REVIEW OF CURRENT HEART FAILURE APPS

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### Abstract

**Background:** Heart disease is the second leading cause of death in Canada, with tremendous economic impacts on the healthcare system. Currently, there are several smartphone based heart failure (HF) apps available for patients. These apps provide information to patients regarding HF, and how to monitor and manage their condition. This review describes the current literature on HF apps, and describes the features offered by these apps. **Methods and Results:** Peer-reviewed literature was searched and revealed only a limited number of studies (8) related to HF apps, including HeartMapp, SUPPORT-HF and CardioManager. A Google-based grey literature search was conducted, and Google Play and the Apple Store were also searched to identify additional HF-related apps. These searches revealed several other HF-related apps (total 11), the features of which are described in the current review. **Conclusion:** This review will help healthcare providers select apps for themselves and recommend HF apps to their patients that provide the most suitable disease and management information and monitoring capability. The insight will also help software developers design apps in the future that will provide better support to patients with HF and help the healthcare providers monitor their condition better.

**Keywords:** heart failure; apps; smartphones; mHealth; review

### Introduction

Heart failure (HF) is one of most common conditions affecting people, with more than 15 million patients in Europe,<sup>1</sup> and about 6.5 million patients in the USA living with HF.<sup>2</sup> It is estimated that about 600,000 Canadians are living with the condition.<sup>3</sup> HF is a growing epidemic as more people survive myocardial infarction and other acute heart conditions (peripartum cardiomyopathy, viral myocarditis or perimyocarditis, or alcohol myopathy), the elderly live longer, and chronic diseases (diabetes and hypertension) lead to HF.<sup>4,5</sup> Currently, there is no cure for this serious condition, but with lifestyle changes and treatment options, patients can manage their condition very well, and lead a full and normal life.

A Google search of Heart Failure retrieves millions of hits, which is very confusing for patients. The increasing availability, convenience, and use of smartphone-based apps could play a significant role in managing HF. The apps can provide patients with specific important information, warning signs, and information on how to better manage their HF. Apps could also help healthcare providers better monitor their patients' HF. Martínez-Pérez et al. reviewed mobile apps in cardiology,<sup>6</sup> but there were only two mobile-based telemonitoring systems identified specifically for HF. This review describes the limited peer-review research on the usability, effects, and clinical outcomes of various popular smartphone based apps and on HF specific apps currently available from Google Play and the Apple Store. This article also gives suggestions about features which could be incorporated into the apps in the future.

### Methods

A scoping narrative review was conducted to identify and describe the current peer-reviewed and grey-literature on smartphone based HF apps. A PubMed

search of peer-reviewed literature was conducted in March 2017 to identify studies related to the use of HF apps. The search terms used for 3 independent searches were (1) heart failure AND apps, (2) heart failure AND mobile phones, and (3) heart failure AND smartphones. The search was updated in May 2018 to include any new studies. In addition, a grey literature search using Google was conducted in March 2017 using the same keywords as above in three separate searches to identify any HF apps which have not been described in peer-review literature. A Google Play and Apple Store search was also conducted in March 2017 to identify HF-related apps using the search term ‘heart failure’. Inclusion criteria for both peer-reviewed and grey-literature articles retrieved were: 1) apps focussed on HF and 2) apps and the research conducted were in English. Peer-reviewed articles and apps identified from the grey-literature were excluded if they focussed on any other disease or heart condition other than HF, or did not focus on smartphone / mobile phone based apps.

## Results

The PubMed search retrieved 224 articles. Duplicates were removed and articles were further screened (PS, AK) using the inclusion criteria, retrieving a total of eight articles which were included in this review (Figure 1). These eight articles described the use and outcomes of HF-related apps. The Google search generated many millions of hits, and only the first 10 pages of results (first 100 hits) for each of the three searches were screened to identify any additional HF-related apps, yielding a total number of 300 hits for screening. Neither the Apple Store nor Google Play listed the number of apps retrieved. The apps from these two stores were manually screened which identified several HF-related apps that can help patients get more information and monitor their condition better. After screening, 11 relevant apps were identified which were included in the review.

In the current review, the results are presented by describing the features of the current HF apps and research on their usability, development, and reported outcomes. The results are divided into (1) Peer-reviewed literature search and (2) Google grey literature, Google Play and Apple Store searches. Because no additional apps were identified in the Google grey literature search which were not already identified in Google Play and Apple Stores, the results

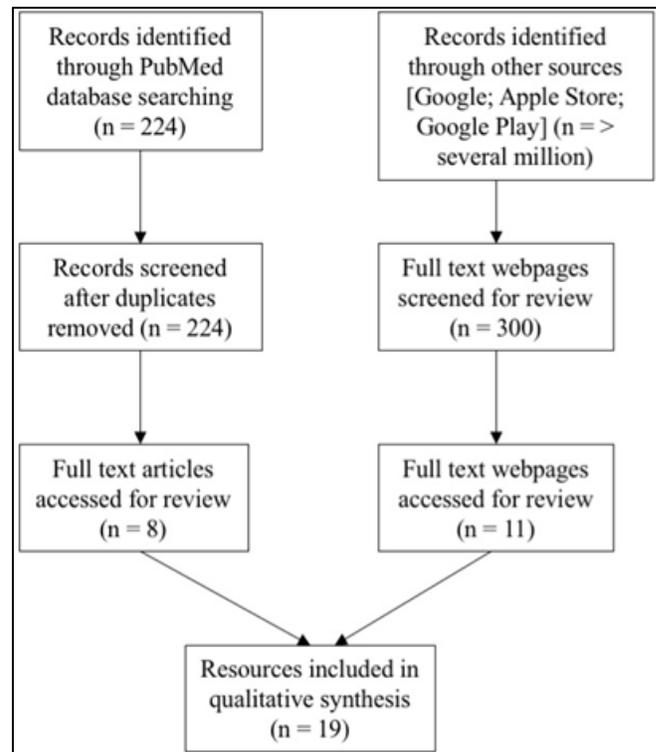


Figure 1. Search outcomes.

of all three searches are presented together. In addition, apps identified in Google Play and Apple stores overlapped, therefore making it redundant to describe Google Play and Apple Store apps separately. In total, eleven apps were identified by grey-literature search.

### Peer-reviewed literature search

Athilingam et al. described the features and usability assessment of a patient-centred mobile application (HeartMapp) for self-management of heart failure.<sup>7</sup> The study described the HeartMapp as a mobile application which worked independently of the healthcare system. The app allows patients to enter their weight. A wearable Bluetooth sensor is used to measure vital signs in real-time which then transmits the data to the app. The app also has a built-in HF symptoms questionnaire. Depending on the severity of patient-reported HF symptoms, the app can prompt patients to contact their doctor or 911. In addition, the app provides information about HF and suitable exercises for patients. Also, physicians are able to monitor their patients using the data provided through the app.<sup>7</sup> In terms of usability of the HeartMapp app, patients reported moderate self-confidence in using the app. Furthermore, healthcare providers reported high-confidence in using patient-reported data to make clinical decisions.<sup>7</sup>

Athilingam et al. also described a mobile-based app for HF education.<sup>8</sup> The app provided patients with information as text and audio, along with an option allowing patients to test their knowledge using various quizzes. The study evaluated patient confidence in using the app by responding to a self-confidence questionnaires. Results indicated that patients were confident in using the app, found the education material appropriate, and were highly likely to use the app, thus highlighting the need for a comprehensive app for HF patients to monitor and manage their HF.<sup>8</sup>

Triantafyllidis et al.<sup>9</sup> described the features of a mobile-based app used by the SUPPORT-HF (Seamless User-centred Proactive Provision Of Risk-stratified Treatment for Heart Failure) study, along with preliminary findings about the use of this application. Patients were provided with a tablet computer which contained the android-based app. Patients could receive app updates using the Google Play Store. Patients were also provided with various sensing devices such as a blood pressure monitor, weigh scales, and a pulse oximeter which transmitted data to the app via Bluetooth. The app could also transmit patient data to clinicians. The app allowed patients to measure and enter their vital signs, answer questions related to HF symptoms, get more information about HF self-management, and communicate with their healthcare providers. The study reported constantly high patient engagement with the app and better patient-clinician communication.<sup>9</sup>

Cano Martín et al.<sup>10</sup> assessed the *ex ante* economic impact and cost-effectiveness of a mobile app, CardioManager, for the self-management of heart diseases by patients with HF in a region of Spain. CardioManager was developed by the study team and provided information about HF to patients. The app also recorded user activity such as rehabilitation, physical activity, and food intake (estimating excess intake), along with blood pressure, glucose, and cholesterol levels. The app also provided medication reminders. The study reported that the app could cause a 33% reduction in management and treatment costs of HF, resulting in a saving of 0.31% of the total healthcare expenditure in the region.<sup>10</sup>

On the other hand, Vuorinen et al. examined the effect on HF-related hospitalisation of multidisciplinary care of HF patients using a phone-based app.<sup>11</sup> Patients were provided with a mobile phone with a pre-installed software app, which they could use to measure and/or track their body weight,

blood pressure, and pulse rate. The patients were also asked to answer HF symptom-related questions every week. The app transmitted all the patient data to a HF nurse. The study reported a high patient adherence (~90%).<sup>11</sup> However, no significant differences were found in the number of HF-related hospital days between patients using the app and patients not using the app. Interestingly, patients using the app used more healthcare resources, while reporting no statistically significant differences in clinical health status or in their self-care behaviours.<sup>11</sup>

Anglada-Martínez et al. suggested that a smartphone-based app could improve medication adherence in HF patients.<sup>12</sup> However, no significant differences in health outcomes or in the use of healthcare resources were observed. On the other hand, Goldstein et al. showed that medication reminders using a smartphone-based app did not significantly improve medication adherence among patients.<sup>13</sup> The study, however, did suggest the need to address other factors of poor medication adherence, such as motivation, in future apps.<sup>13</sup>

Furthermore, Masterson Creber et al. reviewed and evaluated current HF-apps using the Mobile Application Rating Scale (MARS), IMS Institute for Healthcare Informatics functionality scores, and Heart Failure Society of America (HFSA) guidelines for nonpharmacologic management.<sup>14</sup> The study identified that the best apps for managing HF were Heart Failure Health Storylines, Symple, ContinuousCare Health App, WebMD, and AskMD.<sup>14</sup> The Heart Failure Health Storylines app will be described later. However, other apps were not specific to HF as they provided information on various health related topics, and were excluded from this review.

### **Google grey literature, Google Play and Apple Store Store searches**

#### **Apps for use by patients**

##### ***Mind my Heart*<sup>15</sup>**

This app was developed by University College London Hospitals (UCLH) and was specifically designed for UCLH patients with heart failure. The app was intended to improve patient experience at UCLH, and help manage HF better. The app includes features such as a heart failure information resource, weight diary reminder, outpatient appointment reminder function, and one-touch access to the heart failure or cardiac rehabilitation team for advice.

##### ***FAQs in Heart Failure*<sup>16</sup>**

This app by Focus Medica India Pvt. Ltd. provides

answers to common questions related to the anatomy and pumping function of the heart; causes, risk factors, types and symptoms of HF; diagnostic tests; medications for managing HF; implantable devices; and surgery. The app also provided guidelines to prevent HF, and listed the precautions to be taken when implanted with a cardiac device or after undergoing heart surgery. The developer claimed that the text in the app is supported by lifelike videos and relevant images. The app could be a useful tool for patients to understand their HF and manage their condition better.

#### *Heart Failure Coach*<sup>17</sup>

Heart Failure Coach was developed by the University of Pittsburgh Medical Center, a healthcare provider with more than 20 hospitals and 500 doctors' offices based in Pittsburgh, USA. The app was described as a patient engagement game administered by members of the healthcare team. In the game, the player (HF patient) interacts with and guides Simon, a character with congestive heart failure (CHF) who was recently released from the hospital. The game focuses on reinforcement of critical self-maintenance skills necessary for HF patients to stay out of the hospital. Each day for a virtual week, players help Simon complete key behaviours such as tracking weight, taking prescribed medicines, and calling the doctor if needed. Players also need to watch out for midnight snacking and other cravings that could negatively affect Simon's progress, and might cause him to be readmitted to the hospital. At the end of the game, patients are given feedback on their treatment of Simon. According to the developers, this healthcare game has improved retention of the critical self-management skills for patients who have played and has had a positive impact on the number of readmissions.

#### *HF Buddy*<sup>18</sup>

HF Buddy app, by Singapore Health Services, provides patients with information and tools to improve the overall understanding of their HF, and how to better manage their condition.

#### *H2O Overload: Fluid Control for Heart-Kidney Health*<sup>19</sup>

This app, developed by the National Kidney Foundation, is targeted towards patients with chronic heart and kidney disease. One section of the app focusses on patients with both HF and kidney disease. The app describes the link between kidney disease, heart disease, and hyponatremia. It also provides important medical information about risk factors, symptoms, treatments, and when to call a doctor. The

app includes a fluid tracker, weight tracker, blood pressure tracker, nutrition tips, and an appointment diary. The developer claims that the app is easy to read and navigate. The information is presented in an easy to understand form.

#### *Apps for use by healthcare providers* *iCCS*<sup>20</sup>

This app, developed by the Canadian Cardiovascular Society, helps healthcare providers to adopt the latest clinical guidelines in daily clinical practice. The app includes the Canadian Cardiovascular society guidelines for Heart Failure (2012, 2013, and 2014), and places the guideline information, recommendations, and algorithms directly in the hands of practitioners in an easy to use interactive format. The iCCS app contains guideline summaries, introductory videos, clinical calculators, useful drug tables, clinical trial summaries, and a comprehensive library of guidelines and pocket guides.

#### *Heart Failure Nurse Care Plan*<sup>21</sup>

This app helps nurses write customised care plans for their patients with HF. The nurses can print-out care plans for their patients and provide them with appropriate homework assignments. The app includes updates from clinical experts to ensure the most current, accurate, and relevant content.

#### *Heart Failure*<sup>22</sup>

Heart Failure is an educational app for healthcare providers. It provides students with information regarding the basic thought process behind assessing and treating patients with systolic heart failure.

#### *Apps for use by both patients and healthcare providers* *MyHF*<sup>23</sup>

MyHF app, developed by Les Laboratoires Servier, can be used by patients to monitor their heart failure. This app enables patients to regularly record their medical parameters (weight, blood pressure, heart rate, and quality of life). Quality of life is assessed by using a short questionnaire. The app displays the history of a patient's parameters as graphs, which can help the patient better monitor their condition. This can also help healthcare providers at appointments, as they are able to review how a patient's medical parameters changed over time. MyHF app also offers practical tips on diet and exercise to better manage HF. The app also has the option of sending daily medication reminders to patients.

#### *Heart Failure Health Storylines*<sup>24</sup>

Heart Failure Storylines by the Heart Failure Society of America is a mobile and web app to keep track of

patients' health. The app, which was developed with input from people with HF and CHF, enables patients to record and graphically track their symptoms, vital signs, medications, and physical activity and provides low sodium guidelines, and a daily mood journal. These data can provide healthcare providers with information about the patient between visits. The app also allows patients to sync and import data from other health and fitness apps that a patient might be using.

#### *HF Defender*<sup>25</sup>

HF Defender is a remote heart management app that incorporates a patient's medical profile, comorbidity, and heart failure data into a patent pending algorithm that individualises the patient's care. During enrolment into HF Defender, healthcare providers input the patient's health information including past medical history, previous encounters, social history, current medications and other relevant health data. Based on the information provided, HF Defender calculates the patient's individualised treatment directives and goals. Providers can easily update this information as needed which will update goals within the profile module.

The app can also provide daily monitoring of patients. After the intake process is complete, the system calculates individualised goals for the patient. Each day, patients or their caregivers can log into the system and input vital signs, daily weight, activity level and quality of life. HF Defender then assures this information meets the patient's individualised treatment directives. If daily patient data falls outside the treatment goals, an alert is sent to the provider on duty and an immediate encounter will then be initiated if required. Furthermore, if patients or caregivers fail to enter data after seven consecutive days, the providers are alerted to check in with the patient and ensure that everything is alright. HF Defender also provides an avenue for electronic communication between patients and caregivers. All electronic communications are archived in the system, enabling either party to review past communications if required.

## Discussion

This paper has reviewed the current peer reviewed literature (eight articles) that reported use of various HF apps, and identified and reviewed a further 11 HF-related apps described in grey literature and app stores.<sup>6-25</sup> All of these apps are currently available in the market for use by patients and / or healthcare providers.<sup>6-25</sup> A limitation of this study is that only

articles or apps using the English language were selected, which could have led to exclusion of articles and apps relevant to the topic.

The current literature suggests a high rate of acceptance and use of mobile apps among patients to obtain information and monitor their HF.<sup>3,7-21,23-25</sup> The apps can provide patients with more information about the risk factors, symptoms, prevention, and treatment of HF.<sup>7-9,15-19</sup> Some apps allow patients to monitor their HF and enable them to record their medical parameters such as weight, blood pressure, heart rate, and quality of life.<sup>7,8,10,11,23-25</sup> This allows patients to better manage their condition. Healthcare providers can also monitor their patients better as they can easily visualize the performance and history of their patients. It becomes easier for the physicians to ensure that their patients are meeting the recommended guidelines, taking the correct medications and dosages, and maintaining their vital signs within the safe range. This can save time and cost for the healthcare system as the physicians can see information in a graph format during their patient's visit.

Some other apps help the healthcare providers by giving them with the latest clinical guidelines on treatment and management of HF, and helping them create personalised care plans for their patients.<sup>7,20-25</sup> The healthcare providers are also able to track and monitor their patients between visits by checking their vital signs remotely via the app. The healthcare providers can even be notified if a patients vital signs fall outside their current treatment goals. HF Defender app<sup>25</sup> also allows electronic communication between patients and healthcare providers, which can help patients get their questions answered, and avoid the need for a patient visit. This can drastically save time and healthcare costs.

Despite the above example, few applications allow two-way communication between patients and their healthcare providers. HeartMapp<sup>7</sup> and SUPPORT-HF<sup>9</sup> were the only apps described in peer-reviewed literature which allow for two-way communication. Among the publically available apps, the only app found with a two-way feature was the HF Defender app.<sup>25</sup> However, based on the number of downloads on Google Play store, it seems that the HF Defender app is not extensively used. We could not find information regarding whether this app is available to healthcare providers in Canada or not. Therefore, more apps need to be developed which can allow two-way communication between patients and their caregivers.

There is a general lack of mobile based technology to manage HF. Most current HF applications provide basic information about the disease and tips to manage it. There are few that actively manage the HF by intervening earlier and thereby keep patients from being readmitted to hospitals. Applications that identified patients who are worsening and proactively managed them (e.g., changing diuretic doses) prior to requiring emergency admission would be highly beneficial. These apps would decrease the number of patients waiting in hospital emergency rooms, and reduce hospital admissions of patients with HF. This would, in turn, decrease the financial burden on an already stretched medical system.

In addition there is the need for a comprehensive app to be developed which can provide to patients detailed, but easy to read, information regarding HF. This would enable them to monitor their condition and vital signs, and also enable healthcare providers to monitor their patients and take early corrective action. Some smartphones allow patients to record their heart rate using the camera sensor.<sup>26</sup> Any comprehensive app should include this feature, along with a survey capability to monitor how patients are feeling. The app should also allow interactive, real-time two-way communication between patients and their doctors, nurses, and clinics. A comprehensive app that included these features would be a significant step forward in monitoring and managing patients with HF, which in turn could lead to improved clinical outcomes, and less temporal and financial burden on the healthcare system.

The information in this review can help patients choose the best apps with which to gain knowledge of their HF, and how to monitor and manage it. Healthcare providers can also use this information to recommend good apps to their patients, while selecting and using apps that can enable them to better monitor their patients. Finally, the same information can help developers in creating better and more comprehensive apps in the future.

## Conclusion

This review has summarised the relatively sparse peer-reviewed literature available on HF-related apps. The information provided will help patients and healthcare providers select the best app or apps for distributing information about HF, and how to monitor and manage the disease. Similarly, the information could help

inform developers leading to design of better and more comprehensive HF apps.

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