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ORIGINAL ARTICLE

An m-Health intervention to improve education, self-management, and outcomes in patients admitted for acute decompensated heart failure: barriers to effective implementation

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Aims Effective and efficient education and patient engagement are fundamental to improve health outcomes in heart failure (HF). The use of artificial intelligence (AI) to enable more effective delivery of education is becoming more widespread for a range of chronic conditions. We sought to determine whether an avatar-based HF-app could improve outcomes by enhancing HF knowledge and improving patient quality of life and self-care behaviour.

Methods and results In a randomized controlled trial of patients admitted for acute decompensated HF (ADHF), patients at high risk (≥33%) for 30-day hospital readmission and/or death were randomized to usual care or training with the HF-app. From August 2019 up until December 2020, 200 patients admitted to the hospital for ADHF were enrolled in the Risk-HF study. Of the 72 at high-risk, 36 (25 men; median age 81.5 years; 9.5 years of education; 15 in NYHA Class III at discharge) were randomized into the intervention arm and were offered education involving an HF-app. Whilst 26 (72%) could not use the HF-app, younger patients [odds ratio (OR) 0.89, 95% confidence interval (CI) 0.82–0.97; $P < 0.01$] and those with a higher education level (OR 1.58, 95% CI 1.09–2.28; $P = 0.03$) were more likely to enrol. Of those enrolled, only 2 of 10 patients engaged and completed ≥70% of the program, and 6 of the remaining 8 who did not engage were readmitted.

Conclusions Although AI-based education is promising in chronic conditions, our study provides a note of caution about the barriers to enrolment in critically ill, post-acute, and elderly patients.

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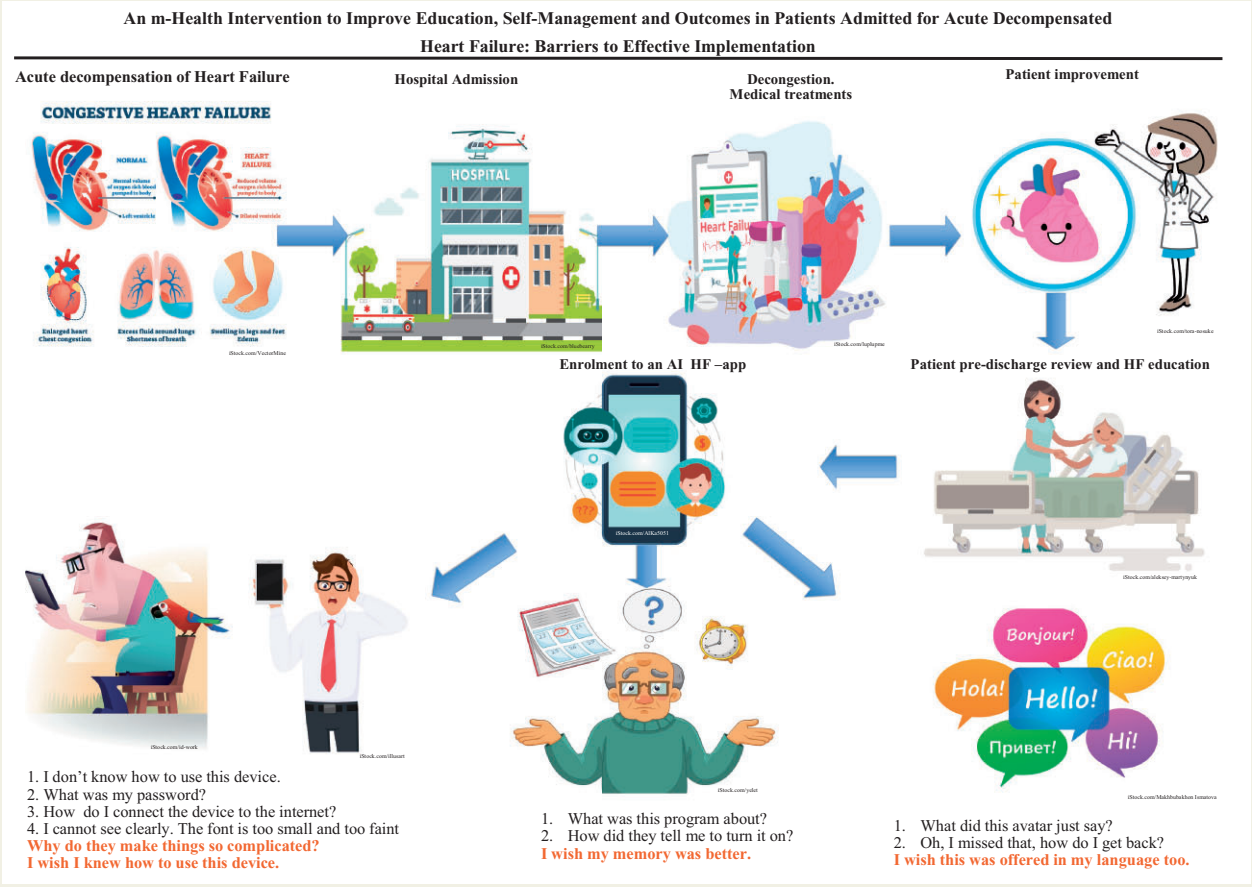
Graphical Abstract



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Keywords Heart failure education • Artificial intelligence • Self-care • m-Health • Engagement

Introduction

Patient education and self-management are complementary to medical treatment in order to improve heart failure (HF) outcomes.[1] Effective pre-discharge education[2] and ongoing post-discharge patient support[3] improve self-care and subsequently reduce readmissions and mortality. The problem is that a post-discharge education or disease management program (DMP) is not always available for patients admitted for acute decompensated HF (ADHF). As technology improves, novel methods to enhance patient education and provide ongoing support to improve self-care and promote patient engagement (e.g. tele-monitoring and telehealth[4]) are becoming increasingly available. The provision of education and self-management using Artificial Intelligence (AI) in chronic diseases has been used with promising results,[5–8] including in HF.[9,10] In one of the first studies designed to deliver patient education via an avatar style app in an outpatient setting, we co-developed an HF-app digital coach for symptom monitoring and education. Pilot testing suggested overall improvements in quality of life (QoL), Self-Care, and HF knowledge. In 21 recently discharged chronic HF patients, median age 84 years (interquartile range 77.5–86.5 years), improvements were observed over 8 weeks follow-up in QoL (13 of 21), self-care (12 of 21), and HF knowledge (13 of 21).[10] These positive results led us to test the efficacy of the HF-app digital coach within a multi-factorial intervention and tested in a randomized controlled trial (RCT), that aimed to reduce short-term readmission and mortality in patients admitted for ADHF.[10] This report presents our experience with post-acute HF patients on enrolling to use an HF-app, as well as use and barriers to both enrolment and HF-app engagement.

Methods

Study design overview

The Risk-HF study[10] is an RCT of Usual Care (UC) and UC *plus* a multi-component nurse-led intervention (DMP-Plus) involving improved links between hospital and primary care, home visits, lung ultrasound to assess fluid status, and an app-based avatar, ('the Digital HF-Coach') to provide education.[10] This report concerns the Digital HF-Coach for participants who were admitted for ADHF from August 2019 up until December 2020 in Melbourne (Footscray and Sunshine Hospitals) and Hobart (Royal Hobart Hospital); and randomized to the intervention arm. Ethics approval was granted by the Alfred Human Research Ethics Committee (local ethics ID: 40036), and the trial was registered before recruitment commencement with Australia New Zealand Clinical Trials Registry (ACTRN): ACTRN12618001273279.

Patient recruitment

Details regarding study recruitment and eligibility criteria have been described previously.[10] Briefly, the Risk-HF study aimed to randomized 404 high-risk patients to usual care or intervention on a 1:1 ratio. Potentially eligible patients were identified by site nurses and were referred to study researchers. Subsequently, the study researchers determined eligibility, described the study, and answered the patients' study-related questions. Patients were eligible for enrolment if they were 18 years of age or older, admitted for ADHF, and did not have any of our exclusion criteria.[10] All enrolled patients provided signed informed consent and were assessed for readmission and/or death to determine eligibility for randomization. Enrolled patients underwent assessment for readmission and/or mortality risk and those at high-risk (defined as an estimated risk of ≥33% for short-term hospital readmission and/or death, using a previously developed risk score)[11] were eligible for randomization. The patients were deemed ineligible for randomization if they had an estimated risk <33% and they were allocated to our low-risk arm. A REDCap database[12] was used to capture patient demographics, clinical information, baseline, and follow-up measures and randomize eligible patients. High-risk patients were randomized to UC or Intervention (DMP-Plus) using a Prospective Randomized Open Blind design in blocks of six. Randomization was stratified by HF type [HF with reduced ejection fraction (HFrEF) or HF with preserved ejection fraction (HFpEF)] and enrolment site. The randomization model was designed by an independent biostatistician and the study researchers were not aware nor had access to the randomization sequence. Uptake of the HF-app was a part of our multi-factorial intervention and was not an inclusion/exclusion criterion. Therefore, patients with low technical literacy or lacking access to digital technology were still eligible for participation.

Use of the Heart Failure app

Education with the Digital HF-coach was offered to all patients who were randomized to DMP-Plus. Of the 404 eligible patients to be randomized, it was anticipated that 202 patients would be randomized to the intervention arm and undertake training with the HF-app. The problems with adherence to the app led to the discontinuation of this part of the intervention on the grounds of futility. Here, we report our experience from this approach and barriers to recruitment to an HF-app.

The app was either installed on each patient's mobile device (phone or tablet) or pre-installed on a study tablet PC.

Details about the content of the app and questionnaires administered, along with results from our pilot study are detailed in the published protocol.[10] Briefly, our HF-app is a 52-day program that engages daily with the patients in order to provide education about HF and prompts related to HF management. It reminds them to weigh themselves daily and to record the result, with recommendations to notify their nurse or doctor if ≥2 kg is gained within 2 days. The patient responds to questions at the start and the end of the program about their HF knowledge [Dutch Heart Failure Knowledge Scale (DKFKS)[13]], self-care efficacy [European HF Self-Care behaviors scale (EHFSCBs[14])], and their perceptions of their health status [Kansas City Cardiomyopathy Questionnaire (KCCQ[15])]. The program duration is 10 sessions delivered over a period of 8 weeks (52 days). The HF-app was co-designed by Baker Institute researchers (J.B. and M.C.) with a scientific focus in chronic disease management, community intervention, and cardio-metabolic disease prevention; and Clevertar Pty Ltd, a company that is specialized in AI software development. Our pilot study was delivered in patients who were recently discharged after an HF admission and recruited from an HF clinic in Sydney, New South Wales. This pilot study found that HF patients who were trained with an avatar style Digital Coach showed improvements in QoL, self-care, and HF knowledge, suggesting that these enhancements could lead to better HF outcomes.[10]

The research nurse determined patient computer literacy via oral interview, introduced the app to each HF-app enrolled patient, and explained how to use and follow the HF-app prompts. A username and password that could be easily memorized by the patient were preferred (i.e. first name or a nickname). Patients who were unfamiliar with using such an app on a mobile device were given the option to be trained in its use by the study nurse. The study nurse spent adequate time with the patient and explained step-by-step how to log in to the app and how to follow the prompts. Common errors were explained to the patient and how to solve them (i.e. accidental log-out and how to log in again). The HF-app was a component of a multi-factorial intervention and was not mandatory for participation in the Risk-HF study, therefore patients who were not computer literate were still eligible to participate. In that situation, HF education was delivered via an oral interview over the phone, or face-to-face, and questionnaires were collected via an oral interview.

Data collection

At baseline, demographics, medical history, and treatment were obtained by oral interview and/or patient medical records. Demographics included: gender, age, country of birth, marital status, and years of education. Medical characteristics included: New York Heart Association Status (NYHA)[16,17] at admission and at discharge type of HF (HFrEF or HFpEF), HF cause (ischaemic or non-ischaemic), vital signs, and Charlson Comorbidity Index score.[18] Measures that were not captured automatically by the HF-app were collected via paper scale or direct entry into the REDCap database. Cognitive function was assessed with the Montreal Cognitive Assessment (MOCA),[19] depression was evaluated with the Patient Health Questionnaire (PHQ-9),[20] and anxiety was evaluated with the Generalised Anxiety Disorder (GAD-7)[21] tool.

Data analysis

In this report, we analysed high-risk patients who were randomized into the intervention arm only. These patients were divided into two groups: patients who used the HF-app and patients who did not use the HF-app. The group of those who used the app were sub-divided into those who were engaged or not engaged. Data were not available for one patient who used the app, therefore this patient was classified as not engaged. Continuous variables are presented as means and standard deviations (SD) or medians and interquartile range (IQR) and categorical variables as numbers (*n*) and proportions (%). Differences in continuous variables

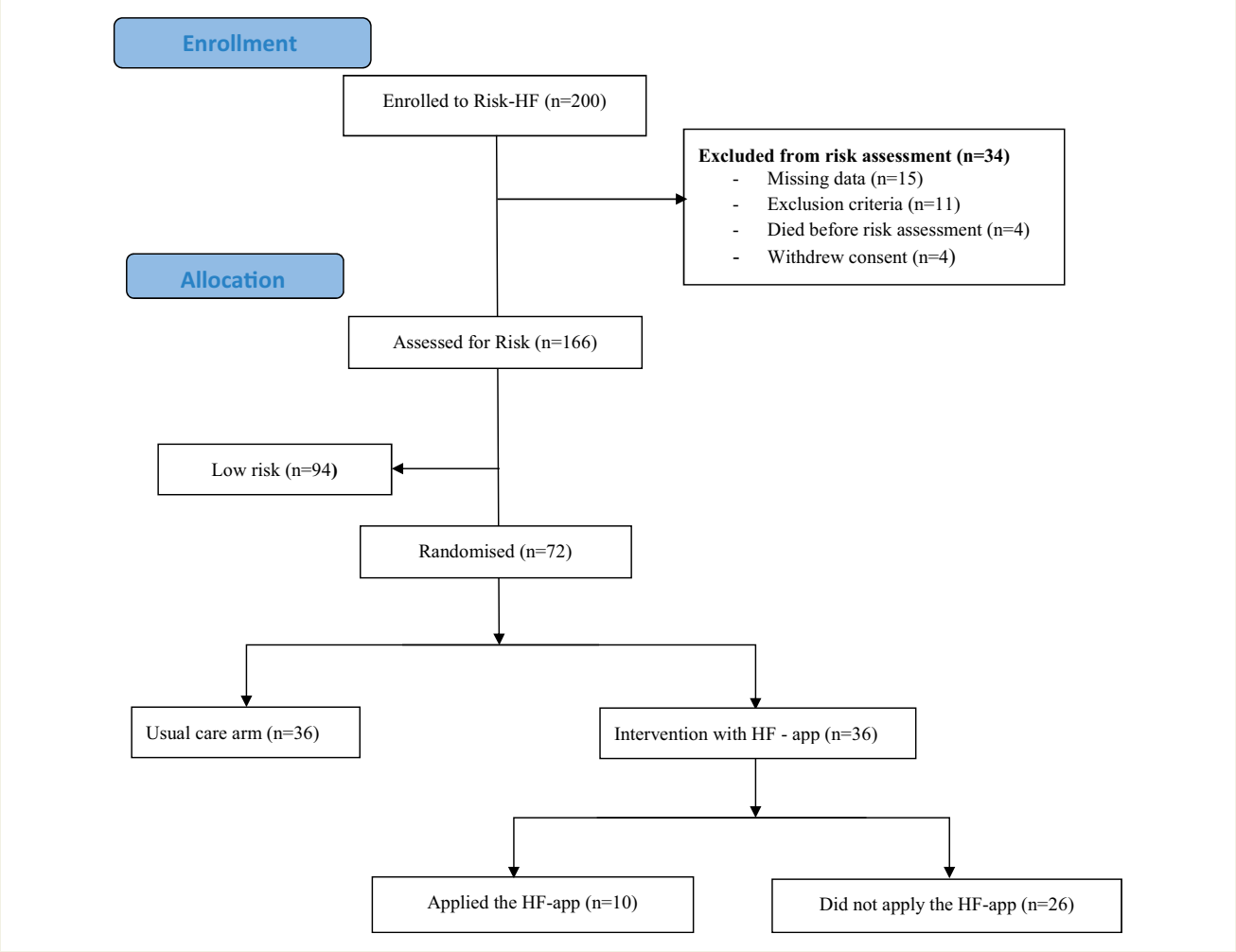

Figure 1 Patient allocation from study enrolment to randomization and allocation to HF-app.

Table 1 Sample baseline characteristics

Patient characteristics	All patients (36)	Enrolled (*n* = 10)	Not enrolled (*n* = 26)	*P*-value
Age in years, median [IQR]	81.5 [72.25–85.75]	71.5 [57.50–78.50]	82 [76.75–86.75]	<0.01*
Gender male	25 (70%)	7 (70%)	18 (69%)	0.96
Born in Australia	23 (64%)	6 (60%)	17 (65%)	0.76
Marital status				
Married	17 (47%)	6 (60%)	11 (42%)	0.40
Divorced	9 (25%)	2 (20%)	5 (19%)	
Single	5 (14%)	–	3 (12%)	
Widowed	5(14%)	2 (20%)	7(27%)	
Years of education (SD)	9.5 (3.1)	11.6 (2.5)	8.5 (3)	<0.01
Live alone	19 (53%)	3 (30%)	16 (62%)	0.09
Discharged at winter	9 (25%)	3 (30%)	6 (23%)	0.67
Work financial status				
Pensioner	32 (88%)	8 (80%)	24(92%)	0.58
Full time	2(6%)	1 (10%)	1 (4%)	
Unemployed	2 (6%)	1 (10%)	1 (4%)	

IQR, interquartile range; SD, standard deviation; *non-parametric test was done.

Table 2 Sample clinical characteristics

Medical history	All patients ($n = 36$)	Enrolled ($n = 10$)	Not enrolled ($n = 26$)	*P*-value
NYHA on admission				0.39
Class III	16 (44%)	3 (30%)	13 (50%)	
Class IV	19 (53%)	6 (60%)	13(50%)	
NYHA at discharge				0.46
Class II	19 (53%)	6 (60%)	12 (46%)	
Class III	15 (42%)	4 (40%)	14 (54%)	
Type of HF				0.58
HFrEF	20 (56%)	6 (60%)	14 (54%)	
HFpEF	14 (39%)	3 (30%)	11 (46%)	
HF cause				0.82
Ischaemic	13 (36%)	4 (40%)	9 (34%)	
Non-ischaemic	22 (61%)	6 (60%)	16 (62%)	
Years living with HF (SD)	3.5 (5.2)	3.6 (6.8)	3.20 (3.9)	0.88
Previous hospital admission	13 (36%)	2 (20)	11 (43)	0.21
SBP at consent	121 (19)	12 (22)	121 (18)	0.96
DBP at consent	73 (11)	74 (12)	73 (10)	0.72
Heart rate	81 (17)	85 (18)	79 (17)	0.40
Respiratory rate	18 (2)	18 (2)	19 (3)	0.49
LVEF	43 (12)	40 (16)	44 (10)	0.43
Mean risk score[a] (SD)	48 (12)	49 (17.5)	47 (9)	0.71
CCI median score, [IQR]	6 [5–8]	5.5 [4.5–6.50]	7 [5–8]	0.15
CCI over median	16 (44%)	2 (12%)	14 (88%)	0.46

CCI, Charlson Comorbidity Index; HF, heart failure; HFpEF, heart failure with preserved ejection fraction; HFrEF, heart failure with reduced ejection fraction; IQR, interquartile range; LVEF, left ventricular ejection fraction; NYHA, New York Heart Association; SBP, systolic blood pressure; DBP, diastolic blood pressure; SD, standard deviation.
[a]Readmission and/or mortality.

Table 3 HF-App enrolment and engagement stats

HF-app enrolment status ($n = 36$)	Patients
Enrolled	10
Engaged	2
Not engaged ($n = 8$) and reasons	
Loss of interest	3
Not 'tech-savvy' and/or NESB	3
App questions caused anxiety. Preferred to quit	1
Data not retrieved by the server	1
Reasons not enrolled ($n = 26$)	
Unable to use a device and/or not interested to be taught	20
No internet access or no device	4
Died before discussions about the HF-app	2

NESB, Non-English speaking background.

among groups were compared with independent *t*-test and dichotomous (categorical) variables were compared with the χ^2 test; Mann–Whitney and Wilcoxon rank-sum test were done to compare medians. Univariate logistic regression analysis was used to observe associations between app enrolment and demographic and clinical variables. Analyses were done using IBM SPSS statistics version 26 and Stata SE V16. A two-sided *P*-value of <0.05 was considered statistically significant.

Results

Baseline characteristics

As shown in *Figure 1*, from August 2019 to December 2020, we enrolled 200 patients admitted for ADHF. Of these, 36 of 72 at high risk for hospital readmission and/or mortality were randomly allocated to our intervention arm. The remaining 164 patients were part of the usual care arm, were low risk for hospital re-admission (<33%), or withdrew consent/excluded. *Tables 1* and *2* summarize the baseline demographic and clinical characteristics, and Supplementary material online, *Table S1* describes the medical treatments of the 36 high-risk patients who were randomly allocated to the intervention arm. Recruitment occurred at the Cardiology and/or General Medicine wards of Footscray and Sunshine Hospitals (Melbourne, Victoria $n = 17$) and Royal Hobart Hospital (Hobart, Tasmania $n = 19$). The median age was 81.5 years (IQR: 72.25–85.75); 25 (70%) were male and the mean years of education were 9.5 ± 3.1. The main cause of HF was non-ischaemic (22 patients, 61%) and the HF type in 20 (56%) patients was HFrEF. Patients who were enrolled in the HF-app group were not different from patients that were not enrolled, in terms of demographic and medical characteristics. However, enrolled patients were significantly younger ($P < 0.01$) and more educated ($P < 0.01$) than patients not enrolled. In addition, this group was more likely to be treated with digoxin ($P < 0.01$).

Table 4 Baseline measures mean scores

	All patients ($n = 36$)	Enrolled ($n = 10$)	Not enrolled ($n = 26$)	95% CI	*P*-value
MOCA	17.3 (5.5)	18.6 (4.8)	16.8 (5.8)	-6 to 2.4	0.4
PHQ-9	10.3 (5.5)	10.2 (6.5)	10.4 (5.2)	-4 to 4.4	0.9
GAD-7	4 (4)	5.9 (5.9)	3.3 (2.7)	-5.7 to 0.4	0.8
HF knowledge	10.2 (2.6)	10.2 (2.7)	10.2 (2.7)	-2.2 to 2.1	1
KCCQ-QOL	42 (24)	34.1 (24)	45.4 (23.8)	-7.3 to 30	0.2
EHFSCBs	77.3 (22.3)	90.5 (9.6)	71.4 (24)	-36 to -2	0.03

EHFSCBs, European Heart Failure Self-care Behaviours Scale; GAD-7, General Anxiety Disorder-7; HF Knowledge, Dutch Heart Failure Knowledge Scale; KCCQ, Kansas City Cardiomyopathy Questionnaire; MOCA, Montreal Cognitive Assessment; PHQ-9, Patient Health Questionnaire-9; QoL, quality of life.

Table 5 Predictors to enrolment to the HF-app

Predictors to HF-app enrolment	OR	95% CI	*P*-value
Age, years	0.89	0.82–0.97	<0.01
Years of education	1.58	1.09–2.28	0.03
CCI score	0.72	0.49–1.07	0.10
Self-care behaviours	1.34	0.80–2.24	0.26
Previous hospital admission for HF	0.34	0.58–1.98	0.23
Risk score[a]	1.01	0.95–1.07	0.68

CI, confidence interval; CCI, Charlson comorbidity index; HF, heart failure; OR, odds ratio.
[a]Readmission and/or mortality.

Uptake of the heart failure app

Whilst education with the HF-app was offered in all 36 patients, 26 (72%) did not utilize the HF-app. Of these, 20 (56%) were unable to use the tablet device and were unwilling to be taught how to use it, 4 (11%) did not have access to the internet, and 2 (5%) died in hospital before they were provided with more details about the HF-app (*Table 3*).

The baseline scores are summarized and compared in *Table 4*. There were no significant differences between the groups in mood (GAD and PHQ-9), cognition (MOCA), HF knowledge (DHFKS), or health-related quality of life (QoL) as defined by the QoL component of the KCCQ. However, enrolled patients had better self-care behaviour ($P = 0.03$). Younger patients were more eager to enrol and engage with the app [odds ratio (OR) 0.89, 95% confidence interval (CI) 0.82–0.97; $P < 0.01$], as were those who were more educated (OR 1.58, 95% CI 1.09–2.28; $P = 0.03$) (*Table 5*). In contrast, those who were not technologically experienced and older did not engage with the app and dropped out after the first session. They found it difficult to follow the app prompts and that the app questions may have caused them anxiety.

The reasons that 8 of 10 patients who were enrolled in the HF-app group did not engage are summarized in *Table 3*. Of the HF-app enrolled patients, only 2 of 10 engaged and completed ≥70% of the full program. There were no significant differences in demographics and baseline measures between patients who engaged with the app and those who dropped out (Supplementary material online, *Table S2*). Neither of the patients who completed at least 70% of the program had adverse events (*Table 6*), but six of eight of those who did not engage were readmitted and two of these individuals died.

Discussion

This is the first RCT to evaluate the feasibility of engagement with a program integrating m-Health, delivered via an HF-app, in patients admitted for ADHF and at high risk for hospital readmission and/or death. In this small group of patients who were enrolled in an HF-app as part of a multi-intervention RCT, our data showed significant challenges.

m-Health apps and patient engagement

Patient engagement is fundamental for improving HF outcomes.[16,22] Novel patient approaches that are delivered through mobile devices are promising, but difficult to roll out in an elderly and technologically challenged population with an unstable chronic disease such as HF. Unstable HF and/or frequent or recent admissions may be accompanied by cognitive impairment,[23] which makes device training challenging. Indeed, a large proportion of our HF patients have impaired cognitive function, consistent with the observations of previous studies,[24] and those with better cognitive scores may be more likely to complete the program. Mood may also be impaired in HF patients,[25,26] as well as their QoL.[27]

We observed that younger individuals were more likely to enrol and engage with an HF-app. None of those who engaged were readmitted to the hospital, suggesting that they may have had some benefits from interaction with the HF-app. However, research is required to demonstrate whether targeting a younger group of high-risk ADHF patients into an HF-app could improve short-term outcomes. We also showed that enrolment to an HF-app is determined not only by age but also by self-care, suggesting that patients who are confident about their self-care are open to enrol in novel approaches to enhance their knowledge and self-management. On the other hand, people with limited digital literacy may be less likely to accept a technology-enabled intervention and they will require more support before being able to use such technology. Patients with limited English knowledge and/or basic computer knowledge were willing to undertake training on how to use a mobile device and be educated by the HF-app. However, most of them still required additional support to use the intervention effectively and in due course, they either discontinued the program or they missed critical components of the

Table 6 Readmission for adverse events or mortality

	Enrolled ($n = 10$)	Not enrolled ($n = 26$)	*P*-value	Engaged ($n = 2$)	Not engaged ($n = 8$)	*P*-value
Readmission 0–30 days	1 (10%)	7 (27%)	0.42	0	1 (12%)	0.60
Readmission 0–90 days	6 (60%)	7 (27%)	0.20	0	6 (75%)	0.53
Mortality	2(20%)	4 (15%)	0.74	0	2 (25%)	0.43

intervention with the HF-app. Communication with patients with a non-English speaking background (NESB) is an ongoing challenge in everyday clinical practice and new HF-digital coaches need to incorporate alternative languages to support patients living in a multicultural environment. Although many patients speak basic English, they often need an interpreter for their consultation with the treating physicians during their hospital admission. This group of patients were unable to engage with an app that is solely in English and broad language availability may support patient engagement and maintain motivations.

In addition, perhaps digital coaches should have a simplified version in addition to the standard version, in order to be more easily understood by older patients who may have never used a mobile device before. Simplified versions could then focus on delivering only the most critical parts of the full program, allowing people to log in more easily and without the need to set complicated passwords. Such programs should also be available to use offline, as connecting the device to the internet is another barrier for technologically disadvantaged people.

m-Health in stable and unstable heart failure

Patients with a mean age >71 years, with stable HF are eager to undertake education and self-management delivered via a mobile-app if it is easy to use and modifiable to their needs.[28,29] A previous RCT[30] delivered education with a similar digital coach, but in stable HF patients (age <70 years), recruited from outpatient HF clinics and who were cognitively normal. These patients showed improvements and enjoyed using the HF-app.[30] These results suggest that cognitively normal, stable HF patients, below the usual age of HF patients,[16] could derive benefit from education with an HF-app. Foster M. designed a HF-app[31,32] to support self-care and symptom awareness in HF patients (mean age 65 years) recruited from a cardiac rehabilitation program. Results from the feasibility study demonstrated that the use of the app to enhance self-care and increase symptom awareness is acceptable to middle- to older-aged HF patients.[32] Similar results were demonstrated in our pilot study of stable HF patients,[10] which enrolled chronic HF patients [median age 84 years, IQR (77.5–86.5 years)], fluent in the use of a mobile and/or tablet device, who attended an HF clinic appointment. The primary objective of the pilot study was to optimize our Digital HF-coach through a patient–avatar interaction method and determine whether our HF-app would establish patient rapport. Indeed, 21 patients completed the program and the vast majority showed improvements in QoL, HF knowledge, and self-care behaviours, suggesting that 'tech-savvy' chronic HF patients may benefit from such an approach.

The sample we describe here, differs in age, acuity, digital device fluency, disease severity, and social determinants. These older patients were largely from a socially disadvantaged region, were studied in the acute phase after a crisis event (decompensation of HF; NYHA Class III or IV at admission), were cognitively impaired and they had multi-comorbidities. They were more difficult to engage; most of them were unfamiliar with the use of technology for this purpose and they were challenged by the intervention. In this first experience with ADHF patients, even though our expectations about enrolment to an m-Health app were high, the HF-Digital coach was optimally used only by younger patients, with higher education level and motivated self-care behaviours. In support of our statement about younger age and education, Gong et al. used a similar digital coach in an RCT that was designed by the same company (Clevertar, Adelaide, South Australia), in patients with type 2 diabetes.[8] The mean age of participants in the intervention arm was significantly lower than our cohort (55 years) and the majority had at least 15 years of education (bachelor degree or higher). Similarly, patients who were excluded from the digital diabetes coach study, had lower education levels and were less likely to be a smartphone users.[8] In contrast, enrolment to the diabetes digital coach was high and enrolment expectations met, the cohort was otherwise stable and enrolled from the community rather than the post-acute phase, and use of the app was well adopted by the patients. Participants in the intervention arm appeared to benefit from the use of the app; however, long-term engagement dropped from 81% in the first month to 15% after 12 months.[8] The notable differences between these two conditions and the sociodemographic characteristics of the two populations may impact on patient enrolment and engagement. The chronicity and severity of the disease may be key contributors to patient engagement, whilst younger age may contribute to disengagement as most people at this age group are likely to be full-time employed, hence will likely have limited time.[8]

Although we showed that enrolment to the HF-app was not affected by previous hospital admission or years living with HF, the app may be more beneficial for *de novo* HF, in part because of the younger profile of *de novo* HF patients.

Barriers to enrolment and engagement to a m-Health coach

Socioeconomic factors impact on the access to an app like that used in this trial because many of the patients lacked an appropriate device and did not have an internet connection. As sending data live to the app server is critical for maintaining and ensuring the safety of the data, this adds another barrier to patient engagement. Therefore, digital coaches should have the option to operate off-line, gather and

store data on the device and be uploaded automatically, when the device is connected to the internet.

Complicated usernames and passwords add to the complexity of a technologically disadvantaged person. A simple unique ID number should be preferred in the first instance, without the need to re-enter it again, in order to facilitate device and app use.

In ADHF patients, cognitive impairment (an independent predictor of adverse outcomes in HF patients[16,33]), older age, NESB, level of education, and advanced or end-stage HF accompanied by multi-comorbidities, may impact enrolment in an m-Health program, engagement or both. These observations in HF align with an integrative review of telehealth in older adults with chronic illness in identifying a number of barriers (including the computer skills of the patient, hearing problems, impaired vision, and cognitive impairment) that may influence patient engagement and adoption of telehealth.[34] Poor selections of colour and font size, multi-tasking apps that deliver too much information, and the need to press too many buttons to complete a task are all avoidable causes of frustration. These barriers should be taken into consideration by health care professionals and telehealth developers.

As enrolment to m-Health in an older population may be challenging, once achieved it is important to maintain and facilitate it by patient motivational aspects, in order to keep the patient engaged and minimize barriers to engagement. In patients who decide to discontinue from the app, a survey to collect data about reasons for disengagement and patient views and perceptions should be gathered. Data from such surveys may suggest improvements for future app updates and may help to minimize or eliminate common disengagement reasons.

Limitations

The authors acknowledge the small enrolment numbers and low patient engagement. There were high drop-outs from the HF-app use. Our findings are based on our experiences from a single trial; however, we believe that the participants are representative of the population with ADHF.

Conclusions

The use of m-Health-based education and monitoring delivered via an HF-app is promising but challenging. Our study sample provides a note of caution in using such an approach in older patients with recent HF instability. A broad availability of languages should also be available in a very multicultural environment. Patient views and perceptions should be taken into consideration when designing a new digital coach app or when updating an existing app. Subsequent research should focus on exploring the benefits, enrolment, and engagement in an HF-app in patients who are admitted for *de novo* HF.

Supplementary material

Supplementary material is available at *European Heart Journal – Digital Health*.

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Conflict of interest: M.J.C. and J.B. received funding from Clevertar Pty Ltd to develop the Digital Coach for Heart Failure Program and to evaluate pre- and post-participant data collected from patients using the Program. Others declare no conflict of interests.

Data availability

Requests to share data should be directed to the corresponding author.

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