Increased motivation for and use of digital services in heart failure patients participating in a telerehabilitation program

a randomized controlled trial

Spindler, Helle; Dyrvig, Anne-Kirstine; Schacksen, Cathrine Skov; Anthonimuthu, Danny; Frost, Lars; Gade, Josefine Dam; Kronborg, Sissel Højsted; Mahboubi, Kiomars; Refsgaard, Jens; Dinesen, Birthe; Hollingdal, Malene; Kayser, Lars

Published in:
mHealth

DOI (link to publication from Publisher):
10.21037/mhealth-21-56

Publication date:
2022

Document Version
Publisher's PDF, also known as Version of record

Original Article

Increased motivation for and use of digital services in heart failure patients participating in a telerehabilitation program: a randomized controlled trial

Helle Spindler[1], Anne-Kirstine Dyrvig[2], Cathrine Skov Schacksen[3], Danny Anthonimuthu[3], Lars Frost[4,5], Josefine Dam Gade[3], Sissel Højsted Kronborg[3], Kiomars Mahboubi[6], Jens Refsgaard[7], Birthe Dinesen[3], Malene Hollingdal[7], Lars Kayser[8]

[1]Department of Psychology and Behavioral Sciences, Aarhus University, Aarhus, Denmark; [2]The Danish Clinical Quality Program – National Clinical Registries (RKKP), Odense University Hospital, Odense, Denmark; [3]Laboratory for Welfare Technologies – Digital Health & Rehabilitation, Department of Health Science and Technology, Aalborg University, Aalborg, Denmark; [4]Cardiology Ward, Regional Hospital in Silkeborg, Silkeborg, Denmark; [5]Department of Clinical Medicine, Aarhus University, Aarhus, Denmark; [6]Cardiology Ward, Regional Hospital in Randers, Randers, Denmark; [7]Cardiology Ward, Regional Hospital in Viborg, Viborg, Denmark; [8]Department of Public Health, University of Copenhagen, Copenhagen, Denmark

Contributions: (I) Conception and design: B Dinesen, J Refsgaard, M Hollingdal; (II) Administrative support: CS Schacksen, D Anthonimuthu, SH Kronborg, JD Gade; (III) Provision of study materials or patients: L Frost, K Mahboubi, J Refsgaard, M Hollingdal; (IV) Collection and assembly of data: CS Schacksen, D Anthonimuthu, SH Kronborg, JD Gade, B Dinesen; (V) Data analysis and interpretation: H Spindler, AK Dyrvig, CS Schacksen, D Anthonimuthu, L Frost, JD Gade, SH Kronborg, B Dinesen, L Kayser; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Helle Spindler. Department of Psychology and Behavioral Sciences, School of Business and Social Sciences Aarhus University, Bartholins Allé 11, Building 1350, Room 324, 8000 Aarhus C, Denmark. Email: hellesp@psy.au.dk.

Background: eHealth literacy (eHL) may be an important factor in the adoption of telerehabilitation. However, little is known about how telerehabilitation affects patients' eHL. The current study evaluated changes over time in eHL for heart failure (HF) patients in a telerehabilitation program (the Future Patient Program) compared to a traditional rehabilitation program.

Methods: As part of a randomized controlled trial comparing telerehabilitation with traditional rehabilitation, 137 HF patients completed the eHealth Literacy Questionnaire (eHLQ) at 6 and 12 months of their respective rehabilitation programs.

Results: At 6 months, the telerehabilitation group indicated higher levels of 'using technology to process health information' and 'motivated to engage with digital services'. This difference was consistent over time, and we found no other differences between groups or over time with regard to eHL.

Conclusions: Providing a digital toolbox for processing health information to HF patients may aid in increasing their eHL, motivation, and ability to engage with digital services in HF patients. Especially, if the technology is designed to support patient needs in terms of the educational content of the program. Preferably technology should be provided early on in the rehabilitation process to ensure optimal outcome.

Trial Registration: The study was registered in ClinicalTrials.gov (NCT03388918).

Keywords: Heart failure (HF); telerehabilitation; patient education; e-health literacy

Received: 21 December 2021; Accepted: 20 June 2022; Published: 20 July 2022.

doi: 10.21037/mhealth-21-56

View this article at: https://dx.doi.org/10.21037/mhealth-21-56

Introduction

Heart failure (HF) is a chronic heart condition diagnosed in more than 37 million people worldwide (1). HF is the cause of a substantial proportion of the 31% of all fatalities worldwide (corresponding to 17.9 million people in 2016) ascribed to cardiovascular disease (2). Overall, the prevalence of HF is rising, in part through increasingly unhealthy lifestyles among the elderly. The rising prevalence of HF has led to a corresponding increase in the burden on healthcare systems (3).

To facilitate the rehabilitation of people with HF, the European Society of Cardiology recommends provision of education and support in self-care skills in order to impede or prevent a worsening of their condition, e.g., more exercise, improving diet, taking prescribed medicine, weighing themselves daily, and knowing when to contact their healthcare provider. Inclusion of these recommendations in rehabilitation programs, both at healthcare centers and at home, has been shown to reduce readmission rates (4). Despite the clear-cut advantage of rehabilitation, one study (5) found a 56% drop-out rate during exercised-based rehabilitation programs, even with a supportive environment that included multiple contacts and educational methods suggesting that non-adherence is the main challenge to the rehabilitation programs. A systematic review found that comorbidities, advanced age, and accessibility were the main factors resulting in low participation in and adherence to cardiac rehabilitation programs (6). This suggests that diverse groups of people initially engaging in rehabilitation need alternative support and pathways, especially when attendance at the healthcare centres is not an option or not perceived as a necessity for them. A possible solution to the non-adherence problem is telerehabilitation, defined as the provision of rehabilitation via information and communication technologies over distance (7).

To advance the telerehabilitation field, we developed a cardiac rehabilitation web portal, called the 'HeartPortal', which aims to increase the quality of life of people with HF and to provide education on self-monitoring so that patients can detect worsening of their symptoms, react by contacting healthcare professionals, and thereby avoid rehospitalization (8). With telerehabilitation technologies, the rehabilitation activities may be targeted to the patient's lifestyle and self-management needs using digital channels (9). Moreover, providing patients with telerehabilitation technologies aligns well with the general development of digitalized public service provision, which is the case in Denmark (10). In Denmark, 88% of citizens have searched for information, downloaded forms or submitted information to public authorities via online portals (11). In addition, 82% of Danes consider the use of welfare technology a "good" option in future. This suggests that in addition to encouraging patients to become more health literate (i.e., be motivated and able to gain access to, understand, and use health information to promote and maintain good health) (12,13), it is also necessary that they acquire electronic health literacy, also known as eHealth literacy (eHL) or digital health literacy, in order to access public digital health services.

The literature on eHL employs several definitions emphasizing different frameworks and scales associated with each conceptualisation of eHL. The eHealth Literacy Scale (eHEALS) is a measure of the users' competence to engage with digital health services (14). Although this scale evaluates information-seeking behaviour on the internet in relation to health, it falls short as an evaluation tool for assessing the suitability of a given design solution to the specific user's needs and capabilities. To address this issue, Kayser *et al.* developed the eHealth Literacy Questionnaire (eHLQ) based on the eHL framework (eHLF) (15), in order to measure users' knowledge, skills, perception, and experiences in relation to digital health services and health technologies in a singular measure (15). The resulting eHLQ is a multidimensional measure of the dimensions in the eHL framework, which may be of relevance for evaluating innovative telerehabilitation technologies (15).

The HeartPortal was designed through a participatory design process, involving HF patients, their relatives, healthcare professionals, and researchers as an interactive portal that included communication of information in the form of text, video, and sound in order to match patients' preferences (8). As such, the HeartPortal was in part designed to support and develop patient's eHL, by providing relevant information in a digital format that matched the desires and abilities of the users. The design and usability of the HeartPortal was evaluated by Joensson *et al.* (16), who found that the HeartPortal was easy to navigate and understand. Furthermore, the study indicated that the usability of the HeartPortal motivated users to adhere to the rehabilitation program and to learn more about their own disease using eHL (16). To our knowledge, few studies have investigated eHL within the framework of a telerehabilitation program for patients with ischemic heart

disease or HF (17-19). In the Teledialogue study by Melholt *et al.* (19), a significant change over time in self-reported eHL was found when testing a web cardiac portal over three months.

The aim of the current study was to explore changes in eHL from 6 to 12 months, comparing a telerehabilitation group (TR) and a control group (CT) as part of the Future Patient Telerehabilitation (FPT) Program for people with heart failure. We present the following article in accordance with the CONSORT reporting checklist (available at https://mhealth.amegroups.com/article/view/10.21037/mhealth-21-56/rc).

Methods

Study design and data collection

This study is a sub-study of the FPT Program which was designed as a randomized controlled trial using 1:1 allocation of participants (8). The sample size for this sub-study was contingent upon the main study outcomes (15). All participants completed the eHLQ after 6 and 12 months of participation. Each patient received at least two reminders to complete and return the questionnaire. The reminders were messaged via the HeartPortal, e-mail, phone, voicemail, or text. All data from the questionnaires were entered into and stored in REDCap (20).

Participants and inclusion criteria

Participants in the study were people diagnosed with HF according to the New York Heart Association (NYHA) class I–IV (21). The recruitment of participants was performed by a project nurse, who contacted patients at four cardiology wards at public hospitals in Randers, Silkeborg, Skive, and Viborg, all located in the central region of Jutland, Denmark.

Inclusion criteria were 18 years of age or above, heart-failure-related hospitalization within the previous two weeks, knowledge of basic Danish language, and access to a stable internet connection at home. No more than 20% of the total sample could be categorized as NYHA class I, and patients with a pacemaker were also eligible.

Exclusion criteria were not being able to understand Danish, an active psychiatric condition other than depression or anxiety related to cardiac or other chronic illness, and coronary revascularization and/or open-heart surgery within the previous three months. Also excluded were patients whose medical records indicated previous neurological, musculoskeletal or cognitive disabilities. In addition, four participants with more than 50% missing values on a specific subscale of the eHLQ were excluded from analysis.

After inclusion, all patients were randomly allocated to either the TR or the CT group. This process is illustrated in the CONSORT diagram below (*Figure 1*), including reasons for dropouts at each step.

Intervention

The FPT Program follows three phases over a 12-month period (see *Figure 2*). The phases are: (I) HF education and titration of medicine; (II) telerehabilitation in a healthcare center; and (III) everyday life with telerehabilitation. The TR group of patients with HF were provided with self-tracking devices and an iPad to be used to access the HeartPortal, which acted as a digital toolbox for this group. The digital toolbox was used (I) to obtain educational material on life with HF; (II) to contact health professionals in hospitals digitally; (III) to monitor their personal data, such as blood pressure, heart rate, weight, step, respiration, and sleep; (IV) to create a rehabilitation plan and set personal goals; and (V) to monitor Patient Reported Outcomes. As such, the HeartPortal provided information and opportunities for patients to develop and strengthen their eHL. This was in line with our use of the self-determination theory (STD) (22) to inform our design process in order to optimize patient motivation (8,16). The SDT states that in order to obtain motivation three basic needs must be supported: (I) autonomy (acting in accordance with one's internal values); (II) competency (having the necessary skills and knowledge to carry out desired behaviour); and (III) relatedness (feeling supported by a social network). Hence improving skills relevant to eHL is also important for patient motivation.

Outcomes

The eHLQ (15) was used to evaluate eHL. The eHLQ is a 35-item questionnaire consisting of seven scales (see *Table 1*). Each item is scored using a four-point Likert scale response format of strongly disagree [1] to strongly agree [4], and item content is based on the eHL framework (15). The seven scales can be combined into three dimensions (see *Table 1*); users' knowledge and skills, elements comprising

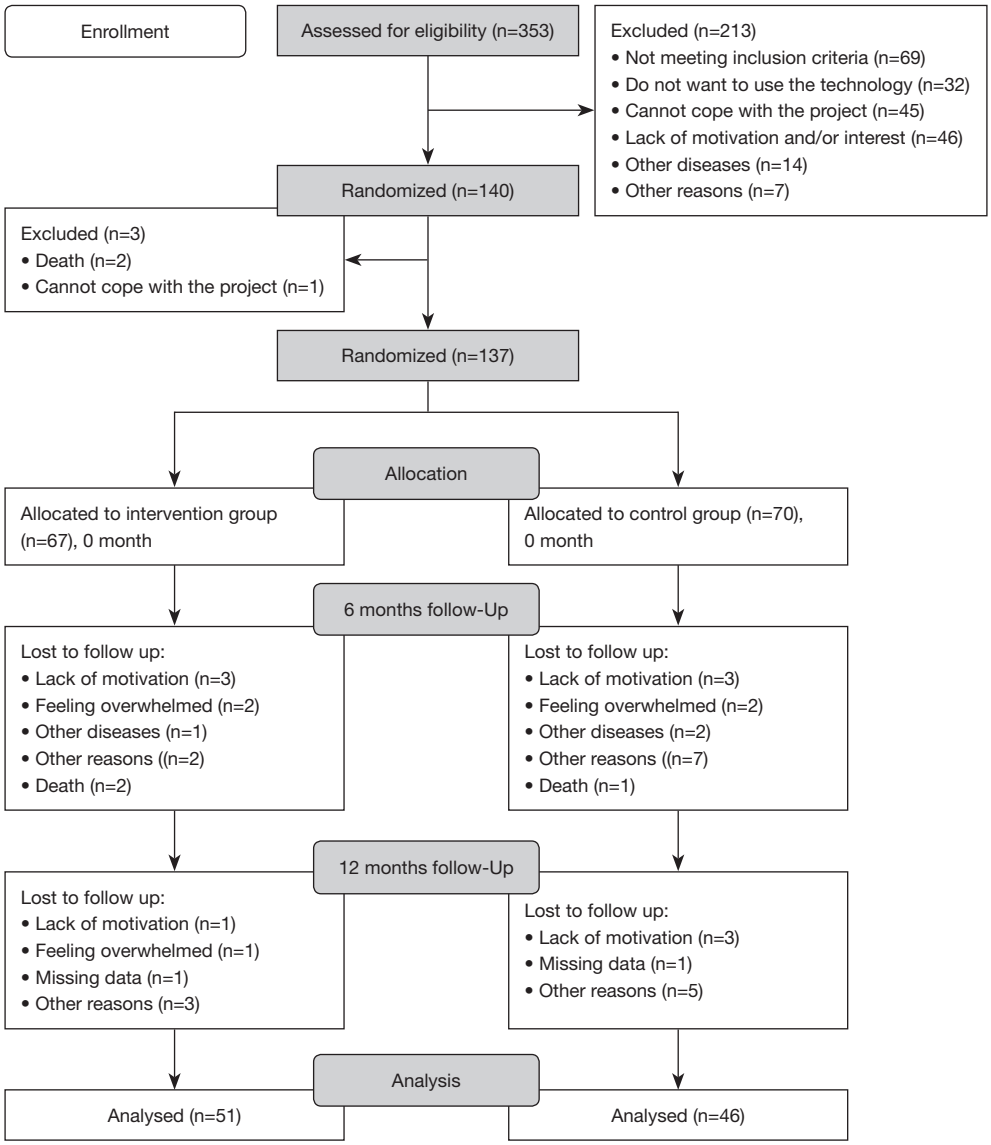

Figure 1 CONSORT diagram for the eHealth literacy sub-study in the Future Patient Telerehabilitation Program.

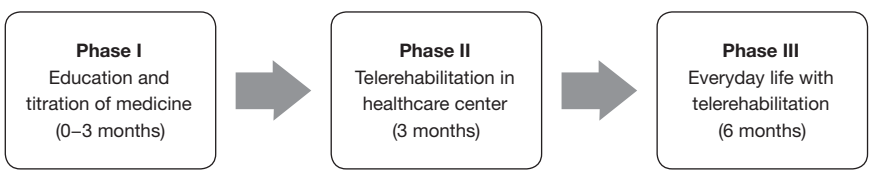

Figure 2 Phases in the Future Patient Telerehabilitation Program. The figure was Originally published in (8) JMIR Research Protocols (http://www.researchprotocols.org), 19.09.2019 ©Birthe Dinesen, Lars Dittmann, Josefine Dam Gade, Cecilia Klitgaard Jørgensen, Malene Hollingdal, Soeren Leth, Camilla Melholt, Helle Spindler, Jens Refsgaard.

Table 1 Overview of eHLQ scales and dimensions

eHLQ scale	No of items	Dimensions
1. Using technology to process health information	5	The user's individual competence or eHealth literacy
2. Understanding of health concepts and language	5	
3. Ability to actively engage with digital services	5	The interaction between the user and the digital services
4. Feeling safe and in control	5	
5. Motivated to engage with digital services	5	
6. Access to digital services that work	6	The user's experience with digital systems or services
7. Digital services that suit individual needs	4	

eHLQ, eHealth Literacy Questionnaire.

eHL (scales 1–3), trust and motivation (scales 4–5) and experience (scales 6–7). The eHLQ is considered user-friendly and suitable for use in both non-clinical and clinical populations, as well as for people with low literacy. As described previously, this questionnaire was chosen because it is multidimensional and assesses key user characteristics (e.g., the interaction between digital services and user, as well as the user experience). Moreover, the eHLQ has shown good psychometric properties in a Danish context (15). In the current project, we planned to include the eHLQ at 0, 6, and 12 months, however, due to an unfortunate error, the eHLQ was not included at 0 month, but only distributed to all participants via e-mail at 6 and 12 months. Consequently, we have no data for eHLQ at 0 month.

Ethics

The FPT Project was approved by the Regional Ethics Committee for North Denmark (N-20160055) and by the Danish Data Protection Agency. The study was registered in ClinicalTrials.gov (NCT03388918). The study was carried out in accordance with the Helsinki Declaration (as revised in 2013), and all participants signed an informed consent form prior to enrolment in the study.

Statistical analysis

Mean substitution was used when at least 50% of data was available on a specific measure for a participant (23). Data was examined for issues of non-normality using the Shapiro-Wilk test and by inspection of normality plots. As this process revealed potential problems with normality, we chose to accommodate for issues of non-normality by using a robust analysis in all subsequent analyses, i.e., a bootstrapping procedure using 1,000 samples. This procedure was chosen over non-parametric tests because it would enhance clinical interpretation of results.

Baseline characteristics were compared using χ^2, *t*-test or Fisher's exact test as appropriate. Since the eHLQ was not used at baseline, we had data only for 6 and 12 months. As a consequence, we treated our 6-months data as a baseline proxy. Due to the use of robust analysis to accommodate for non-normality, we did not use analysis of variance (ANOVA), but conducted analyses in three steps. Initially, we compared our two groups on 6 months scores on the eHLQ using a robust two-tailed independent *t*-test with a bootstrapping procedure of 1,000 samples accompanied by estimates of effect sizes (ES) including a 95% CI. We then evaluated changes over time in each group by conducting a robust two-tailed paired samples *t*-test for each of the 7 scales on the eHLQ, again using a bootstrapping procedure with 1,000 samples. Based on these analyses, we also calculated ES with a 95% CI in order to aid clinical interpretation of our results. Finally, to compare eHLQ changes in groups over time, we first transformed our 6- and 12-month data sets into change scores for each scale, and then conducted a robust two-tailed independent *t*-test for each scale. ES with a 95% CI were also calculated based on these analyses. Although we conducted several sets of analyses, we opted for reporting all analyses rather than conducting a Bonferroni correction, significance level of 0.05 was chosen for all analyses, and all analyses were carried out using SPSS version 26 (24).

Results

Of 353 patients assessed for eligibility, 140 were enrolled in

the FPT Project, of which 137 were included in this sub-study. Excluded participants tended to be <50 years of age, male, and more likely to have an educational status as skilled worker (see *Table 2*).

Analyses of baseline characteristics (χ^2, *t*-test or Fisher's exact test) showed no significant differences between our TR and our CT groups on any of our baseline sociodemographic and clinical variables (see *Table 2*). As our sample is relatively small, we therefore chose not to adjust for any of our baseline characteristics in the subsequent analyses.

At 6 months, robust independent *t*-test indicated significant differences between our TR and our CT group with regards to subscale 1, 'Using technology to process health information' in the skills and knowledge or e-health literacy dimension, as our TR group scored significantly higher than our CT group with an estimated ES based on our bootstrap procedure of 0.42; indicating a difference of a small to medium ES between the two groups. A similar result emerged for subscale 5, 'Motivation to engage with digital services' in the trust and motivation dimension, with an ES of 0.59, i.e., a medium ES between groups, with our TR group scoring higher than our CT group. As we have no true baseline measure from eHLQ, it is uncertain whether these differences emerged from 0 to 6 months, or whether they were present already at baseline.

In the next step, we examined changes on the eHLQ subscales from 6–12 months within each group. The robust paired samples *t*-tests indicated that neither group experienced significant changes from 6 to 12 months on any of the eHLQ subscales. These results were supported by the fact that ES for changes over time failed to reach the threshold for a small effect (see *Table 3*).

In a final set of analyses, we evaluated differences in patterns of change across our two groups by calculating changes in the scores for each group based on the measures for 6 and 12 months, respectively (see *Table 3*). Based on these change scores on each of the 7 scales of the eHLQ, we conducted robust independent *t*-tests and found no differences in changes over time across our two groups, suggesting that any small variations in eHLQ scores over time were comparable across our two groups. Taken together, our analyses indicate that eHLQ changed very little from 6 to 12 months of the FPT program, and that the variations over time within each group were comparable.

Discussion

The current study examined changes in eHL as measured by the EHLQ from 6 months to 12 months, comparing a TR group and a CT group in the FPT program. Our results indicate that our groups differed on the eHLQ scales 'Using technology to process health information' (on the dimension knowledge and skills, which incorporate eHL) and 'Motivated to engage with digital services' (on the trust and motivation dimension) 6 months into our program. Unfortunately, due to an error, we have no baseline measures from the EHLQ that could help determine whether these differences emerged from 0 to 6 months, or were already present at baseline. Despite the lack of baseline measures, it is likely that the TR group indicated more use of digital technology to process health information as well as higher motivation to engage with digital services at 6 months, as they had been engaged in telerehabilitation since baseline and were therefore more familiar with digital health services. Further analyses indicate that from 6 to 12 months, no significant changes in any eHL measure were found in either group, a pattern that was consistent across groups. These results were supported by bootstrapped estimates of ES, which showed that none of the comparisons crossed the threshold for a small ES, except for the 6 months' differences between groups on the two scales mentioned above. Taken together, these findings suggest that the differences between groups identified at 6 months were consistent over time.

The fact that our TR group felt more motivated to use digital services indicate that the FPT program may have successfully motivated patients to use the digital telerehabilitation platform, as they engaged in using relevant digital health services. As such, these findings supports the notion that when designing telerehabilitation programs, it is important to create digital health services that motivate and match the needs of the users in order to give them a positive user experience (25). Simply digitalizing existing services is not sufficient for successful engagement in telerehabilitation, motivation is essential for digital practices becoming a routine part of the patients' everyday lives, in turn improving disease management and self-care. The current results from the FPT program align with the findings in a review by Oudkerk Pool *et al.*, who concluded that digital cardiac patient education increases patient knowledge, improves their quality of life, and increases cardiac patients' level of satisfaction with digital platforms (26).

Table 2 Baseline clinical and demographic characteristics of the telerehabilitation and control groups

	Telerehabilitation group (N=67)	Control group (N=70)	P
Clinical parameters			
Weight (kg), mean (SD)	85.3 (20.4)	90.03 (20.9)	0.19
Systolic blood pressure (mmHg), mean (SD)	124.4 (17.7)	129.2 (18.6)	0.10
Diastolic blood pressure (mmHg), mean (SD)	78.9 (10.9)	81.9 (12.2)	0.13
Heart rate(beats/minute), mean (SD)	78.7 (17.8)	75.1 (16.0)	0.22
Ejection fraction (%), mean (SD)	31.8 (8.5)	32.1 (9.4)	0.83
NYHA class, n [%]			0.37
I	10 [15]	15 [21]	
II	42 [63]	44 [63]	
III	13 [19]	11 [16]	
IV	2 [3]	0 [0]	
Demographic parameters			
Age, mean (SD)	61.73 (10.75)	61.36 (11.46)	0.84
Male gender, n [%]	51 [76]	54 [77]	0.89
Civil status, n [%]			0.46
Single	24 [36]	20 [28]	
Married/living with a partner	43 [64]	50 [71]	
Education, n [%]			0.41
Primary school	4 [6]	1 [1]	
Unskilled	16 [24]	13 [19]	
Skilled worker	30 [45]	38 [54]	
High school	5 [7]	5 [7]	
Bachelor degree	9 [13]	7 [10]	
Master degree	2 [3]	6 [9]	
PhD+	1 [1]	0 [0]	
Work status, n [%]			0.28
Unemployed	0 [0]	1 [1]	
Sick leave	19 [28]	26 [37]	
Works less than 20 hours per week	5 [7]	1 [1]	
Works 20–36 hours per week	2 [3]	1 [1]	
Works full-time 37 hours per week	9 [13]	8 [11]	
Retired	32 [48]	33 [47]	

Table 3 Scores and change score on the eHLQ at 6 and 12 months for the telerehabilitation group and control group

Scale	6 months (mean ±SD)	12 months (mean ±SD)	Change score: 6 *vs.* 12 months (mean ±SD)	P	Cohen's d (95% CI)
1. Using technology to process health information					
Telerehabilitation (n=51)	(2.98±0.66)	(3.01±0.60)	(0.03±0.65)	0.75[1]	0.05 (–0.23 to 0.32)
Control (n=46)	(2.71±0.65)	(2.78±0.70)	(0.08±0.48)	0.27[2]	0.16 (–0.13 to 0.45)
TR (n=51) *vs.* CT (N=46) 6 months				0.04[3]	0.42 (0.02 to 0.83)
TR (n=51) *vs.* CT (N=46) change scores				0.69[4]	–0.08 (–0.48 to 0.32)
2. Understanding of health concepts and language					
Telerehabilitation (n=51)	(3.21±0.43)	(3.27±0.44)	(0.06±0.50)	0.41[1]	0.12 (–0.16 to 0.39)
Control (n=46)	(3.08±0.43)	(3.1±0.51)	(0.02±0.37)	0.72[2]	0.05 (–0.24 to 0.34)
TR (n=51) *vs.* CT (N=46) 6 months				0.14[3]	0.31 (–0.09 to 0.71)
TR (n=51) *vs.* CT (N=46) change scores				0.64[4]	0.09 (–0.31 to 0.49)
3. Ability to actively engage with digital services					
Telerehabilitation (n=51)	(3.11±0.70)	(3.2±0.56)	(0.11±0.77)	0.32[1]	0.14 (–0.14 to 0.42)
Control (n=46)	(2.87±0.66)	(2.90±0.71)	(0.03±0.50)	0.74[2]	0.05 (–0.24 to 0.34)
TR (n=51) *vs.* CT (N=46) 6 months				0.08[3]	0.36 (–0.04 to 0.77)
TR (n=51) *vs.* CT (N=46) change scores				0.53[4]	0.13 (–0.27 to 0.52)
4. Feel safe and in control					
Telerehabilitation (n=51)	(3.22±0.42)	(3.27±0.47)	(0.05±0.57)	0.55[1]	0.09 (–0.19 to 0.36)
Control (n=46)	(3.17±0.46)	(3.22±0.51)	(0.05±0.40)	0.38[2]	0.13 (–0.16 to 0.42)
TR (n=51) *vs.* CT (N=46) 6 months				0.57[3]	–0.12 (–0.28 to 0.51)
TR (n=51) *vs.* CT (N=46) change scores				0.98[4]	0.00 (–0.40 to 0.39)
5. Motivated to engage with digital services					
Telerehabilitation (n=51)	(3.12±0.54)	(3.15±0.50)	(0.03±0.64)	0.76[1]	0.04 (–0.23 to 0.32)
Control (n=46)	(2.79±0.60)	(2.86±0.61)	(0.07±0.48)	0.30[2]	0.14 (–0.15 to 0.43)
TR (n=51) *vs.* CT (N=46) 6 months				0.00[3]	0.59 (0.18 to 0.99)
TR (n=51) *vs.* CT (N=46) change scores				0.73[4]	–0.07 (–0.47 to 0.33)
6. Access to digital services that work					
Telerehabilitation (n=51)	(3.07±0.50)	(3.14±0.37)	(0.07±0.60)	0.40[1]	0.12 (–0.16 to 0.39)
Control (n=46)	(2.90±0.54)	(2.97±0.54)	(0.06±0.36)	0.24[2]	0.18 (–0.12 to 0.46)
TR (n=51) *vs.* CT (N=46) 6 months				0.12[3]	0.32 (–0.08 to 0.72)
TR (n=51) *vs.* CT (N=46) change scores				0.96[4]	0.01 (–0.39 to 0.41)

Table 3 (*continued*)

Table 3 (*continued*)

Scale	6 months (mean ±SD)	12 months (mean ±SD)	Change score: 6 *vs.* 12 months (mean ±SD)	P	Cohen's d (95% CI)
7. Digital services that suit individual needs					
Telerehabilitation (n=51)	(2.89±0.61)	(2.98±0.54)	(0.09±0.81)	0.46[1]	0.11 (–0.17 to 0.38)
Control (n=46)	(2.66±0.68)	(2.78±0.62)	(0.11±0.45)	0.11[2]	0.25 (–0.04 to 0.54)
TR (n=51) *vs.* CT (N=46) 6 months				0.09[3]	0.36 (–0.05 to 0.76)
TR (n=51) *vs.* CT (N=46) change scores				0.84[4]	–0.04 (–0.44 to 0.36)

[1], comparison of group scores in the TR group at 6 and 12 months; [2], comparison of group scores in the CT group at 6 and 12 months; [3], comparison of 6 months scores across the TR and CT group; [4], comparison of change scores (6–12 months) across the TR and CT group. eHLQ, eHealth Literacy Questionnaire; TR, telerehabilitation group; CT, control group.

Furthermore, we found that our TR group used technology to process health information more frequently than did our CT group (see *Table 3*), which may reflect that the TR group became more accustomed to using digital services and made it part of their daily lives. A study by Albert *et al.* found that HF patients with higher health literacy and previous/current device use history tended to be more comfortable in using the devices (27), and Joensson *et al.* found that patients who received feedback regarding their health status and rehabilitation activities used this information to further improve their health condition (16). As such, patients who have become accustomed to using digital services increase their benefit and competency when using the digital services, suggesting that providing patients with opportunities to learn how to use digital services may increase patients' benefits.

Overall, both our groups scored high on e-health literacy measures, indicating that eHL such as skills and knowledge, trust in, and motivation to use, as well as experiences with digital health services generally was high in our sample. This may reflect that the Danish health care services are highly digitalized, and Danes have become very familiar with digital public services (10,11). As such, e-health literacy may already be high among the Danish population in general, and the changes identified in this study may reflect patients adapting existing eHL to their acute needs and specific health situation and not a specific development of or changes in eHL in general.

In addition, our results indicate that once the formal rehabilitation program ends, there is little chance of further changes in aspects of eHL. This may reflect that interventions aimed at increasing eHL and associated skills and knowledge, building trust and motivation, and providing opportunities for using digital health services should preferably be provided early on in any form of rehabilitation program, and care should be taken to identify and support patients, who may find it difficult to adapt to digital health services. This is especially pertinent in so far as increasing eHL, enabling patients to engage with digital health services has become even more important in the wake of the COVID-19 pandemic, which required a rapid and comprehensive digitalization of health care services generally.

Overall, the findings from this study indicate that exposure to and familiarization with digital health services may increase patients' perception of the usability of web-based interventions, which is important for the user's motivation and for creating and ensuring their adherence to digital tools. There is limited research on eHL in telerehabilitation programs for patients with ischemic heart disease or HF (17-19), and we have not identified other studies that have investigated the eHL perspectives in patients with HF doing TR. However, studies in other patient populations support the benefit of using telerehabilitation programs. A recent study investigating the use of an app-based intervention in prostate cancer patients showed that the patients found the app to be equivalent or easier to use compared to the traditional pen and paper approach (28). Another study that examined eHL among patients with chronic obstructive pulmonary disease (COPD) found a statistically significant association between greater knowledge of COPD and higher eHL together with the use of web-based health resources (29). Taken together, the current findings and previous studies support the importance of incorporating educational elements in rehabilitation programs, as is done in the HeartPortal.

This study was carried out in a Danish context. Hence, there might be differences in the patient population and organization of the healthcare systems when seen in a global context. As such, results may not be directly transferable to other health care systems and care should be taken to adapt the FPT program and HeartPortal to the specific patient population and health care system in which it is implemented, in order to ensure that specific needs are met as suggested by the SDT.

In addition, due to an error, we did not include our eHL measure at 0 month, but only at 6 and 12 months. This limits the interpretability of current results, as it is unclear whether any differences were present at baseline. Furthermore, we only examined changes over a 6 months period, and future studies should examine the effect of online interventions in relation to eHL long term, as well as ensure that a baseline measurement on eHL is included in addition to the measures used here. In addition, although the multidimensional nature of our eHealth measure in some aspects is a clear strength of this study, it also requires that analyses must be carried out on 7 different parameters simultaneously, increasing the risk of serendipitous results. It is therefore paramount that future studies address these findings examining whether they can be replicated in other countries, larger samples, and even in other patient groups.

Conclusions

When people with HF are provided with a digital toolbox to process their health information, they increase their skills and knowledge regarding their disease, and become more motivated to engage with digital services, compared to patients who have not been provided with relevant technology. These results indicate that providing patients with HF with access to technology, i.e., a telerehabilitation program, early on, may increase their motivation to use digital services as part of their rehabilitation.

Acknowledgments

We would like to thank patients and relatives who participated in the study. We would also like to thank Richard H. Osborne for his invaluable comments on earlier versions on this manuscript.

Funding: This work was supported by Aage and Johanne Louis-Hansen's Foundation, Aalborg University, Viewcare, and partners in the project: Health Care Centers in Viborg, Skive, Silkeborg and Randers; the Danish Heart Association; the Cardiology Wards at the regional hospitals in Viborg, Skive, Silkeborg and Randers; Technical University of Denmark; Department of Psychology and Behavioral Sciences, Aarhus University; Department of Computer Science, Aalborg University; CIMT, Odense University Hospital; and Laboratory for Welfare Technologies-Digital Health & Rehabilitation, Aalborg University.

Footnote

Reporting Checklist: The authors have completed the CONSORT reporting checklist. Available at https://mhealth.amegroups.com/article/view/10.21037/mhealth-21-56/rc

Trial Protocol: Available at https://www.researchprotocols.org/2019/9/e14517

Data Sharing Statement: Available at https://mhealth.amegroups.com/article/view/10.21037/mhealth-21-56/dss

Peer Review File: Available at https://mhealth.amegroups.com/article/view/10.21037/mhealth-21-56/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://mhealth.amegroups.com/article/view/10.21037/mhealth-21-56/coif). DA reports that using AUB (library) for study materials and articles, and software used from Aalborg University: SPSS. LF reports educational activities for Pfizer. Malene Hollingdal reports study nurse salary as their part in the study. The other authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The trial was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Regional Ethics Committee for North Denmark (N-20160055) and by the Danish Data Protection Agency, and informed consent was taken from all individual participants.

References

1. Ziaeian B, Fonarow GC. Epidemiology and aetiology of heart failure. Nat Rev Cardiol 2016;13:368-78.
2. World Health Organization. Cardiovascular diseases (CVDs). Available online: https://www.who.int/health-topics/cardiovascular-diseases#tab=tab_1
3. Ambrosy AP, Fonarow GC, Butler J, et al. The global health and economic burden of hospitalizations for heart failure: lessons learned from hospitalized heart failure registries. J Am Coll Cardiol 2014;63:1123-33.
4. Ponikowski P, Voors AA, Anker SD, et al. 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: The Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC). Developed with the special contribution of the Heart Failure Association (HFA) of the ESC. Eur J Heart Fail 2016;18:891-975.
5. Conraads VM, Deaton C, Piotrowicz E, et al. Adherence of heart failure patients to exercise: barriers and possible solutions: a position statement of the Study Group on Exercise Training in Heart Failure of the Heart Failure Association of the European Society of Cardiology. Eur J Heart Fail 2012;14:451-8.
6. Ruano-Ravina A, Pena-Gil C, Abu-Assi E, et al. Participation and adherence to cardiac rehabilitation programs. A systematic review. Int J Cardiol 2016;223:436-43.
7. Brennan D, Tindall L, Theodoros D, et al. A blueprint for telerehabilitation guidelines. Int J Telerehabil 2010;2:31-4.
8. Dinesen B, Dittmann L, Gade JD, et al. "Future Patient" Telerehabilitation for Patients With Heart Failure: Protocol for a Randomized Controlled Trial. JMIR Res Protoc 2019;8:e14517.
9. Cranen K, Groothuis-Oudshoorn CG, Vollenbroek-Hutten MM, et al. Toward Patient-Centered Telerehabilitation Design: Understanding Chronic Pain Patients' Preferences for Web-Based Exercise Telerehabilitation Using a Discrete Choice Experiment. J Med Internet Res 2017;19:e26.
10. Danish Ministry of Health, Danish Ministry of Finance, Danish Regions, et al. A Coherent and Trustworthy Health Network for All: Digital Health Strategy 2018-2022 (2018). Copenhagen, Danish Ministry of Health.
11. Tassy A, Nielsen MB, Jakobsen DT. The use of information technology in the general population. Published in Copenhagen; 2018.
12. Batterham RW, Hawkins M, Collins PA, et al. Health literacy: applying current concepts to improve health services and reduce health inequalities. Public Health 2016;132:3-12.
13. Nutbeam D. Health promotion glossary. Health Promot 1986;1:113-27.
14. Norman CD, Skinner HA. eHealth Literacy: Essential Skills for Consumer Health in a Networked World. J Med Internet Res 2006;8:e9.
15. Kayser L, Karnoe A, Furstrand D, et al. A Multidimensional Tool Based on the eHealth Literacy Framework: Development and Initial Validity Testing of the eHealth Literacy Questionnaire (eHLQ). J Med Internet Res 2018;20:e36.
16. Joensson K, Melholt C, Hansen J, et al. Listening to the patients: using participatory design in the development of a cardiac telerehabilitation web portal. Mhealth 2019;5:33.
17. Jørgensen CB, Hansen J, Spindler H, et al. Heart Patients' Experiences and Use of Social Media in Their Rehabilitation: A Qualitative Study. Linköping University Electronic Press; 2013:51-4.
18. Khan D, Fjerbæk A, Andreasen JJ, Thorup CB, Dinesen B. Cardiac surgery patients' e-health literacy and their use of a digital portal. Health Education Journal 2018;77:482-94.
19. Melholt C, Joensson K, Spindler H, et al. Cardiac patients' experiences with a telerehabilitation web portal: Implications for eHealth literacy. Patient Educ Couns 2018;101:854-61.
20. Harris PA, Taylor R, Thielke R, et al. Research electronic data capture (REDCap)--a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform 2009;42:377-81.
21. Dolgin MNYHACC. Nomenclature and criteria for diagnosis of diseases of the heart and great vessels. Boston: Little, Brown; 1994:253-6.
22. Ryan RM, Patrick H, Deci EL, et al. Facilitating health behaviour change and its maintenance: Interventions based on Self-Determination Theory. Eur Heal Psychol 2008;10:2-5.
23. Schafer JL, Graham JW. Missing data: our view of the state of the art. Psychol Methods 2002;7:147-77.
24. IBM. SPSS. Armonk, NY: IBM Corp; 2020.
25. Spindler H, Hollingdal M, Refsgaard J, et al. Motivating patients in cardiac rehabilitation programs: A multicenter randomized controlled trial. Int J Telerehabil

2021;13:e6365.
26. Oudkerk Pool MD, Hooglugt JQ, Schijven MP, et al. Review of Digitalized Patient Education in Cardiology: A Future Ahead? Cardiology 2021;146:263-71.
27. Albert NM, Dinesen B, Spindler H, et al. Factors associated with telemonitoring use among patients with chronic heart failure. J Telemed Telecare 2017;23:283-91.
28. Tran C, Dicker A, Leiby B, et al. Utilizing Digital Health to Collect Electronic Patient-Reported Outcomes in Prostate Cancer: Single-Arm Pilot Trial. J Med Internet Res 2020;22:e12689.
29. Stellefson ML, Shuster JJ, Chaney BH, et al. Web-based Health Information Seeking and eHealth Literacy among Patients Living with Chronic Obstructive Pulmonary Disease (COPD). Health Commun 2018;33:1410-24.

doi: 10.21037/mhealth-21-56
Cite this article as: Spindler H, Dyrvig AK, Schacksen CS, Anthonimuthu D, Frost L, Gade JD, Kronborg SH, Mahboubi K, Refsgaard J, Dinesen B, Hollingdal M, Kayser L. Increased motivation for and use of digital services in heart failure patients participating in a telerehabilitation program: a randomized controlled trial. mHealth 2022;8:25.