

Health Literacy Impacts Knowledge and the Use of Education App in Heart Failure: A Pilot Study

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ABSTRACT

Background and Introduction: The chronicity of heart failure (HF) requires patients to follow complex self-care regimen. Many factors impede patients' ability to follow the prescribed multi-component self-care regimen that include lack of knowledge attributed to inadequate health literacy.

Objective: This prospective pre- and post-intervention study assessed the usability and potential efficacy of a HF-educational application (APP) in a smartphone. The HF education App included ten educational modules at a reading level of 6th grade. The study examined the association of health literacy level of participants at baseline with HF knowledge improvement after using the App for 30-days. HF related hospital readmissions was assessed at 30, 60 and 90-days.

Results: A total of 31 patients with HF and (15) family member dyads were recruited for the study. Health Literacy level was measured using the Rapid Estimate of Adult Literacy in Medicine - Short Form showed a strong association with HF knowledge measured using the validated Atlanta HF Knowledge Test ($t=3.629$; $p=0.001$). Knowledge of patients with HF improved significantly after 30-days of using the HF education App ($t=13.03$; $p=0.001$); as well the knowledge of caregivers ($t=9.08$; $p=0.001$). None of the patients with HF were hospitalized during 30-days and 60-days follow-up, while one patient was hospitalized in 90-days.

Conclusion: Our data suggests evaluating alternative methods of communicating health information including written material at a low literacy level verbal communication that a person with inadequate literacy may understand, and presentations using videos and Apps targeting individuals with limited literacy at 6th grade level.

Keywords

Heart failure, Health Literacy, HF Education App, Knowledge, Hospitalization.

Background and Introduction

Heart failure (HF) is a growing healthcare burden that affects an estimated 6.2 million American adults [1]. The chronicity of HF

requires patients to follow complex medication regimen, daily HF symptom assessment, weight and diet management, as well as early interventions and seeking care for decompensation to avoid hospitalization [2]. Many factors impede patients' ability to follow the prescribed multi-component self-care regimen that include lack of knowledge to recognize and respond to symptom changes [3].

In the United States (U.S) an estimated 36% adults (90 million) have inadequate or below basic health literacy (HL) [4]. Adults with inadequate HL experienced 6% more hospitalization, two days-longer hospital stays, and four times higher health care costs [5]. In a large prospective study (n=2487) of patients with HF, inadequate HL was strongly associated with hospitalization 1.30 (95% CI, 1.02-1.66; $P=0.03$) and mortality (HR=1.91 (95% CI, 1.38-2.65; $P<0.001$) [6].

The Joint Commission and American Medical Association mandate hospitals to provide patients with written discharge instructions that are understandable to patients and their caregivers [7,8]. Many healthcare providers and institutions offer printed health information to patients as brochures and articles [9]. However, in many instances' patients do not recall receiving discharge instructions and those who received discharge instructions had limited information [10]. A large HF survey (N=2331) from 22 countries reported that 12 weeks after discharge, only half of patients (49%) with a clinical diagnosis of HF recalled receiving advice to check weight and approximately two-thirds (67%) followed the advice completely [11]. In patients with HF, those with adequate HL had better adherence to prescribed medications ($P=0.001$) than those with inadequate HL [12]. This indicates that traditional paper format of discharge instruction or educational materials has not translated in practice to follow self-care at home. In addition, 24% of adults with chronic diseases were willing to accept prescriptions for a mHealth App than a pill or device [13]. As technology continues to innovate healthcare, 97% of Americans own a mobile phone and smartphone ownership is up to 85%, up from just 35% in 2011 with 40% among the Silent Generation aged 74 and above [14]. Thus, having HF educational materials readily available on a mobile device at a prescribed reading level of 6th grade may improve knowledge and engage individuals in self-management skills at home.

Methods

Design and Sample

This prospective pre- and post-intervention study assessed the usability and potential efficacy of a HF-specific educational application in a smartphone. The study followed patient hospital readmissions at 30, 60 and 90-days after using the intervention. The study protocol was approved by the South University Institutional Review Board (IRB) and the Tampa General Hospital Research Department.

The study recruited a total of 45 participants. Participants were included in the study if they had a HF diagnosis or were family members or caregivers between the ages of 18-64 years old, able to speak, read, write, and understand English, own an Android mobile phone with a data plan or access to Wi-Fi or willing to use a loaner phone for the study period. Participants were excluded if they had a diagnosis of Alzheimer's disease, uncontrolled psychiatric disorders, or a history of severe depression, listed for cardiac transplant as status 1A, had a left ventricular assist device.

Intervention

The HF educational intervention application (HF education App) was provided to participants to use during a 30-day period. The smartphone HF education App included a total of ten educational modules, some were adapted from the Heart Failure Society of America, with permission, and the rest of the educational materials were developed based on findings from a prior study[15]. The HF education App is audio-enabled with a zoom function and include interactive teaching tools to educate patients about HF, the importance of adhering to a low salt diet, HF medications, importance of exercise regimen, managing other chronic disease or conditions, managing feelings about HF, and the heart and brain connection. See Figure 1 below.



Figure 1. HF Education App

The HF education App was developed, and beta tested and the contents were validated by cardiologists [16]. The reading level for each of the ten HF educational module included in the App was assessed using the comprehensive online Text Readability Consensus Calculator[17]. The education materials included in the App ranged from fifth grade to eighth grade reading level with an average reading level of sixth grade as recommend by the American Medical Association [18].

Outcome Measures

Primary Outcome

Health Literacy: HL was measured using the Rapid Estimate of Adult Literacy in Medicine - Short Form (REALM-SF). REALM-SF is a validated instrument which consists of seven words to evaluate reading ability and assessing adult literacy related to

health [19]. Participants receive one point for each word read and pronounced correctly. A score of zero correlates to a third grade reading level, indicating that a patient will not be able to read and understand most materials. A score of 1 to 3 indicates a fourth to sixth grade reading level indicating a limited ability to read and understand prescriptions and written instructions. A score of 4 to 6 indicates a seventh to eighth grade reading level, suggesting some struggle with most patient education materials. A score of 7 indicates a high school reading level and can understand most patient education materials. The internal consistency of the 7 item responses (Cronbach's alpha .94) was highly correlated with the original 66-item questionnaire at 6th grade level [19,20].

Secondary Outcome

Improvement in HF Knowledge: Heart failure knowledge was measured using the validated Atlanta HF Knowledge Test (A-HFKT) [21]. The A-HFKT consists of 30 questions with scores ranging from 0 to 100%. This self-administered questionnaire measures self-care knowledge, HF medications, symptoms, pathophysiology, nutrition, and behavior ($r=.84$ for patients). Scores 70% or higher indicate adequate self-care awareness in patients with HF.

Exploratory Outcome

Usability of HF Education App: A survey was utilized to evaluate the application's usability. This survey used the Likert scale to evaluate ease of use, confidence, and helpfulness. The survey also consisted of 2 open-ended questions to assess if there was additional information they would have liked incorporated into the application and their perception on how the application helped them understand HF information.

Hospital Readmissions: Patients with HF were followed for 90-days and were asked about any readmissions and data were confirmed with hospital medical records.

Covariates

Demographic Variables: All participants completed a demographic survey that included age, gender, race, and education. Heart failure patients also provided information on duration of HF, ejection fraction, device history, and medications. Caregivers provided information on their relationship to the patient.

Data Collection and Data Analysis

Participants were recruited while being hospitalized for HF at a tertiary teaching hospital in Tampa, Florida. Eligible participants were consented and completed baseline measures. All participants had the HF education App downloaded to their own or a loaner mobile phone provided for use during the study.

The SPSS version 25 was used for data analysis [22]. Descriptive statistics were used for participant's baseline demographic information, REALM-SF scores, and A-HFKT pre and post assessments. A linear regression analysis was performed to uncover influence of baseline HL level on REALM-SF score

and knowledge improvement after using the HF education App. Demographic variables including age, gender, education, and race were collected. A paired t-test was used to compare the means of the pre and post A-HFKT assessments.

Results

Demographic Details of Participants

The study screened a total of 102 participants that included dyads of patients with HF and their caregivers. The final enrolled sample included 31 patients with HF and 15 caregivers. The mean age of patients with HF was 52.48 ± 8.73 and the caregivers 46.13 ± 14.92 years. Most patients (74%) were men, and the caregivers were mostly women (86.7%). Health literacy score on REALM-SF was almost the same for both patients and caregivers at seventh-eighth grade level (Table 1).

Table 1: Demographic Variables of Patients and Caregivers.

	Patients (n=31)		Caregivers (n=15)	
Age	52.48 ± 8.73	26-64 years	46.13 ± 14.93	20-64 years
Gender				
Male		74.2% (23)		13.3% (2)
Female		25.8% (8)		86.7% (13)
Race				
White		54.8% (17)		66.7% (10)
African American		38.7% (12)		26.7% (4)
Hispanic		3.2% (1)		6.7% (1)
Others		3.2% (1)		0%
Education				
<High School		3.2% (1)		0%
High School or GED		41.7% (13)		26.7% (4)
Some College		48.4% (15)		33.3% (5)
Degree or above		6.4% (2)		40% (6)
Baseline REALM-HF				
4 th -6 th grade		16.1% (5)		20.0% (3)
7 th -8 th grade		51.6% (16)		46.7% (7)
High school level		32.3% (10)		33.3% (5)

Health Literacy Level Associated with Knowledge Improvement

The baseline HL measured on REALM-SF score demonstrated a strong association with knowledge improvement ($t=3.629$; $p=0.001$) (Table 2).

Table 2: Regression Analysis on Health Literacy and Knowledge Improvement.

	Coefficient Beta	Std. Error	T	Sig (p)
REALM Score	-0.479	1.287	3.629	0.001**
Age	0.206	0.085	1.443	0.157
Gender	-0.025	1.867	-0.179	0.859
Race	-0.116	1.279	-0.891	0.378
Education	0.193	1.095	1.473	0.149

Demographic variables including age, sex, race, and education of participants were not associated with HL level and knowledge.

Knowledge Improvement

Independently, knowledge of patients with HF on A-HFKT improved significantly after 30-days of using the HF education

App ($t=13.03$; $p=0.001$). Caregivers' HF knowledge also improved ($t=9.08$; $p=0.001$) (Table 3).

Table 3: Knowledge Improvement of Patients and Caregivers After Using HF Education APP.

	Baseline AHFKT Score	Post-AHFKT Score	Between Groups	Sig
	Mean/SD	Mean/SD	T	P value
Patients with HF	14.96 ± 6.35	27.71 ± 1.90	13.03	0.001**
Caregivers	16.93 ± 7.22	27.60 ± 2.64	9.08	0.001**
Between Group Difference	12.81 ± 6.47	10.40 ± 7.42	1.271	0.266

Usability of HF education App

All participants were interviewed using a questionnaire developed for the study to rate the usability of the HF education App for ease of using, confidence in using the mobile App, and how much of the information provided was new and helpful. The study used a Likert scale of 0-4 (0=Not at all confident to 4=Extremely confident). Ninety-five to 100% of participants rated the application as very confident to extremely confident on all three measures (Figure 2).

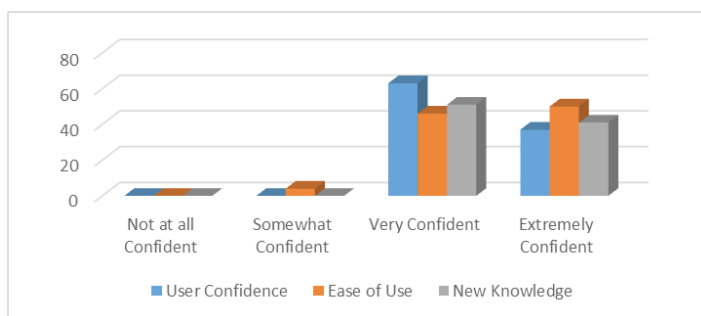


Figure 2: HF Education App Usability by Participants.

Participants offered feedback to include additional educational information on different types of pacemakers and/or defibrillators, more information on cardiac rehabilitation, sample low sodium recipes, vaccinations and other preventive measures needed for a person with HF. The HF education App was updated to include the suggestions and will be tested in future trials.

Hospital readmission

None of the patients with HF were hospitalized during 30-days and 60-days follow-up. One patient was admitted in 90-days.

Discussion

The key difference in this study is the inclusion of patients and caregivers and assessment of the participants HL level. The results indicated that baseline HL score was associated with knowledge improvement after using the HF education App. This is supported in an intervention study that patients with HF who had adequate HL had better adherence to medication than those with inadequate HL [12]. Inadequate HL is a significant public health problem with more than a third of Americans having difficulties understanding basic health information [23]. Screening for inadequate health literacy is easy and can be performed accurately with a single

question of asking "How confident are you in filling out medical forms by yourself?" [24]. Therefore, providers and health care institutions should evaluate alternative methods of communicating health information including written material at a low literacy level, verbal communication that a person with inadequate literacy may understand, and presentations using videos and Apps targeting individuals with limited literacy [23].

Our data revealed that both patients and caregivers showed significant improvement in HF knowledge after using the HF education App for 30-days. Results also showed that women were more likely to have significantly higher knowledge improvement than men. Although education attainment is strongly associated with literacy, individuals with inadequate HL may attempt to conceal this information from others [23]. Our result indicated that persons with higher education such as an associate degree or higher had improved knowledge. Nearly 70% of participants had an educational level of 12 years/high school or GED or higher. Thus, in our study, HL level showed no significant association with education. This supports our HF education App that was created and tested to be at 6th-grade reading level as recommended by the AMA [18]. Currently, most institutions provide online patient education links within electronic health records (EHRs). An assessment of reading levels of three commonly used patient education links showed varied reading levels: 11th-13th grade for EBSCO, 14th-17th grade for MedlinePlus, and 11th grade for Micromedex [25], which is higher than the AMA-recommended 6th-grade reading level.

The participants' survey showed that the HF education App helped them better understand key HF information that health care providers did not offer. Additionally, participants affirmed that the App was readily available to look up information when needed. The main feature all participants enjoyed in the App is the capability of it to read to them. Listening to the HF education App as they read validated the information for them and helped to retain the information better. This validates the need for providing educational information using alternative methods [11] through mHealth, that provides patients and their caregivers with additional information in the management of their HF self-care that is accessible at any time.

With advances in medical science, health educational information can overwhelm people, even those with advanced literacy skills. Given the influence of HL on understanding educational material, assessing suitability and reading level of patient educational material in mobile App or online is paramount. This format differs from the traditional discharge education provided through print materials that patients do not recall receiving the information or did not refer the materials when needed. All patient educational material, whether in paper format, an App version, or online version should identify reading level for ease of understanding by common people.

Limitations

The major limitation of the study is relatively small sample size that included more Whites. As in any study, we could have

incurred non-responder bias; specifically, those with inadequate HL could have been less likely to decline to participate in research studies. Thus, the results are not generalizable.

Conclusion

Health literacy must be considered when creating any smartphone application. This study emphasizes the impact on health promotion through technological intervention and evidence-based practice to improve health. Promoting health through active learning helped study participants attain positive health outcomes. This study reported optimistic results. A longitudinal follow-up with increased sample size is needed to define the association between HF knowledge and self-management to reduce re-hospitalization and death.

Practice implication

- Reading levels and HL must be considered while developing educational materials.
- Adding an interactive educational mobile App such as ours may stimulate engagement, foster improved knowledge, and promote healthy behaviors.
- Given that HL is vital to self-care to avoid readmission, it is imperative that information is readily accessible and at an appropriate reading level for the audience served.
- Screening for HL can be stigmatizing; however, HL must be assessed using simple and non-threatening measures.

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