ORIGINAL ARTICLE

A multimodal technology intervention for heart failure patients to reduce readmissions

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ABSTRACT

Background: Heart failure (HF) is a prevalent and costly condition. Technology is increasingly being used to deliver patient self-care programs to provide knowledge and skills for early symptom recognition, prompt treatment, and successful management.
Objective: The purpose of this study was to provide a home telemonitoring (HT) and telephonic nurse coach (NC) motivational interviewing (MI) educational intervention.
Methods: Thirty participants (M age = 75) were enrolled in a three-arm randomized controlled trial. Group A participants (n = 9) received HT devices, NC, and MI HF self-care education while Group B (n = 11) had NC, MI HF self-care, and Group C (n = 9) received NC health promotion only.
Results: Eighty-four percent of participants completed the study. Only 1, of the total 9 readmissions that occurred among the 3 groups, was in Group A but there was no statistical significance regarding readmissions. Both depression (p = .008) and telemedicine satisfaction (p = .046) were statistically significant between the groups. Over time, Group A participant depression declined (p = .047) while Group C demonstrated improved self-care confidence (p = .047).
Implications: There are numerous challenges related to the care and management of chronically ill HF patients. Potential benefits that may result from the use of HT in promoting self-care of HF patients should be further explored.

Key Words: Telehealth, Self-care, Heart failure, Readmissions, Motivational interviewing

1. INTRODUCTION

Heart failure (HF) is a prevalent and costly condition, affecting some 5.7 million people in the United States (U.S.)[1] and an additional estimated 23 million people worldwide.[2] The incidence of HF continues to rise with 825,000 new cases diagnosed annually in the U.S. and a projected cost of $43 billion dollars in 2020.[3] It accounts for more than 1 million hospitalizations and approximately 2.8 million physician office, emergency department (ED), and hospital outpatient visits each year at an estimated cost exceeding $32 billion.[4] Furthermore, HF is the most common reason for both hospitalizations and readmissions among Medicare beneficiaries.[5,6] As a result, excess 30-day readmissions for Medicare patients discharged with HF now trigger a financial penalty through the Hospital Readmission Reduction Program (HRRP) mandated by the Patient Protection and Affordable Care Act.[7] Therefore, developing strategies to reduce readmissions of all HF patients is a national priority.

Background

Many stakeholders believe that technology has the potential to be a cost effective strategy that will permanently change

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the delivery system for providing patient self-care management.[8] Today, various technology devices are being successfully used to help health care providers offer accessible and available HF patient self-care.[9,10] Remote home telemonitoring (HT) is one of the strategies that provides HF self-care information and supports individual decision-making.[11] However, as promising as remote HT appears to be in enhancing HF patient self-care, it is equally important that a HF patient has the essential knowledge base and skill set to independently manage much of their own self-care.[12] Historically, self-care education has been mostly unsuccessful due in part to the teaching/learning methodology compounded by existing patient depression and inadequate health literacy.[13,14] In fact, both depression and low health literacy are especially common among older adults who also have the highest prevalence of HF.[15]

While HT has been found to be a useful tool for HF patients toward meeting the goals of improving symptom recognition, treatment adherence, and decreasing hospital readmissions,[10,16] HF patients must also engage in a behavioral change experience that affords them the intrinsic motivation and self-confidence essential for long-term self-care management. Increasingly, providers have incorporated motivational interviewing (MI)[17] as a successful behavior change intervention with chronic illness populations including HF patients. MI has been found to promote patient participation, health literacy, self-management, and improved outcomes for individuals with a variety of chronic illnesses including HF.[18] By engaging HF patients in MI, nurse coaches can successfully employ an individualized educational change intervention whereby a HF patient collaborates with the nurse coach in acquiring the knowledge base needed for that patient to increase self-confidence in HF self-care resulting in an improvement of their symptom awareness and management of their symptoms.[19] Furthermore, incorporating useful biometric data from the HT device can further empower patients to review their data and correlate these data with daily symptoms. Ultimately, HF patients can participate in the decision-making process that is integral for improved HF symptom awareness and management of symptoms promoting patient empowerment independently and/or through seeking prompt and effective intervention from a provider.[20,21]

The primary objective of this study was to implement and evaluate a HT, telephonic NC, MI educational intervention with standard HF self-care in a cohort of adult heart HF patients recently discharged from the hospital. The specific aim of this feasibility study was to examine the relationships between selected demographic variables (age, gender, ethnicity, level of education, living situation, health literacy), selected clinical variables (ejection fraction, # medications, # co-morbidities), depression, telemedicine satisfaction, completion of a 4 month intervention, and hospital readmission between 3 study groups. Study results will be used to shape a future study with a larger patient sample.

2. METHODOLOGY

2.1 Study design, sample and setting

This prospective, randomized controlled feasibility study consisting of 30 HF patients was conducted at a large medical center in southern California. Given the intention of this project was a feasibility study, with the primary intention being to ascertain if the treatment/intervention could be readily implemented, null hypothesis significance testing (NHST) was not an over-arching objective. Thus, we were aware that with a smaller sample size that the probability of rejecting the null would be greatly attenuated, excepting the occurrence of a relatively large effect size. Hence, from this study we were using the results (effect size, *etc*.) and methodological lessons-learned as a springboard for subsequent extensions for telehealth interventions.

Approval was received by the hospital's Institutional Review Council and the university-affiliated Institutional Review Board. Participants were recruited from the inpatient setting from December 2013 through July 2014. Inclusion criteria included: (1) age greater than or equal to 40 years of age; (2) a primary or secondary diagnosis of heart failure; (3) ability to communicate and read in English, and; (4) a landline telephone in the home (needed for the specific HT device used in this study). Exclusion criteria included: (1) severe renal impairment and/or renal failure requiring hemodialysis; (2) severe visual or dexterity impairment; (3) inability to provide self-care due to depression or cognitive impairment and/or; (4) participation in another research study.

One of three research assistants collaborated with the charge nurse(s) of a HF progressive care unit(s) to determine potential participant eligibility. Interested participants who were clinically stable and within 24-48 hours of hospital discharge were pre-screened by completing the Short Portable Mental Status Questionnaire.[22] Once consented, demographic data were collected along with administration of the Heart Failure Self-Care Index (HFSCI),[23] Geriatric Depression Score (GDS),[24] Telemedicine Perception Questionnaire (TMPQ),[25] and Short Test of Functional Health Literacy in Adults (S-TOFHLA)[26] instruments. A $20 gift card to a local retailer was given to all consented participants. Prior to discharge, all HF participants received standardized discharge education and a written HF education pamphlet routinely provided by the hospital nurse.

2.2 Intervention

Research participants were randomized into one of three groups using a random table of numbers designed by a statistician. Participant sociodemographic data (*e.g.*, age, gender, race/ethnicity, marital status, education, health literacy) and clinical information (*e.g.*, HF duration, ejection fraction, and medication regimen) were abstracted from the participants' electronic medical records with the exception of health literacy scores which were determined using the S-TOFHLA for at the time of recruitment. The health literacy scores were blinded to the study personnel until study completion. Prescreening measurement of cognitive ability was conducted using the SPMSQ. The primary outcome measure was the 30-day readmission rate. Secondary outcomes included study completion which was monitored by the nurse interventionist. Pre and post intervention HF self-care, depression, and telemedicine perception scores were determined by administration of the SCFHI, GDS, and TMPQ, respectively, with details specific to each of these instruments outlined in table (see Table 1).

Table 1. Study instruments

Instrument Name & Author	# Items	Administration	Score Range/Interpretation	Psychometrics	Variable(s) Measured(s)
Short Portable Mental Status Questionnaire (Pfeiffer, 1975)	10	Fill in blank	0-10/intact (0-2); mild (3-4); moderate (5-7); severe (8-10)	Test-retest reliability (r = .83); construct & criterion validity	Cognition-Intellectual Impairment
Short Test of Functional Health Literacy of Adults (Parker, *et al.*, 1995)	36	Cloze procedure; Timed (maximum 7 minutes)	0-36/inadequate (0-16); marginal (17-22); adequate (23-36)	Cronbach's alpha (r = .97); content validity	Health literacy
Self-Care Heart Failure Index (Riegel & Dickson, 2008)	22 (total); 10 = SCM; 6 = SCMg; 6 = SCC	4 pt. Likert scale	0-100	Cronbach's alpha (r = .76); construct validity	Self-care-maintenance, management, confidence
Geriatric Depression Scale (Yesavage, *et al.*, 1983)	15	Yes/No	0-15/Normal (0-4); mild (5-8); moderate (9-11); severe (12-15)	Test-retest reliability (r = .84); criterion validity	Depression
Telemedicine Perception Questionnaire (Demiris, et al., 2000)	17	5 pt. Likert scale	17-85/Higher scores more positive	Test-retest reliability (r = .98); construct validity	Telemedicine satisfaction

2.2.1 *Telehealth*

Specific interventions for each of the three groups are highlighted in Table 2. Only Group A participants received home installation of the Foracare^{TM} telemonitoring blood pressure and weight scale devices that have a modem or Internet access for transmission of daily biometric data. These devices were loaned without cost to the participants for the duration of the study. Instructions for use of the devices were reviewed during the installation conducted by the two health care informatics students from the affiliated university. Participants were instructed to obtain a morning reading within two hours of awakening. They could immediately visualize their readings on the devices which were transmitted to the router within 15-20 seconds, as well as access their data in trended graphics on the manufacturer's website. As part of the installation, each device was tested and participants provided a return demonstration noting their readings on each of the devices. In addition, each participant was provided written information at a fourth grade reading level and a contact phone number available 24/7 for any technical issues related to the use of the devices. A member of the technology team was assigned to monitor the daily readings and communicated with the participant via phone if data transmission was missing for greater than 2 days and/or if blood pressure and/or weights were out of pre-determined ranges. The most common reason for lack of data transmission was due to a need to replace the batteries in the device(s). When biometrics were outside the preset limits, the technology team contacted the study nurse who collaborated with the participant's primary care provider to facilitate a plan of action which included one or more of the following: (1) providing advice to the participant, (2) resetting the biometric parameters, and/or (3) scheduling an appointment with their primary care provider (PCP). This study was aligned closely with the participant's usual care. For example, participants were asked about their upcoming PCP appointment when receiving the monthly NC, MI phone call.

2.2.2 *Education and motivational interviewing*

The mailed packet of educational materials for Group A and B participants consisted of (6) 1-2 page handouts pertaining to the following HF-related topics: (1) low sodium diet, (2) alcohol and smoking, (3) activity and exercise, (4) fatigue, (5) medication management, and (6) daily weights. In contrast, participants in Group C received a mailed packet of (6) 1-2 page general healthcare handouts related to these topics: (1) safety travel tips, (2) fire prevention planning, (3) fall prevention, (4) pneumonia vaccinations, (5) flu vaccinations, and (6) what to bring for your PCP visit. The rationale for providing general health topics in Group C was to prevent, or reduce attrition during the 4-month study. In addition to the initial telephonic educational nurse coaching session, each of the study participants received 4 monthly telephonic sessions scheduled at their convenience for a total

of 5 NC sessions. MI was used as the foundation for the 15-minute patient-centered educational nurse coaching session with Group A and B participants. At the beginning of the session, each participant was asked to select 1 of the 6 HF topics. The use of MI promoted patient-centered care encouraging participants to be engaged in discussing topics that they identified and desired discussion. In contrast, MI was not incorporated into the 5-minute educational nurse coaching sessions with Group C participants. The participant selected the topic but the nurse coach directed the review of the handout and any participant questions were limited to the handout topic. While participants in Groups A and B received a reminder call approximately 24 hours prior to the schedule monthly call, there was no reminder call for Group C participants. At the end of the 4 months, participants in each of the 3 groups were phoned by a member of the study team to complete the 3 post-intervention instruments. Participants had a copy of each instrument to read along as the researcher administered the instrument. Following completion of this call, each participant was mailed a $30 gift card to a local retailer.

Table 2. Study interventions based on group assignment

Interventions	Group A (n = 5)*	Group B (n = 11)*	Group C (n = 10)*
Usual Care (D/C Instructions & MD Office Visits)	X	X	X
RN Phone Call (24-48 Hrs Post D/C)	X	X	X
Educational Materials Mailed to Home (24 Hrs Post D/C)	HF topics	HF topics	Non-HF topics
HT Device (B/P & Wt Scale) Installation (72-96 Hrs Post D/C)	X		
Manual Weight Scale Mailed to Home		X	
APN Initial Phone Call (72-96 Hrs Post D/C)	X	X	X
Monthly MI (15) Minute Phone Call on HF Topic (N=4)	X	X	
Monthly MI (5) Minute Phone Call on non-HF Topic (N=4)			X

Note. RN = Registered nurse; Hrs = Hours; D/C = Discharge; Tech = Technology; APN = Advanced Practice Nurse; NC = Nurse coach; BP = Blood pressure; Wt = Weight; HT = Home telemonitoring; MI = Motivational interviewing; HF = Heart failure; Mins = Minutes; * = completed study

2.3 Data analysis

Data were entered into SPSS by participant number only and verified for accuracy. Outlier data were examined and corrected if re-coded improperly. All de-identified data were reported in the aggregate to further protect participant anonymity. Statistical significance was established at $p < .05$. Descriptive statistics including means, ranges, and standard deviations as well as chi square statistics were used to characterize the study population. Feasibility was determined by dividing the number of participants who enrolled into the number who completed all data collection. It was determined a priori that the study would be feasible if 80% of all participants completed the study.

Self-care, depression, and telemedicine satisfaction were compared between participants in the three groups using the analysis of covariance (ANCOVA) statistic. Initially, we determined whether there were significant group differences in mean outcome scores over time. To account for the possibility that similar group means might be determined only because outcomes improved over time for one group while worsening for the other group, analyses of group x time interactions were conducted. Repeated measures analysis of variance (ANOVA) was conducted for the primary data analysis using group and time to predict self-care maintenance, self-care management, self-care confidence, depression, and telemedicine satisfaction outcomes. If Group A improved more over time than Groups B and C, the HT-MI telephonic nurse coach educational intervention was supported. The relationships between self-care (maintenance, management, confidence), depression, telemedicine satisfaction, and health literacy within each of the three groups at the completion of the intervention (4 months) were examined using Pearson product-moment or Spearman p correlations. Scatterplots were also used to ascertain the linearity/nonlinearity of the relationships.

3. RESULTS

3.1 Study participants and study feasibility

Thirty participants were recruited during the time frame of December 2013 through July 2014. The sample was, on average, 75 +/- 9.4 years old, predominately white (70%), male (67%), married (50%) living with either a spouse (43%) or an adult child (30%) while 56.7% did not independently drive a car. The majority of participants had completed high school (50%) or some college (23%), and had adequate health literacy (62%). Our study population had an inadequate/marginal HL rate of 38%; HL was not associated with age, gender, race, educational level, marital status or living

environment. Most participants had 6 diagnoses and were taking 12 medications. None of the baseline demographics or clinical variables were statistically significant with the exception of the ejection fraction (M = 0.44, *SD* = .03, *p* = .028).

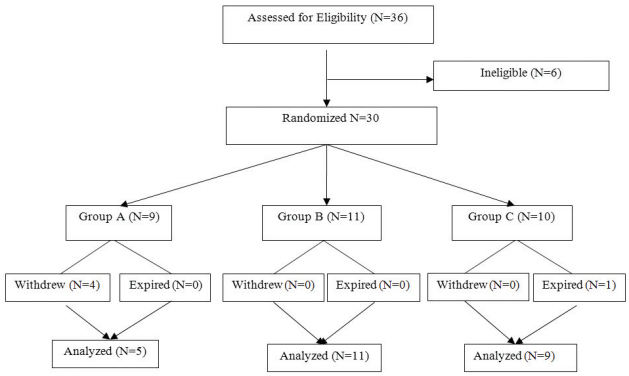

Figure 1. Consort table

Twenty-five of the 30 participants completed the 4-month study (see Figure 1) achieving feasibility with an 84% completion rate. Participants in Groups B and C were more likely to complete the study. Group B participants had a 100% completion rate with a 90% completion rate for Group C participants (one participant expired). Fifty-six percent of participants in Group A completed the intervention and their compliance with daily transmission was nearly perfect ranging from 99%-100% in consistency. In Group A, 4 participants ended the study early, yet 2 of these participants had transmitted their data consistently for 41 and 50 days, respectively. Two participants ended the study early because of personal reasons (one did not like using the TM and one unexpectedly moved out of state for family reasons) while the other two participants experienced a decline in their medical condition necessitating hospice care for one, and long-term skilled nursing care for the other. Regarding the selection of topics for the telephonic nurse coach interventions, participants in Groups A and B most often requested to discuss daily weights measurements and tips for sodium and water restricted diets among the five HF related topics. The average telephonic session was 14 minutes for Group A and B participants. Group C participants chose to discuss what to take with them for their next primary care provider visit (with a focus on bringing a list or bottles of medications along with written questions).

3.2 Comparative data

Table 3 illustrates the baseline and 4-month data on variables of interest. Regarding readmissions, nine (30%) of the 30 HF participants were re-hospitalized within the 4-month timeframe of this study and 5 of the 9 readmissions (55%) were related to a HF diagnosis. Group C participants had the highest readmission rate (56%) compared to Group A participants (20%), while Group B participants had a 27% readmission rate. Participants in Group C had greater numbers of HF-related readmissions than participants in Groups A and B, but were not significant. Of the five Group A participants that completed the 4-month intervention, only one participant was readmitted for a non-HF diagnosis. Yet, there was no statistical significance regarding differences between groups and numbers of readmissions.

Table 3. Self-Care behaviors, depression, and telemedicine perceptions at baseline & 4 months

Group	**Group A (n = 5)**		**Group B (n = 11)**		**Group C (n = 9)**		***p***
Time	**Baseline**	**4 Mo**	**Baseline**	**4 Mo**	**Baseline**	**4 Mo**	
Self-Care Maintenance (SCHFI)	61.1(15)	64.9(7.2)	61.2(15.4)	69.4(15.9)	59.6(15.9)	68.9(17.9)	.741
Self-Care Management (SCHFI)	43.8(19.7)	71.3(26.3)	54.0(26.3)	61.0(25.4)	65.0(18.7)	60.7(13.7)	.681
Self-Care-Confidence (SCHFI)	72.2(15.7)	56.5(24.4)	64.4(18)	72.8(20.2)	76.5(17.6)	66.7(20.6)	.756
Depression (GDS)	5.2(4.6)	3.3(2.1)	3.2(2.3)	2.5(1.9)	3.2(2.2)	4.7(4.2)	.008+
Telemedicine (TMPQ)	63.5(2.4)	64.0(4.8)	59.7(10)	61.6(4.9)	61.1(6.2)	62.1(9.3)	.046+

Note. Data are presented as mean (SD); (+) = $p \leq .05$; Monitor = home remote telemonitor; MI = motivational interviewing; SCHFI = Self-Care Heart Failure Index Version 6.2; GDS = Geriatric Depression Score Short Form; TMPQ = Telemedicine Perception Questionnaire

Mixed results were found from the analysis of the three self-care components (maintenance, management, and confidence) measured by the SCHFI instrument. All three groups demonstrated improvement in self-care maintenance with Group C participants experiencing the greatest improvement, but none were significant. Similarly, Group A and B participants experienced improvement in self-care management from baseline to 4 months but Group C participants worsened. Group A participants did have the greatest amount of improvement in self-care management but it was not statistically significant. Regarding self-care confidence, only Group B participants improved over time while Groups A

and C participants experienced a decline in self-confidence scores (see Table 4). When examining and comparing the three components of self-care (maintenance, management, and confidence) to depression, there was statistical significance between the three groups related to depression scores. Utilizing the GDS instrument, Groups A and B participants demonstrated a decline in their depression over time while Group C participants experienced an increase in their depression ($p = .008$). Similarly, there was statistical significance ($p = .046$) between the three groups related to their perceptions of telemedicine.

Table 4. Groups by time based on key variables

Variable	*p* (Time)	*p* (Time/Group)
Self-Care Maintenance (SCHFI)	.075	.856
Self-Care Management (SCHFI)	.122	.141
Self-Care- Confidence (SCHFI)	.162	.047+
Depression (GDS)	.500	.047+
Telemedicine (TMPQ)	.571	.956

Note. (+) = $p \leq .05$; SCHFI = Self-Care Heart Failure Index Version 6.2; GDS = Geriatric Depression Score Short Form; TMPQ = Telemedicine Perception Questionnaire

3.3 Univariate findings

The relationships between the three self-care behaviors, depression, and telemedicine perceptions within each of the three groups are reported in Tables 5, 6, and 7. The only statistically significant correlation reported was between self-care maintenance and self-care management in Groups A ($r = .983$, $p = .017$) and B ($r = .806$; $p = .029$) participants. This supports the premise that as self-care maintenance increased, self-care management also improved. Even though there was a trending in the right direction between self-care maintenance and self-care confidence ($r = .681$; $p < .05$) as well as self-care management with self-care confidence ($r = .886$; $p < .05$) with Group A participants, there was no statistical significance. Similarly, the relatively strong inverse relationship between self-care confidence and depression scores ($r = -.681$; $p < .05$) reported with Group A participants are consistent with thoughts that greater depression decreases self-care behaviors including self-care confidence.

4. Discussion

Our study supports that integrating a HT system with a telephonic NC, MI educational intervention for HF patients following discharge from the hospital is feasible. In addition, patients in the HT group had no HF related readmissions throughout the 120-day intervention and only 1 non-HF related readmission. These findings are consistent with multiple studies that also reported successful incorporation of HT with HF study participants in order to promote self-care resulting in both reductions and/or absences of hospital readmissions.[27–32]

Patients in the HT Group A reported higher levels of being able to manage their HF self-care over time in contrast to participants in Groups B and C. This behavior specifically refers to the decision-making process in which patients recognize and respond to their symptoms. Self-care management is an active, deliberative process that is essential in HF self-care if patients are going to control the balance between relative health and symptomatic HF.[23] Based on study findings, the increased accessibility and availability to care afforded these participants an opportunity to react earlier to indications of worsening conditions and more successfully manage their HF self-care. It is possible that the telephonic MI intervention was contributory to this positive outcome too since there was also improvement in Group B. The value of regular and frequent contact with a health care provider has proven to be valuable in promoting HF patient self-care and reduction of readmissions.[33]

Table 5. Correlational matrix of Group A key variables at 4 months (N = 5)

Variables	1	2	3	4	5	6
1 Maintenance (SCHFI)	1.00					
2 Management (SCHFI)	0.983+	1.00				
3 Confidence (SCHFI)	0.681	0.886	1.00			
4 Depression (GDS)	0.357	-0.374	-0.623	1.00		
5 Telemedicine (TMPQ)	0.270	0	0.543	-0.041	1.00	
6 Literacy (S-TOFHLA)	0.439	0.421	0.411	-0.574	0.576	1.00

Note. (+) = $p \leq .05$; SCHFI = Self-Care Heart Failure Index Version 6.2; GDS = Geriatric Depression Score Short Form; TMPQ = Telemedicine Perception Questionnaire; S-TOFHLA = Short Test of Functional Health Literacy for Adults

All three groups demonstrated higher levels of self-care maintenance but Group A participants conveyed less knowledge improvement than Groups B and C. It is possible that Group A did not have as steep a learning curve as the other two groups. Another possible explanation is that this group may have experienced more challenges related to recall of the

information. Riegel and Dickson[23] recommend that pre and post administration of the SCHFI instrument should not exceed 3 months and the interval was slightly greater than 4 months in this study. The most surprising finding was related to self-care confidence since both Group A and C participants experienced a decline while Group B increased self-care confidence scores. The decline with Group C participants was anticipated but self-care confidence with Group A participants was expected to improve since there have been reports of a positive relationship between HT and self-care confidence.[33,34] Yet, evidence is still mixed especially in studies with larger sample sizes regarding the effectiveness of HT regarding HF self-care.[35,36] Another possibility is that self-care confidence declined with Group A participants due to the additional responsibility required with the HT devices which may have been perceived as complicating their self-care.

Table 6. Correlational matrix of Group B key variables at 4 months (N = 11)

Variables	1	2	3	4	5	6
1 Maintenance (SCHFI)	1.00					
2 Management (SCHFI)	0.806+	1.00				
3 Confidence (SCHFI)	-0.241	0.495	1.00			
4 Depression (GDS)	-0.189	0.447	0.053	1.00		
5 Telemedicine (TMPQ)	0.544	0.536	-0.019	0.304	1.00	
6 Literacy (S-TOFHLA)	-0.028	0.563	-0.082	0.408	-0.061	1.00

Note. (+) = $p \leq .05$; SCHFI = Self-Care Heart Failure Index Version 6.2; GDS = Geriatric Depression Score Short Form; TMPQ = Telemedicine Perception Questionnaire; S-TOFHLA = Short Test of Functional Health Literacy for Adults

Participants in Group A experienced a significant decline in depression over time compared to the other two groups; there was a slight decline in Group B and an increase with Group C participants. There is convincing evidence that supports the incidence of depression with chronic illnesses such as HF, and the challenges associated with engaging and empowering HF patients in their self-care with an existing depression.[35,36] Depressive symptoms typically interfere with the ability to assess and respond to symptoms, as well as make decisions and influence physical activity, independent of symptom severity. Increased physical symptoms of HF are frequently associated with lower or declining self-care behaviors.[36] However, incorporation of social support mediates the effect of symptom severity, thereby lowering the risk that an individual will experience depressive symptoms. Thus, through the frequent and regular interaction experienced by Group A, and to a lesser extent with Group B, care and concern was extended influencing the incidence of depressive symptoms.

Table 7. Correlational matrix of Group C key variables at 4 months (N = 9)

Variables	1	2	3	4	5	6
1 Maintenance (SCHFI)	1.00					
2 Management (SCHFI)	-0.398	1.00				
3 Confidence (SCHFI)	-0.251	0.052	1.00			
4 Depression (GDS)	0.149	0.386	-0.240	1.00		
5 Telemedicine (TMPQ)	0.350	-0.242	0.149	0.093	1.00	
6 Literacy (S-TOFHLA)	-0.314	0.014	-0.346	-0.186	0.273	1.00

Note. (+) = $p \leq .05$; SCHFI = Self-Care Heart Failure Index Version 6.2; GDS = Geriatric Depression Score Short Form; TMPQ = Telemedicine Perception Questionnaire; S-TOFHLA = Short Test of Functional Health Literacy for Adults

Even though the sample size was small (n = 5), the participants in Group A who completed the study were adherent with daily transmission of biometric data (99%-100% consistency). Each participant had received individualized instruction in their home by a team of two health care informatics students and had 24 hour telephone access to this resource. These findings are supported in the literature whereby Polisena *et al*.[29] found high rates of adherence with HT resulted when patients' received individualized training and perceived the equipment to be simple to use. Appraisal re-

garding telehealth (TH) benefits can range from positive (helpful) to negative (a waste of time or too disruptive to routine). In a study by Domingo, Lupon, & Gonzalez,[37] 65% of the 97 patients who had used home TH wished to continue with HT after the monitor was discontinued; the benefits of HT were positively perceived.

Careful patient selection is an important consideration for HT in the HF population. The identification of which HF patient characteristics are ideal for selection into a HT program continues to challenge both healthcare providers and researchers. HF patients must learn to trust the devices as well as understand the personal benefits derived from device use.[37,38] Additionally, the patient must have the cognitive and physical capabilities to utilize the HT device. Antonicelli, Mazzani, Abbatecola, & Parati,[39] attributed the limited efficacy of home patient monitoring to either physical or cognitive inability to perform daily measurements. Mobility and dexterity constraints, without the support of a home support person, can be especially problematic for older adults and lead to frustration in working with the equipment. These limitations may lead to disengagement and/or measurement error.[40] In a recent study by Sanders, *et al*.,[41] patients who refused to participate in the HT research study discussed concerns about technical competence and specials skills that were needed to operate the equipment, but most were based on misunderstanding. The use of HT in the end-stages of heart failure has not been well researched[42] and the use of HT in the palliative setting is considered controversial.[43] Patients who are nearing the end-of-life can be inappropriate for home HT; palliative care support services are more important, and the HT device may be perceived as intrusive.[37,41] More research is needed to determine the ideal patient characteristics, technology, parameters, frequency, and duration of HT.

4.1 Study limitations

There were several important limitations to our findings. First, our overall sample size was small and the division of that sample into three even smaller cohorts of participants allows for the possibility of Type II errors. Despite the small sample, there was statistical significance regarding self-care management, depression, and telemedicine satisfaction as well as 84% of the participants completed the 4-month intervention with no HF readmission. Another limitation of this study is the lack of racial diversification as most study participants were Caucasian. Many patients were Spanish speaking and did not qualify for the inclusion criteria since no one on the research team was fluent in Spanish. Clearly, future research conducted in this geographic region must include both participants and a study team that is fluent in Spanish especially since the Hispanic population is the fastest growing segment of our population with multiple high-risk factors for HF.[44] Lastly, future studies including multiple students who are novice researchers likely require a design that promotes even greater interrater reliability with administration of instruments. It seems that more training and supervision of all study team members to assure intervention stability across study personnel would be beneficial. Yet, the value of forming a study team with students who obtain research experience is of paramount importance in order to advance nursing science.

4.2 Future research

This study highlights the numerous challenges related to the care and management of chronically ill HF patients along with the potential benefits that may result from the use of HT. Continued emphasis must be given to studying the variables that facilitate or create barriers to HT adoption such as ideal patient selection criteria, length and frequency of HT monitoring, and the role of family members and significant others. Research findings[45] from these potential topics will be useful to health professionals, patients, families, and device manufactures. We are still in the early stages of exploring how home-based health care technology can improve the quality of care delivery and improve patient self-care in chronic disease management strategies.

Lastly, further research needs to be conducted regarding the incidence of depression and HF patient self-care. It has been well-established that as many as 50% of HF patients frequently report clinically subjective depressive symptoms such as hopelessness, low energy, and/or depressed mood.[46] Typically, these symptoms worsen in association with increasing HF symptomatology[35] resulting in reduced quality of self-care.[47] Nurses are ideally positioned to assess HF patients for existing depression and assure that appropriate follow-up treatment including both counseling and pharmacological interventions is initiated to effectively manage the depression.

5. SUMMARY

Chronic illnesses and the aging population are driving the need to review the organization of health care services and provide more effective interventions. As our chronically ill patient populations continue to grow, nurses and healthcare providers are challenged to think in novel and creative ways to improve the coordination of patient care, facilitate self-care, and reduce hospital readmissions. HT is not intended to replace health professional care visits, but rather to enhance the level of care provided to patients, especially those suffering from chronic medical conditions.[29] Given the consider-

able resource burden of HF, the nurse is a key health team member to optimize home HT programs while incorporating customized educational approaches to facilitate optimal patient outcomes. In fact, there should be a greater emphasis on multimodal telehealth interventions since it is improbable that only one telehealth modality will yield optimal self-care patient outcomes.[33]

Using a multimodal technology educational intervention, this study provides the basis for a larger future more rigorous research study in a more diversified HF patient population. While HF patient self-care maintenance and management improved, and depression declined with the incorporation of HT, greater scrutiny must be given to patient inclusion criteria, frequency and length of device utilization, and selection of HT modalities. Findings from such future studies can assist to more clearly determine important patient and provider considerations for home HT in the HF population.

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CONFLICTS OF INTEREST DISCLOSURE

The authors declare that there are no conflicts of interest.

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