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Telehealth Call Compliance of Older Veterans with Heart Failure

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Abstract

Background: In order to optimize one's own health status, older adults with heart failure need to adhere to medication and lifestyle recommendations as well as recognize worsening dyspnea and fatigue. Telehealth can guide care, but inadequate compliance to program activities may adversely impact heart failure self-management. The aim of this 90-day retrospective study was to describe call compliance of older veterans with heart failure participating in one telehealth program.

Method: Data were collected for naturally occurring health status measures from the electronic telehealth and medical records of 187 older veterans with heart failure participating in the Care Coordination Home Telehealth program using either the Cardiocom® or Health Buddy® telehealth system to characterize participants and report call compliance.

Results: The average age of participants was 73.9 years, and 97.9% were male, 96.3% were non-Hispanic, 87.7% were White, and 93.6% had a history of hypertension. Total call compliance was 75.8% with no significant difference in overall compliance between users of the two telehealth systems. There was a sharp decline in daily compliance the first two weeks of program participation that leveled off for the remaining duration of the review period. Participant characteristics had no significant effect on compliance.

Conclusion: The finding of a rapid drop in compliance the initial weeks, followed by more sustained levels of participation, highlights that initial start-up is challenging for older adults with heart failure. Tailored training early in the program and reminders throughout the program may improve call compliance over time.

Introduction

Heart failure is a condition in which the cardiac muscle does not pump blood as well as it should to meet the body's needs [1]. More than 80% of individuals with heart failure are older adults over the age of 60 [2]. An acute decompensating heart failure (ADHF) episode is identified as an abrupt onset of worsening dyspnea and fatigue [3]. Ongoing daily care, including adherence to medication and lifestyle recommendations and recognition of worsening symptoms of dyspnea, fatigue, and edema, is needed to optimize the health status of older adults with heart failure and to avoid an ADHF episode [4]. Poor outcomes of an ADHF episode include hospital readmission due to inadequate outpatient management of the clinical syndrome [5] and a mortality rate of approximately 22% at two years [2].

The healthcare provider and home-based heart failure patient each have responsibilities in managing ongoing care, with the patient responsible for daily self-management, including close adherence to medication, diet, and physical activity therapies [4,6]. Individuals with heart failure who actively engage in self-management have better communication with healthcare providers [7], are more likely to adhere to recommended medical advice [8] experience increased length of time in stable health [4,9] and have fewer healthcare expenditures [10] than those who are not engaged. In general, poor self-management and the progression of symptoms contribute to heart-failure-related hospital admissions [1]. Nonetheless, self-management remains challenging for older adults [11]. Therefore, strategies are needed to actively engage older adults with heart failure to improve self-management in order to minimize exacerbation of ADHF and decrease the rate of preventable hospital readmissions.

Telehealth is a promising strategy to actively engage older adults in heart failure self-management by prompting the individual to assess and report changes in symptoms (dyspnea, fatigue, edema) and prescribed regimens (medication, diet, activity), as well as to collect vital signs and body

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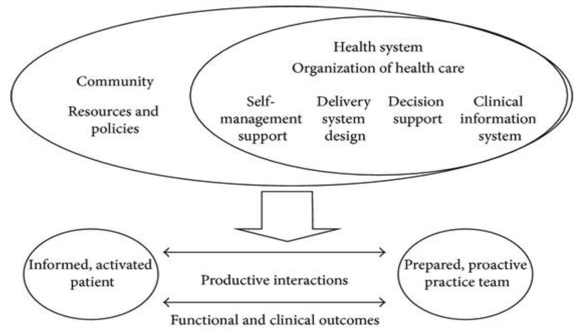

Figure 1a: The Chronic Care Model (Wagner, E. H., 1998). Reprinted with permission.

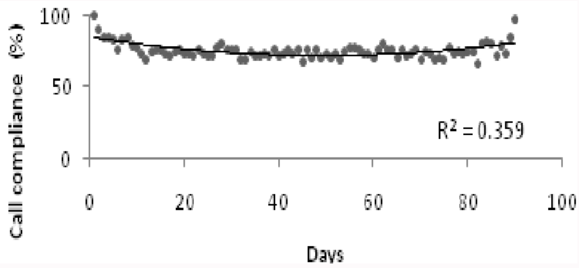

Figure 1b: Call Compliance over Time.

weight (Dierckx, Pellicori, & Clark, 2015). Telehealth technology has been shown to reliably measure both vital signs and weight [12,13]. Participation in a telehealth program has been associated with improvement in care coordination and increased medication compliance of individuals with chronic disease [14].

The impact of telehealth on older adult heart-failure-related hospital readmissions is not clear. In a Cochrane meta-analysis of small studies, telehealth was associated with a reduction in hospital readmission rates [15]. Conversely, in controlled trials of older adults, no significant difference was found between telehealth participants and individuals receiving care in the clinic setting for heart-failure-related hospital readmissions [16].

Studies on the impact of telehealth should include information on participant compliance to submitting telehealth measures in order to describe an aspect of self-management [17]. Compliance can be defined as the extent to which a participant's behavior coincided with the action recommended by the healthcare provider [4]. Telehealth call compliance was reported in the above-mentioned meta-analysis and controlled trial but was calculated by different methods in each [15,16]. Among the five telehealth studies within the meta-analysis, call compliance was calculated as the number of received daily telehealth submissions divided by the number of expected submissions in three studies and ranged from 74% to 97% [18-20]. In the fourth study, participants were considered compliant if they submitted daily requested telehealth data at least every two days, and 98.5% call compliance was reported [21]. In the fifth study, participants were considered compliant if they submitted weekly data, and 81% call compliance was reported [13]. In the large controlled trial conducted by Chaudhry et al. [16], call compliance was calculated as a proportion of weeks with at least three days of submissions; in that study, call compliance was 90.2% at week 1 and 55.1% at week 26.

The considerable resources required to optimize telehealth compliance was noted in all of the above studies. Most compliance studies have been randomized controlled trials operating within rigid protocols and not necessarily reflecting daily, real-world telehealth use [22]. The aim of this real-world retrospective study was to describe participant compliance the initial 90 days of telehealth program enrollment in a veteran population. The Chronic Care Model designed to illustrate ongoing self-management behaviors of an informed, active patient within a prepared, proactive healthcare system guided the study [23].

Method

A retrospective descriptive design was used to examine the medical and telehealth records of older adults with heart failure participating in one Veterans Health Administration's (VHA) Care Coordination Home Telehealth (CCHT) program between September 2007 and September 2013. The study was approved, with waivers of consent, by Institutional Review Boards at the Veteran Affairs of Connecticut Healthcare System (VACTHCS), West Haven, CT and the University of Utah, Salt Lake City, UT.

Chronic Care Model

The Chronic Care Model (CCM) was the theoretical framework used to guide this telehealth study (Figure 1a). The CCM allows for reviews of the health status of individuals within the context of community, the health system, self-management support, delivery system design, and clinical information systems (Coleman, Austin, Brach, & Wagner, 2009). Within the telehealth program, the CCM provides a framework to illustrate the ongoing self-management behaviors of an informed, active participant interacting with the healthcare delivery system (Desai & Stevenson, 2010).

Sample

The final study sample included 187 records of participants meeting the following inclusion criteria: 60 years of age or older, residing at a private residence, evaluated as oriented to place and time prior to telehealth program participation, and using telehealth equipment supplied by Cardiocom® or Health Buddy® vendors. Participants were assigned to one of two telehealth systems-the Health Buddy® system, first available in 2007; or the Cardiocom® system, first available in 2011-based on equipment availability at the time that each participant joined the telehealth program. Veterans who were participating in a medical device or clinical trial, had memory limitation, or had a life expectance of less than three months were excluded from participating in the CCHT program. Records of telehealth participants using telehealth equipment that was supplied by other vendors, that connected to the Internet, or that contained audio or video features were excluded.

Data Collection

Demographic and medical history information was obtained from the secure password-protected electronic medical record. Daily telehealth data were extracted from the Cardiocom® and Health Buddy® secure password-protected telehealth program websites. The medical and telehealth records were linked and de-identified by the principal investigator. The de-identified information for demographic, medical history, and telehealth data were organized by participant number in an excel file and imported into SPSS 22 [24] for analysis.

Demographics and Health History

Demographic data included age, gender, race, ethnicity,

Table 1: Frequency and Percentage Summaries of Demographics and Health History.

Variable	Frequency	Percent
Gender		
Male	183	97.9
Female	4	2.1
Ethnicity		
Spanish Hispanic	3	1.6
Non-Hispanic	180	96.3
Unknown or Unreported	3	1.6
Missing	1	0.5
Marital Status		
Currently married	74	39.6
Divorced or widowed	90	48.1
Never married	23	12.3
Race		
American Indian	1	0.5
Native Hawaiian; Pacific Islander	1	0.5
Black African American	21	11.2
White	164	87.7
Education Level		
Unknown	3	1.6
Some High School	30	16
HS Grad or GED	79	42.2
Vocational After HS	19	10.2
Some College AAS	40	21.4
College Grad BA BS	14	7.5
Completed MA MS	2	1.1
ACEI or ARB Medication		
No	76	40.6
Yes	111	59.4
Medication Beta Blocker		
No	42	22.5
Yes	145	77.5
Medication Loop Diuretic		
No	55	29.4
Yes	132	70.6
B-Type natriuretic peptide (BNP)		
Missing	4	2.1
<100 pg/mL	56	29.9
≥100 pg/mL <600 pg/mL	62	33.2
>600 pg/mL	65	34.8
Chronic pulmonary disease		
No	82	43.9
Yes	105	56.1
Chronic renal insufficiency		
No	120	64.2
Yes	67	35.8
Diabetes Mellitus		
No	96	51.3
Yes	91	48.7
Hypertension		
No	12	6.4
Yes	175	93.6
Left Ventricular Ejection Fraction		
Missing	9	4.8
Systolic dysfunction <40%	47	25.1
Preserved systolic function ≥ 40%	131	70.1

education level, and marital status. Medical history information recorded in the most recent progress note prior to telehealth program participation was collected. Co-morbidity data included measures commonly collected in heart failure studies: ischemic vascular disease of myocardial infarction or stroke, diabetes mellitus, hypertension, chronic lung disease, and chronic renal disease [25]. Left ventricular ejection fraction (LVEF) percentage and serum B-Type natriuretic peptide (BNP) data were included because both are diagnostic measurements of heart function [3]. Data for first-line prescribed medications of angiotensin-converting enzyme inhibitors or angiotensin receptor blockers (ACE-I or ARBs), and/or beta blockers, and/or loop diuretics for heart failure management were included as guideline recommendations from the American College of Cardiology Foundation (ACCF) and American Heart Association (AHA) [4].

Telehealth Data

Telehealth participants used a vendor-supplied wireless scale and a telehealth device connected to the home telephone service. Daily telehealth submission data were collected during the initial 90 days of program participation, including heart rate, systolic blood pressure, diastolic blood pressure, body weight, and responses to prompts displayed on the telehealth device for adherence-to-recommendations and recognition-of-change in symptoms. Despite telehealth program instructions to submit daily data, participants may not have submitted data each day and may not have continued program participation throughout the review period. Therefore, individuals were no longer considered participants in the program after the last day they submitted data. First, daily compliance was defined by whether or not an individual still participating in the study submitted any data on any given day. Call compliance was calculated in two ways. Total call compliance was calculated from the number of days of submitting any telehealth data divided by the number of days of program participation (range 1–90). Daily and total call compliance was reported as averages of the sample. Although data were collected from two telehealth systems, the measures were similar for participant submission of physiologic, adherence, and recognition of symptom data. However, variation in order and wording of displayed prompts was identified between the Cardiocom® and Health Buddy® systems (Appendices A & B); therefore, the percentage of telehealth submissions were reported first as combined telehealth results and then separately for users of the two telehealth systems.

Statistical analysis

Statistical analyses were performed using SPSS 22 [24]. Univariate descriptive methods (i.e., frequencies, percentages, means, and standard deviations [*SD*]) were used to analyze the naturally-occurring demographic characteristics, co-morbidities,

Table 2: Program Participation and Call Compliance.

Variable	Combined (n = 187)	Cardiocom® (n = 86)	Health Buddy® (n = 101)	Telehealth System Difference t	p
Program Participation(%)	88.7(*SD*=22.8)	85.0(*SD*=28.6)	91.7 (*SD* = 15.8)	1.95	0.053
Total call compliance (%)	75.8 (*SD* =5.5)	76.7(*SD*=21.3)	75.0 (*SD* = 23.9)	1.04	0.298

Note. $p < 0.05$ is significance level.

Table 3: Total Compliance for Telehealth Measures.

Measure	All Data (n = 187) Call Compliance Percentage	Cardiocom® (n = 86) Call Compliance Percentage	Health Buddy® (n = 101) Call Compliance Percentage	t	p
Physiologic Measures					
Heart rate	64.9 (*SD* = 29.3)	61.6 (*SD* = 30.8)	67.6 (*SD* = 27.9)	1.41	0.16
Systolic blood pressure	66.2 (*SD* = 28.2)	64.4 (*SD* = 28.8)	67.7 (*SD* = 27.8)	0.80	0.43
Diastolic blood pressure	66.2 (*SD* = 28.2)	64.4 (*SD* = 28.8)	67.7 (*SD* = 27.8)	0.80	0.43
Weight	69.8 (*SD* = 25.0)	69.7 (*SD* = 26.0)	69.9 (*SD* = 24.3)	0.04	0.97
Self-Rated Health Status Measures					
Medication	64.0 (*SD* = 25.5)	53.7 (*SD* = 25.0)	69.6 (*SD* = 24.1)	3.90	0.001[a]
Diet	65.6 (*SD* = 27.4)	63.6 (*SD* = 29.5)	67.3 (*SD* = 25.6)	0.91	0.36
Physical activity	64.6 (*SD* = 28.9)	61.1 (*SD* = 32.3)	67.6 (*SD* = 25.4)	1.53	0.13
Dyspnea	66.1 (*SD* = 27.9)	65.1 (*SD* = 26.9)	67.0 (*SD* = 26.9)	0.47	0.64
Fatigue	52.7 (*SD* = 28.2)	42.6 (*SD* = 27.3)	61.3 (*SD* = 26.1)	4.78 0.001[a]	
Edema	63.7 (*SD* = 27.9)	64.6 (*SD* = 28.9)	62.9 (*SD* = 27.1)	0.43	0.67

[a] $p < 0.01$ is significance level.

LVEF percentage, BNP, medications, telehealth measures, and call compliance. Comparisons between total call compliance and participant characteristics, medical history, and telehealth measures were performed using ANOVA, *t*-test, and bivariate correlations. Changes across a period of time can be modeled using a regression curve-fitting procedure to account for both linear and nonlinear effects [26,27]. A nonlinear model using the curve-fitting procedure was used to reflect changes in daily compliance where day within the review period was the independent variable and daily compliance was the dependent variable. Significance of the coefficients model was checked using *t*-test. Results were considered statistically significant with a *p* value < 0.05.

A sensitivity analysis was conducted using the smaller dataset from the Cardiocom® participants (n = 86) with an alpha 0.05 and power 0.80 using the program G*Power v 3.1 [28]. The sample of 86 participants was adequate to detect a medium effect size from either the Cardiocom® or Health Buddy® datasets.

Results

Demographics and health history

Participant demographics and health histories as reported in the medical record are shown in (Table 1). The mean participant age was 73.9 years (*SD* = 9.73, range 60 to 93). Most participants were male (n = 183; 97.9%), non-Hispanic (n = 180; 96.3%), and White (n = 164; 87.7%). Almost half of participants were divorced or widowed (n = 90; 48.1%). Most participants were educated at the high school level or higher (82.4%). At the time of participation, most had hypertension (n = 175; 93.6%), and many had LVEF ≥ 40% (n = 131; 70.1%). Heart failure medications varied, with many participants prescribed an angiotensin-converting enzyme inhibitor or angiotensin receptor blockers (ACE-I or ARBs) (n = 111; 59.4%), and/or beta blockers (n = 145; 77.5%), and/or loop diuretics (n = 132; 70.6%; (Table 1).

Telehealth participation

Program participation: The majority of veterans (n = 112; 59.9%) participated in the program throughout the review period (100% program participation). On average, participants remained in the program 88.7% of the 90-day review period, ranging from 4.4% to 100% of the time. Among the 75 (40.1%) individuals participating less than the full review period, the average program participation was 71.8% (*SD* = 28.6), ranging from 4.4% to 98.9%. Individuals did not remain in the program for a number of reasons, which included no longer wishing to participate in the program (n = 46; 61.4%), requiring a higher level of care (n = 7; 9.3%), relocation (n = 1; 1.3%), provider discharge from telehealth (n = 6; 8.0 %), or participant lack of collaboration resulted in retrieval of equipment after an average of 31 days (n = 6; 8.0%). The reason for program discharge was not selected in the documentation of nine (12%) participants. No significant difference for percent of program participation was found between users of the Cardiocom® (n = 86) and Health Buddy® (n = 101) telehealth systems (Table 2).

Telehealth Compliance

Call compliance

The average total call compliance, defined as the number of days with telehealth submissions divided by the number of program participation days, was 75.8% (*SD* = 5.5). Even though participants were instructed to submit telehealth data every day, only 8.0% of individuals did so for the entire 90-day review period. No significant difference in total call compliance was found between users of the Cardiocom® and Health Buddy® telehealth systems see (Table 2). Results for change in compliance over time showed a significant nonlinear effect, (t = 6.64, $p < 0.001$; see (Figure 1b). The nonlinear regression for daily compliance reflects full compliance (100%) at Day 1 followed by a sharp decline during the first week and a leveling

Table 4: Percent of Compliance for Medical History Measures.

	Independent Samples *t*-tests					
	Characteristic Present		Characteristic Not Present			
	Percent	*SD*	Percent	*SD*	*t-test*	*p*
Variable						
Preserved left ventricular ejection fraction (≥ 40%)	75.2	23.5	74.4	20.1	0.82	0.33
History of Diabetes mellitus	74.0	22.6	75.7	23.0	0.52	0.53
Hypertension	74.3	23.0	82.9	17.4	1.26	0.13
Myocardial infarction or stroke	77.3	21.2	73.7	23.5	1.00	0.50
Chronic pulmonary disease	77.2	21.7	71.9	23.9	1.57	0.14
Chronic renal disease	73.4	22.8	75.7	22.8	0.64	0.68
Medications						
Beta adrenergic blockers	75.9	22.3	71.4	24.1	1.12	0.64
Loop diuretics	74.6	23.0	75.5	22.5	0.24	0.57
Angiotensin-converting enzyme inhibitor Or angiotensin receptor blocker	75.4	22.1	74.1	23.8	0.39	0.56

Note. SD= Standard Deviation, *p < 0.05 is significance level.

off as participation progressed. Compliance on day 90 was an obvious outlier.

Physiologic measures

Total compliance was highest for the physiologic measures of weight (69.8%), heart rate (69.4%), and blood pressure (66.2%), with no significant difference between users of the two telehealth systems see (Table 3).

Adherence measures

A medication prompt was displayed weekly for users of the Cardiocom® system and daily for users of the Health Buddy® system. Among the 187 participants, total compliance to the medication prompt was 64.0%; however, users of the Health Buddy® system had significantly higher (69.3%) total compliance than users of the Cardiocom® system (53.7%), $t(153)$, 3.85, $p < 0.001$ for this prompt. No significant difference for diet (65.6%) or physical activity (64.6%) total compliance was measured between users of the two telehealth systems see (Table 3).

Recognition of symptom measures

A prompt for fatigue was displayed approximately once each week in both telehealth systems. Among the 187 participants, total compliance for the fatigue prompt was 52.7%; however, users of the Health Buddy® system had significantly higher (61.3%) total compliance than users of the Cardiocom® system (42.6%), $t(185)$, 4.78, $p < 0.001$. Dyspnea was the only symptom prompt displayed every day in both telehealth systems. Average total compliance for the dyspnea measure was 66.1%, with no significant difference between users of the two telehealth systems. Average total compliance for the edema measure was 63.7%, with no significantly different between users of the two telehealth systems see (Table 3).

Call Compliance and participant characteristics

Pearson correlation showed no association between total compliance and age ($r = 0.014$; $p = 0.86$). ANOVA testing showed no association between total compliance and the means of levels for race $F(3, 183) = 1.39$, $p = 0.25$; education $F(6, 180) = 0.71$, $p = 0.64$; marital status $F(2, 184) = 0.17$, $p = 0.85$; or BNP $F(3, 183) = 0.52$, $p = 0.67$. Similarly, independent samples *t*-tests showed no significant association between total compliance and the bivariate measures of LVEF, clinical history, or prescribed medications see (Table 4).

Discussion

Most previous telehealth program participation results are from randomized controlled trials that invest considerable amounts of study resources to optimize telehealth participation [16]. Very few studies have explored telehealth participation within a real-world construct [29]. The purpose of this study was to describe the reality of one specific telehealth program using naturally-occurring data, with a focus on both total and daily compliance during the initial 90 days of telehealth program participation in a sample of older veterans with a diagnosis of heart failure.

A key finding of the study was that total compliance was 75.8%. Telehealth total compliance within the five randomized trials described in meta-analyses by Inglis et al. [15] included 82% among a sample of 67 reported by Capomolla et al. [18], 89% among a sample of 20 reported by de Lusignan et al. [19], and 97% among a sample of 160 reported by Soran et al. [20]. Goldberg et al. [21] reported a 98.5% compliance rate using a relaxed definition for telehealth compliance from daily submissions received every 1–2 days, and Mortara et al. [13] reported an 81% compliance rate for weekly submissions. Chaudhry et al. [16] described compliance as a proportion of weeks with at least three days of submissions, with compliance reported as 90.2% at week 1 and 55.1% at week 26. Variations in call compliance identified between the current study and those reported in randomized controlled trials may be a result of different approaches to calculating compliance. However, these results are congruent with observations by Koppenall et al. [30], who showed that compliance to healthcare practices within randomized controlled trials tend to measure higher than compliance to the same measures in the real-world setting. Adoption of a specific method to calculate compliance among similar datasets will provide a consistent framework and improve the quality of data comparison between research studies [31]. Since there is a lack of standardized means for calculating telehealth call compliance, the current study method of calculating call compliance from the number of days of submitting any telehealth data divided by the number of days of program participation may be a constraint on generalizability of findings.

Similar to the findings reported by Chaudhry et al. [16], daily call compliance decreased after program onset. Calculating compliance for each day in the current study helped identify when compliance decreased among the sample. There was a statistically significant sharp decline in daily compliance during the first two weeks, which leveled off for the remainder of the study period. Conducting a literature review of patient compliance in telehealth programs, Maeder and colleagues [32] similarly reported that compliance drops off most rapidly in the period immediately after the start of a telehealth program.

In this study's sample, individuals began leaving the program as soon as four days after beginning. In prior investigations, lower compliance has been attributed to participant frustration while using the technology [32,33]. In a randomized trial investigating telehealth use among older adults with chronic pulmonary disease, 50 participants assigned to the technology-based group wore a bracelet that beeped five times each day as a reminder to collect a pulse oximeter reading [33]. The authors reported that participant non-compliance and early discharge from the program was associated with dissatisfaction with the technology either from discomfort using the telehealth device or disruption in the participant's life rhythm [34]. In the current study, "*no longer wishing to participate*" was frequently noted in program discharge records, but if this was from dissatisfaction with the technology, that reason was not elucidated.

Passive procurement of data collected within a telehealth program occurs when an individual uses wireless equipment, such as a weight scale, and the collected data are automatically uploaded to a synchronized data collection source [35]. In this study, measures for weight, heart rate, and blood pressure data were passively procured. In contrast, adherence and symptom data were actively procured only when the participant deliberately took the time to turn on the telehealth device and input answers to self-rating prompts. In this study, compliance for passively collected data was higher than that of actively collected data, similar to findings reported within literature reviews that included description for the comparison of the two equipment methods [35,31].

There were occasions when participants did not respond to all prompts within the session, which contributed to compliance differences between the two telehealth systems for the self-rated measures of medication adherence and the symptom of fatigue. Utilizing retrospective data, participant reasons for skipping a specific prompt within a session were unable to be determined. However, ease-of-use when responding to a telehealth prompt has been associated with higher participant compliance [36]. Compliance to self-reported health status measures in the current study was highest among users of the Health Buddy system for the medication prompt viewed each session: *"In the past 24 hours, have you taken all of your medicine(s) as ordered?"* Receiving the same medication adherence prompt each session may have contributed to ease-of-use for the Health Buddy system users when compared to prompts with a variety of medication-adherence questions received by users of the Cardiocom® system. Fatigue prompt compliance was also higher among users of the Health Buddy® system, who received content describing fatigue within the prompt—such as, *"Are you more fatigued or tired and unable to do routine activities (like cooking, dressing, bathing) today?"*-compared to a general inquiry regarding the symptom of fatigue received by users of the Cardiocom® system. In a previous evaluation for the usability of telehealth technology by older adults, eight study participants with chronic pulmonary disease were asked to think aloud during observed telehealth sessions [33]. Participants stated that prompts were not always easy to answer, adjustment to wording of previously challenging prompts increased participant satisfaction, and further supports the importance of evaluating ease-of-use to optimize compliance [33]. In the current study, content within prompts may have influenced ease-of-use and may account for some of the variability in total compliance identified between users of the two telehealth systems for the two described self-rated measures for medication adherence and the symptom of fatigue.

The benefit of self-management is that it supports one's own ability to actively monitor health status over time. The clinical syndrome of heart failure is identified as an age-related disease. The challenge for an individual with heart failure is that heart function may deteriorate over time [1]. In this study's sample, advancing age was not found to impact compliance to the telehealth program, similar to previous findings that telehealth program compliance was similar between heart failure participants older than 70 years and younger telehealth users [37]. These results suggest that advancing age should not be exclusion criteria when considering assigning individuals to a telehealth program.

The Chronic Care Model Wagner et al. [23] is well-suited to illustrate the use of health informatics, disease management, and home telehealth technologies when describing support that favorably influences self-management by older adult with heart failure. The Care Coordination Home Telehealth service within the Veteran Health Administration implements the Chronic Care Model to help move toward the goal of making the patient's home into the preferrred place of care where possible and appropriate [14]. The Chronic Care Model illustrates the productive interactions that may occur when identifying and addressing participant challenges and dissatisfactions while participating in the telehealth program. A larger prospective study is needed to identify factors that contribute to either ease-of-use or participant frustration with the technology and measure the impact of these factors on compliance to the telehealth program.

Limitations

Limitations of this study include its small size and convenience sample of telehealth participants from one regional Veteran Healthcare setting. After review of the descriptions for a large sample of older veterans with chronic diseases Selim et al. [38], the current study sample is identified as sicker. In addition to their chronic heart failure, participants in the current sample had a respectively higher proportion of hypertension (93.5% *vs.* 65.7%), myocardial infarction (32.6% *vs.* 28.3%), diabetes mellitus (48.7% *vs.* 28.2%), and chronic pulmonary disease (56.1% *vs.* 25.8%) than the larger sample of older veterans.

The veteran population is identified as sicker than the non-veteran U. S. population [39], and the sicker health status characterization of our sample may be a constraint on generalizability of findings. When reporting daily compliance, the reason for the identified obvious outlier on Day 90 is unknown and is identified as another limitation. Finally, the inherent disadvantage of analysis of retrospective data is that it did not provide for collection of direct information from participants on factors that may have influenced call compliance. Descriptions were unable to be provided for participants' perceived barriers to using technology, discomforts with using the telehealth device, life disruptions associated with program participation, or any uncertainties experienced when responding to self-rated prompts on health status.

Conclusion

In summary, compliance measured lower using this real-world dataset than compliance reported within randomized controlled trials. Adopting the specific method of calculating call compliance from the number of days of submitting any telehealth data divided by the number of days of program participation allows for comparisons to other compliance studies using a similar approach. Calculating daily compliance allows for the identification of compliance change as the program progresses over time. There was a sharp drop in compliance throughout the initial week of program participation; therefore, initial start-up is identified as a vulnerable period of time for telehealth program participation. While no difference was measured in total call compliance between users of the two telehealth systems, compliance differences between systems for the medication and fatigue self-rating prompts highlight the need for future research to investigate ease-of-use and participant perceptions about the technology. No relationship was identified between call compliance and participant characteristics, including age; therefore, older adults with heart failure should not be excluded from participating in a telehealth program. In order to sustain program participation, efforts to provide additional support to new participants at the program's onset and periodically thereafter may positively impact program participation long-term.

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