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Home Telehealth Technologies for Heart Failure: An Examination of Adherence Among Veterans

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Abstract

The current retrospective cohort study uses Department of Veterans Affairs (VA) clinical and facility data of Veterans with heart failure enrolled in the VA Home Telehealth (HT) Program. General estimating equations with facility as a covariate were used to model percent average adherence at 1, 3, 6, and 12 months post-enrollment. Most HT patients were White, male, and of older age (mean = 71 years). Average adherence increased the longer patients remained in the HT program. Number of weekly reports of HT use, not having depression, and being of older age were all associated with higher adherence. Compared to White Veterans, Black and other non-White

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Veterans had lower adherence. These findings identify subgroups of patients (e.g., those with depression, of younger age, non-White) that may benefit from additional efforts to improve adherence to HT technologies.

Use of home telehealth (HT) programs for daily monitoring of chronic disease signs and symptoms is increasing. Specific to heart failure, systematic reviews support the use of remote monitoring and HT in reducing readmissions and mortality; however, results have not been consistent (Bashi et al., 2017). Studies have reported statistically significant improvements and lack thereof in health status compared to control groups (Bashi et al., 2017; Ong et al., 2016; Ware et al., 2019). Variations in rates of adherence to telemonitoring technologies could explain the discrepancy (Inglis et al., 2016; Ong et al., 2016; Ware et al., 2018; Ware et al., 2019). In one recent randomized controlled trial, Ong et al. (2016) reported that only 55.4% of patients randomized to telemonitoring were using technology at least 50% of the time in the first 1 month, and only 51.7% of the time at 6 months.

As heart failure has high mortality rates, total costs (Groeneveld et al., 2018), and readmission rates (Kaboli et al., 2012), it is critical to understand adherence to HT in this population. Few studies have examined predictors of Veteran adherence to HT technologies. One regional study of Veterans with heart failure found that adherence to telehealth technologies decreased significantly in the first 90 days post-enrollment (Guzman-Clark et al., 2013). Examining HT program adherence and its predictors will be important to ensuring HT program efficiency and success.

The current study is a retrospective program evaluation that (1) describes adherence to HT technologies by Veterans with heart failure in the first 1 year after enrollment in the Veterans Health Administration (VHA) HT Program; and (2) identifies patient characteristics associated with adherence to HT technologies at 1, 3, 6, and 12 months after first use of the HT device.

METHOD

Research Design and Data

The current retrospective cohort study uses Department of Veterans Affairs (VA) data, including adherence to daily HT technology use from the HT Program Office and covariates (e.g., demographics, health services use, clinical elements) from the VA Corporate Data Warehouse (a repository of data from the electronic health record used in clinical care) (Gonsoulin, 2016). Institutional Review Board approval was obtained prior to the start of the study. The Andersen Behavioral Model was used as a framework to study the relationship between environment and patient characteristics and health behavior, namely adherence to HT technologies over time (Anderson, 1968; Anderson, 1995). The Andersen model includes predisposing characteristics, enabling resources, and need factors to define patient characteristics.

VA Home Telehealth Program Description

The VA has been at the forefront of HT for patients with heart failure. The VA's HT Program began approximately 20 years ago and has seen dramatic growth in recent years. In fiscal year 2016, the program provided more than 150,000 Veterans with HT services for a variety of chronic conditions, with an associated 59% reduction in hospital length of stay and a 31% decrease in hospital admissions overall (VA Office of Public Affairs & Media Relations, n.d.).

HT is a service available through the VA in which a Veteran is assigned a care coordinator to help manage chronic diseases using health technologies (VA Office of Academic Affiliations, n.d.). Inclusion criteria for enrollment in HT include: multiple hospital admissions in the past 1 year, frequent emergency department (ED) visits, being at risk for institutionalization, having frequent face-to-face visits for chronic disease management, or having complex conditions and problems in regularly making clinic visits due to homebound status or travel problems (VA Office of Academic Affiliations, n.d.). Exclusion criteria for HT enrollment are: living in a nursing home (i.e., already institutionalized), lack of interest in participation in the HT program, and being outside the service area.

HT patients are expected to participate in daily monitoring using HT technology (VA Office of Academic Affiliations, n.d.). The system also includes Disease Management Protocols, which are a series of questions presented on a regular basis to the Veteran that screen for disease exacerbation and patient self-management needs that then drive care coordination interventions and education provided by HT Care Coordinators (Guzman-Clark et al, 2013). Disease Management Protocols also provide educational information specific to the disease and self-management tips. Types of HT technologies vary and include a web browser, interactive voice response, and in-home messaging devices with or without peripheral devices for vital signs monitoring (e.g., blood pressure cuff, weighing scale) (VA Office of Academic Affiliations, n.d.). Type of technology given to patients depends on their needs and abilities. Once enrolled, patients are assigned reasons for enrollment, which include need for non-institutional care, acute care, chronic care management, or health promotion/disease prevention. Patients assigned to non-institutional care usually require a higher level of care (e.g., an assisted living facility) if they are not enrolled in programs to support continued safe community dwelling (VA Office of Inspector General, 2015).

Participant Selection

Veterans included in the current study enrolled in the VA HT Program between January 1, 2014 and June 30, 2014, for heart failure and were assigned to the Heart Failure Disease Management Protocol using a messaging device, web browser, or interactive voice response. Exclusion criteria were being enrolled during this same time period and assigned to a different Disease Management Protocol without heart failure (e.g., for diabetes only).

Measures

The primary outcome examined in the current study was percent average adherence at 1, 3, 6, and 12 months following first use of HT technology. *Weekly percent adherence*, defined as the number of days the patient used the technology in a week (0 to 7 days) divided by the

number of days in the week (usually 7), to HT technologies was calculated from weekly response reports obtained from the VA HT Program Office. Adjustments to the denominator were made if the patient was hospitalized (i.e., if the patient was in the hospital for 3 days of 1 week, then the denominator for that week [7 days minus 3 days] is 4, as that is the number of days the patient could have used HT technology at home). Average adherences were then calculated for 1 month (4 weeks), 3 months (12 weeks), 6 months (26 weeks), and 1 year (52 weeks) after first HT technology use. All patients were included in the 1-month cohort, but patients were only included in subsequent groups if they had weekly response reports during the time frames mentioned. Patients who stopped using their HT technology after the first month were not included in subsequent models based on time points because they were discharged from the HT program. Missing weekly adherence data (0 or null in the dataset) were not imputed, and number of weekly response reports obtained from the VA HT Program Office was included in the model to adjust for the amount of data that contributed to the outcome being studied (average adherence).

Based on the Andersen Behavioral Model, predisposing factors included age, race, gender, health service use during 1 year prior to HT use (length of inpatient stays, number of ED visits to a VA facility, VA hospital admissions and readmissions after 3 days of an index hospital admission, and VA primary care and cardiology clinic visits). Presence of an implantable cardiac device, pacemaker, or left ventricular assist device was also included as a predisposing factor because a prior study found improved adherence to medications after a cardiac device was implanted (DerSarkissian et al., 2016). Enabling factors included service connection (higher service-connected disability comes with access to certain benefits [e.g., monetary compensation] and services [e.g., priority access to VA nursing homes]) (VA Office of Public & Intergovernmental Affairs, 2015) and familiarity with use of other health technology (i.e., having signed up for the My HealtheVet program [the VA's patient portal]) (My HealtheVet,n.d.). Need factors included comorbidity, as measured by the Charlson Comorbidity Index using diagnostic administrative data (Quan et al., 2005), probability of hospital admission or death in 90 days as categorized by a Care Assessment Need score of ≥95% (Fihn & Box, 2013), a diagnosis of depression, cardiac ejection fraction, and reason for enrollment in the HT program. Type of HT technology used (e.g., in-home messaging device hub, web browser, interactive voice response) was also included as a potential covariate.

Available organizational variables (i.e., rurality of VA facility that the patient used, HT program size [number of patients enrolled at the end of June 2014 in the local facility], and academic affiliation of the patient's facility) were included to account for possible facility level differences.

Data Analysis

Descriptive statistics were used to describe patient and facility level variables and percent average adherence at 1, 3, 6, and 12 months. Missing ejection fractions were imputed. Due to non-normal distribution, length of hospital stays, ED visits, and hospital admissions and readmissions were categorized as *none* or *any*, and the number of primary care and cardiology clinic visits were log transformed prior to analysis. Spearman correlation for

continuous variables, chi-square methods for categorical variables, and analysis of variance were used in the bivariate analyses to determine potential associations with average adherence at various time frames. Multicollinearity was evaluated using the variance inflation factor in a linear model with adherence as the outcome. ED visits, hospital admissions and readmissions, and length of stay were highly correlated, thus only prior year hospital admission was used in the models. General estimating equations (GEE) were used to account for clustering by facility with an unstructured covariance matrix, as this had the smallest quasi-likelihood information criterion. Analyses used the VA Informatics and Computing Infrastructure (VINCI) platform (VA Health Services Research & Development, n.d.), Statistical Analysis System 9.2, and R 3.4.

RESULTS

The final cohort included 3,449 Veterans from 141 VA facilities nationwide. Most patients were White (75%), male (98%), used an in-home messaging device (78%), and had a Care Assessment Need score of ≥95% (58%) (Table 1). Approximately one half of patients enrolled in the VA patient portal My HealtheVet (46%), and one third had a diagnosis of depression (29%). Most patients received their health care in a VA facility that was in an urban area (91%) and had an academic affiliation (96%). Mean patient age was 71 years and mean ejection fraction was 43% (Table 1). Mean number of ED visits in the past 1 year was 2.2 *(SD* = 3.4), with 33% of the sample having no ED visits.

Approximately 15% of patients died in the first 1 year after first use of HT technology, and 66% were still using the device 12 months after first use. Percent average adherence increased over time from 53% at 1 month and 69% after 1 year despite fewer patients using their HT technology (3,449 at baseline and 2,291 after 1 year). Table 2 describes average adherence and number of weekly response reports obtained at each time frame studied.

Table 3 shows point estimates of predictors that were found to be statistically significant ($p < 0.05$) at specific time points. Higher number of weekly response reports, not having depression, and being of older age were all significantly associated with higher average adherence, and Black race (as opposed to White race) was significantly associated with lower average adherence at all time points studied. Other variables were also found significant but varied depending on the time point being studied.

DISCUSSION

The current study is the first to examine characteristics that may influence use of HT technologies over time using VA data and is important for the design of future targeted interventions to improve VA HT Program efficiency (Gensini et al, 2017). Similar to other studies, the number of patients who remain enrolled in HT programs decreases over time (Guzman-Clark et al, 2013; Maeder et al, 2015; Ware et al, 2019). When average adherence for various time points was calculated (patients who dropped out at earlier times were not included in the calculation of average adherence in later times), patients who continued to use HT technology had better average adherence (53% average adherence at 1 month compared to 69% at 1 year). Individuals who continued to use HT technology may have

found comfort in knowing that someone was monitoring them and/or may have built a relationship with telehealth nurses or staff such that they preferred telehealth over in-person care (Gorst et al, 2014). In addition, in view of the high rate of patients declining to participate in telehealth programs noted in many clinical trials (Foster et al, 2015), program leaders may want to consider putting processes in place to capture patients who initially decline participation, as sustainability of programs involves continued enrollment of new patients in addition to sustained engagement of current patients (Foster et al, 2015; Sanders et al, 2012).

Special focus should be given to various populations to increase our understanding of reasons why they have poor average adherence. Older age was associated with increased percent average adherence at all time frames studied, and other studies have noted that older patients have better HT program engagement compared to younger patients (Maeder et al, 2015; Ong et al, 2016). This finding may be due to older adults having more time for self-care and management during retirement. Other modalities (e.g., smartphones) may better serve younger populations to improve remote monitoring for chronic disease management. Having depression and non-White race were associated with decreased adherence to HT technologies. Depression has been found in prior studies to be associated with decreased adherence to use of HT technologies (Corotto et al, 2013; Rosen et al, 2017) and is most concerning due to the high prevalence of depression in patients with heart failure (Corotto et al, 2013). Race has not been consistently associated with adherence in prior studies that used telemonitoring, which may be explained by differences in sample characteristics and details of the telemonitoring intervention (Rosen et al, 2017). However, current findings from our large national study suggest that increased support should be provided to patients who are non-White and those with depression to encourage continued use of HT technology. This support could include a range of approaches, such as using a daily adherence reminder (Bui & Fonarow, 2012) and collaborating with VA mental health care experts in managing Veterans with depression who are enrolling in HT for chronic disease management (VA Office of Public & Intergovernmental Affairs, 2016).

In our study, several variables were found to be significant predictors of percent average adherence, but not consistently for each time frame studied. Our finding that Veterans with lower service connection percentage had higher adherence is similar to a recent study that also examined service connection in Veterans with heart failure (Yoon et al, 2016). It is unclear why lower percent service connection was found associated with higher average adherence at 3 and 6 months. It may be that higher service connection leads to adequate monetary compensation to allow Veterans access to other services outside of the VA, such that they are not dependent on their HT technologies for chronic disease management. Similar to other studies, left ventricular ejection fraction was used as a measure of functional capacity in the current study (Batalli et al., 2017). Higher ejection fraction was associated with higher average adherence at 3 and 6 months. Further research is needed to clarify the role of ejection fraction on other factors (e.g., activities of daily living) that were not available in this secondary data analysis study, which may have a more direct link with patient adherence to HT technologies. Having no prior hospital admissions was associated with higher average adherence only in the first 1 month after first use of HT technology. In a prior study of patients with heart failure who used an in-home messaging device, engaged

patients had a higher number of outpatient visits in the prior year compared to nonengaged patients (Kao et al., 2016). Further study is needed to determine how prior health service use may affect patient adherence to HT technologies and the duration of its effects.

Use of other types of technologies to support telemonitoring may influence adherence. In the current study, enrollment in an electronic health patient portal such as My HealtheVet, where patients can access their medical records, lab results, and request medications, could be considered a measure of patients' comfort and familiarity with technology. Patients who use My HealtheVet are considered more engaged with their health care (Turvey et al., 2012). Thus, it was not surprising that patients who were not enrolled in My HealtheVet had lower adherence at 1 and 3 months. As availability of electronic patient health portals becomes the norm, it is likely that patients will be more comfortable in their use, and likely other telehealth technologies as well. In addition, patients who used a web browser or interactive voice response instead of an in-home messaging device with a hub had 2.5% lower average adherence at 1 year. Prior studies have noted differences in which device patients would use when more than one type is available, possibly due to portability and ease of use (Inglis et al., 2015).

In the current study, only HT program size was found significant as a facility level predictor of average adherence. Prior research has reported organizational structures that affect successful implementation and program sustainability, but none are specific to program size (Bui & Fonarow, 2012; Sanders et al., 2012).

LIMITATIONS

The current study has several limitations. This study only focuses on Veterans with heart failure enrolled during a specific period in 2014. Other factors not available in the administrative data may be important in adherence to HT technologies as well as sustainability of HT programs within and outside the VA, such as patient—provider communication/interactions, ease of equipment use, patients' perceived benefits, patient health literacy level and training received, and self-efficacy in using HT technologies (Maeder et al., 2015; Seto et al., 2012). Other limitations inherent in electronic health record—based studies include information bias and misclassifications.

CLINICAL NURSING IMPLICATIONS

With the aging of the population, the subsequent expected rise in the number of Veterans receiving care for chronic progressive diseases, and the recent approval of a VA regulation that allows clinicians to provide care through telehealth modalities regardless of state laws that govern location of the patient and/or clinician during a telehealth interaction (Department of Veterans Affairs, 2018), it is important to think critically on how health care systems can promote sustained patient adherence to HT technologies for disease monitoring and to promote continued self-management. With the COVID-19 pandemic, home telehealth or remote patient monitoring programs are being increasingly used to monitor and manage high-risk patients at home, including those with positive COVID-19 screenings or tests to help decrease potential transmission of disease (Healthcare Information and Management

Systems Society, 2020; National Consortium of Telehealth Resource Centers, 2020). Nurses are often care managers and leaders in disease self-management, including chronic and acute disease monitoring and management provided through HT technologies, and are ideally situated to provide added supports to address factors associated with poor adherence. These supports may include screening for and addressing depression, problem solving with younger Veterans on how to incorporate use of HT technologies into their daily living, and identifying cultural barriers to the use of HT technologies in non-White patients.

CONCLUSION

This is the first national study to look at adherence to the use of HT technology for heart failure monitoring and management among Veterans. Future strategies should target subgroups of patients (e.g., those with depression, of younger age, non-White) who may benefit from additional efforts to improve adherence to HT technologies to optimize program effectiveness.

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TABLE 1

Patient Characteristics (N = 3,449)

Characteristic	*n* (%)	Mean (*SD*) (Range)
Age (years)		70.8 (10.4) (32.4 to 100.5)
Race		
White	2,577 (74.7)	
Black	645 (18.7)	
Other	227 (6.6)	
Gender		
Male	3,377 (97.9)	
Female	72 (2.1)	
Marital status[a]		
Married	1,415 (41)	
Divorced/separated	394 (24.6)	
Widowed	343 (9.9)	
Never married/single	176 (5.1)	
Has insurance other than VA[a]	2,436 (70.6)	
Income ($)[a]		24,609 (42,443) (0 to 1,380,244)
Caregiver available[a]	1,142 (33.1)	
Lives alone[a]	657 (19.1)	
Enrolled in My HealtheVet	1,602 (46.5)	
Ejection fraction (%)		42.7 (15.8) (7.5 to 89)
Presence of cardiac device	1,063 (30.8)	
Care Assessment Need (CAN) score		
<95%	1,308 (37.9)	
≥95%	2,008 (58.2)	
Reason for enrollment		
Non-institutional care	2,058 (37.9)	
Other	1,391 (58.2)	
Technology type		

Characteristic	*n* (%)	Mean (*SD*) (Range)
In-home messaging device	2,678 (77.7)	
Other	758 (21.99)	
Has depression	1,1016 (29.5)	
Charlson Comorbidity Index		6.5 (3.2) (0 to 22)
1 to 3 (lower comorbidity)	1,002 (29.1)	
4 to 5	793 (23)	
6 to 7	779 (22.6)	
8 to 22 (high comorbidity)	855 (24.8)	
Service connection		35.7 (42.8) (0 to 100)
<70%	2,324 (67.4)	
≥70%	1,125 (32.6)	
Rurality		
Urban	3,151 (91.4)	
Rural	298 (8.6)	
Program size		
Small	1,139 (33)	
Medium	1,155 (33.5)	
Large	1,155 (33.5)	
Goes to a facility with an academic affiliation	3,324 (96)	
Emergency department visit in the prior year		2.2 (3.4) (0 to 106)
0	1,138 (33)	
≥1	2,311 (67)	
Hospital admissions in the prior year		1.2 (1.6) (0 to 12)
0	1,503 (43.6)	
≥1	1,946 (56.4)	
Hospital readmission within 3 days of discharge in the prior year		0.04 (0.2) (0 to 3)
0	3,313 (96.1)	
≥1	136 (3.9)	
Length of hospital stay (days)		7.3 (16.9) (0 to 297)
0	1,514 (43.9)	
1 to 7	857 (24.9)	

Characteristic	*n* (%)	Mean (*SD*) (Range)
≥8	883 (25.6)	
Cardiology clinic visits		3.0 (4.1) (0 to 45)
0	1,094 (32)	
≥1	2,355 (68)	
Primary care clinic visits		8.9 (7.1) (0 to 54)
0	88 (2.6)	
≥1	3,361 (97.4)	

[a]Not used in the model; for descriptive purposes only.

TABLE 2

Average Adherence (%) and Number of Weekly Reports Submitted Per Time Period

Time Period (Months)	Sample Size	Measure	Mean	*SD*	Median	Range
1	3,449	Adherence	52.95	31.24	57.14	0 to 100
		Weekly reports	3.82	0.64	4	1 to 4
3	3,097	Adherence	62.85	27.28	69.05	0 to 100
		Weekly reports	10.44	3.22	12	1 to 12
6	2,670	Adherence	69.29	24.17	72.02	0 to 100
		Weekly reports	20.20	8.71	26	1 to 26
12	2,291	Adherence	69.17	22.79	73.63	0 to 100
		Weekly reports	34.04	19.43	43	1 to 52

TABLE 3

Predictors of Average Adherence By Various Time Frames - Point Estimate[a,b]

Variable	1 Month	3 Months	6 Months	12 Months
Number of weekly response reports submitted	16.93	6.24	2.24	0.60
Has no depression	3.00	3.83	4.13	3.79
Age	0.14	0.22	0.26	0.32
Race: Black versus White	−4.27	−5.16	−6.35	−5.03
Race: Other (non-Black) versus White	NS	−5.48	−6.63	−5.70
Not enrolled in patient portal	−5.25	−2.96	NS	NS
Ejection fraction	NS	0.07	0.06	NS
HT program size: Small versus large	NS	4.04	NS	4.85
Service connection <70%	NS	2.32	1.94	NS
No prior hospital admission	3.17	NS	NS	NS
Used a web browser or interactive voice response instead of an in-home messaging device	NS	NS	NS	−2.51

Note. NS = not significant.

[a] *All* $p < 0.05$ *unless otherwise stated.*

[b] Gender, reason for enrollment, rurality, primary care clinic visits, and Care Assessment Need scores were not found to be significant in bivariate screening.