TELEMEDICINE AND e-HEALTH
Volume 12, Number 3, 2006

Outcomes Associated with a Home Care Telehealth Intervention

FAITH HOPP, Ph.D.,[1] PETER WOODBRIDGE, M.D., M.B.A.,[2–4]
USHA SUBRAMANIAN, M.D., M.S.,[2,3,5,9] LAUREL COPELAND, Ph.D.,[7,8]
DAVID SMITH, M.D.,[3,5] and JULIE LOWERY, Ph.D.[1,6]

ABSTRACT

To determine whether adding telehealth technology to traditional home care services increases health-related quality of life (HRQOL) and home care satisfaction, and decreases resource utilization among home care patients. This trial included 37 home care patients receiving services in a Veterans Affairs medical center, randomized into intervention and control groups. Outcome measures included patient satisfaction and HRQOL at baseline and 6-month follow-up, and the use of inpatient and outpatient services before and during the 6-month study period. Intervention group patients reported greater improvement in the mental health component of HRQOL, ($t = 2.27$; $df = 15$; $p = 0.04$). Satisfaction with the telehealth equipment was high (means exceeded 4.0 on six measures ranging from 1–5). However, no statistically significant differences were observed between intervention and control groups in terms of changes in physical health, inpatient admissions, bed days of care, emergency department visits, or general satisfaction with home care services. Intervention group members did show a trend ($p = 0.10$) toward fewer overall outpatient visits (mean = 29.1; standard deviation [SD] ± 30.1) compared to those receiving traditional home care services (mean = 38.9; SD ± 28.9) The use of telehealth services as an adjunct to traditional home care is associated with greater improvements in mental health status and a trend toward lower use of inpatient and outpatient healthcare services. Further work, utilizing larger sample sizes, is needed to investigate the relationship between telehealth services, the use of healthcare resources, and other outcomes.

[1]HSR&D Center for Practice Management and Outcomes Research, VA Ann Arbor Health Care System, Ann Arbor, Michigan.
[2]Richard L. Roudebush VAMC, Center of Excellence on Implementing Evidence-Based Practice, Indianapolis, Indiana.
[3]Department of Medicine, Division of General Internal Medicine and Geriatrics, Indiana University School of Medicine, Indianapolis, Indiana.
[4]Department of Pathology and Laboratory Medicine, Indiana University School of Medicine, Indianapolis, Indiana.
[5]Regenstrief Institute for Healthcare, Indianapolis, Indiana.
[6]Department of Health Management and Policy, University of Michigan School of Public Health, Ann Arbor Michigan.
[7]Department of Veterans Affairs, South Texas Veterans Health Care System VERDICT HSR&D, San Antonio, Texas.
[8]Department of Psychiatry, University of Texas Health Science Center at San Antonio, San Antonio, Texas.
[9]Indiana Center for Aging Research, Indianapolis, Indiana.

INTRODUCTION

Home care programs, faced with the challenges of providing services to growing numbers of frail older adults, have become increasingly interested in home care telehealth services, programs that involve the use of interactive video to facilitate communication between home-based patients and home care nurses. The Balanced Budget Act of 1997 and subsequent Medicare, Medicaid, and State Children's Health Insurance Programs Benefits Improvement Act of 2000 established the mechanism whereby home care agencies can be paid for home telehealth services as part of the prospective payment system (PPS), a factor that has resulted in increased interest in home telehealth programs.[1] Under PPS, home care agencies are paid a fixed amount for a period of home care services regardless of intensity of effort. As part of PPS, home care agencies may use home telehealth to "promote efficiencies or improve quality of care" provided that it is part of a physician ordered treatment plan.[2]

The Veterans Health Administration (VHA) is the largest single provider of healthcare in the United States. It is a fully integrated healthcare system that is at risk for all lifetime costs of care of its beneficiaries. Eligible beneficiaries cannot be denied benefits or lose enrollment status. The VHA, through the Home-Based Primary Care (HBPC) program, is among the largest providers of home care services, with 88 separate home care programs nationwide. In fiscal year 2003, 15,645 veterans received HBPC services, with an average daily census of 8,386 nationwide and annual expenditures of $72 million (VA Central Office, written communication, February 11, 2004). Recently telehealth has been reported to have the potential to influence processes and outcomes of care among home care patients.[3,4] Consequently, healthcare organizations, including the VHA, are devoting considerable financial resources to research and development on telehealth, as a means of furthering goals related to preventive medicine and chronic illness management.[5,6]

Despite the growing use of telehealth in healthcare delivery, reviews of the literature have concluded that relatively little information is available concerning telehealth outcomes.[7,8] With regards to studies involving home care applications, some nonrandomized studies have shown improved outcomes for patients receiving telehealth services in conjunction with home care services, compared to those receiving traditional home care. For example, a study was conducted involving 16 newly enrolled home care patients in a program involving the use of home video systems designed to facilitate communication between patients and home care staff members.[9] Outcomes for those receiving video telehealth services in addition to traditional home healthcare were compared to outcomes with those for a reference group ($n = 16$) receiving traditional home care services, and the two groups were matched by age, functional status and gender. The videophone group showed significantly greater improvements in functional status (activities of daily living [ADL]), communication, and social cognition compared to the reference group, suggesting that the use of videophones was associated with improved independence compared to traditional home care services. Patient satisfaction and the use of healthcare services were not examined as outcomes. A recent study involved a multifaceted intervention for 791 veterans involving the use of care coordinators, home video, and store-and-forward devices.[10] The comparison group was randomly selected from a stratified sample that was described as similar to the intervention group in terms of diagnoses, age, and gender. The comparison group was not matched by prior use of healthcare services and prior cost of services, both of which were criterion used to target patients for the intervention group, and the authors note that the intervention group was likely biased toward more adverse events prior to the intervention. The intervention group patients demonstrated greater reductions in emergency department use, nursing home admissions, and hospital admission and bed days of care over a 1-year period compared to the comparison group.

Reviews of the literature have uncovered few rigorous studies, particularly randomized clinical trials, of telehealth applications,[11] and among the few randomized trials conducted of home telehealth, results have been mixed. A recent study randomized 163 patients with dia-

betes to either telehealth video system in conjunction with home care services (intervention group) or to traditional home care services (control group) with 60-day follow-up.[12] No group differences were observed in terms of functional status, quality of life, or patient satisfaction at follow-up. However, patients in the control group were more likely to need continued home healthcare at follow-up, and were also more likely than the intervention group to be discharged to a hospital or skilled nursing facility. One of the largest studies to date of home telehealth involved 212 patients who were randomized to either telehealth (video monitoring in conjunction with home care services) or traditional home care.[13] The study reports that no differences were seen in the use of services between the two groups. However, intervention group members had lower average total health care costs (excluding home care costs) compared with the control group ($1,948 versus $2,674), differences that were largely attributable lower hospitalization costs in the intervention group. Home health costs for the intervention group were higher than for controls ($1,830 versus $1,167). No differences were found between intervention (telehealth) and control (traditional home care) groups on patient satisfaction and information on health-related quality of life (HRQOL) was not reported. A study of home care patients receiving an intervention involving telehealth devices that forwarded information on vital signs from patient homes to home care nurses was conducted in the VA Connecticut Healthcare System.[14] A comparison of persons randomized to the intervention versus traditional home care services found significantly greater 6-month declines in bed days of care, urgent care clinic visits, emergency department visits, and A1c levels among intervention group members compared to controls. Significant differences were not observed in terms of changes in level of functioning or self-rated health status. The results are promising, but because the intervention did not involve the use of interactive video, the results are not directly comparable to the majority of home care telehealth studies, including the present study, that evaluate an intervention involving live video interactions between home care patients and nurses.

In summary, despite considerable investment in telehealth technologies, very few rigorous studies have been conducted to determine whether these technologies actually reduce the use of hospital services, beyond that which might be expected from existing home care or care management programs. Those studies that have been conducted using rigorous methodologies have shown mixed results. The present randomly controlled trial (RCT) further examines the outcomes associated with the provision of telehealth care among home care patients in a VA medical center, compared to those for patients receiving traditional home care services. Research hypotheses for the study include the following:

1. Patients receiving home care telehealth services, compared to patients receiving traditional home care, will report more positive changes in HRQOL and patient satisfaction with home care services, between baseline and the 6-month follow-up.
2. Patients receiving home care telehealth, compared to patients receiving traditional home care, will have lower levels of healthcare resource use, in terms of number and duration of inpatient admissions, number of outpatient visits for primary and specialty care, number of emergency room visits, and number and duration of nursing home admissions during the 6-month study period.

METHODOLOGY

Study design

The study was a randomized trial evaluating the effects of a telehealth intervention among persons receiving home care services. Patients were recruited over a 2-year period, and data were collected at or prior to enrollment, and again 6 months later. Prior to initiation of the study, Institutional Review Board (IRB) approval was obtained for all aspects of the protocol.

Study population

All patients receiving home care services at the Richard L. Roudebush VAMC in Indi-

anapolis, Indiana, were reviewed for potential inclusion in the home telehealth research study.

Previous research has shown that prior use of health services is among the strongest predictors of future health service use.[15–18] Therefore, to select patients at high risk, our inclusion criteria included one or more hospitalizations, two or more emergency department visits, or 10 or more outpatient visits in the prior twelve months. Other inclusion criteria included a care plan specifying two or more home care visits per month and an expected need of future visits for at least 1 month, as determined by a review of the care plan and the patient's condition by the home care treatment team. This last criterion was included in order to allow sufficient time to observe the effects of the intervention. Exclusion criteria included not having a telephone, being judged incapable of operating the telemedicine system if sufficient caregiver support was lacking, or having a survival expectation of less than 6 months. The latter exclusion criterion provided some assurance that patients would complete the 6-month study follow-up.

Between September 2001 and August 2003, 370 home care patients were reviewed for possible inclusion in the study. Among those reviewed, 252 (68.1%) were excluded because they did not meet one or more of the inclusion criteria. Patients were frequently excluded from participation because they were expected to have a stay in the home care program of less than 1 month. Among the remaining patients (n = 118), 81 (68.6%) declined to participate in the trial, and 37 (31.4%) were enrolled. Among those who refused, many mentioned a perceived lack of benefit from the intervention as a reason for nonparticipation. Consequently, only a small subset of home care patients enrolled in the randomized trial.[19]

Enrollment procedure

A research assistant (RA) contacted eligible patients by telephone to explain the study and arrange a meeting. At this meeting, the RA provided additional information about the study and obtained informed consent. After completion of a baseline survey, the RA unsealed an envelope containing the randomized group assignment. Persons assigned to the treatment (telehealth) group had videophone units installed in their homes within a week after enrollment.

Intervention description

Traditional home care patients received nursing services at home and periodic telephone contact with the clinical staff concerning their home care services. Intervention group patients, in addition to receiving traditional home care services, had contact with the home care staff using telehealth units. The telemedicine equipment was an Aviva 1010 video monitor manufactured by American TeleCare, Inc. Each unit was 16 inches wide, 13 inches deep, and 10 inches tall. The system required a 110-V electrical connection and a regular analog telephone line. Each telemedicine unit consisted of several components: a home unit with interactive voice and video technology, and a video camera allowing the patients to be seen by the nurses in the home care program. Some patients were also given units with peripheral attachments, such as blood pressure monitors, stethoscopes, and glucose monitors. A central unit (base station) was available to clinical providers. Patients were able to see the clinical staff members on the video monitor, and clinical staff members were able to see the patient at home. When the unit was turned off, there was no ability for clinical staff and patients to communicate.

The focus of the telehealth visits was on providing nursing contacts beyond those available under traditional home care, to increase contact between patients and home care staff members, facilitate more frequent monitoring of patient conditions, and provide greater encouragement for self-care practices. The frequency of video encounters was determined by the home care nurse, in consultation with the patient's primary care provider and a review of the patient's medical record. Video sessions included the following components: discussion of the patients overall health status; review of medications in terms of type and dosage; discussions of any health concerns by the patient; and nurse reminders concerning appropriate self-care behaviors, including diet, exercise, and monitoring of symptoms such as blood pressure and weight.

Measures and data sources

Data were obtained from two major sources: a questionnaire at baseline and 6 months after baseline to obtain information on HRQOL and patient satisfaction with home care services and national VA databases, to obtain data on number and duration of inpatient days, nursing home admissions and days, outpatient visits, emergency department visits, and in-person home care visits by a registered nurse during the 6-month study period. Data were also collected on the total number of registered nurse contacts, including both in-person and telehealth visits, during the 6-month study period. The primary independent variable was study group (intervention versus control).

Telehealth contacts. For the intervention group, data were compiled on the total number of telehealth contacts during the 6-month study period.

HRQOL. HRQOL data, which assess the ability to perform usual social, recreational, and work activities, were obtained from the Medical Outcomes Study Short-Form 36-item Veterans' version (SF-36V), a modified version of the SF-36 adapted for use with VA patients with demonstrated reliability and validity.[20] The physical component scale (PCS) and mental component scale (MCS) were computed according to established algorithms, including treatment of missing data.[21] We calculated changes in HRQOL between baseline and 6-month follow-up.

Patient satisfaction. Patient satisfaction questions were based on a previously validated version of an instrument designed to assess satisfaction with outpatient clinical care, and adapted so that patients were specifically asked about their perceptions of home care services.[22] The scale is a sum of four items, each of which ranges from 1 to 5; higher scores on this measure indicate more satisfaction with home care.

For the intervention group, separate questions were asked concerning satisfaction with the telehealth equipment. These questions were from the VA National Ambulatory Care Survey, originally designed to assess perceptions of outpatient service use, and modified for use in evaluating telehealth services.[23]

Resource utilization. Information on VA health resource use, for the 6 months prior to and 6 months after enrollment, was gathered from the patient treatment file (PTF) and the outpatient care (OPC) file, national VA databases that are compiled from local hospital record systems.[24] Separate dependent variables were constructed summarizing the use of healthcare resources: (1) total bed days of inpatient care; (2) total number of hospitalizations; (3) total number of outpatient visits for primary and specialty care; (4) total number of emergency department visits; (5) total number of in-person home care visits; (5) total number of nursing home visits; and (6) duration of nursing home visits.

Comorbidity. Comorbidity was measured for the 6 months prior to study enrollment to ensure case–mix adjustment between the two groups. Diagnosis with each of eight conditions, as an inpatient or outpatient, was assessed. These indicators were then summed, resulting in a scale with a range of 0 to 8. The eight conditions tracked were diabetes, hyperlipidemia, hypertension, coronary artery disease, atrial fibrillation, congestive heart failure (CHF), stroke, and chronic obstructive pulmonary disease (COPD), as used in previous studies.[25] Details on the *International Classification of Diseases, 9th edition* (*ICD-9*) codes used to define these conditions are available on request.

Statistical analysis

Student's t tests for continuous variables and χ^2 analysis for categorical variables were conducted to establish comparability of the study groups in terms of demographics and severity of illness measures. Statistical tests used to examine each hypothesis are described below.

The first hypothesis, that intervention group members would have greater changes in HRQOL and patient satisfaction, was examined with Student's t tests of the change scores,

appropriate because the data were normally distributed. Possible demographic covariates were considered, but because no differences were detected between the groups on any demographic variables, and the power of the analyses was limited, none was included in models of these outcomes. Sample sizes varied because of item-specific missing data.

The second hypothesis, that the intervention group members would have a lower level of healthcare resource use, was examined using linear, Poisson, and negative binomial regression. Negative binomial regression is a variant of Poisson regression that handles count data where the variance exceeds the mean, a violation of the Poisson distribution.[26] Prior service use was included as a covariate in the models, to control for service use prior to enrollment. Survival was included as a covariate in the models of healthcare services to control for the shorter follow-up period among those who did not survive the 6-month study period.

RESULTS

Patient characteristics

Among all study participants (intervention and control patients combined), the mean age was 69.6 (standard deviation [SD] = 12; range = 40–89), 100% were male, 14% were Hispanic, 35% were African American, and 51% were Caucasian. Among those with available data on educational attainment ($n = 33$), mean years of education were 11.3 (SD = 2.8; range = 7–17). Patients typically had multiple comorbidities (mean = 3.4; SD = 1.8). Most had one or more of these chronic conditions ($n = 34$; 92%), and the majority (68%) had three or more comorbid conditions. The most common comorbidities were diabetes (54%) and hypertension (80%). Baseline measures of HRQOL, including both the PCS (mean = 24.83; SD = 7.47) and MCS (mean = 40.52; SD = 11.98), were below norms established for a general population.[20] As shown in Table 1, no significant differences were observed between intervention and control groups on baseline measures of these variables. The mean number of telemedicine visits for the experimental group over the 6-month study period was 10.89 (SD = 10.80). Two patients from each group (4 total) died during the 6-month follow-up period.

HRQOL

Outcomes related to HRQOL and patient satisfaction are shown in Table 2. Intervention patients showed greater increases on the PCS of the SF-36V compared with controls, but no statistically significant differences were observed ($t = 0.30$; $df = 15$; $p = 0.77$). Intervention patients showed improvement on the MCS of the SF-36V ($n = 10$; MCS = +4.05), while the control group members declined on this measure ($n = 7$; MCS = −4.11). This difference was statistically significant ($t = 2.27$; $df = 15$; $p = 0.04$).

Patient satisfaction

High levels of satisfaction were found for both intervention and control groups at baseline (mean = 15.2; SD = 3.7) and follow-up (mean = 14.0; SD = 3.6). As shown in the third row of Table 2, no statistically significant difference was observed between intervention and control group in terms of changes in general home care satisfaction ($t = 0.48$, $df = 18$; $p = 0.64$).

The majority of patients in the intervention group reported satisfaction with the telehealth equipment, as shown by their responses to a five-point Likert scale indicating their agreement with statements concerning telehealth services. Most reported being taught the use of the equipment (21%, somewhat; 57%, definitely), although fewer persons reported their family members being taught the use the equipment (21% not sure, 14% somewhat, 36% definitely). Most reported that the equipment somewhat (38%) or definitely (54%) worked properly, and the majority (64%) reported knowing whom to call at the VA hospital in case of problems. The majority of participants reported that they somewhat (50.0%) or definitely (36%) learned more about self-care by using the equipment, and most also reported that the equipment somewhat (36%) or definitely (43%) increased their contact with VA health providers. Almost three quarters (71%) reported that they definitely wanted to continue using the equipment.

Table 1. Baseline Patient Characteristics (n = 37)

Measure[a]	*Intervention* (n = *18*) *Mean (SD)*	*Control* (n = *19*) *Mean (SD)*
Age	69.8 (11.6)	69.5 (12.7)
Gender	all participants were male	
Ethnicity		
Hispanic	11% (2)	16% (3)
African American	33% (6)	37% (7)
Caucasian	56% (10)	47% (9)
Education in years	12.2 (3.1)	10.6 (2.3)
Comorbidities		
Diabetes	50% (9)	58% (11)
Hyperlipidemia	39% (7)	53% (10)
Hypertension	78% (14)	84% (16)
CAD	33% (6)	47% (9)
Atrial fibrillation	6% (1)	16% (3)
CHF	39% (7)	47% (9)
Stroke	17% (3)	16% (3)
COPD	39% (7)	63% (12)
Number of conditions	3.0 (1.8)	3.8 (1.7)
General satisfaction	15.3 (3.2)	15.6 (4.2)
Physical component summary (PCS)[b]	26.6 (7.7)	22.9 (7.0)
Mental component summary (MCS)[b]	40.2 (10.4)	40.9 (13.9)

[a]No significant differences were detected on any measures.
[b]Higher scores denote higher health-related quality of life. The PCS and MCS summary scores are norm-based scores; thus, obtained values can be compared with a healthy population (mean = 50 and SD = 10).[21]
CAD, coronary artery disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; SD, standard deviation.

Use of health services

Table 3 displays the regression results comparing the intervention and control groups on the use of health services, including inpatient admissions and bed days of care, outpatient care, and emergency department use, as described below.

Number of inpatient admissions and days of care. Patients in the intervention and control groups did not differ significantly in terms of the number of inpatient admissions during the 6-month study period (mean of 0.67 for treatment group versus 1.26 for control group members; p = 0.61). There were differences in total inpatient bed days of care between the intervention group (mean days = 2.83) and the control group (mean = 7.11). However, they were not statistically significant in the negative binomial regression model, which adjusted for overdispersion (the control group included a patient with a 53-day hospitalization).

Number of outpatient visits. No significant differences were found between the two study groups in terms of the number of primary care

Table 2. Patient Satisfaction and Physical and Mental Health Outcomes (n = 20)

Measure	*Intervention (mean, 95% CI)*	*Control (mean, 95% CI)*	p-*value*
Change in SF-36V Physical Component Summary (PCS)	1.56 (−3.53, 6.64)	0.64 (−3.83, 5.11)	0.77
Change in SF-36V Mental Component Summary (MCS)	4.05 (−0.40, 8.51)	−4.11 (−12.13, 3.90)	0.04
Change in General Home Care Satisfaction Scale	−1.00 (−2.37, 0.38)	−1.56 (−3.93, 0.82)	0.64

CI, confidence interval.

Table 3. Comparison of Health Services Utilization ($n = 37$)

	Intervention (n = *18)*	*Control* (n = *19)*	p *value*
Inpatient care			
Number of hospital admissions[a]	0.67 ± 1.03	1.26 ± 2.00	0.61
Total inpatient bed days of care[a]	2.83 ± 4.12	7.11 ± 12.86	0.41
Outpatient visits			
Total number of outpatient visits (excluding home care)[a]	29.06 ± 30.11	38.89 ± 28.88	0.10
Number of primary care visits[a]	3.39 ± 3.85	3.89 ± 5.03	0.43
Number of specialty care visits[a]	2.06 ± 2.49	2.47 ± 2.61	0.41
Emergency department visits[b]	1.00 ± 1.33	2.11 ± 2.89	0.83

[a]Negative binomial regression. Group differences in mean hospital days of care were influenced by an outlier, a patient in the control group who had a 53-day hospitalization.
[b]Poisson regression.

or specialty care outpatient visits. There was a trend ($p < .10$) toward fewer overall outpatient visits for patients in the intervention group (mean visits = 29.06) compared to the control group (mean visits = 38.89).

Number of emergency department visits. No significant difference was found between the two groups in terms of the number of emergency department visits ($p = 0.83$).

Number and duration of nursing home admissions. Although the use of nursing home admissions was of interest, there were insufficient numbers of study patients receiving this type of care for analysis. Two patients in the experimental group had nursing home admissions during the 6-month study period (lasting 1 day and 152 days, respectively).

DISCUSSION

Home care providers need more information on the outcomes of existing telehealth programs in order to make critical decisions concerning the allocation of scarce medical resources. Results from this study indicate a significant improvement in the mental health component of HRQOL among patients receiving telehealth services compared to controls. However, no statistically significant differences were observed between intervention and control groups in terms of changes in physical health, inpatient admissions, bed days of care, emergency department use, or general satisfaction with home care services. Patients in this study rated telehealth services positively, supporting previous research that suggests that the introduction of telehealth technologies can potentially enjoy wide acceptance.[27,28] However, both intervention and control groups rated home care services highly, and hence there was a possible ceiling effect that may have contributed to the lack of significant differences observed between the groups in terms of the effect of adding telehealth services to an existing home care program.[27] There was also a trend toward fewer total outpatient visits among telehealth patients.

An issue that has not been fully resolved among home care telehealth providers concerns whether home telehealth services should substitute or supplement in-person home care visits. Home telehealth has been suggested as a means of improving the efficiency of home care services by reducing the number of in-person visits conducted by home care nurses. For example, a review of home care agencies in both urban and rural areas in the United States found that approximately half (46%) of all home care visits could be conducted using home telehealth technology.[29] However, as has been the case in previous studies,[13] the nurses involved in the intervention for this study were reluctant to use home telehealth as substitutes for in-person visits, and instead viewed video visits as a supplement to in-person care. The issue of substitution versus supplementation should be carefully considered as home tele-

health programs are further developed. Especially given the additional costs associated with the implementation of telehealth programs, and the equivocal findings to date regarding the benefits of these programs when used for supplementing existing services, the true benefits of telehealth programs may lie in substituting less costly telehealth services for more costly in-person home visits. However, more research is needed to determine the extent to which telehealth visits can substitute for in-person visits in a safe and efficient manner.

There are several strengths to the study design compared with previous studies. First, this was one of very few randomized trials of home telehealth conducted to date. Such a rigorous design is an essential step for obtaining information on the outcomes associated with home telehealth compared to a control group receiving home care treatment from the same program, and who are recruited using the same inclusion and exclusion criteria. Second, prior use of healthcare services (a known predictor of future use) was included as a covariate in the model. These covariates have not been used in previous studies, and are suggested for inclusion in future work examining the effect of telehealth services. Third, the outcomes examined, which included HRQOL, patient satisfaction, and the use of both inpatient and outpatient health care services, are more comprehensive than those reported for other studies, which have frequently examined a limited number of outcome measures. Finally, the intervention group for this study consisted of persons receiving telehealth services in addition to traditional home care, and the control group patients received only traditional home care services. Such a design makes it possible to determine if telehealth services are associated with improved outcomes beyond those that might be expected from traditional home care. In contrast, previous studies have involved multi-faceted interventions that include telehealth as part of a comprehensive program of care management, and compared the results to those for patients who do not receive care management or telehealth services.[10] Although such designs allow for information to be obtained on the outcomes associated with comprehensive programs, it is not possible to determine whether similar results could be obtained from programs involving care management in the absence of telehealth services.

There are several limitations to this research study. First, as in previous studies,[30] it is likely that type II error, related to the smaller than expected sample size, is a factor contributing to the lack of significant differences for the utilization outcomes. For the HRQOL measures, there were missing data on response items, and only 17 of 37 enrolled patients had items available for analysis, a factor that also contributed to lower than expected statistical power. Second, related to the issue of small sample size, a greater number of patients than anticipated had short home care days that resulted in their exclusion from the study. Many of these patients were recently discharged from the hospital and were evaluated as needing home care services for only a short period of time. Such persons were not eligible for home telehealth services, because the time required for equipment setup and training was not believed to be justified given their expected short stay in the program. A third limitation is that this was a single-site study, and involved only VA patients, all of whom were male. More information is needed on the outcomes associated with home telehealth care across a broader range of VA sites, and ultimately on patients receiving services in home care programs outside the VA health care system. Detailed information was also not available on the extent to which peripheral devices, such as the use of blood pressure monitors, stethoscopes, and glucose monitors. Future research, using more detailed information on the use of these peripherals and associated outcomes, is an important area for future research. Finally, the telehealth program examined in this study was relatively new at the time the study was conducted, a factor that may have contributed to reluctance to participate in the program.

The results from this study suggest several areas for future research. First, given the increasingly large number of patients who are in home care programs for short periods of time, more research should be conducted on the feasibility of developing short-term telehealth programs for this short-stay population. Quite possibly, interventions can be designed to provide short-term education and monitoring, and

if telehealth units can be deployed and retrieved quickly, such programs could benefit the short-term home care population. Second, some research suggests that lower cost strategies, including telephone care, may be equally effective compared with higher cost programs such as the video-based telehealth services examined in the present study. For example, a recently published study conducted among CHF patients involving randomization to telehealth, telephone follow-up, or traditional home care, reports that home telehealth did not offer an incremental benefit beyond that obtained from usual telephone follow-up in terms of health resource use.[30] More studies, based on randomization to a variety of technologies (including telephone care), would help better determine the most cost effective and optimal way of coordinating care for persons with chronic conditions.

A third area for future research concerns the need for new study designs, including multisite randomized trials as well as quasiexperimental designs. Given the large amount of time and effort needed to develop and implement home telehealth programs, single-site studies often produce small sample sizes.[7] Consequently, future studies, involving multiple sites, are needed for rigorous evaluations of the effectiveness of this technology. One challenge to home telehealth studies is that once these programs have been implemented, program administrators may be reluctant to enroll patients in randomized trials, because this would involve restricting access to telehealth for persons randomized to the control group. In situations where randomization is not feasible, well-designed quasiexperimental designs, involving a comparison of outcomes for patients participating in a home telehealth program with a comparison group of patients in a different program who do not receive telehealth services, may provide important information on telehealth outcomes. For such designs to be valid, it is essential that the comparison group patients have similar characteristics to those participating in the intervention, including severity of illness and past use of health care services. Multiple measurements of study outcomes for both groups, both before and after the start of the intervention, can help to ensure that the observed outcomes are caused by the intervention and not simply due to regression towards the mean.[31]

CONCLUSION

Despite considerable interest and investment in telehealth services for home care programs, findings concerning the outcomes associated with the use of this technology remain equivocal. The present study found significantly greater increases in self-reported mental health status among telehealth versus traditional home care control patients, as well as a trend toward lower use of outpatient healthcare services among this group. Given the considerable investment in telehome care technology by home care providers, more information based on larger clinical trials is needed in order to obtain critical information necessary for improving the care of patients receiving home care services.

ACKNOWLEDGMENTS

Funding for this study was obtained from a VA Health Services Research and Development grant, entitled "An Evaluation of Home-Based Telemedicine Services" (Grant No: VA HSRD–Tel: 20015-1). The study was presented in part as a poster display, American Geriatrics Society Annual Meeting on March 15, 2003. The main study was presented as a poster at the Society of General Internal Medicine Annual Meeting, May 12–14, 2004. The authors wish to thank other study staff involved in data collection, including Aaron Goldsmith, M.S.W., Theresa Bubenzer, R.N., and Heather Wallace, B.A. Carla Anderson, R.N., M.S.N., Director of the Home Care Program, provided needed clinical expertise in the design and development of the program.

REFERENCES

1. Puskin D. Telemedicine: Follow the money. www.nursingworld.org/ojin/topic16/tpc16_1.htm Last accessed November 1, 2005.
2. Kinsella A. About home telehealth. www.longtermcarelink.net/eldercare_home_telehealth.htm Last accessed November 1, 2005.

3. Kaye LW. Telemedicine: Extension to home care. *Telemed J* **1997;**3:243–246.
4. Warner I. Telemedicine applications for home health care. *J Telemed Telecare* **1997;**3(Suppl 1):65–66.
5. Veterans Health Administration. Telemedicine Strategic Planning Document. Washington, D.C.: Department of Veterans Affairs,1999.
6. VA Health Services Research and Development. HSR&D Priorities for Investigator Initiated Research: Fiscal Year 2002. www1.va.gov/resdev/ps/psrhrd/HSRD_Umbrella_Solicitation_021202.doc. Last accessed 10 Feb 2004.
7. Grigsby J, Kaehny M, Sandberg E, Schlenker R, Chaughnessy P. Effects and effectiveness of telemedicine. *Health Care Financ Rev* **1995;**17:115–131.
8. Telemedicine for the Medicare Population. Summary, Evidence Report/Technology Assessment: Number 24. AHRQ Publication Number 01-E011, February 2001. Agency for Healthcare Research and Quality, Rockville, MD. www.ahrq.gov/clinic/epcsums/telemedsum.htm Last accessed November 1, 2005.
9. Nakamura K, Takano T, Akao C. The effectiveness of vidoeophones in home healthcare for the elderly. *Med Care* **1999;**37:117–125.
10. Meyer M, Kobb R, Ryan P. Virtually healthy: Chronic disease management in the home. *Dis Manag* **2002;**5:87–94.
11. Hailey D, Roine R, Ohinmaa A. Systematic review of evidence for the benefits of telemedicine. *J Telemed Telecare* **2002;**8:1–7.
12. Dansky K, Bowles KH, Palmer L. How telehomecare affects patients. *Caring* **1999;**18:10–14.
13. Johnston B, Weeler L, Deuser J, Sousa KH. Outcomes of the Kaiser Permanente tele-home health research project. *Arch Fam Med* **2000;**9:40–45.
14. Noel HC, Vogel DC, Erdos JJ, Cornwall D, Levin F. Home telehealth reduces healthcare costs. *Telemed J eHealth* **2004;**10:170–183.
15. Boult C, Dowd B, McCaffrey D, Boult L, Hernandez R, Krulewitch H. Screening elders for hospital admission. *J Am Geriatr Soc* **1993;**46:811–817.
16. Coleman E, Wagner E, Grothaus L, Hecht J, Savarino J, Buchner D. Predicting hospitalization and functional decline in older health plan enrollees: Are administrative data as accurate as self-report? *J Am Geriatr Soc* **1998;**46:419–425.
17. Smith D, Norton J, Roberts S, Maxey W, McDonald C. Unexpected hospital admissions among patients with diabetes Mellitus. *Arch Intern Med* **1983;**143:41–47.
18. Wolinsky F, Culler S, Callahan C, Johnson R. Hospital resource consumption among older adults: A prospective analysis of episodes, length of stay, and charges over a seven year period. *J Gerontol* **1994;**49:S240–S252.
19. Subramanian U, Hopp F, Lowery J, Woodbridge P, Smith. D. Research in home telemedicine: Challenges in patient recruitment. *Telemed J e-Health* **2004;**10:155–161.
20. Kazis L. *The SF-36V*. Bedford, MA: Center for Health Quality, Outcomes, and Economic Research, **1997.**
21. Ware JE, Kosinski M, Keller SD. *SF-36 Physical and Mental Summary Scales: A Users Manual*. Boston, MA: The Health Institute, **1994.**
22. Ware JE, Snyder MK, Wright R, Davies AR. Defining and measuring patient satisfaction with medical care. *Eval Program Plann* **1983;**6:247–263.
23. Meterko M, Jacobs M, Sisson E, Humble C. Customer satifaction in the Veterans Health Administration. In: Jacobs M, Nelson A, Berrio M, eds. *Measurement tools to support outcomes evaluation*. Milwaukee WI: National Center for Cost Containment, **1998;**119–125.
24. Veterans Affairs Information Resource Center. Researchers' Guide to VA Data. www.virec.research.med.va.gov/ Last accessed November 1, 2005.
25. Subramanian U, Weinberger M, Eckert GJ, L'Italien GJ, Lapuerta P, Tierney W. Geographic variation in health care utilization and outcomes in veterans with acute myocardial infarction. *J Gen Intern Med* **2002;**17:604–611.
26. Cameron, A. C and Trivedi, PK. *Regression analysis of count data*. Cambridge, UK, Cambridge University Press, **1988.**
27. Baines B. Tele-home care in a managed care setting. *Remington Rep* **1996;**November/December:27–29.
28. Johnston B, Wheeler L, Deuser J. Kaiser Permanente Medical Center's Pilot Tele-Home Health Project. *Telemed Today* **1997;**August:14–18.
29. Allen A, Doolittle G, Boysen C, Komoroski K, Wolf M, Collins B, Patterson JD. An analysis of the suitability of home health visits for telemedicine. *J Telemed Telecare* **1999;**5:90–96.
30. Jerant AF, Azari R, Nesbitt TS. Reducing the cost of frequent hospital admissions for congestive heart failure: A randomized trial of a home telecare intervention. *Med Care* **2001;**39:1234–1245.
31. Hayward, Rod. Quasi Experimental Designs for Studying QI Interventions: Strengths and Pitfalls. VA Health Services Research and Development, HSR&D Cyber Seminars. hsrd.webex.com/hsrd/k2/tool/record/recordings.php?Rnd[t=]1663926607 Last accessed November 1, 2005.

Address reprint requests to:
Faith Hopp, Ph.D.
Research Investigator
VA Ann Arbor Healthcare System
HSR&D Center for Practice Management
and Outcomes Research
P.O. Box 130170
Ann Arbor, MI 48113

E-mail: Faith.Hopp@med.va.gov

This article has been cited by:

1. Adam Darkins , Patricia Ryan , Rita Kobb , Linda Foster , Ellen Edmonson , Bonnie Wakefield , Anne E. Lancaster . 2008. Care Coordination/Home Telehealth: The Systematic Implementation of Health Informatics, Home Telehealth, and Disease Management to Support the Care of Veteran Patients with Chronic ConditionsCare Coordination/Home Telehealth: The Systematic Implementation of Health Informatics, Home Telehealth, and Disease Management to Support the Care of Veteran Patients with Chronic Conditions. *Telemedicine and e-Health* **14**:10, 1118-1126. [Abstract] [PDF] [PDF Plus]