ASSESSMENT OF A TELEREHABILITATION AND A TELEHOMECARE PROGRAM FOR VETERANS WITH CHRONIC ILLNESSES

By

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To my loving husband; he is the reason.

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ASSESSMENT OF A TELEREHABILITATION AND A TELEHOMECARE PROGRAM FOR VETERANS WITH CHRONIC ILLNESSES

By

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In the United States today, over 100 million individuals suffer from chronic illnesses. Each year chronic illnesses account for approximately 70 percent of all U.S. deaths and 75 percent of all healthcare costs. Chronic conditions often lead to disabilities, which result in functional limitations and loss of independence, thereby increasing medical expenditures. The elderly population is at a higher risk for developing chronic conditions such as diabetes, heart disease, or arthritis, increasing their risk for disabilities. The disability rate of the population over age 65 is at least three times higher than the general population. Given the rapid growth of the aging population, and the chronic illnesses, disabilities, and loss of functional independence endemic to elders, novel methods of rehabilitation and care management are urgently needed. Telehealth models that combine care coordination with communications technology offer a means for decreasing healthcare costs and increasing patient satisfaction, and have been shown to be an important component in the management of chronic illnesses.

This dissertation examined the effects of a Veterans Administration (VA) telerehabilitation program (Low ADL Monitoring Program - LAMP) and a VA telehomecare program (Technology Care Coordination Program - TCCP) on healthcare costs, as well as patient reported health-related quality of life measures. Additionally, a qualitative study utilizing a random sampling of veterans enrolled in LAMP and TCCP provided patients' perceptions on telehealth interventions, the technology used for home-based remote monitoring, and satisfaction with VA healthcare services.

TCCP is based on a medical model of care. LAMP is based on a rehabilitative model of care. LAMP patients received adaptive equipment and environmental modifications, which focused on self-care and safety within the home. Care-coordinators for LAMP and TCCP remotely monitored their patient's vital signs, such as blood pressure and weight, and provided education and self-management strategies for decreasing the effects of chronic illnesses. Healthcare costs post-enrollment were examined through a difference-in-differences multivariable model. Results determined that there were no significant differences between LAMP and their matched comparison group, TCCP and their matched comparison group, or LAMP and TCCP, following the 12-month intervention. For TCCP patients, daily remote monitoring resulted in increases in all healthcare costs. For LAMP patients, the provision of adaptive equipment and environmental modifications, plus intensive in-home monitoring of patients, lead to significant increases in clinic visits post-intervention, but decreases in hospital and nursing home stays. LAMP patients also increased in physical functioning based on self-report from the Veterans Quality of Life SF-12V. Through personal interviews, veterans reported increased connectedness with the VA, found the technology easy to use, were satisfied with the services, and would recommend telehealth to their peers.

CHAPTER 1
INTRODUCTION

The declining health of our elders is one of the greatest medical problems and greatest economic burdens facing the U.S. today (Fries, 2002). Approximately 70 percent of healthcare spending in the U.S. is focused on the health of our elder population (Centers for Disease Control [CDC], 2003a). In 2005, this amounted to more than 1.3 trillion dollars, and is expected to rise to 2.5 trillion dollars by 2014, totaling more than 13 percent of the gross domestic product (Heffler et al., 2005). Of particular concern is the increase in chronic illness and disability in our aging population, which is projected to rise sharply through 2030 as the baby boom generation enters old age (Department of Health & Human Services [DHHS], 2004). Chronic illnesses contribute to disability, diminish quality of life, and increase health and long-term care costs (CDC, 2003b; Ostchega, Harris, Hirsch, Parsons, & Kington, 2000). In fact, chronic illnesses are among the leading causes of death and functional disability in older adults (Freedman, Martin, & Schoeni, 2002; Murray & Lopez, 1996). The aging population, especially those who are chronically ill and disabled, place a strain on healthcare resources and challenge healthcare providers. Healthcare programs that could assist elderly patients in the self-management of their chronic illnesses and limit hospital and emergency room visits could potentially reduce the overall economic burden of these diseases.

The purpose of this dissertation is to examine the effectiveness of two telehealth programs within the Veterans Health Administration (VHA) that were designed to serve at-risk elders. A retrospective, concurrent matched cohort study design was employed to determine healthcare costs and functional health status from a telehomecare program and a telerehabilitation program. Additionally, the telehealth participants' personal experiences were investigated through qualitative interviews in their homes. This study provides valuable information regarding telehealth models of care that may assist in managing chronic illness and disability in our elderly population, therefore reducing health-related costs and increasing safety and independence within the home environment.

Challenges in Healthcare

Tending to the multiple disease processes that often coincide in chronically ill elders can be quite challenging to healthcare providers. Primary care providers are often called to concurrently manage a variety of illnesses in the same patient, requiring increasingly complex medical regimens (E. H. Wagner, 2001). The best possible outcomes depend on the delivery of a multitude of services, including preventive care, disease management, and rehabilitation. Such coordinated services hold the greatest promise for improving the health of our elderly. Yet the provision of evidence-based, comprehensive care is exceedingly difficult and numerous barriers exist (Grumbach & Bodenheimer, 2002).

Preventive care measures include regular health maintenance evaluations, immunizations and vaccines, and laboratory testing (Godfrey, 2001). Screening for additional chronic and/or life-threatening diseases or exacerbation of an illness is also important. An essential preventive measure for individuals with chronic illnesses is to be knowledgeable of their healthcare regimens and be in regular contact with their healthcare provider. Yet it is difficult for primary care providers and patients to maintain contact and keep track of necessary screenings, laboratory tests and immunizations.

Additionally, elders often have functional disabilities and numerous comorbid conditions, reducing their ability to manage their chronic diseases (E. H. Wagner, 2001). Moreover, studies have shown that preventive care has had limited success in decreasing the incidence of chronic illness and disability (Godfrey, 1999; Tulloch, 2005; Walker & Jamrozik, 2005). The reasons preventive care is not always successful vary. Many conditions may be overlooked by conventional care, such as urinary tract infections, diabetes and anemia, as well as depression and dementia (Tulloch, 2005). Therefore, individuals who have not been adequately diagnosed will not receive the necessary preventive measures for self-management of their disease. Furthermore, there is limited training of nurses and physicians in preventive care for elders, as well as inadequate health education for elders themselves (Williams, Ricketts, & Thompson, 1998). Other barriers associated with receipt of preventive services include provider continuity and site continuity, as well as inadequate health insurance coverage and difficulty traveling to visit specialists (Doescher, Saver, Fiscella, & Franks, 2004).

Disease management "is a system of coordinated healthcare interventions and communications for populations with conditions where patient self-care efforts are a significant factor in supporting the physician/patient relationship and their plan of care" (Disease Management Association of America [DMAA], 2006). Disease management programs for patients with chronic illnesses, such as diabetes, have become increasingly common in recent years as a mechanism to help educate patients on how to self-manage their disease (Congressional Budget Office [CBO], 2004; New et al., 2003; Stille, Jerant, Bell, Meltzer, & Elmore, 2005). Disease management programs typically include clinical guidelines for disease phases, patient education for self-management, aggressive screening for complications, and coordination of care among numerous healthcare providers (CBO, 2004; Gamm, Bolin, & Kash, 2005). Yet, under a system designed for acute and episodic care, healthcare providers, as well as patients themselves, are not always focused on disease management (Bodenheimer, Wagner & Grumbach, 2002a). Additionally, the impact of disease management programs is mixed. Disease management programs are difficult to efficiently provide because they require ongoing collaboration, patient self-management education, compliance, routine reporting and outcomes measurement (CBO, 2004; Leider & Krizan, 2004; Roglieri et al., 1997; E. H. Wagner, 2000).

Lastly, understanding the longer-term consequences of chronic diseases is as important as the immediate management of the disease, and deserves attention. Rehabilitative interventions are aimed at reducing disability and improving independence and function (Godfrey, 2001). In rehabilitation, a multidisciplinary team works cohesively with patients to carefully assess their strengths, deficits, and personal desires for achieving their highest functioning level and living an independent life. Rehabilitation is a creative and individualized process of preparing an individual with a disability to preserve or regain optimal functional independence and adapt to physical limitations and architectural barriers (Godfrey, 2001; Hochstenbach, 2000). However, obstacles exist that make it difficult for the elderly to receive adequate and timely rehabilitative services. Such obstacles include availability of specialists, appropriate assessments and recommendations of services and assistive devices, and traveling to access services. Additionally, when rehabilitation is received strictly in a clinical setting, carryover into the home may be sub-optimal. Delivery of care within the home is able to target key areas to stem this, yet home rehabilitative services are rarely provided and when provided are often of an inadequate duration and intensity.

Other factors also impact the ability to receive adequate and timely healthcare. There are notable healthcare disparities for individuals who live in rural areas, including problems of management and provision of services due to difficulties with access and transportation outside the home (Eldar, 2001; Freedman et al., 2002). These challenges are further compounded by clinic and healthcare facilities that have a limited number of physical locations from which they can provide patient treatment. Difficulties in access also occur due to problems with recruitment and retention of practitioners in rural areas.

To date, little progress has been made toward restructuring healthcare systems to address these concerns. Recent reports in healthcare trends urgently recommend an overhaul of American's healthcare system (Bodenheimer et al., 2002a; Institute of Medicine [IOM], 2001; E.H. Wagner, 2004). Given the rapid growth of the aging population, and the chronic illnesses, disabilities, and loss of functional independence endemic to elders, novel methods of care management and care delivery are urgently needed.

The Veterans Healthcare System

The Department of Veterans Affairs (VA) is responsible for operating nationwide programs for healthcare, financial assistance and burial benefits to veterans and their families. The most visible of the VA systems is healthcare. The Veterans Health Administration (VHA) is the largest integrated healthcare system in the U.S., providing a multitude of services to over 5 million veterans in fiscal year 2005 (Office of Public Affairs [OPA], 2006). Because the VHA provides a uniform and comprehensive set of healthcare benefits for their patients, it is a useful system to explore resource use and patient outcomes.

The impact of aging and chronic illness in the VA

In fiscal year 2005, the VHA provided medical care to over 5.3 million veterans at a cost of $31.5 billion (OPA, 2006). Much of the VHA's medical care is focused on a rapidly aging and chronically ill veteran population. The number of veterans over the age of 85 is increasing by a mean rate of 11 percent a year, and is projected to reach approximately 1.3 million by the year 2010 (Yu, Ravelo, Wagner, & Barnett, 2004). Although the increasingly aging veteran population has amplified the demand for healthcare services, studies have show that the presence of chronic illnesses combined with aging has a more significant effect on healthcare costs than age alone (Asch et al., 2004; Yu, 2004; Yu, et al., 2003a). Veteran's enrolled in the VHA report a higher prevalence of recent or long term chronic disease than their community counterparts (Asch et al., 2004; Kazis et al., 2004b; Rogers et al., 2004). In a recent study of prevalence and costs of chronic conditions in the VHA, Yu and colleagues (2004), reported that among the VA patients aged 65 and older, 85 percent had one or more chronic conditions, with 40 percent having three or more. Chronic illnesses, which are the main reason veterans seek care through the VHA, accounted for 96 percent of the total VA healthcare expenditures in 2000.

VA telehealth applications

As more veterans are facing debilitating chronic diseases, there is a need to ensure timely access to preventive care, disease management, and rehabilitative care. Beginning in April 2000, the VHA initiated funding of several clinical demonstration projects related to telehealth to test the integration of care coordination with communications technology for home-based disease management (Meyer, Kobb & Ryan, 2002). The complexity of our veteran's healthcare needs places greater demand on coordination of care. In the past, care or case management was defined by an episode of care, either in the clinic or hospital, typically with a set number of phone calls to follow-up on a patient after discharge. The VA care coordination model combines the role of a care coordinator with home telehealth technologies that allow for consistent follow-up that transcends clinical programs and physical settings. The Care Coordinator is responsible for being a team member, providing a clinical thread between therapists, specialists and general care, and providing consistent information on the veteran's response to treatment at home. Telehealth models which combine care coordination with communications technology offer a means for decreasing healthcare costs and increasing patient satisfaction, and have been shown to be an important component in the management of chronic illnesses (Bennett, Fosbinder, & Williams, 1997; Hooper, Yellowlees, Marwick, Currie, & Bidstrup, 2001; Joseph, 2006; Kobb, Hoffman, Lodge, & Kline, 2003; Noel, Vogel, Erdos, Cornwall, & Levin, 2004). Today, telehealth and the use of telecommunications technology is widely used by the VA, which views telehealth as integral to the delivery of health services and education within their systems. Thus, it is not surprising that the VA has placed a major emphasis on the development of various in-home telehealth models of care, such as telehomecare and telerehabilitation.

Models of VA telehealth care

Telehomecare. Telehomecare (THC) uses technology to enable the communication and transfer of information between the healthcare provider at a clinical site and the patient in the home (Finkelstein et al., 2004). A typical application of THC is the use of telehealth technology with oversight by nurse practitioners who provide medical care for chronically ill individuals within their homes (Celler, Lovell, & Basilakis, 2003; Finkelstein, Speedie, & Potthoff, 2006; Kobb et al., 2003; Noel et al., 2004). Using telehealth technology, home-based video visits and monitoring of vital signs can be accomplished electronically, medication compliance can be verified, and patient education can be enhanced. Within the VHA, the THC model is based on the traditional medical model of care. Professionals working in the field of THC are skilled in the management of chronic illnesses through diagnosis, medical intervention and patient education. THC interventions are typically disease-specific and focus on the monitoring of physiologic parameters. A very important clinical goal in THC is to minimize the impact of the condition, often through symptom tracking, which results in a medical intervention.

Technology Care Coordination Program

The Technology Care Coordination Program (TCCP) is a VA telehomecare program that uses telehealth technology in conjunction with nurse practitioners and a social worker to coordinate care for chronically ill veterans living in remote areas in North Florida/South Georgia. During our study period, veterans were eligible to be enrolled in TCCP if they met the following criteria:

1. had past high-cost medical care needs (>$25,000) and high healthcare utilization (two or more hospitalizations and frequent emergency room visits),
2. had electricity and phone service,
3. accepted technology in their homes for monitoring purposes, and
4. signed an informed consent form or had the consent form signed by a proxy.

The TCCP targeted veterans with multiple co-morbidities such as congestive health failure (CHF), diabetes, hypertension, and chronic obstructive pulmonary disease (COPD). The care coordination (CC) team consisted of two nurse practitioners, a social worker, and a program support assistant for office support. Veterans were identified as high-facility use, high-cost by the VHA's computerized cost allocation system. Veterans were then contacted by telephone to determine their interest in participating in TCCP. Following initial contact, an enrollment appointment was made to visit the home, explain the program, and assign and install the technology for remote monitoring. TCCP participant's health-related quality of life was measured by the Veteran's Quality of Life SF-36V Health Survey Form (SF-36V) and the shorter version, the SF-12V (Brazier et al., 1992) at baseline and every 6-months thereafter.

Veterans enrolled in TCCP were risk-stratified into three levels based on severity of disease, functional and cognitive status, living situation, and type of residence and provided with different remote monitoring devices based on the stratification. (1) Veterans with stable chronic illnesses and psychosocial issues impacting health received a videophone. The videophone is a stand-alone device that connects to a regular telephone line and allows video and audio input between the veteran and the CC. (2) Veterans with frequent hospitalizations, who lived in a private residence, and were able to read, received a Health Buddy (HB) (Health Hero Network, Inc., Redwood City, California). The HB is an in-home messaging device that serves as the interface between patients at home and CCs located at the VA. The HB presents veterans with a list of questions they answer by selecting one of four options to help monitor and assess a patient's clinical condition, and provides education for the patient based on their answers. An example of a question includes, "How do you feel today?" with answers excellent, good, fair, or poor; with a follow-up response based on the answer. Another question may be, "Have you fallen?" with answers yes or no, and a follow-up question if the answer is yes, "Do you need medical attention?" with answers yes or no. Should the patient require medical attention, the HB will provide the patient with the phone number for the VA and alert the patient's care coordinator for follow-up. Patient data is sent over a telephone line through a secure data center where the data is then available for review on the Health Buddy® Desktop. Patient responses are color-coded by risk level as High (red), Moderate (yellow) and Low (green) based on symptoms, patient behaviors and self-care knowledge. (3) Veterans with frequent hospitalizations, who lived in a congregate or private setting, were able to handle peripherals, and had a diagnosis such as heart failure or emphysema, received an Aviva (Centralia, WA). The AVIVA Home Telecare System consists of a central station, which connects via ordinary telephone lines to the patient station, which is placed in the patient's residence. The Aviva functions with a PC-based monitoring station and two-way video to allow care coordinators to visually monitor the patient remotely. The Aviva program provides live audio and video communication with a CC.

Telerehabilitation. Telerehabilitation (TRH) is an emerging practice defined as the remote delivery of rehabilitation services through compensatory strategies, training and education, monitoring, and long-term care of individuals with disabilities using assistive technology (Office for the Advancement of Telehealth [OAT], 2002). The focus of TRH is to increase access to rehabilitation services, and to allow individuals to achieve and maintain safe and independent lives in their own homes. TRH has the potential to manage multiple components of health, including functional independence, self-care and self-management of illness (Burns, Crislip, Daviou, Temkin, & Vesmarovich, 1998; Cruise & Lee, 2005; Halamandaris, 2004b; Winters, 2002). TRH is a rehabilitative model of care, which views health as more than the absence of disease. As health is intimately related to and influenced by the environment and the person's characteristics (Brandt & Pope, 1997; Dahl, 2002), many TRH programs emphasize the whole person and focus on decreasing the impact of chronic illnesses, thereby improving health and functional outcomes. TRH assesses the immediate environment (home) and provides interventions such as education and training, therapeutic exercises, adaptive devices, and simple home modifications in an attempt to improve daily function (Cieza & Stucki, 2005).

The Low Activities of Daily Living (ADL) Monitoring Program

The Low ADL Monitoring Program (LAMP) is a VA telerehabilitation program designed to promote independence and reduce healthcare costs. LAMP services are home-based and use a combination of traditional and advanced technologies to promote independence and the maintenance of skills necessary to remain living at home. Occupational therapists (OT) serve as care coordinators for veterans, and work collaboratively with healthcare providers, rehabilitation specialists and other clinicians, as well as with families and caregivers. LAMP interventions range from the provision and installation of assistive technology/adaptive equipment (AT/AE) and modifications of the home environment to daily therapeutic regimens, and on-going support for self-care needs. LAMP staff also provides hands-on and remote training in the use of AT/AE.

For our study period, participants were eligible to be enrolled in LAMP if they met all of the following criteria:

1. lived at home,
2. had a functional deficit with at least two ADL's, (transferring and mobility are considered ADL's for the purpose of inclusion),
3. had electricity and phone service,
4. accepted technology in their homes for monitoring purposes, and
5. signed a consent form or had the consent form signed by a proxy.

The LAMP target population included veterans with multiple co-morbidities such as arthritis, diabetes, hypertension, and stroke. The LAMP CC team consisted of two licensed OTs, a technology expert also assisted with technology installation and training, and a program support assistant provided office support. Following eligibility determination, a licensed OT conducted a physical/functional, cognitive, and home assessment in each of the study participants' homes. The assessment included instruments that measured functional independence, cognition and quality of life. Two instruments were used to measure functional status: the Older Americans Research and Service Center Instrumental Activities of Daily Living (IADL) (Fillenbaum, 1988), and the motor subscale of the Functional Independence Measure (FIM) (Fricke, Unsworth, & Worrell, 1993; Pollak, Rheult, & Stoecker, 1996). Mental status was evaluated through the Mini Mental Status Examination (M. Folstein, S. E. Folstein, & McHugh, 1988) and the cognitive subscale of the FIM. Health-related quality of life was measured by the Veteran's Quality of Life SF-36V Health Survey Form (SF-36V) and the shorter version, the SF-12V (Brazier et al., 1992). Veterans enrolled in LAMP received functional, cognitive, and health-related quality of life measurements in their home at baseline and 12-month follow-up. A comprehensive home assessment was conducted and included evaluation of the home's exterior and interior, focusing on accessibility and safety. Subsequently, care plans were developed based on information obtained from these assessments. Care plans included the type of adaptive equipment needed to increase safety and independence within the home, the type of technology to be used for remote monitoring, and health-related diagnostic parameters. An additional home visit for installation and training on each piece of equipment was required.

Three different communications systems were used for LAMP remote monitoring: (1) a basic computer with internet capability, (2) a smartphone (cell phone) with internet capability, and (3) the HB. Veterans who met criteria for computers or smartphones demonstrated either past computer knowledge, or the cognitive and physical abilities necessary for computer or smartphone use. Motivation to learn and use the computer or smartphone was also considered. Veterans who did not meet criteria for computers or smartphones received a HB. The HB was installed during the initial evaluation, whereas additional home visits were required for installation and training on the use of the computer or smartphone. Veterans who required more than 3 home visits for computer or smartphone training were switched to a HB.

LAMP was based on preliminary work performed by Mann and colleagues (Mann, Hurren, Tomita & Charvat, 1995; Mann, Marchant, Tomita, Fraas, & Stanton, 2001; Mann, Ottenbacher, Fraas, Tomita & Granger, 1999) which showed that functional decline may be attenuated through the provision of AT/AE. LAMP services were based on the experience of Mann's 3-year National Institute on Disability and Rehabilitation Research (NIDRR) funded study where frail elders were provided adaptive equipment and monitored for self-care needs using computers with video-teleconferencing capability. Results from their study demonstrated that frail elders experienced functional decline over time, but indicated that compared to a control group the rate of decline could be slowed, and institutional and certain in-home personnel costs reduced, through a systematic approach to providing AT/AE and home modifications. Other studies have also demonstrated that the use of AT/AE can provide assistance for individuals with disabilities (Berry & Ignash, 2003; L.M. Verbrugge & Sevak, 2002; Gitlin, et al, 2006).

Daily Remote Monitoring by LAMP and TCCP

Daily remote monitoring comprises a multi-component, chronic disease management model through the review of personal health dialogues. TCCP and LAMP daily remote monitoring included patient assessment based on a variety of health-related diagnostic parameters, such as blood pressure or blood sugar readings. Disease-specific education was provided based on individual healthcare needs. Patient adherence to medication and treatment plans was also addressed. Maintaining daily contact with telehealth patients allowed for comprehensive patient-provider communication, and follow-up support. LAMP patients were assessed daily on the same health-related diagnostic parameters as the TCCP patients, but were also monitored on self-care parameters and the promotion of therapeutic lifestyle changes. LAMP daily self-care reports included information on falls, self-care and mobility throughout the home environment, as well as the ability to get outside of the home and participate in leisure and social activities. Communications technology provided both LAMP and TCCP Care Coordinators (CC) with the necessary information to evaluate health status and provide immediate intervention and ongoing care management through the VA. Care management is important for accessible, coordinated, and continuous healthcare across all settings, especially the home.

Theoretical Model

In all areas of healthcare, theoretical models and frameworks are important for clinical practice, research and education. The World Health Organization (WHO) International Classification of Functioning, Disability, and Health (ICF) is a framework designed to classify health and health-related states (World Health Organization [WHO], 2001). The ICF has broad applications to a variety of areas in medicine and rehabilitation, and provides the basis for understanding the interrelationships between the person, the environment, health, and function. The ICF allows us to illustrate the instrumental similarities and differences between THC and TRH.

The International Classification of Functioning, Disability and Health model

The ICF is considered a biopsychosocial model, as it integrates the medical model, the disability model, and the social model to view health as being influence by the condition, the person, and the environment (WHO, 2001, 2002).

The ICF has shifted the focus from health as a “consequence of disease” to a “components of health” classification (2001). The ICF provides a scientific basis for viewing and studying all health conditions, allowing them to be compared using a common measure of function and disability (Dahl, 2002). Part I of the ICF framework focuses on Functioning and Disability; Part II of the ICF relates to Contextual Factors. Both Part I and Part II have interrelating components, and functioning and disability are seen as outcomes of interactions between both parts. The two interrelating components within Functioning and Disability are “body functions and structures”, and “activity and participation.” Interrelating components within Part II, Contextual Factors, are comprised of “environmental factors” and “personal factors.” To classify each of these components, the ICF uses qualifiers. Qualifiers allow one to measure the presence or severity in the level of functioning within the body, person and society. Therefore, function is not limited to a single domain but is a dynamic blending of components across domains. This indicates that the true marker of success for any individual undergoing the process of rehabilitation is not only regaining physical and cognitive function, but by participation in life activities (Fougeyrollas & Beauregard, 2001).

The ICF allows for the measurement and reporting of health at an individual and population level, and has been used in the evaluation of numerous healthcare systems and the study of healthcare interventions (Arthanat, Nochajski, & Stone, 2004; Bilbao et al., 2003; Haglund & Henriksson, 2003; Lomax, Brown, & Howard, 2004; Mayo et al., 2004; Stamm, Cieza, Machold, Smolen, & Stucki, 2004; Stucki et al., 2002a; Stucki, Ewert, & Cieza, 2002b; Weigl et al., 2003). The ICF is an important component for healthcare policy design and implementation. The implementation of new strategies in healthcare requires coordinated efforts and significant investment in research. This is especially true of applications in telehealth.

Telehealth / ICF framework

Chronic illnesses and their impact on veterans and the VA healthcare system are the focus of this study. Chronic illnesses relate to the ICF component of Functioning and Disability. Chronic illnesses involve domains within body functions and body structures such as the cardiovascular and respiratory systems, as in hypertension or chronic lung disease, neuromusculoskeletal and movement systems involved with osteoarthritis, and the metabolic system related to diabetes mellitus. The ICF component of Activities and Participation are likely to be negatively affected through impairments within the body functions and structures, which often accompany chronic illnesses. Such impairments may limit one's ability to independently perform self-care, engage in work, or spend time with family and friends. Contextual Factors includes environmental factors and personal factors. Environmental factors include interventions within the home environment, assistive devices and technology, and support and relationships that may be enhanced through care coordination. Personal factors vary based on one's particular background and are not a feature of a chronic or disabling illness. In this study personal factors include age, marital status, and disease state. The ICF model demonstrates that chronic illness related impairments, combined with environmental and personal factors, may decrease one's ability to function within the home.

TCCP uses the medical model in conjunction with communications technology to coordinate care for chronically ill individuals. The medical model of care places an emphasis on diagnosing and successfully treating a disease. Functioning and health are seen primarily as a consequence of a disease. This disease-specific model dominates the healthcare system (Kaplan, 2002). TCCP focuses on minimizing the impact of the condition through symptom tracking and the provision of a medical intervention. However, symptom tracking alone may not give us an accurate picture of how a chronic illness actually affects a person's everyday life (Kaplan, 2002; Ustun, Chatterji, Bickenbach, Kostanjsek, & Schneider, 2003). Chronic conditions are usually not cured, and require ongoing disease management, patient education, and provision of resources to assist patients to cope with the impact of the illness.

The rehabilitation model of care is a continuous process that ranges from identifying difficulties and needs, relating the difficulties to impaired body functions and structures, targeting the person and the environment through interventions, and managing the interventions (Stucki et al., 2002b). Therefore, the severity of an illness may be reduced through the provision of environmental modifications and adaptive devices to remove the limitations that alter functioning. LAMP uses the rehabilitation model to coordinate care for chronically ill individuals through assessing personal and environmental factors in order to provide the appropriate technology for remote monitoring, as well as modifying the immediate home environment through the addition of grab bars to a shower stall, recessed doorways for accessibility, or ramps for entrance into a home. From the LAMP perspective, function is not only an outcome, but also an important component of assessment, intervention, and quality of care (Cieza & Stucki, 2005). These factors can be put into perspective through the use of the ICF model.

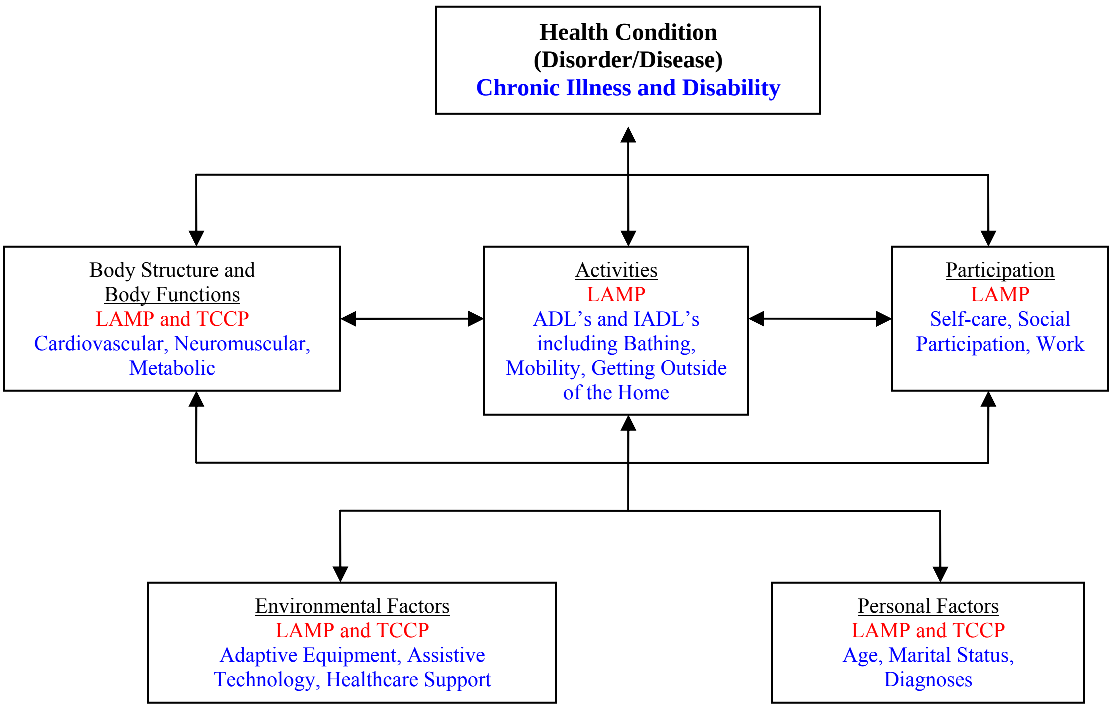


Figure 1-1. The International Classification of Functioning, Disability and Health (ICF) comparison of LAMP and TCCP

Specific Aims

The proposed study will evaluate a telehomecare and telerehabilitation model of care for chronically ill veterans using both quantitative and qualitative methods. Telehomecare and telerehabilitation strategies will be assessed from multiple perspectives including cost effectiveness, functional/health status, and patient satisfaction with telehomecare and telerehabilitation models.

The purpose of this dissertation is to explore differences in health-related outcomes and costs between (1) veterans enrolled in a telerehabilitation intervention (LAMP); (2)

veterans enrolled in a telehomecare intervention (TCCP); and (3) veterans who receive VA standard care without a telehomecare or telerehabilitation intervention. In addition, we will qualitatively explore the "experience" of a telerehabilitation and a telehomecare intervention through personal stories from veteran telehealth enrollees.

By targeting veterans with chronic illnesses and disabilities, we anticipate that the provision of compensatory strategies (adaptive equipment) and home monitoring through communications technology will proactively manage the consequences of chronic illnesses, increase safety and independence, and thereby enhance functional independence and reduce institutional care and other healthcare costs. This study is an important addition to the limited research available, as it combines both a cross-sectional qualitative analysis with retrospective quantitative analyses utilizing longitudinal (1-12 months) data.

For these hypotheses, VA services are defined as costs for hospital bed days of care, emergency room visits, nursing home bed days of care, and clinic visits. Four groups of veterans will be compared: (1) veterans receiving the LAMP intervention (telerehabilitation); (2) veterans receiving the TCCP intervention (telehomecare); (3) a comparison group of veterans matched to LAMP and TCCP based on primary diagnoses, number of hospital bed days of care 12-months pre-study, and demographic variables of age and marital status.

Specific Aim 1: To quantify the effect of telerehabilitation and telehomecare in reducing healthcare costs among the four groups of veterans.

Hypothesis 1: Veterans enrolled in LAMP, veterans enrolled in TCCP, and their corresponding matched group of veterans who have not received telerehabilitation or telehomecare interventions will differ in their use of VA services and healthcare costs.

Specific Aim 2: To define the effect that telerehabilitation exerts in promoting functional independence by comparing functional health status measurements within and between the two telehealth groups.

Hypothesis 2: Veterans enrolled in LAMP and veterans enrolled in TCCP will differ in functional health status following a 12-month enrollment period.

Specific Aim 3: To evaluate the effect of telerehabilitation and telehomecare interventions on satisfaction with VA services.

Research Question (Qualitative Data): How do veterans and their caregivers describe their experiences with telerehabilitation and telehomecare interventions?

This study utilized existing quantitative data sets comprised of patient's medical history, clinical assessments, and VA health-related expenditures for chronically ill and disabled veterans enrolled in telerehabilitation, telehomecare or receiving standard VA care. We examined relationships between the four groups of veterans based on costs of healthcare services, as well as LAMP and TCCP patient reported health-related quality of life measures. Additionally, as patient's perceptions of disease, illness and health have been deemed critically important by the VA (Kazis et al., 2004b), a qualitative review was initiated utilizing a sampling of veterans enrolled in a telerehabilitation (LAMP) and telehomecare (TCCP) intervention.

Summary

The special care needs required for individuals with chronic illness and disabilities, coupled with the VA integrated healthcare system, make it an excellent model for studying care delivery innovations. Thoughtful evaluation of telehealth models will help to clarify potential roles of telehomecare and telerehabilitation interventions to reduce chronic illnesses and disabilities and enhance safety and independence in the home.

Outcomes from this study will allow assessment of the impact of veteran's illnesses and physical impairments on system utilization. The cost analysis permits identification of the benefits of the telehomecare and telerehabilitation systems compared to usual care. Results from this study will help advance knowledge and promote innovations that will contribute to optimal care of chronically ill and disabled veterans who are living at home.

CHAPTER 2
REVIEW OF THE LITERATURE

Aging, Chronic Illness and Disability

According to the 2000 U.S. Census, more than 35 million people in the United States are aged 65 and older (Gist & Hetzel, 2004). This constitutes approximately 12.4 percent of the total U.S. population. The number of elders aged 85 or older is the fastest growing cohort. By the year 2010, the 85+ population is expected to reach 6.1 million and account for approximately 1.2 percent of the total U.S. population (DHHS, 2004). Paralleling this population increase is the projected increase in the numbers of elderly with poor health (DHHS, 2004). Illnesses affecting the elderly impact life expectancy and healthcare costs considerably, placing more and more demands on the public health system and on medical resources (Joyce, Keeler, Shang, & Goldman, 2005). The majority of healthcare resources for the elderly are now devoted to the treatment of chronic conditions (CDC, 2003b). Total healthcare costs for individuals with chronic conditions are more than five times higher than healthy individuals (Partnership for Solutions [PFS], 2004).

The elderly population is at risk for developing chronic conditions such as diabetes, heart disease, and arthritis. Chronic conditions are the leading cause of death and disability in the elderly, accounting for approximately 70 percent of all deaths and 75 percent of all healthcare costs (CDC, 2003a). The disability rate of the population over age 65 is at least three times higher than the general population (Chan et al., 2002; Gist &

Hetzel, 2004). Disability causes functional limitations in activities of daily living (ADL), such as walking, transferring, bathing and toileting. Approximately 43 percent of those individuals over age 65 report difficulties with self-care and mobility activities within the home (Gist & Hetzel, 2004). A systematic review of literature by Freedman and colleagues determined a correlation between aging, chronic illnesses and disabilities and the need for personal assistance with daily living tasks (Freedman et al., 2002). Difficulties performing ADLs, such as bathing or ambulating, generate the need for personal assistance or placement in a residential facility and significantly increase medical expenditures (Gill & Kurland, 2003; Naik, Concato, & Gill, 2004; Ostchega et al., 2000). Chan, et al. (2002) reviewed disability and healthcare costs and determined that functional limitations in ADLs may be an independent risk factor for increases in healthcare expenditures. The authors reported that the total mean healthcare costs for the most disabled (i.e., those reporting 5-6 ADL limitations) was more than seven times higher than for individuals without functional limitations.

Environmental contributors to functional decline

Functional limitations imposed by chronic conditions threaten an elders' quality of life and the ability to age safely and independently. It is well-known that elders and those with disabilities prefer to remain in their homes and live autonomously (Bayer & Harper, 2000; Tang & Venables, 2000). Research has shown that the provision of adaptive equipment and home modifications may allow elders to perform self-care tasks at close to their highest ability and decrease the need for personal assistance (Gitlin et al., 2006).

The use of adaptive equipment and home modifications that target environmental contributors to disability and functional decline have been shown to compensate for declining abilities for elders (Kraskowsky & Finlayson, 2001). Although there is no single approach that can address all functional limitations, numerous studies have shown the positive effect of adaptive equipment and home modifications when focused on areas that therapists and elders together identify as problematic (Cumming et al., 1999; Gitlin et al., 2006; Hoenig, Taylor, & Sloan, 2003; Mann et al., 1999; Tinker & Lansley, 2005; Verbrugge, Rennert, & Madans, 1997). An increasing percentage of elderly manage their ADL difficulties with the use of adaptive equipment, especially in the areas of bathing, toileting and mobility (Spillman, 2004). Environmental modifications, such as the addition of grab bars in the bathroom, increase safety and decrease the risk of falls. Assistive devices and environmental modifications have been found to help conserve energy and time, and provide a sense of security (Kraskowsky & Finlayson, 2001; Tinker & Lansley, 2005). Moreover, the use of adaptive equipment and environmental modifications enable elders to remain in their own homes longer.

Functional difficulties within the home environment deserve attention from the medical community (Gitlin et al., 2006). Rehabilitation specialists, such as occupational therapists (OT), recognize the importance of ameliorating functional difficulties that may result from a mismatch between the elderly person and their home environment, resulting in the risk of accidents, such as falls. Functional difficulties serve as eligibility criteria for home-based OT services, yet such services are seldom provided unless an acute medical episode or hospital stay triggers a referral. Additionally, services are often short-term and focus on acute care goals in lieu of the long-term needs imposed by chronic illnesses. Such issues challenge rehabilitation efforts and increase individuals' health risks and access to healthcare services (Demiris et al., 2004). Improvements in quality of care should be aimed at an elders' desire to remain independent and live at home, as well as control healthcare costs. By focusing attention on chronic conditions, functional limitations, and access to healthcare services, sizeable improvements in the quality of care should be achievable (Bodenheimer et al., 2002a; IOM, 2001).

Access to healthcare services

Elders with chronic illnesses and disabilities strain healthcare resources and healthcare providers. This economic strain and profit-driven healthcare systems have lead to cost containment efforts, limiting access to services and compromising quality of care. The majority of elderly patients with chronic illnesses present with difficulties accessing care in a timely manner which increases their risk for disabilities (Bodenheimer, Wagner, & Grumbach, 2002b; PFS, 2004). Access to healthcare may also be due to the problems of transportation and distance, as well as understaffed clinics and rehabilitation facilities. The Institute of Medicine (IOM) defines quality of care as being contingent on access to healthcare in a timely and equitable manner (Hawkins & Rosenbaum, 2005; IOM, 2001). The failure to receive timely and ongoing care for chronic conditions can lead to serious health consequences and result in higher healthcare expenditures.

Numerous factors exist which limit access to healthcare. Many elderly reside in rural communities with limited availability of adult specialty services, such as psychiatry, neurology, comprehensive wound care, and rehabilitation. Rural areas frequently require long-distance travel by patients and their home healthcare providers. A recent study determined that the health of individuals who live in rural areas is worse than those who live elsewhere, even after adjusting for socioeconomic factors (Weeks et al., 2004). Barriers to healthcare for rural-dwelling patients include geographic isolation, functional isolation, economic barriers, a scarcity of health professions, or a combination of these factors.

Evidence has shown that responding to a patient's needs in a timely fashion can improve the management and quality of their care (Balas et al., 2000; Goldsmith, 2000). Timely and equitable access to care may require that we view the delivery of healthcare in a different way. One method to increase availability of specialty healthcare services and provide timely access to healthcare is to expand the capacity of healthcare centers through the use of information technology.

Information technology

Information technology (IT) uses technology applications to manage and process information. Historically, the healthcare sector has used IT for administrative tasks, such as billing and inventory, but its use in the area of clinical care has been limited. IT can play a critical role in the effective and efficient delivery of clinical care. IT allows healthcare providers to systematically gather, process, analyze, communicate, and manage patients and patient data (Kelley, Moy, Stryer, Burstin, & Clancy, 2005).

Telecommunication is defined as the use of technology to transfer information over a distance. Telecommunication has been used to quickly provide essential patient data to healthcare providers at a distance. Both patients and healthcare providers benefit through the use of telecommunications for immediate access to automated clinical information, diagnostic tests, and treatment results. Telecommunication has also been used to assist healthcare specialists in educating and training new practitioners who may be in a different room of a building, a different state, or even a different country.

Table 2-1. Health-related applications for information technology*

Health-related Areas	Applications for Information Technology
Financial & Administrative	Enrollment of patients
	Scheduling of appointments
	Billing for services
	Payment of providers
Clinical Care	Access to information for diagnoses
	Care delivery
	Reminders and alerts (re: vaccines, etc.)
	Video-based medical consultation
	Consultation with specialists
	Patient monitoring: in-home (monitoring vital signs, etc.)
	Disease Management
	Patient education
	Transfer of medical records/images
Professional Education	Medical literature searches
	Accessing reference material
	Distance education
	Consultations
	Credentialing
Consumer Information & Health	Online searches for health information
	Searches for doctors or health plans
	Health insurance benefits information
	Participation in support and chat groups
	Self-monitoring
	Access to personal health records
	Purchase products
	Medical consults (2nd opinions)
	Email between patient and provider
	Clinical trial information
Public Health & Homeland Security	Incident reporting
	Integration of data sources
	Videoconferencing among public health officials
	Surveillance (diseases or epidemics)
	Delivery of health alerts
	Response to bioterrorist attacks
Research	Enrolling patients in trials
	Collection of data
	Collaboration with colleagues
	Transfer of large data sets
	Searches of large databases
	Literature searches
	Outcomes measurement

*Adapted from the National Research Council, 2005

Numerous IT applications are currently available for healthcare providers. Table 2-1 provides a listing of health-related applications for IT (National Research Council, [NRC], 2005a).

Benefits to the use of IT

Despite the fact that learning to live with and manage a chronic disease or disabling condition is an important aspect of aging, current medical care and health education does not adequately address this issue (Nodhturft et al., 2000). IT can support self-management of chronic illnesses through education and collaboration from healthcare providers. IT has the potential to assist patients to learn the skills needed to manage illness, making healthcare more patient-centered. Numerous IT applications are currently being used to bring healthcare into the home and reduce the need for clinic care and inpatient services. Whereas clinical instruction and intervention traditionally occur in hospitals and clinics, a growing range of information technologies are being utilized, including remote monitoring, interactive videoconferencing and web-based e-Health applications. IT devices are increasingly employed to help gather, send and manage large amounts of health information needed to assist both caregivers and patients in their self-care efforts.

The ability to remotely and timely monitor patients' physiological parameters, provide patient education and intervene quickly is essential for quality of care. Home-based monitoring can provide healthcare providers with daily information about their patient's health, allowing for quick response to healthcare needs. Home-based monitoring can provide patients with customized health education, access to providers, and support for their healthcare needs. Potential advantages of using technology to deliver patient education include its immediate availability, consistency of instructional content, increased accessibility, a private learning environment within the home, and the ease of reinforcement of learning (Dang, Ma, Nedd, Aguilar, & Roos, 2006; Lewis, 1999). Additionally, monitoring healthcare needs and trends over time allows healthcare providers to determine the programs that are more effective and cost efficient. Home monitoring by the healthcare team can detect and remediate functional and health problems before they spiral out of control, improving access, effectiveness, and efficiency of healthcare services. Although the potential for the use of IT in the healthcare industry is tremendous, barriers continue to exist.

Barriers to the use of IT

Currently, the internet offers enormous potential to make the delivery of healthcare more timely and patient centered. Yet many healthcare settings lack basic computer systems or support the use of the internet for information or decision making (NRC, 2005a). To date, email is only used sporadically between patients and healthcare providers, but the interest is growing. Moreover, clinicians and patients have varied experience and comfort with IT and both may be wary of adopting the use of IT for healthcare delivery.

A major impediment is both patients' and healthcare providers' concerns about privacy and confidentiality of data. The U.S. has issued neither national standards regarding the protection of health data, nor policies for the collection, storage and processing of health data through communications technology. Although this is viewed as a barrier to the use of IT, proponents of IT fear that enactment of stringent privacy rules and regulations may impede the integration and success of IT applications addressed to meet the quality needs of the current healthcare system (Detmer, 2000; DHHS, 2000).

IT proponents also believe expansion of IT for healthcare delivery is impeded by reimbursement policies of the federal government and private insurers. Healthcare payers, government and private, are reluctant to cover IT services as a part of health insurance because of the uncertainty about efficacy and cost (Hersh et al., 2001). The demands for immediate financial returns by private industry and sponsoring organizations have precluded large-scale and long-term coordinated research efforts (Krupinski et al., 2002).

The IOM (2001) reports that a challenging barrier to the establishment of IT applications in healthcare "relates to human factors" [pg. 174]. Widespread adoption to the use of IT for healthcare delivery may require behavioral adaptations on the part of both the patient and the healthcare provider. Many of the concerns voiced by both clinicians and patients focus on the loss of face-to-face interactions and the demise of the patient-clinician relationship. Mangusson and Hanson (2003) view the debate as a moral and social one, stating that analysis should qualitatively evaluate complex issues relating to quality of life, as well as job satisfaction for the healthcare professions. Research has shown positive views from patients and their healthcare providers. Hebert and Korabek (2004) determined through focus groups and interviews that patients were positive about the potential of technology to support their independence, increase self-control over their care, and provide access to services. Nurses in their study felt improved outcomes would result from the provision of disease-management education, and frequent monitoring and timely interventions would result in health improvements. Physicians were more reticent about the reliability and accuracy of the technology for assessing patients, and were concerned about reimbursement, liability and training (Hebert & Korabek, 2004).

A further impediment to the use of IT in healthcare is the paucity of reliable information on the costs and benefits. The idea that the use of IT can improve care and lower costs through fewer office visits and timely medical interventions has yet to be fully tested in rigorous settings. Before IT can become widespread in healthcare, research on technologies and the evaluation of health applications must be achieved. Although funding has been limited for large scale studies, "IT demonstration projects can serve as venues for continued identification of technology needs" [page 257] and develop standards for the provision of healthcare services (NRC, 2005b).

Telehealth Applications

Telehealth, an approach that connects individuals with their healthcare providers through the use of telecommunications technology, addresses many of the above-mentioned aims. The 2001 Report to Congress on Telehealth defines telehealth as the "use of electronic information and telecommunications technologies to support long-distance clinical health care, patient and professional health-related education, public health, and health administration" (OAT, 2002) [page 1]. Specialized medical devices, video-conferencing, computer networking, and software management systems allow for the evaluation, diagnosis and treatment of patients in locations such as their homes. Medical applications of telehealth are numerous. The main objectives include:

- More equitable distribution of healthcare through increased access to services for individuals with disabilities and others for whom access is difficult (i.e. rural areas).
- Removing the barriers of distance, time and travel from healthcare.
- Cost effectiveness by avoiding unnecessary emergency room visits and hospitalizations.
- Preventative medicine and early intervention of medical complications that might otherwise go unreported.

- Better diagnostic and prognostic capabilities, as patients submit vital health information daily, allowing for tracking of trends.
- A holistic team approach, which may comprise physicians, nurses, therapists, psychologists, and social workers.
- Patient-centered treatment and increased patient compliance, as patients are more aware of their vital parameters (blood pressure, blood glucose levels, body weight and temperature) and able to become actively involved in the process of managing their care and treatment interventions.
- Promotion of independence through maintenance of life at home; enhanced quality of life through prevention of chronic illnesses (Celler et al., 2003; Hersh et al., 2001).

Telehomecare

Home-based telehealth applications, or telehomecare, represent a special application of growing significance. One of the central driving forces for telehomecare is the elderly patient's wish to remain safely at home for as long as possible. The home, therefore, is becoming an increasingly important location for "care and cure" (Tang & Venables, 2000) [pg 8]. Using telehealth technology, home-based video visits and monitoring of vital signs can be accomplished electronically, medication compliance can be verified, and patient education can be enhanced (Finkelstein et al., 2004).

Through telehomecare, remote health devices can record and transmit vital information such as blood pressure, blood glucose levels and electrocardiograms from home-based clients (Nakamura, Takamo, & Akao, 1999; Tsang et al., 2001). Home monitoring can link patients to clinics, physician offices, disease management companies, and home care agencies for the purpose of streamlining care delivery, maintaining a closer patient connection, and monitoring early changes in patient status (Field & Grigsby, 2002; Frantz, Colgan, Palmer, & Ledgerwood, 2002). Monitoring devices typically incorporate alert systems that allow for rapid detection and treatment of early signs and symptoms of instability. Home health devices often provide the patient with the education necessary for disease-management and long-term compliance. As patients are responsible for ensuring that accurate information is submitted, telehomecare requires that patients assume much greater roles in the treatment and care of their chronic illnesses (Holman & Lorig, 2000). Although telehomecare has the potential to assist elders in the self-management of their chronic illnesses, and in turn reduce healthcare costs, randomized controlled trials to test this proposal are lacking.

Telehomecare research studies

As referrals for home health services continue to escalate, healthcare organizations are encouraged to seek more effective methods for providing patient care and saving costs. In a landmark study of home health services by Kaiser Permanente Medical Center, positive health outcomes were reported in terms of quality, patient satisfaction, and cost savings (Johnston, Wheeler, Deuser, & Sousa, 2000). More than 22 percent of Kaiser's enrollees have diagnosed chronic illnesses, and generate 47 percent of the emergency room visits and approximately 75 percent of the non-obstetric hospital bed days of care (Bodenheimer et al., 2002a). Kaiser randomized 212 patients into control and intervention groups, each receiving routine home healthcare (home visits and telephone contact). In addition, the intervention group was provided with access to a remote video system, which allowed nurses and patients to interact in real time, and provided peripheral equipment for assessing vital health information. Remote video technology in the home healthcare setting was shown to be effective and well received by patients. Following the 18 month observational study, total cost savings of approximately $900 per patient in the intervention group was reported, when controlling for equipment costs and depreciation. Based on these findings, Kaiser Permanente is now integrating telehomecare services within its organization (Johnston et al., 2000).

Additional smaller studies have compared conventional home healthcare services with the use of home-based telecommunications equipment for remote monitoring. Nakamura (1999) evaluated the effect of home healthcare compared to home healthcare with the addition of a videophone. The videophone allowed patients to receive remote medical assessments and consultation regarding health problems, ADLs, physical exercise and nutrition, as well as emotional support for patients and caregivers. Patients and providers responded to questionnaires at the end of the study, which determined a potential benefit in the use of the videophone in terms of improving communication and offering better assistance. As has been noted in numerous other studies (Hebert & Korabek, 2004; Magnusson & Hanson, 2003; Nelson, Citarelli, Cook, & Shaw, 2003; Williams, May, & Esmail, 2001), both the participants and the home health professionals felt that services via videophone could supplement but not replace all face-to-face healthcare visits.

Many telehomecare applications focus on specific healthcare needs, such as individuals with congestive heart failure (CHF). CHF is one of the most common causes of hospitalization due to exacerbation of a chronic condition among adults aged 65 years and older in the U.S. (Scalvini et al., 2004). Through a randomized controlled trial (RCT), the U.S. Department of Commerce is examining the benefits of using low-cost telecommunications and monitoring technologies for homebound frail elders needing skilled home healthcare (Demiris et al., 2001; Finkelstein et al., 2004). The study is focusing on elders with CHF, chronic obstructive pulmonary disease (COPD), and chronic wound-care, but final results have yet to be published. Outcome measures will evaluate mortality and morbidity, length of time to transfer to a higher level of care (e.g., hospitalization or long-term care facility), subject perception of telehomecare, subject satisfaction with care and technology, quality and clinical usefulness of virtual visits, utilization of services, and costs for both subjects and service providers. At this point in time, initial information from the study has shown that elderly patients can use the technology successfully, are satisfied with the care they receive, are confident in handling the technology, and are accepting of the underlying concept of telehomecare. Roglieri and colleagues presented a multicenter, longitudinal comparison of a comprehensive CHF disease management program focused on patients with pure CHF and CHF-related diagnoses. The impact of telemonitoring of CHF patients and post-hospitalization follow-up in a managed care setting was evaluated. The researchers report significant cost savings for participants based on reduced hospital admissions and readmission rates, length of stay, and emergency room utilization (Roglieri et al., 1997). Dimmick et al. (2003) discussed the establishment of a CHF disease management telehomecare program as part of an integrated telehealth network that linked three hospitals, a federally qualified healthcare clinic with six sites, a county dental clinic, and patients from nine different counties and two states. In lieu of providing specific information regarding this CHF program, the authors analyzed labor and equipment costs and estimated cost savings on a national scale, projecting that the national costs of care for CHF hospitalizations could be reduced from $8 billion to $4.2 billion annually. The University of California at Davis Hospital (UCDH) studied 3 groups of individuals with the diagnosis of CHF (Jerant, Azari, & Nesbitt, 2001). All groups were provided with standard healthcare, a second group also received a weekly telephone call, and the third group was provided with a videophone and remote health monitoring equipment. Differences were not detected between the telephone and telehomecare groups, but trends were seen toward fewer CHF related and all-cause readmissions, and shorter mean length of stay in both the telephone and the telehomecare intervention groups compared to standard care. Although the researchers discussed charges as primary and secondary outcomes, true cost figures were not provided. This study is one that questions whether more expensive telehomecare programs offer any incremental benefit beyond telephone follow-up.

Diabetes is another significant chronic illness, which is costly and common in the elderly. The high prevalence and complexity of diabetes poses major clinical challenges which may be attenuated by telehomecare (Shea et al., 2002). An ongoing RCT is Columbia University's Informatics for Diabetes Education and Telemedicine (IDEATel) Project. IDEATel is a four-year demonstration project funded by the Centers for Medicare and Medicaid Services (Shea et al., 2002). A total of 1,500 participants have been randomized to a telehomecare intervention (n=750) and a control group receiving standard care (n=750). IDEATel is a large, complex project designed to provide data relevant to policy formation for the use of telehomecare in diabetic management. Outcomes from this study should provide significant information regarding the use of telehomecare for the management of diabetes in the elderly population. Integrated telehealth networks have been designed to assist diabetic participants manage their care through telehomecare support systems (Dimmick et al., 2003; Shea et al., 2002). In Dimmick et al., participants were given a blood glucose monitor that used telephone lines to transmit values to a health clinic. Although their sample size was small (N=36), researchers reported progress in achieving better blood sugar control by participants. The researchers felt that a key outcome in this demonstration project was the ability to provide support and incremental education over time so that participants learned to manage their chronic health problems. The TeleHomecare Project is a partnership between the Pennsylvania State University, the Visiting Nurses Association (VNA) of greater Philadelphia, and the American Telecare, Inc. (ATI) (Dansky, Palmer, Shea, & Bowles, 2001). The TeleHomecare Project was designed to test the effects of telehomecare on quality and financial costs associated with care for elderly diabetic patients. All costs were examined, both direct and indirect, but the focus was costs occurring at the home health agency level. Researchers provide a specific cost breakdown for each component of the telehomecare services, including home visits, video visits, training and meeting time, and equipment. Reported outcomes focused on the percent of patients who were discharged from home healthcare (64 percent of the telehomecare group compared to 39 percent of the control group) and the percent of patients who were readmitted to the hospital (10 percent telehomecare group compared to 28 percent control group), yet they do not report on cost savings or the findings from the health-related quality of life measures that were used.

Telerehabilitation

Another application of telehealth is Telerehabilitation. Telerehabilitation is an emerging practice that uses specialized communications technology for the remote delivery of care to patients with rehabilitation needs. Telerehabilitation has the potential to manage multiple components of health, including functional independence, self-care and self-management of illness (Halamandaris, 2004a). The focus of telerehabilitation is to increase access to rehabilitation services, and to allow individuals to remain safe and independent in their homes.

Over 50 million Americans today live with a functional impairment, often combined with a chronic illness, which impacts their ability to perform basic and instrumental activities of daily living (CDC, 2003b). Although most do not receive specialized therapy, millions require some sort of therapeutic intervention. Typically these rehabilitative interventions are supplied through inpatient care, skilled nursing facilities, outpatient clinics, or home health visits. Unfortunately, as healthcare delivery is restructured in the U.S. due in part to financial considerations, rehabilitation entitlements are being reduced, resulting in shortened lengths of stay in acute and subacute care settings. With earlier discharges, there is an increased need to deliver services to patients in their homes in a comprehensive yet efficient and cost effective manner. Researchers have expressed confidence in the "idea" of applying IT for the remote delivery of medical rehabilitation services and support for independent living; they are sure that the potential is great (Burns et al., 1998; Kinsella, 1999; Rosen, 2004; Schopp, Hales, Brown, & Quetsch, 2003; Winters, 2002; Winters & Winters, 2004).

Telerehabilitation research studies

The ability to remotely assess and monitor physical outcomes is an important area in telerehabilitation. Telerehabilitation has been used successfully for administration of standardized assessment tools (N. C. Dreyer, K. A. Dreyer, Shaw, & Wittman, 2001; Hauber & Jones, 2002; Russell, Jull, & Wootton, 2003b; Savard, Borstad, Tkachuck, Lauderdale, & Conroy, 2003) suggesting this is an accurate and reliable method of performing physical and cognitive assessments. Additionally, televideo technology may also have potential for providing cost-effective in-home assessments for home modification services prior to a patient's discharge (Sanford, Jones, Daviou, Grogg, & Butterfield, 2004). Findings from this small study suggest that remote telerehabilitation assessments have the potential to enable specialists to diagnose potential accessibility problems in home environments and prescribe appropriate modifications regardless of the location of the client, home, or specialist.

Managing the health complications of disability is costly. A number of studies in a variety of care settings illustrate the ability to provide clinical care through telerehabilitation. Russell and colleagues used an Internet-based system in a replicated home environment within a clinical setting to provide rehabilitation to patients who had undergone total knee arthroplasty. Treatment for both the control and intervention groups included therapist guided stretching and mobilizations, a tailored exercise program and education. Treatment outcomes for the telerehabilitation group were comparable to the control group. Following the treatment intervention, patients were surveyed and reported high ratings for satisfaction of the telerehabilitation program, and ease of use of the technology (Russell, Buttrum, Wootton, & Jull, 2003a).

Telerehabilitation may provide a way to improve care and to continue patient education following discharge from a hospital or inpatient setting. In a quasi-experimental study, 35 spinal cord injury (SCI) patients were recruited for a telerehabilitation intervention in the prevention of pressure ulcers (Phillips, Temkin, Vesmarovich, Burns, & Idleman, 1999). Pressure sores have been identified as one of the most common problems for SCI patients, and are also a serious problem for the elderly. Pressure ulcers can lead to expensive and dangerous complications, and treatment often requires that patients be hospitalized (Vesmarovich, Walker, Hauber, Temkin, & Burns, 1999). The study's main objectives were to determine which of three approaches to care (videophone, telephone, standard care) produced the lowest incidence of pressure ulcers, promoted the most effective care of sores that did develop, and lead to the fewest hospitalizations in newly injured patients with SCI after discharge. Phillips and colleagues reported that the telerehabilitation intervention was effective in ulcer tracking and management of all ulcer occurrences. Interestingly, the video group reported the greatest number of pressure ulcers, but the investigators felt that visual contact with the nurse in the video group may have attributed to more ulcers actually being identified and reported.

A large client base for rehabilitation includes adults with stroke and traumatic brain injury (TBI), yet few telerehabilitation studies have focused on these populations. Savard and colleagues reported on two clinical programs that used videoconferencing to provide rehabilitation consultation to individuals with neurologic diagnoses living in remote areas (Savard et al., 2003). The Minnesota Telerehabilitation Initiative serves patients and clinicians in rural Minnesota. The Pacific Rim Initiative serves patients and clinicians on the island of American Samoa. Both service areas have a scarcity of rehabilitation clinicians. Both programs used a two-monitor system for continuous presence videoconferencing between the patient in their home and the rehabilitation specialist in the clinic. Their patient population included elderly individuals with diagnoses of TBI, stroke, and Parkinson's disease. All patients reported satisfaction with the project, 23 patients had positive clinical outcomes, and average mileage saved was 150 miles one way. Two cases studies were presented. As these studies were descriptive in nature, the authors were unable to provide more than recommendations to others considering the provision of telerehabilitation services.

Telerehabilitation may be a way to extend post-acute stroke care into a non-clinical setting, such as the community. Telerehabilitation allows providers to monitor patients' progress, identify areas in need of improvement, and ultimately improve function and decrease long-term disability and costs. A recent community-based study presented a model for providing telerehabilitation for stroke patients using videoconferencing (Lai, Woo, Hui, & Chan, 2004). Twenty-one stroke patients attended an 8-week intervention program at a community center for seniors. The intervention used a videoconference link and provided education, exercise, and psychosocial support for 1.5 hours at one session per week. Significant improvements were noted in balance, stroke knowledge, self-esteem, and health-related quality of life. Advantages of community-based telerehabilitation includes ease of access, enhanced learning and applying knowledge in a group atmosphere, increased social support, and allowance of real-time interaction between participants and the medical professionals. The authors recommend that future studies consider investigating the length, duration and frequency of the intervention, as results may improve with more intense exercise and additional education.

The development of telerehabilitation multi-center teams may make it possible to conduct, analyze and publish more extensive research results in the area of telerehabilitation. In 1997, NIDRR issued a set of proposed priorities for a new Rehabilitation Engineering Research Center (RERC) on Telerehabilitation. NIDRR's main motivation was to explore methods to eliminate the barrier of distance in the delivery of comprehensive rehabilitation services. As well, the INTEGRIS Jim Thorpe

Rehabilitation Center has teamed up with a group of researchers, clinicians, engineers, and administrators to create the Collaborative Alliance for Research in Telerehabilitation (CART). CART's goal is to create a large database of telerehabilitation studies through aligning standardized instruments for data gathering and developing a framework for collection of data across multiple institutions. CART argues that the development of a model database linking the delivery of telerehabilitation services, reimbursement, and outcome evaluation is critical to meeting the challenge for long-term sustainability of telerehabilitation (Kaur, Forducey, & Glueckauf, 2004).

The current literature also provides educational articles that define the basic operations of a telerehabilitation program (Winters & Winters, 2004), emerging opportunities in telerehabilitation (Winters, 2002), advantages and disadvantages of telerehabilitation (Torsney, 2003), and important components to consider when designing a telerehabilitation program (Schopp, Hales, Quetsch, Hauan, & Brown, 2004). Winters (2002) reports that one of the apparent reasons telerehabilitation isn't thriving may be because there is not one optimal protocol for rehabilitation. Different problems require different technologies and procedures. Based on these reports, the development of a conceptual framework may be needed to provide a foundation for clinical research in telerehabilitation.

Telehealth applications within the Veterans Health Administration

The Veterans Health Administration (VHA) provided medical care to approximately 5.3 million veterans in 2005 (OPA, 2006). A significant portion of this medical care is provided for the management of chronic illnesses which are especially prevalent amongst the aging veteran population in comparison to their community counterparts (Asch et al., 2004; Kazis et al., 2004b; Rogers et al., 2004; Yu et al., 2003a).

Additionally, when compared to the general U.S. population, veteran enrollees tend to be poorer and more likely to live alone (Stineman et al., 2001). Living alone may increase healthcare utilization due to lack of available support at home, inability to rely on others for assistance, or lack of support for basic and instrumental activities of daily living (Guzman, Sohn, & Harada, 2004). Prior studies have found living alone to be an independent risk factor for morbidity and mortality (DHHS, 2004; Lund et al., 2002). Furthermore, serious health or disabling conditions may lead to residence in a nursing home due to the difficulties of home management. Each of these issues significantly increases the healthcare challenge and places our veterans at risk for healthcare crises. Cost effective and efficient approaches that foster the well-being and independence of our veteran enrollees must be explored. Telehealth is viewed by many individuals within VHA as an innovative means to increase access and improve healthcare for veterans through telecommunications applications linking clinical care, education, and administrative systems.

In October 1999, the Veterans Health Administration (VHA) published a notice entitled, "Telemedicine Strategic Planning Document," which outlined a national strategy for VHA telehealth and provided recommendations for the development, evaluation and optimization of telehealth to improve healthcare for veterans (VHA, 1999). This planning document concluded the following:

- Telehealth has the potential to serve the healthcare needs of veterans by decreasing the barriers of distance and time. In remote areas, travel distances represent a significant barrier for veterans to access timely care.
- Telehealth has the potential to enhance care for veterans who may be isolated from necessary care, and to augment healthcare services in home and community based care locations.

- Telehealth must be more thoroughly evaluated to demonstrate the efficacy, safety, reliability and outcomes of clinical Telehealth.

Despite over three decades of telehealth activities in different healthcare sectors, few clinical studies in telehealth have comprehensively evaluated and documented such outcomes. To address these strategic planning initiatives, in April 2000 the VHA initiated funding of several clinical demonstration projects to test the integration of care coordination with communications technology for disease management (Meyer et al., 2002). Numerous publications have resulted from this initiative, but few VHS telehealth programs have existed long enough to provide convincing cost effectiveness results.

Telehealth research studies within the VHA

The use of technology to improve health behaviors and self-management in the veteran population and reduce the risk of early institutionalization is a focus of telehealth within the VHA. The Rural Home Care Project (RHCP) was one of eight clinical demonstration projects within this original initiative (Kobb et al., 2003). A prospective, quasi-experimental design with period data collection at 6-month intervals was used in one of the initial studies. The population of interest included veterans with multiple co-morbidities who were high-cost medical users. The authors report that the intervention group showed greater improvement in healthcare resource consumption than the usual care group when comparing 6-month pre- to 6-month post-enrollment data. Patient and provider satisfaction was also reportedly high. This VHA telehealth initiative included a multi-site study, which analyzed healthcare utilization and clinical impact. Three telehomecare demonstration projects from Ft. Myers, Lake City, and Miami, Florida were included (Cherry, Dryden, Kobb, Hilsen, & Nedd, 2003). All participants (n=345) were elderly, had multiple chronic diseases (specifically CHF, coronary artery disease, diabetes, hypertension, and COPD), and were high cost users of the VHA within the previous year (≥ $25,000). Home-based monitoring equipment allowed for daily responses to be categorized and risk prioritized to alert the care coordinators at each of the VA hospitals of the most serious outcomes first. Care coordinators contacted veterans by telephone based on the seriousness of the alerts. The intervention group was compared to themselves at 6 months pre- and 6 months post-enrollment. The authors report reductions in inpatient admissions, emergency room encounters, and hospital bed days of care, as well as improvements in medical compliance.

The VA Connecticut Healthcare System used telehomecare, integrated with the VA's electronic medical record system, to determine whether telehomecare could reduce healthcare costs and improve quality of life outcomes relative to standard care for chronically ill and frail elderly veterans (Noel et al., 2004). Home telecommunication units allowed for peripheral devices to monitor vital signs and provided a questionnaire to evaluate quality of life. Data was transmitted over telephone lines directly into the facility's electronic database. In comparison to the randomized control group, at six months the telehomecare group showed a significant decrease in costs in hospital bed days of care and emergency room visits, as well as a decrease in blood glucose levels. Functional level and patient-rated health status did not show a significant difference for either group at any period in time during the study.

Most of the telehealth studies within the VHA focus on healthcare costs and utilization, and little is known about the impact on physical and cognitive functioning. A case-control design study determined a causal relationship between the use of telehomecare and care coordination and improvements in functional and cognitive status

(Chumbler, Mann, Wu, Schmid, & Kobb, 2004). The investigators examined changes over a 12-month period and analyzed the before-after improvements in functional health and cognitive outcomes using the Functional Independence Measure and the Mini Mental Status Examination. The telehomecare group had significant improvements in all outcome measures over the 12 months.

Results from an effectiveness study of a care coordination telehomecare program for veterans with diabetes determined that after two years of enrollment, a statistically significant reduction in hospitalizations was observed in the treatment group (T. E. Barnett et al., 2006). An interesting phenomenon with many of the VHA telehealth programs is the increase in care-coordinator initiated primary care clinic visits following enrollment (Chumbler et al., 2005). This increase in newly scheduled clinic visits is congruent with daily monitoring and the necessity to intervene quickly before a hospitalization is required. In lieu of observing healthcare utilization at 12-months post-enrollment, Barnett et al. observed outcomes at 24 months following implementation and noted a reduction in care-coordinator initiated clinic visits.

Summary

As the chronically ill and disabled elderly populations become ever larger, there is greater urgency to find ways to provide efficient, cost-effective care, as well as improve functional performance and quality of life (Cruise & Lee, 2005). In an attempt to address this need, the provision of healthcare services has shifted from inpatient and outpatient settings to the home as the site of care. Allowing patients to remain within their home environments and still have direct communication with their healthcare providers increases access and quality of care, and may in turn reduce healthcare expenditures. Recent advances in information technology allow for the provision of such care to patients in their homes through telehealth applications. Telehealth may provide the means, yet significant research questions remain.

A number of studies in a variety of care settings illustrate the promise of telehealth, but little systematic and controlled research has occurred to date. Based on the available literature, it appears that telehealth programs have yet to provide compelling objective documentation of successful outcomes. Because of serious limitations in experimental design, these studies are hindered by small sample sizes, short durations, and other methodological flaws. Moreover, few studies provide actual evidence that the interventions have resulted in clinical outcomes comparable to or better than the gold standard, conventional face-to-face care, although the technology and the technique seems to show promise in certain areas (Frantz et al., 2002). The overall methodology, quality of the evaluative studies, and small sample sizes that limit statistical power precludes producing convincing scientific results. These outcome studies have demonstrated inconclusive medical and functional improvements and cost savings, and result in the lack of evidence-based guidelines that are imperative for the implementation of telehealth programs (Palsbo & Bauer, 2000; Whitten & Kuwahara, 2003). Such evidence-based results are essential to add to the scientific knowledge base and ensure acceptance in the professional community.

The next generation of studies needs to advance beyond efforts to replicate these earlier studies. Although large-scale randomized trials are important before one can argue convincingly that the medical, psychosocial, functional, and fiscal outcomes of telehealth are positive, comprehensive studies evaluating current telehealth models are important and will serve as a standard for the methodology of future telehealth applications.

CHAPTER 3
HEALTH RELATED COST ANALYSIS

The Veteran's Health Administration (VHA) has experienced unprecedented growth in the healthcare system workload over the past few years. During the last six years, the VHA has provided more medical services to more veterans and family members than at any time during VHA's history (OPA, 2006). The number of veteran enrollees receiving medical services within the VHA increased by 22 percent from 2001 to 2005. Many veteran enrollees today are elderly, chronically ill and disabled. Chronic illnesses account for a disproportionate amount of healthcare utilization and costs within the VHA (Yu et al., 2003a). Based on a recent study, data indicates that 72 percent of the VHA patients have one or more chronic illnesses, and these patients account for 96.5 percent of the total VHA healthcare costs (Yu et al., 2004). Overcoming these challenges is a major barrier facing the VHA and healthcare in general today. It has been proposed that telehealth can help meet these challenges (American Telemedicine Association [ATA], 2003; Bashshur, 2001; Brantley, Laney-Cummings, & Spivack, 2004; Cherry et al., 2003; Hibbert et al., 2004; Krupinski et al., 2002; Liss, Glueckauf, & Ecklund-Johnson, 2002; MacDonald-Rencz, Cradduck, & Parker-Taillon, 2004; OAT, 2002). Telehealth used as a part of a coordinated, comprehensive care program has demonstrated the ability to assist with the management of chronic conditions and reduce healthcare costs.

Telehealth is a specific clinical application of monitoring patients in their homes from a central station usually located at a hospital. Telehealth is viewed by the VHA as one of the more innovative advanced telecommunication applications. Telehealth has the potential to link clinical care, education, fiscal, and administrative systems to improve veteran's healthcare, while at the same time increase veteran's access to care. The premise is that improvements in healthcare services and reductions in healthcare costs can be effected by establishing a continuum of patient care from the patient's home to service providers in the healthcare sector.

Clinical effectiveness as well as the educational benefits of telehealth have been presented in the literature (Gamble, Savage, & Icenogle, 2004; Grigsby & Sanders, 1998; Taylor, 1998). Healthcare cost savings have been demonstrated in numerous telehealth studies (Bynum, Irwin, Cranford, & Denny, 2003; Finkelstein et al., 2006; Hooper et al., 2001; Joseph, 2006; Noel et al., 2004). In a randomized controlled trial, Finkelstein and colleagues demonstrated that telehealth visits between a skilled home healthcare nurse and chronically ill patients at home using videoconferencing technology improved patient self-care activities and lowered costs when compared to traditional face-to-face home healthcare visits. Nakamara focused on activities of daily living (ADLs) in his effectiveness study, and determined that there was not only a reduction in healthcare costs, but also significant improvement in ADLs, communication and social participation for participants in a telehealth intervention when compared to a control group receiving traditional care (Nakamura et al., 1999). Noel and colleagues (2004) determined that a home telehealth system which monitors vital signs and provides patient questionnaires reduced cost and improved quality of life outcomes for elderly patients with complex comorbidities . In a recent report on home telehealth for diabetic patients, Dansky showed that monitoring patients in their homes contributed substantial overall cost savings despite the additional expenses associated with the technology (Dansky et al., 2001). Meystre concluded following a literature review on the state of telehealth, that long-term disease monitoring of patients at home is the most promising application for technology for delivering cost effective quality care (Meystre, 2005). The use of technology combined with a chronic care model has the potential to reduce healthcare costs and lower use of healthcare services, as well as improve the management of chronic illnesses (Bodenheimer et al., 2002a; Liss et al., 2002).

In contrast, critical reviews of the cost-effectiveness and cost-benefit of telehealth report that current research has methodological and analytical weaknesses, and that it is premature to generalize about either the positive or negative effects of telehealth applications (Gamble et al., 2004; Hakansson & Gavelin, 2000; Mair & Whitten, 2000). There continues to be a call for studies measuring the cost-effectiveness of the application of telehealth to specific clinical practices compared to conventional medical care (Gamble et al., 2004; Ohinmaa & Hailey, 2002).

This chapter of the dissertation presents the health-related cost analyses between a telerehabilitation program (LAMP) and a matched comparison group, a telehomecare program (TCCP) and a matched comparison group, and a comparison between the telerehabilitation and telehomecare program. Methods for obtaining the cost data and the comparison groups are presented, as well as the results and discussion from the analyses.

Methods

Cost Data

The U.S. Department of Veterans Affairs (VA) uses the Decision Support System (DSS) to track its healthcare system workload and determine the cost of patient care. The National Data Extracts (NDEs) were created to assist VA researchers in accessing this workload and cost information. The NDEs are extracted from DSS and report total actual costs of every inpatient and outpatient encounter provided by the VA. NDEs include information based on fiscal years and report costs that incurred from the beginning of a fiscal year up to the current month. VA fiscal years run from October 1 through September 30.

There are three core NDE files: inpatient discharge, inpatient treating specialty, and outpatient files. The inpatient discharge files have one record for each hospital discharge that occurred during the fiscal year. This file includes the entire cost for the hospital stay, i.e., nursing care, pharmacy, and laboratory testing. The inpatient treating specialty reports the type of bedsection unit where the care was provided, allowing for nursing home bed days of care (BDOC) to be distinguished from hospital bed days of care. The outpatient NDE files consist of one record for each unique clinic encounter, defined as a clinic stop. Therefore, there is a separate record for each clinic the patient visits, even if the patient visits multiple clinics in one day. Each record contains the total cost of the encounter and information that identifies the patient, the location of the service and the date the service occurred. Outpatient visits include the costs of laboratory testing and ancillary services. Pharmacy records and associated costs are stored in separate files.

The NDEs are SAS files stored at the VA Austin Automation Center (AAC). They are accessed using SAS batch programs. To access the NDE files, an account was established at the AAC in Austin, Texas. A “Time Sharing Request Form” as well as a “Privacy Act Statement” was submitted in order to work with real Social Security Numbers (SSNs) from a single Network (VISN 8) for this project only. This was required as the local VHA facilities use real SSNs as the patient medical record number. The medical center director from the Malcom Randall VAMC in Gainesville, Florida granted approval to access real SSNs. To obtain NDE records for our study participants, real SSNs were linked to encrypted SSNs included in the NDEs. All data from this point on contained only data with encrypted SSNs.

Linking of the Treatment Groups to the Comparison Group Pool

Our matched comparison group was obtained from a database from the 1999 Veterans Large Health Study (LHS). The LHS was a national VA survey that established baseline health status on approximately one million veterans. The LHS was based on a random sample of all veteran enrollees in the nation.

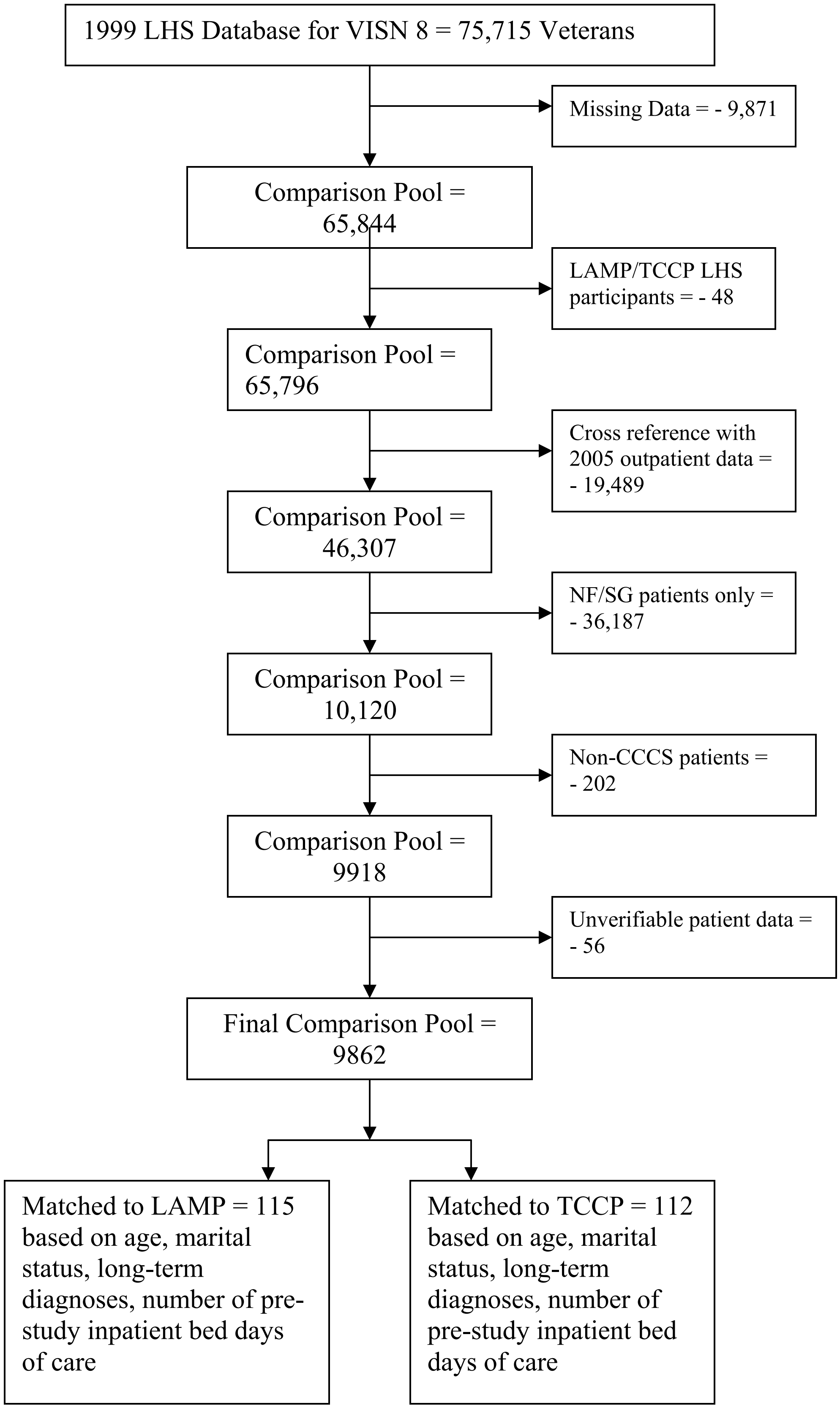
A data use agreement was submitted to the Office for Quality Performance (OQP) requesting use of the data for benchmarking of the SF-36 / SF-12 Health Related Quality of Life Survey and comparison of VA health related costs (hospitalizations, clinic visits, emergency room visits, nursing home BDOC). Following approval from OQP, a compact disk was provided which contained encrypted SSNs, diagnoses, age, marital status, education, and SF-36V scores of all veterans from VISN 8 that participated in the 1999 LHS. The database consisted of 75,715 veteran enrollees.

Cleaning of the database was required and initially included removing all individuals with missing demographic and diagnostic data, leaving the pool with 65,844 veterans. Forty-eight veterans enrolled in LAMP or TCCP also participated in the 1999 LHS; therefore, they were removed from the LHS database so that they were not double counted. As the LHS database was from a 1999 study, it was necessary to cross-reference these individuals with individuals in VISN 8 who had received medical care during FY 2005 (at least 1 clinic visit). This ensured that the veterans used for the matched comparison group were alive and utilizing services during the full pre-post periods. Individuals who died during the study period were not eligible for inclusion in the study. This reduced our comparison group pool to 46,307. Next, individuals who were not being treated in the North Florida/South Georgia Health Care System were deleted from the database. This reduced the total pool to 10,120. Lastly, the comparison pool was cross-referenced with all enrollees in the CCCS database to ensure that no veterans in the comparison group had ever participated in a VA telehealth program. This reduced our total to 9918. From the 9918, 56 individuals were then deleted from the pool due to unverifiable inpatient data, leaving 9862 individuals in our final comparison pool. These 9862 patients comprised the control pool for subsequent matching to the treatment groups. Figure 3-1 presents the initial linking procedure.

Reported long-term chronic diseases

The LHS database consisted of veterans who were enrolled in and receiving healthcare through the VA at the time of the 1999 survey. Reported demographics and disease states for the LHS veterans were obtained in 1999. To ensure comparability of our treatment and comparison groups, inpatient and outpatient workload files with reported primary and secondary diagnoses based on the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9) diagnostic codes were obtained for LAMP and TCCP from 1997-99. Detailed clinical information, including diagnoses, came from the VA National Patient Care Database (NPCD) healthcare workload/encounter files, which includes the Patient Treatment Files (PTF) and the outpatient files. PTF and outpatient files for fiscal years 1997, 1998, and 1999 were explored in order to review diagnoses and ensure that each of the study arms was

Figure 3-1. Preparation of comparison pool for final matching to LAMP and TCCP.


1999 LHS Database for VISN 8 = 75,715 Veterans
Missing Data = - 9,871
Comparison Pool = 65,844
LAMP/TCCP LHS participants = - 48
Comparison Pool = 65,796
Cross reference with 2005 outpatient data = - 19,489
Comparison Pool = 46,307
NF/SG patients only = - 36,187
Comparison Pool = 10,120
Non-CCCS patients = - 202
Comparison Pool = 9918
Unverifiable patient data = - 56
Final Comparison Pool = 9862
Matched to LAMP = 115 based on age, marital status, long-term diagnoses, number of pre-study inpatient bed days of care
Matched to TCCP = 112 based on age, marital status, long-term diagnoses, number of pre-study inpatient bed days of care

receiving VA care and was diagnosed with their reported chronic illness between 1997-99. All patients enrolled in LAMP and TCCP were identified in the 1997-99 PTF, signifying they were receiving VA care during that time period. Only diagnoses reported in the 1997-99 NPCD files were used for matching purposes. Therefore, VA healthcare use and chronic illness diagnoses were consistent between our study arms. Chronic illnesses used for matching purposes for our comparison group and our treatment groups were diagnosed by 1999 or earlier.

Enrollment date

Specific enrollment dates were available for each member of the treatment group. These specific dates were used as a baseline to determine health related costs 12-months pre-enrollment and 12-months post-enrollment. Because our matched comparison group was not actually enrolled in a program, this was not possible; therefore, an arbitrary enrollment date was required for analysis purposes. To determine an arbitrary enrollment date, frequency of enrollment for LAMP and TCCP was calculated from October 1, 2002 through September 30, 2004 (the study period). Eighty-nine percent of our treatment group was enrolled between June 2003 and February 2004. Therefore, the median point of October 1, 2003 was chosen as an appropriate enrollment date. For our comparison group, FY 2003 served as the pre-enrollment period and FY 2004 served as the post-enrollment period.

Inpatient bed days of care pre-enrollment

Inclusion criteria for enrollment in a VHA telehealth program includes previous use of medical services, especially hospital BDOC, and was deemed an important variable for matching purposes. Data on hospital BDOC 12 months pre-enrollment was obtained for both treatment groups and the comparison pool. The NDE files report inpatient BDOC at discharge. Our comparison pool was provided with an arbitrary enrollment date of October 1, 2003 (the first day of FY 2004) in order to determine health related costs for one-year pre and one-year post enrollment. Therefore, for our comparison pool, 12 months pre-enrollment extended from October 1, 2002 through September 30, 2003 (FY 2003). To determine pre-enrollment BDOC for inpatient stays that spanned more than one fiscal year (i.e., stays with admission dates before October 1, 2002 or discharge dates after September 30, 2003), total inpatient BDOC were allocated proportional to the number of days that occurred within FY 2003.

Matching

The demographics of age and marital status, and diagnoses of arthritis, hypertension, congestive heart failure, chronic lung disease, diabetes, and stroke, as well as number of pre-enrollment BDOC were used for matching purposes. Initially, SAS logistic regressions (stepwise) were run for both LAMP and TCCP to determine which variables were significant to the treatment group at the p=.05 level . Using this methodology, in the LAMP treatment group the variables of chronic lung disease and CHF dropped out of the model. Therefore, these diagnoses were not used for matching purposes for the LAMP comparison group. For TCCP, the variables of chronic lung disease and arthritis dropped out of the model and were not used for matching purposes for the TCCP comparison group.

Matching was accomplished by creating a dummy string variable where the elements of the character string represented the variables that remained in each of the regression models. Initially, marital status and diagnoses were dichotomized (1=yes and 2=no), and age and inpatient BDOC remained continuous variables. During the matching process, age was stratified to simplify the dummy variable. For LAMP, age stratification was 1 = ages 49-57, 2 = ages 58-66, 3 = ages 67-75, 4 = ages 76-84 and 5 = ages 85-98, which covered all age ranges. TCCP age stratification was 1 = ages 37-57, 2 = ages 58-66, 3 = ages 67-75, 4 = ages 76-84 and 5 = ages 85-90, which covered all age ranges. The number of pre-enrollment inpatient BDOC remained a continuous variable. Based on this technique, a dummy string variable of 112121327 would represent a LAMP participant who was married and diagnosed with arthritis, diabetes and hypertension, within the age range of 67-75, and who had 27 inpatient BDOC pre-enrollment. Dummy string variables were created for all study participants in LAMP and TCCP, as well as the full comparison pool.

Using the dummy string variable, 76 percent of LAMP and 68 percent of TCCP had direct matches with a patient from the comparison pool. Once the exact direct matches were determined, the remaining were matched manually on age and pre-BDOC and as many of the residual demographic variables as possible.

Telehealth vs. Standard Care

The type of healthcare delivery a patient received was also an independent variable in this study. The three types of service delivery include: VA telerehabilitation/care coordination (LAMP), VA telehomecare/care coordination (TCCP), and VA standard care. For the LAMP and TCCP cohorts, ongoing daily monitoring exists between the care coordinator and the patient through various types of technology. Due to daily monitoring, patients receive increased access to primary care, specialty or rehabilitative care, and self-management support. In contrast, our matched comparison groups had access to all VA healthcare services, with intermittent contact with their primary care providers.

Study Design

A retrospective, matched comparison study design was implemented. The LAMP (telerehabilitation) program included veterans with functional deficits and chronic illnesses, who were at risk for multiple VA hospital and nursing home bed days of care. Veterans were eligible for enrollment in LAMP if they presented with deficits in at least two activities of daily living (ADLs), including mobility and transferring. Veterans enrolled had to live at home, have electricity and phone service, and accept remote monitoring technology into their homes. The TCCP (telehomecare) program included veterans with chronic illnesses, who were at risk for multiple VA inpatient and outpatient visits. Veterans were eligible for enrollment in TCCP if they were noninstitutionalized, had a history of high healthcare costs and utilization, had electricity and phone service, and accepted remote monitoring technology into their homes.

Both treatment and comparison groups received their healthcare from the North Florida/South Georgia Healthcare System. Treatment and comparison groups were matched on demographic variables of age and marital status, as well as primary diagnoses, and number of 12-month pre-study bed days of care. All groups had to be enrolled in the VA for the entire 24-month observation. Actual enrollment dates were used for our treatment groups to determine pre-post costs. The arbitrary enrollment date of October 1, 2003 was used for the comparison groups to determine pre-post healthcare expenditures.

Although selection criteria was stringent for matching of the comparison groups, the absence of randomization between the treatment and comparison groups may result in selection bias. A difference-in-differences (DiD) approach was used to allow for the control of any remaining differences between the treatment and comparison groups, including the differences that may not be directly observed. Such unobserved differences may influence both the treatment and comparison groups, as well as the estimated treatment effect. The DiD method controls for selection bias through measuring the treatment effect while accounting for any pretreatment differences between the groups. This method has often been used in studies of labor economics, with applications increasing in health services research (Tai-Seale, Freund, & LoSasso, 2001; Wagner, Hibbard, Greenlick, & Kunkel, 2001), as well as telehealth studies (T. E. Barnett et al., 2006; Chumbler et al., 2005). The concept of DiD observes the treatment and control group before and after the intervention. Prior to the intervention, intrinsic differences between the groups are measured. Following the intervention, the treatment effect plus the intrinsic differences between the groups are measured. The treatment itself is then calculated by subtracting the intrinsic difference between the two groups pre-intervention from the combined treatment effect plus intrinsic difference post-intervention. Therefore, we are measuring the difference between the differences to obtain the treatment effect.

Statistical Analysis

The dependent variables used in this study were healthcare expenditures defined as costs incurred by the VHA for inpatient BDOC (hospitalizations), outpatient clinic visits, emergency room visits (ER), and nursing home care unit (NHCU) BDOC. Costs presented exclude costs of contract medical services provided at non-VA facilities. Total costs were summed for the final analyses, with cost breakdowns presented in order to clarify final results. In an attempt to decrease variability and skeweness in the cost data, the natural log of costs (lncosts) were initially considered for these analyses. Prior to logging, natural costs were positively skewed. Logging costs resulted in negative skeweness, but did not decrease variability enough to undertake the analyses.

Additionally, a linear regression model using natural log converts to a nonlinear model, which requires complicated corrections, and is difficult to interpret.

A multivariable statistical model was implemented using actual costs as the outcome, based on a difference-in-differences (DiD) approach. The DiD model was used to compare LAMP with their matched comparison group and TCCP and their matched comparison group to determine where differences lie within the groups based on total healthcare costs. The statistical model used for patient costs in this research study was:

$$E(\text{Costs}) = \alpha_0 + \alpha_1 (\text{Treatment}) + \alpha_2 (\text{Time}) + \alpha_3 (\text{Treatment x Time}) + \beta X.$$

The parameter α_3 represents the DiD estimate of the treatment effect.

Finally, a one-way analysis of variance (ANOVA) was used to compare the two telehealth programs, LAMP and TCCP, to determine where differences lie within the treatment groups. ANOVA was used to compare the independent variables of age, marital status, diagnoses, and pre-BDOC, which were the variables used for initial matching of their comparison groups. Following ANOVA, the DiD approach was performed to determine if LAMP and TCCP differed in treatment effects based on costs, after accounting for the covariates determined by ANOVA.

SPSS version 12.0 (SPSS, Inc., Chicago, IL) and SAS version 9.1.3 (SAS Institute, Cary, NC) were both used for these analyses, with significance level set at .05. All analyses were two-sided. Analyses followed intention to treat such that all subjects who were enrolled and participated for one full year in LAMP or TCCP during October 1, 2002 through September 30, 2004 were included in the analyses regardless of study participation level.

Results

Descriptive baseline data including age, marital status, diagnoses and pre-BDOC for LAMP and its matched comparison group are presented in Table 3-1. Chi-square for descriptive variables and independent samples *t*-tests for continuous variables were used to compare treatment and comparison groups on these baseline characteristics.

Table 3-1. Baseline characteristics of telerehabilitation group, Low ADL Monitoring Program (LAMP), and matched comparison group*

Characteristics	LAMP (n=115)	Comparison Group (n=115)	p value
Age, mean, s/d	72.4 ±9.4	71.7 ±9.6	.63
Marital Status	(73.0)	(73.9)	.88
Arthritis	(50.4)	(60.0)	.15
Hypertension	(65.2)	(54.8)	.11
Diabetes	(24.3)	(23.5)	.88
Stroke	(35.7)	(27.8)	.20
Pre-BDOC, mean, s/d	12.6 ±26.3	12.6 ±26.2	.98

*Data are given as number (percentage) unless otherwise indicated. BDOC indicates hospital bed days of care.

LAMP and Matched Comparison Group

LAMP and matched comparison group participants were primarily male (97 percent) with more than 70 percent married. On average, study participants were age 72. On the average, participants reported four chronic illnesses. More than 50 percent reported they had been diagnosed with hypertension and arthritis, approximately 25 percent reported diabetes, and approximately 30 percent had suffered a stroke. The average number of hospital BDOC one year pre-enrollment was 12.6.

Total summed actual costs and cost itemization for LAMP and their matched comparison group are presented in Tables 3-2 and 3-3. Tables include one-year pre-enrollment costs in comparison with one-year post enrollment costs.

Table 3-2. Healthcare expenditures for LAMP (n=115) one-year pre-enrollment and one-year post-enrollment

	Total Sum	BDOC	Clinic	ER	NHCU
Pre-Enroll	$2,767,712.90	$1,494,483	$1,162,211	$23,842	$87,177
Days/Visits		1449	4561	116	214
Percent of total		54.0%	42%	0.86%	3.15%
Post-Enroll	$2,812,250.50	$690,215	$2,053,015	$24,257	$44,763
Days/Visits		623	8728	108	98
Percent of total		24.5%	73%	0.86%	1.6%
Difference in costs pre-post	+$44,537.60	-$804,268	+$890,814	+$415	-$42,414
Difference in days/visits pre-post		-826	+4167	-8	-116

Table 3-3. Healthcare expenditures for LAMP matched comparison group (n=115) one-year pre-enrollment and one-year post-enrollment

	Total Sum	BDOC	Clinic	ER	NHCU
Pre-Enroll	$2,055,283.60	$1,231,656	$642,052	$16,908	$164,668
Days/Visits		1443	3088	76	404
Percent of total		60%	31%	0.8%	8%
Post-Enroll	$1,578,459.30	$553,924	$862,510	$12,826	$149,198
Days/Visits		699	2931	72	400
Percent of total		35%	55%	0.8%	9.5%
Difference in costs pre-post	-$476,824.30	-$677,732	+$220,458	-$4,082	-$15,470
Difference in days/visits pre-post		-744	-157	-4	-4

Hospital bed days of care

Costs for hospital BDOC in the year preceding enrollment in LAMP totaled approximately $1,500,000 and consisted of 1449 days of care. These 1449 hospital days were for 55 patients. The average cost of a BDOC pre-enrollment in LAMP was $1,030. Total costs for hospital BDOC for LAMP decreased more than $804,000 and 826 days in the year following enrollment. This represents a 46 percent decrease in costs. The average cost of a BDOC post-enrollment was $1,100.

Costs for hospital BDOC in the pre-enrollment year for our matched comparison group totaled approximately $1,230,000 and consisted of 1443 days. These 1443 BDOC were for 55 patients, and the average pre-cost of a hospital BDOC for our matched comparison group was $853. Post-costs for hospital BDOC for the matched comparison group decreased approximately $678,000 and 744 days, or 45 percent. The average post-cost of a BDOC decreased by $61.

Clinic visits

Every LAMP participant in our study received at least one clinic visit both pre and post-enrollment. Costs for clinic visits pre-post for LAMP increased more than $890,000 following enrollment, representing an increase of 4167 clinic visits. In an attempt to determine which clinic encounters increased, clinic visits were calculated for each clinic stop code for one-year pre-enrollment in LAMP and one-year post enrollment in LAMP. Clinic visits increased specifically in the area of preventive medicine, including laboratory and x-rays, and primary and geriatric patient care. Increases were also noted in physical medicine and rehabilitation, including speech language services, occupational and physical therapy services, as well as prosthetics. Prosthetic devices increased from 573 pre-enrollment to 1193 post-enrollment. The provision of prosthetic or assistive devices, such as bathroom aids and mobility devices was a primary focus of LAMP services. Diabetes care, urology care, and home health aide assistance were also noted to increase for the LAMP intervention group. Clinic visits also included 127 home assessments performed by LAMP and approximately 2605 patient contacts resulting from enrollment in LAMP.

One hundred eleven of the 115 veterans in the matched comparison group received a pre-clinic visit, and 113 received a post-clinic visit. Clinic visits pre-post for the matched comparison group increased by 157 visits, which resulted in a cost increase of approximately $220,000. There were no significant differences in clinic stop codes pre versus post for the comparison group. In fact, preventive services such as laboratory and x-rays, as well as primary care and geriatric care decreased by over 100 visits during the post-year.

Emergency room visits

ER visits for the LAMP participants remained stable over the two-year period. LAMP ER visits increased in dollar amount by $415, but total visits decreased by 8. Fifty-one LAMP enrollees required ER services pre-enrollment, and 48 LAMP enrollees required ER services post-enrollment. Our matched comparison group decreased their ER visits by 4, resulting in a savings of over $4,000. Thirty-six patients required pre-ER visits, which decreased to 32 patients in the post-period.

Nursing home bed days of care

A main hypothesis was that LAMP would maintain independence over time to a greater extent than the other study arms. While it may be difficult to determine which outcomes signify that one of the study arms is more independent than another, the use of NHCU may be such an outcome. Functional decline and decreased independence in self-care are the main reasons patients are placed in nursing homes (Andresen, Vahle, & Lollar, 2001; Yu, Wagner, Chen, & Barnett, 2003b). LAMP participants spent 214 days in NHCU pre-enrollment, which decreased to 98 days post-enrollment, demonstrating a decline of 116 days. This amounted to a cost reduction of over $42,000. For LAMP, NHCU BDOC averaged approximately $14,000 per person pre-enrollment, and decreased to an average of $8,000 per person post-enrollment.

Our matched comparison group spent over 400 days in NHCU pre-study period, which decreased by 4 days post-enrollment. This amounted to a cost savings of approximately $15,000. Yet, for our matched comparison group, NHCU costs per person increased from $18,000 pre to approximately $25,000 post, compared to $8,000 per person post-enrollment in LAMP.

TCCP and Matched Comparison Group

Descriptive baseline data including age, marital status, diagnoses and pre-BDOC for TCCP and its matched comparison group are presented in Table 3-4. Chi-square for descriptive variables and independent samples *t*-tests for continuous variables were used to compare treatment and comparison groups on these baseline characteristics.

Table 3-4. Baseline characteristics of telehomecare group, Technology Care Coordination Program (TCCP), and matched comparison group*

Characteristics	TCCP (n=112)	Comparison Group (n=112)	p value
Age, mean, s/d	70.94 $\pm$11.2	70.5 $\pm$10.9	.77
Marital Status	(62.5)	(67.0)	.12
Hypertension	(68.8)	(57.4)	.06
Diabetes	(40.2)	(38.4)	.78
Stroke	(6.3)	(8.0)	.60
CHF	(15.2)	(14.3)	.85
Pre-BDOC. mean, s/d	10.23 $\pm$30.1	10.8 $\pm$34.1	.88

*Data are given as number (percentage) unless otherwise indicated. CHF indicates congestive heart failure, BDOC indicates hospital bed days of care.

TCCP and matched comparison group participants were primarily male (98 percent) with more than 60 percent married. On average, study participants were aged 70. Participants reported approximately four chronic illnesses. More than 60 percent of the groups had been diagnosed with hypertension, 40 percent reportedly were diabetic, 6-

8 percent had suffered a stroke, and approximately 15 percent had congestive heart failure (CHF).

Total summed costs and breakdowns for TCCP and their matched comparison group are presented in Tables 3-5 and 3-6. Tables include pre-enrollment costs in comparison with one-year post-enrollment costs. Actual enrollment dates were used for TCCP to determine pre-post costs. The arbitrary enrollment date of October 1, 2003 was used for the comparison group to determine pre-one year and post-one year healthcare expenditures.

Table 3-5. Healthcare expenditures for TCCP (n=112) one-year pre-enrollment and one-year post-enrollment

	Total Sum	BDOC	Clinic	ER	NHCU
Pre-Enroll	$1,474,699	$801,490	$557,159	$10,456	$105,594
Days/Visits		1146	3414	94	338
Percent of total		54.4%	37.8%	0.7%	7.2%
Post-Enroll	$2,140,111	$850,953	$1,095,174	$17,335	$176,650
Days/Visits		1055	5414	193	541
Percent of total		39.8%	51.2%	0.7%	7.2%
Difference in costs pre-post	+$665,412	+$49,463	+$538,015	+$6,879	+$71,056
Difference in days/visits pre-post		-91	+2000	+99	+203

Table 3-6. Healthcare expenditures for matched comparison group (n=112) one-year pre-enrollment and one-year post-enrollment

	Total Sum	BDOC	Clinic	ER	NHCU
Pre-Enroll	$1,606,664	$872,972	$521,625	$6254	$205,812
Days/Visits		1216	2616	31	549
Percent of total		54.3%	32.5%	0.4%	13.0%
Post-Enroll	$1,362,215	$438,097	$763,532	$9493	$151,094
Days/Visits		665	2586	84	436
Percent of total		32.0%	56.5%	0.7%	11.0%

Table 3-6. Continued.

	Total Sum	BDOC	Clinic	ER	NHCU
Difference in costs pre-post	-$244,449	-$434,875	+$241,907	+$3,239	-$54,718
Difference in days/visits pre-post		-551	-30	+53	-113

Hospital bed days of care

Costs for hospital BDOC for TCCP increased more than $49,000 in the year following enrollment, but decreased by 91 days. Hospital BDOC in the year preceding enrollment in TCCP totaled approximately $800,000 and consisted of 1146 days of care. These 1146 hospital days were for 42 patients. The average cost of a BDOC pre-enrollment in TCCP was $700. The average cost of a BDOC post-enrollment increased to $800.

Costs for hospital BDOC for the matched comparison group decreased approximately $435,000 and 551 days. Hospital BDOC in the pre-enrollment year for our matched comparison group totaled approximately $873,000 and consisted of 1216 days. These 1216 BDOC were for 42 patients, with the average pre-cost of a hospital BDOC for our matched comparison group at $718. Post-costs for hospital BDOC for the matched comparison group decreased to an average cost of $658.

Clinic visits

Costs for clinic visits pre-post for TCCP increased more than $538,000 following enrollment. This represents an increase of 2000 clinic visits. To determine where the increase was, clinic visits were calculated for each clinic stop code for one-year pre-enrollment and one-year post enrollment in TCCP. Clinic visits increased in the area of preventive medicine, including laboratory and x-rays, and primary and geriatric patient care. Prosthetic devices increased from 321 pre-enrollment to 534 post-enrollment. Diabetes care, ophthalmology, and home health aide assistance were also noted to increase for the TCCP intervention group. Clinic stops included more than 1154 patient intervention contacts resulting from enrollment in TCCP.

Costs for clinic visits pre-post for the matched comparison group increased approximately $242,000, but number of clinic visits decreased by 30 visits. Preventive services such as laboratory and x-rays, as well as primary care and geriatric care remained stable over the year.

Emergency room visits

ER visits increased for both TCCP and their matched comparison group. TCCP ER visits increased by approximately 100 visits post-enrollment, and more than $6,800. Forty-one patients visited the ER pre-enrollment in TCCP, and 61 patients visited the ER post-enrollment. ER visits for the matched comparison group increased by 53 visits and approximately $3,200, which was an increase from 21 patients to 28 patients pre-post.

Nursing home bed days of care

Pre-enrollment NHCU for TCCP included 338 days at nearly $106,000. The post-enrollment costs increased by $71,000, and 203 days. For the TCCP matched comparison group, we see a decline in NHCU of 113 days and $54,700.

Cost Analysis: Difference-in-Differences Approach

As shown in Table 3-7, multivariate results determined that 1 year following enrollment in LAMP, there are no significant differences in total healthcare costs (costs include inpatient BDOC, clinic, ER, NHCU), between LAMP and their matched comparison group.

Table 3-7. Multivariable regression analysis summary examining the relationship among LAMP and matched comparison group, pre-post intervention, and total healthcare costs based on the DiD method, with the comparison group serving as the reference group.

Variable	B	SEB	β
Main Effects			
Intercept	17,872	2943	6.07***
Treatment	6,195	4162	1.49
Time (pre-post)	-4,146	4162	-1.00
Interactions			
Time*Treatment	4,534	5886	0.77

Note. R^2 = 0.02 (n=230) ***p ≤ .001

In this model, the overall regression equation was significant ($F_{(3,456)}$= 3.09, p < .05), demonstrating the relationship between costs and treatment, but the coefficient of determination (R^2 = 0.02) represents a weak association. The intercept (17,872) is the mean predicted costs pre-intervention when holding treatment and time constant. The treatment coefficient (6,195) is not statistically significant, demonstrating there are no baseline significant differences in the treatment groups prior to the intervention. The slope for time (pre-post intervention = -4,146) is the predicted intervening time effect on costs for LAMP, which was not significant. The interaction demonstrates the treatment effect, and is the product of time and treatment on health related costs. The slope of the product of the two variables represents the change in costs for LAMP as time increases. Based on the regression coefficient (4,534), we are unable to detect a statistically significant treatment effect. The R^2 value is an indicator of how well the model fits the data (e.g., an R^2 close to 1.0 indicates that we have accounted for almost all of the variability with the variables specified in the model). The R^2 of 0.02 indicates that the variables, treatment and time, account for no more than 2 percent of the variance in costs.

Table 3-8 presents the DiD results for the multivariate analysis between TCCP and their matched comparison group.

Table 3-8. Multivariable regression analysis summary examining the relationship among TCCP and matched comparison group, pre-post intervention, and total healthcare costs based on the DiD method, with the comparison group serving as reference group.

Variable	B	SEB	β
Main Effects			
Intercept	14,345	2540	5.65***
Treatment	-1,178	3592	-0.33
Time (pre-post)	-2,183	3592	-0.61
Interaction			
Time*Treatment	8,124	5080	1.60

Note. R^2 = 0.01 (n=224) ***p ≤ .001

In this model, the overall regression equation was not significant ($F_{(3,442)}$= 1.46, p > .05), demonstrating this linear model does not fit the data and has no predictive capability. The regression equation does not provide a basis for predicting costs based on treatment and, therefore, we are unable to statistically detect a treatment effect with this model. The R^2 of 0.01 indicates that this group of variables (treatment and time) account for no more than 1 percent of the variance in costs. Residual scores for our regression equation are widely dispersed around the regression line, indicating a large error component.

Treatment Group Comparisons

A one-way analysis of variance (ANOVA) was used to compare LAMP and TCCP to determine where mean differences lie within the groups based on the independent variables of age, marital status, diagnoses and pre-BDOC. These are the variables used for initial matching of the comparison groups. A significant difference was found between the treatment groups and the diagnoses of arthritis ($F_{(1,225)}$= 51.04, p < .001), stroke($F_{(1,225)}$=33.5, p < .001), and diabetes ($F_{(1,225)}$=6.65, p < .05). This analysis revealed that participants in LAMP had more incidences of arthritis and stroke than participants in TCCP. This is not surprising, as inclusion in the LAMP program focused on individuals with rehabilitative needs. Additionally, the variable arthritis was not used for matching purposes for TCCP and their comparison group. Differences were also found between TCCP and LAMP in the area of diabetes, with TCCP demonstrating higher prevalence of diabetes.

Following the comparison, a multivariable regression model using the DiD method was calculated to examine the effects of group assignment (LAMP/TCCP) and health-related costs, covarying out the effects of arthritis, stroke, and diabetes. Table 3-9 presents the results.

Table 3-9. Multivariable regression analysis summary examining the relationship in healthcare costs between LAMP and TCCP, pre-post intervention, covarying out the effects of diagnoses based on the DiD method, with TCCP as the reference group.

Variable	B	SEB	β
Main Effects			
Intercept	10,999	3061	3.59**
Treatment	12,060	4416	2.73**
Time (pre-post)	5,941	3927	1.51
Arthritis	-3,517	3461	-1.02
Diabetes	5,727	3004	1.91
Stroke	3,890	3783	1.03
Interactions			
Time*Treatment	-5,553	5517	-1.01

Note. R^2 = 0.04 (n=227) **$p \leq .01$

In this model, the overall regression equation was significant ($F_{(6,447)}$= 2.85, $p < .01$), demonstrating the relationship between costs and treatment is not likely to be the result of chance, although the coefficient of determination (R^2 = 0.04) represents a weak association. The intercept (10,999) is the mean predicted costs for the pre-enrollment period when holding time and treatment constant. The slope for the treatment group (LAMP) is the predicted effect on costs of being in the treatment group. Based on the significance of the model and the significance of the treatment variable, there are additional cross-sectional selection biases evident between our two groups prior to the intervention. The slope for time (pre-post intervention = 5,941) is the predicted intervening time effect on costs, which was not significant. The interaction is the product of time and treatment on health related costs. The slope of the product of the two variables represents the change in costs for LAMP as time increases. The coefficient for this variable was negative, and may be interpreted to mean a negative effect on costs based on treatment by LAMP, but this was not significant. Additionally, we are unable to detect a statistically significant effect on costs determined by any of the diagnoses in the model. The R^2 of 0.04 indicates that these variables (treatment, time, arthritis, diabetes, stroke) account for no more than 4 percent of the variance in costs.

Discussion

This retrospective study examined the effectiveness of a VA telerehabilitation program (LAMP) and a VA telehomecare program (TCCP) for a cohort of chronically ill veterans with matched comparison groups by examining healthcare costs at 12 months following the intervention. In the absence of a randomized controlled trial, this quasiexperimental design attempted to overcome methodological shortcomings by using strict matching criteria and a DiD approach to evaluate treatment effectiveness. The DiD method controls for any intrinsic differences between the groups pre-intervention, as well as intervening time factors during the intervention, and provides the observed treatment effect.

Using the DiD approach and actual costs summed for these analyses, no significant differences were observed in post-enrollment costs between LAMP and their matched comparison group, TCCP and their matched comparison group, or between the two treatment groups, LAMP and TCCP. The point estimate of the DiD treatment effect in each of these models was extremely large relative to the mean costs. Therefore, the inability to detect significance is a result of the high variability of the estimate, and does not signify that there is no treatment effect. A larger sample size may improve accuracy of prediction. Additionally, logging of the costs would reduce variability and may increase the ability to detect significance.

There are numerous factors to consider. During the 12-months following enrollment, LAMP participants experienced a considerable increase in clinic visits/stops, increasing 4,167 visits at an increase in costs of more than $890,000. Although inpatient BDOC costs were reduced, including both inpatient BDOC and nursing home BDOC, the increase in clinic costs increased LAMP's overall costs $44,538 post-enrollment. It is important to note that one of telehealth's primary focuses is to increase access to care; as a result, much of the increase in clinic visits was a product of enrollment in LAMP. The increase in LAMP clinic stops includes services provided by the intervention, i.e., the initial evaluation and home assessment, adaptive equipment provided for self-care and safety, and remote monitoring interventions. Additionally, due to the intensity of daily monitoring, patients were more apt to be brought into the clinic for check-ups or more in-depth evaluation in order to ensure an illness did not escalate and require hospitalization. Although the number of intervention-related clinic stops is provided, it is difficult to determine how many of the care coordinator-patient contacts resulted in additional primary or geriatric care visits, lab and diagnostic visits, or secondary clinic visits such as ophthalmology or audiology. This significant increase in care coordinator-initiated clinic visits has been observed in other VA home telehealth studies (Chumbler et al., 2005; Kobb et al., 2003).

During the 12-months following enrollment, TCCP participants also experienced a large increase in clinic visits, increasing 2,000 visits and more than $500,000. For TCCP, while the number of inpatient BDOC decreased, inpatient costs increased slightly post-enrollment. The combined effect of increased costs per BDOC and additional clinic visits increased TCCP's costs post-enrollment by more than $665,000. The increase in TCCP clinic stops includes services provided by the intervention, such as the initial home visits and installation of remote monitoring equipment, and the follow-up monitoring interventions. TCCP's primary goal of remotely monitoring health symptoms and providing increased access to care resulted in a significant increase in clinic visits. Due to the intensity of daily monitoring, patients may receive additional primary or geriatric care visits, which in turn increase lab and diagnostic procedures. In comparison, TCCP's matched cohort received 30 less clinic visits, which resulted in a savings of $242,000. It is evident that when treatment is decreased, costs decrease. Longer term observations are required to determine the health-related cost effects of these increases and decreases in ambulatory care.

Additionally, as stringent as our matching criteria were, this was not a randomized controlled trial; matching was performed retrospectively based on the variables that were available. When we analyze the cost distribution, LAMP enrollees are considerably more costly and, therefore, possibly less healthy. The average cost of each BDOC was approximately $200-$300 higher per day for the LAMP group pre-and post-enrollment in comparison with both their matched cohort and the telehomecare (TCCP) group.

When actual costs are observed pre and post-study period, we note a significant decrease in inpatient costs (BDOC) for LAMP ($t_{(114)}$=3.09, p≤ .01), and both of the comparison groups. LAMP's matched comparison group decreased approximately 45 percent, or \$678,000, based on pre-study costs and post-study costs ($t_{(114)}$=3.09, $p \leq .01$). Hospital costs for TCCP's matched comparison group decreased approximately 50 percent, or \$435,000 within the same study period ($t_{(111)}$=1.95, $p \leq .05$). This phenomenon may be a result of regression to the mean. When using a pre-post design, regression to the mean may bias results in healthcare expenditures (Barnett, van der Pols, & Dobson, 2005; T. E. Barnett et al., 2006; Yudkin & Stratton, 1996). Regression to the mean (RTM) is a statistical phenomenon that may occur whenever there is a nonrandom sample from a population and two measures that are imperfectly correlated, such as pre-enrollment costs and post-enrollment costs following an intervention. Veterans in this study were enrolled into a telehealth program because of their high usage of VA medical services. Our comparison groups were matched with our treatment groups based on pre-BDOC and also demonstrate high levels of healthcare use at baseline. In RTM, observed change may be most negative for those with the largest pretest values. This is often interpreted as showing the effect of the treatment. While the regression effect is real and complicates the study of subjects who are initially extreme on the outcome variable (i.e., costs), we attempted to control for it statistically through the DiD design. Unfortunately, the uses of costs in the design, which were highly variable within and between our study populations, resulted in a high error rate for our regression analysis.

The observed decrease in inpatient costs may also be explained by a system-wide secular trend within VA hospitals to decrease inpatient length of stay (BDOC) and transition to more ambulatory care (Payne et al., 2005; Phibbs, Bhandari, Yu, & Barnett, 2003; Yu et al., 2003a). Additionally, all four study arms demonstrated high costs based on numerous hospitalizations in our pre-study period. We would assume that if a patient had been hospitalized in our pre-study time period, following a successful hospital stay they would not require hospitalization during our post-study period. The ability to observe these patients over a longer period of time may provide more accurate effects of treatment versus non-treatment.

There are limitations in the study that need to be addressed. Healthcare costs included inpatient BDOC, clinic visits, emergency room visits, and NHCU, and were summed for these analyses. Summed costs included VA-incurred expenses and did not consider whether the patient utilized services other than the VA, which may be a key reason for the inability to detect significance. Research has determined that between 25 and 50 percent of veterans are dual users, and seek both primary and inpatient care outside of the VA (Borowsky & Cowper, 1999; Payne et al., 2005; Stroupe et al., 2005). This percentage increases when veterans are not satisfied with their care. LAMP and TCCP enrollees are carefully monitored and referred to VA services, whereas non-telehealth veterans may be more apt to seek medical care outside of the VA. This would likely increase costs for our comparison group. Future studies should consider the impact of differential use of VA services between the groups.

More notably, skewed distribution and heteroscedasticity problems in healthcare expenditure models have been well recognized by health service researchers (Manning & Mullahy, 2001; Yu et al., 2003a). For this study, we analyzed actual healthcare costs. Models were also analyzed using costs transformed by a natural logarithm function. Due to the difficulty in interpreting the logged results, and the large mean differences between groups in the exponentiated residuals, logged costs were not used for the final analysis, but should be considered in future costs studies.

Although patients within each telehealth program, LAMP and TCCP, and their matched comparison groups, were comparable with respect to age, marital status, pre-study period hospital bed days of care, and primary chronic illness, we did not consider additional comorbidities. Many of our participants had multiple comorbidites, which may result in higher healthcare expenditures, and require more intense remote monitoring.

Approximately 30-35 percent of the matching was performed manually. The ability to acquire a direct one-to-one match was increasingly difficult due to the high number of variables incorporated into the matching dummy string along with the wide variability of the pre-BDOC. If pre-BDOC had been stratified, additional matches may have been obtained, but this was not optimal. Moreover, although careful steps were taken to ensure close matching of the comparison groups, we had limited access to such sociodemographic information as educational level, income, or the presence of a caregiver or other social support within the home.

This study attempted to quantify the effect of telerehabilitation and telehomecare in reducing healthcare costs among four groups of veterans. The analyses observed veterans enrolled in LAMP, veterans enrolled in TCCP, and corresponding matched comparison groups who have not received any type of telehealth intervention. The initial hypothesis for this study was that veterans enrolled in LAMP, veterans enrolled in TCCP, and their corresponding matched group of veterans who have not received tele-rehabilitation or telehomecare interventions will differ in their VA healthcare costs.

Based on results from the multivariable regression analyses, we reject the hypothesis that our four study arms will differ in VA healthcare costs following one-year enrollment in a telehealth program. It should be noted that based on the variance of errors in each of the regression equations, numerous unknown or unidentified factors must account for the remaining variance in the models.

Future research should consider using a randomized controlled trial design, following the intervention and comparison groups for more than 12 months, analyzing differential use of VA services, and collecting information to identify care coordinator-initiated outpatient visits.

CHAPTER 4
HEALTH STATUS AND OUTCOMES FROM THE VETERANS SHORT FORM-12 HEALTH SURVEY

Development of the Veteran's SF-36

The ability to quantify an individual's perception of their illness and how their illness affects their social and functional roles is an important component when evaluating healthcare requirements and healthcare interventions (IOM, 2001; Kaplan, 2002; Office of Quality Performance [OQP], 2000). Measurements of health-related quality of life (HRQoL) are increasingly used to assess the impact of chronic disease and healthcare interventions, as physiologic measures often correlate poorly with functional ability and well-being (Andresen & Meyers, 2000; Guyatt, Feeny, & Patrick, 1993). The SF-36 Health Survey is a frequently used patient-derived measure of disease burden and HRQoL. The SF-36 was adapted from the Medical Outcomes Study 20-item short form health survey in an attempt to construct a more efficient scale for measuring general health (Kazis, 2000; J. E. Ware, Jr. & Sherbourne, 1992). The SF-36 includes one multi-item scale that assesses eight health concepts: 1) limitations in physical activities due to health problems; 2) limitations in social activities due to physical or emotional problems; 3) limitations in usual role activities due to physical health problems; 4) bodily pain; 5) general mental health (psychological distress and well-being); 6) limitations in usual role activities due to emotional problems; 7) vitality (energy and fatigue); and 8) general health perceptions (J. E. Ware, Jr. & Sherbourne, 1992). These eight concepts have been summarized into two summary scores: the physical component summary (PCS) and the mental component summary (MCS). The original version of the SF-36 is scored using weights derived from a national probability sample of the U.S. population. Scores are norm-based with a mean of 50 and a standard deviation (SD) of 10, whereby higher scores indicate better health.

Veteran's SF-36 Health Survey

The Veterans version of the SF-36 (SF-36V) is a patient-based questionnaire designed specifically for use among veterans (Kazis et al., 1998). In developing the SF-36V, the original SF-36 was modified to add more precision to the assessment of role functioning (Kazis et al., 2004a). These modifications included changing dichotomized yes/no response choices in two of the role items (role limitations due to physical and emotional problems) to a five point ordinal scale.

The SF-36V is a reliable and valid measure of HRQoL and is widely used within the Veterans Health Administration (VHA) (Brazier et al., 1992; Kazis et al., 2004a; Kazis et al., 2004b; Kazis et al., 1999b; Ware, et al., 1995). Items on the scale were shown to be internally consistent, with Cronbach Apha's ranging from 0.93 for PCS and 0.78 for MCS (OQP, 2000).

The 1999 Veterans Large Health Study (LHS) used the SF-36V to establish baseline health status data on nearly one million veterans. The 1999 LHS established the VA national average for PCS as 36.9 and 45.08 for MCS (Kazis, 2000; OQP, 2000). These two summaries, PCS and MCS, are scored using a linear t-score transformation that was normed to a general U.S. population with a mean of 50 and a SD of 10 (Ware & Kosinski, 2001). Based on these results and results from past surveys, veteran enrollees report lower levels of health status reflecting more disease and health burden than the non-VA civilian population (Kazis, Lee, Ren, Skinner, & Roger, 1999a; Kazis et al., 1998; Kazis et al., 1999b). The l999 LHS also reported overall PCS and MCS by the 22 established Veterans Integrated System Networks (VISNs). This study took place in VISN 8, which includes North Florida/South Georgia and is headquartered in Bay Pines, Florida. VISN 8 overall PCS is 35.99 (0.9 less than the national VA average scores), with MCS at 43.59 (1.49 less than the national VA average scores).

Development of the Veteran's SF-12

The SF-12 was developed in an attempt to shorten the SF-36 instrument and, therefore, shorten the time to take or administer the instrument. The ability to reduce administration time makes the SF-12 an important tool for clinical practice, if the results can assist with decision-making about the patient. The SF-12 was developed using regression methods to select items and weighting algorithms for reproducing the PCS and MCS scales (Ware, Kosinski, & Keller, 1996). A detailed description of the methods utilized for construction of the SF-12 has been fully documented (Ware, et al., 1996; Ware, Kosinski, Turner-Bowker, & Gandek, 2002).

An important factor in development of the SF-12 was the ability to accurately predict SF-36 scores. Based on a study from the general population (n=2,333), the SF-12 achieved multiple R squares of 0.911 and 0.918 in predicting the SF-36 PCS and MCS scores, respectively (Ware, et al., 1996). Numerous studies have followed the initial development of the SF-12, and have determined the validity and reliability of the measurement for a variety of conditions (Cote, Gregoire, Moisan, & Chabot, 2004; Haywood, Garratt, & Fitzpatrick, 2005; King, Horowitz, Kassam, Yonas, & Roberts, 2005; Resnick & Nahm, 2001; Riddle, Lee, & Stratford, 2001). In each of these studies, responsiveness to change was less sensitive with the SF-12 than the SF-36, but essentially parallel for patient groups of at least one hundred.

The Veteran's version of the SF-12 survey (SF-12V) is a subset of identical items from the Veteran's version of the SF-36. The SF-12V also provides a physical component summary score (PCS-12V) and mental component summary score (MCS-12V). The PCS-12V and MCS-12V scales are scored using norm-based methods transformed to have a mean of 50 and a SD of 10. Table 4-1 presents the SF-36V question and the respective SF-12V question.

Table 4-1. Short Form Health Survey-36V questions with respective Short Form Health Survey-12V questions

SF-36V	SF-12V
Question 1 – In general, would you say your health is: Excellent Very Good Good Fair Poor	Question 1
Question 2 – Does your health now limit you in these activities? If so, how much?	
2b – Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf? Yes, limited a lot Yes, limited a little No, not limited at all	Question 2a
2d – Climbing several flights of stairs? Yes, limited a lot Yes, limited a little No, not limited at all	Question 2b
Question 3 – During the past 4 weeks, have you had any of the following problems with your work or regular daily activities as a result of your physical health?	
3b – Accomplished less that you would like: No, none of the time Yes, a little of the time Yes, some of the time Yes, most of the time Yes, all of the time	Question 3a

Table 4-1. Continued.

SF-36V	SF-12V
3c – Were limited in the kind of work or other activities? No, none of the time Yes, a little of the time Yes, some of the time Yes, most of the time Yes, all of the time	Question 3b
Question 4c – Didn't do work or other activities as carefully as usual: No, none of the time Yes, a little of the time Yes, some of the time Yes, most of the time Yes, all of the time	Question 4b
Question 7 – During the past 4 weeks, how much did the pain interfere with your normal work (including both work outside the home and housework)? Not at all A little bit Moderately Quite a bit Extremely	Question 5
Question 8 – These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling	
8d – Have you felt calm and peaceful? All of the time Most of the time A good bit of the time Some of the time A little of the time None of the time	Question 6a
8e – Did you have a lot of energy? All of the time Most of the time A good bit of the time Some of the time A little of the time None of the time	Question 6b

Table 4-1. Continued.

SF-36V	SF-12V
Question 8f – Have you felt downhearted and blue? All of the time Most of the time A good bit of the time	Question 6c
Question 9 – During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)? All of the time Most of the time A good bit of the time Some of the time A little of the time None of the time	Question 7

Methods

The Veterans SF-36 and Veterans SF-12 were fully developed and supported by the Veterans Health Study (VHS) (SDR 91006.S, principal investigator Lewis Kazis), which was funded by the VA Health Service Research and Development Service and the VA Center for Health Quality, Outcomes and Economic Research in Washington, DC. Permission to use the SF-36V and the SF-12V for our study was obtained by the VISN 8 Community Care Coordination Service (CCCS) from the developer, Lewis Kazis. There was no cost for use, only that the developer is made aware of any studies or publications that utilize the measurement.

Design

This portion of the study includes a retrospective analysis of data collected from two telehealth programs funded by the VISN 8 CCCS at the NF/SG VA. Veterans who were enrolled between October 2002 and September 2004 in the Technology Care Coordination Program (TCCP), a telehomecare program, and the Low ADL Monitoring Program (LAMP), a telerehabilitation program, were included in our study. Please refer to Chapters 1 and 3 for in-depth information regarding these two telehealth programs. Our hypothesis focuses on differences in health status between the two telehealth programs from baseline to post 12-months enrollment. The SF-36V and SF-12V were used to measure self-reported physical and mental outcomes. Measurements were administered at baseline during the initial enrollment and at 12-months follow-up. All scores were input into the VISN 8 CCCS database in Bay Pines, FL by their respective telehealth program. The CCCS provided SF-36V and SF-12V data on both telehealth programs for this portion of the study. This secondary analysis was approved by the University of Florida and Veterans Administration Institutional Review Boards (IRB 439-2005).

Participants

TCCP is a VA telehomecare program that uses home-based telehealth technology in conjunction with nurse practitioners and a social worker to coordinate care for chronically ill veterans living in remote areas in NF/SG. Veterans are eligible to be enrolled in TCCP if they meet the following criteria: a) past high-cost medical care needs (>$25,000) and high healthcare utilization (two or more hospitalizations and frequent emergency room visits), b) have electricity and phone service, c) accept technology in their homes for monitoring purposes, d) sign an informed consent form or have the consent form signed by a proxy. Participants included in this study were veterans enrolled in TCCP between October 2002 and September 2004 who had completed a full year in the program (n=112). Of the 112 enrollees participating in this study, 84 completed a self-report health survey both at baseline and one year follow-up. Of the remaining 28 participants, 26 completed baseline testing, but were unavailable for

12-month testing or were unable to complete the survey within an adequate time period. The remaining 2 participants refused to participate in either baseline or follow-up testing.

LAMP is a VA telerehabilitation program that uses home-based telehealth technology and adaptive equipment/environmental modifications (AE/EM) in conjunction with occupational therapists to coordinate care for chronically ill and disabled veterans living in the NF/SG area. Veterans were eligible to be enrolled in LAMP if they met all of the following criteria: a) lived at home, b) had a functional deficit with at least two ADLs (transferring and mobility are considered ADLs for the purposes of inclusion), c) had electricity and phone service, d) accepted technology in their homes for monitoring purposes, e) signed an informed consent form or had the consent form signed by a proxy. Participants included in this study were enrolled during October 2002 through September 2004 and completed a full year in the program (n=115). Of the 115 enrollees, 50 were administered a self-report health survey both at baseline and one year follow-up. Of the remaining 65 participants, 43 completed only baseline testing, 11 completed only 12-month follow-up testing, and 11 were unable to complete testing based on cognitive concerns or declined to be tested. The LAMP care coordinator reports that due to staff limitations, manpower was not available to complete the follow-up testing for many of their enrollees.

Administration of the SF-12V

Beginning in April 2000, the VISN 8 CCCS initiated funding of several telehealth clinical demonstration projects, all of which initially used the SF-36V as a HRQoL outcome measure. Each project administered the HRQoL assessments at baseline during enrollment and at one-year follow-up. In January 2005, the VISN 8 CCCS determined that the SF-36V was lengthy and difficult to administer, and required all telehealth programs to commence using the shorter version (SF-12V). Therefore, for this study's time period (October 1, 2002 through September 30, 2004), if a TCCP/LAMP enrollee was in a program for 12 months prior to December 2004, they were administered the SF-36V. If a TCCP/LAMP enrollee's 12 month period occurred after December 2004, they were administered the SF-12V. Participants who were enrolled from January 2004 - September 2004 received the SF-36V at baseline and the SF-12V in 2005 at one-year follow up. Because the CCCS chose to switch to the SF-12V during our study period, the SF-12V will be utilized as the primary measurement for this study aim.

Baseline data was collected in the participant's home during the initial evaluation; twelve-month follow-up data was collected through a home visit or through telephone contact. Each telehealth program was required to input the health survey results into a database that was managed by CCCS in Bay Pines, FL. CCCS converted all SF-36V scores to SF-12V scores. All health survey data used for this study was supplied to the principal investigator by VISN 8 CCCS.

Scoring

Items on the SF-12V are scored so that higher scores indicate better health. Raw scores are computed for each of the eight scales, which is a simple algebraic sum of responses for all items in that scale. Transformation of raw scores to a 0-100 scale converts the lowest and highest possible score to zero and 100, respectively. A z-score for each scale is then computed. Linear transformation of each z-score to the norm-based (50-10) score is the final step. Norm-based scoring (NBS) allows for direct comparison and interpretation across all SF-12V scales and summary measures. Scoring algorithms have been judged to be accurate enough to warrant use of published norms for SF-36V summary measures in interpreting SF-12V summary measures (Ware, et al., 1996).

Statistical Analysis

Descriptive statistics were used to present demographics of the two samples. TCCP and LAMP baseline and 12-months post-enrollment SF-12V scores were calculated for each of the eight summary scales and the two component scales. Scoring software was purchased from Quality Metric Incorporated, Lincoln, RI, (2005) to score all SF-12V data in this study (Ware et al., 2002). Paired samples *t*-tests were used to evaluate the difference in baseline and 12-month follow-up scores for each of the telehealth programs; a one-way analysis of variance (ANOVA) was used to compare the PCS-V and MCS-V scores of the two telehealth groups at baseline and one-year follow-up. Multiple linear regression analysis was used to determine whether SF-12V PCS scores could be predicted at baseline or 12-months follow-up from the variables of age, marital status, inpatient bed days of care, or diagnoses. All statistical analyses were performed using SPSS software version 12.0 (SPSS, Inc., Chicago, IL), with significant level set at .05.

Results

Baseline demographics of the TCCP participants (n=84) and LAMP participants (n=50) are presented in Table 4-2. The average age of the two samples is 71 years, with 53% married. The entire sample includes 4 females, and 90% are Caucasian. An independent samples *t*-test comparing TCCP and LAMP participants diagnoses found significant differences in arthritis ($t_{(128)}$= -4.66, p>.001), stroke ($t_{(128)}$= -2.66, p>.01), and amputation ($t_{(128)}$= -2.06, p>.05), with these diagnoses significantly higher in the LAMP group.

Table 4-2. Characteristics of participants

	LAMP (n=50)			TCCP (n=84)		
	M	S/D	%	M	S/D	%
Age	71.9	9.7		70.4	10.9	
Married			56.0			50.0
Diagnosis						
Arthritis			50.0			12.5
CHF			8.0			13.8
COPD			22.0			12.5
Diabetes			24.0			40.0
Hypertension			62.0			72.5
Stroke			20.0			3.8
Amputation			8.0			0.0

Table 4-3 presents the paired samples *t*-test calculations comparing the mean pretest SF-12V scores to the mean post-test SF-12V scores for our telerehabilitation group (LAMP). Due to the variability in some of the summary scales, the non-parametric Wilcoxon test was also used to examine the results, which did not change our findings. A significant increase from pre-test at baseline to post-test at 12-months was found for the Role Physical summary scale ($p \leq .001$) and the Physical Component Scale (PCS) ($p \leq .001$). A significant increase from baseline to 12-months was also determined for bodily pain ($p \leq .001$).

The standard error of the measurement (SEM) has been proposed as a useful estimate for meaningful change in HRQoL measures (McHorney & Tarlov, 1995; Wyrwich & Wolinsky, 2000). To calculate the SEM, we use the reliability coefficient of the measurement and the standard deviation (SD) of the sample at baseline. The SEM was computed for the LAMP PCS scores. The reliability component of .93 was used based on results from the 1999 LHS (OQP, 2000), as well as the PCS baseline SD of 8.3. Therefore, $SEM = 8.3 \sqrt{1-0.93} = 2.19$.

Cohen (1988) developed effect size benchmarks for evaluation of group change over time. The effect size is calculated using scores at baseline and subtracting scores at follow-up, then dividing by the SD at baseline. Cohen's guidelines for effect size standards suggest 0.2 for a small group change, 0.5 for a moderate group effect, and 0.8 for a large group change (Cohen, 1988). The standardized difference between the means at baseline and 12-month follow-up in LAMP PCS scores represents a small to medium effect size of .425, with no effect size in MCS scores

Table 4-3. Differences between SF-12V baseline and 12-month follow-up for LAMP (paired sample statistics)

LAMP SF-12V	Baseline	12-Month	Differences
	M ±S/D	M ±S/D	t (49)
Summary Scales			
Physical Function	24.17 ±5.9	25.03 ±1.1	-1.219
Role Physical	32.48 ±12.5	40.23 ±15.0	-2.964**
Bodily Pain	38.69 ±13.9	42.97 ±14.8	-2.636**
General Health	33.49 ±13.9	33.36 ±13.6	0.065
Vitality	37.08 ±11.9	37.28 ±11.5	-0.155
Social Function	41.22 ±13.7	43.84 ±13.4	-1.241
Role Emotional	45.01 ±15.4	46.91 ±14.6	-0.703
Mental Health	47.72 ±12.8	46.74 ±13.2	0.683
Component Scales			
Physical (PCS)	26.34 ±8.3	30.59 ±9.3	-3.619***
Mental (MCS)	50.78 ±12.5	50.32 ±10.7	0.310

*p≤.05 **p≤.01 ***p≤.001

Table 4-4 presents the paired samples *t*-test calculations comparing the mean pretest SF-12V scores to the mean post-test SF-12V scores for the telehomecare group (TCCP). Additionally, we used a non-parametric Wilcoxon test to examine the results, which did not change our findings. A significant increase from pre-test at baseline to post-test at 12-months was found for the Social Functioning summary scale only. Based on the standardized difference between the means at baseline and 12-month follow-up in PCS and MCS scores, no effect size was detected (Cohen, 1988).

Table 4-4. Differences between SF-12V baseline and 12-month follow-up for TCCP (paired sample statistics)

TCCP SF-12V	Baseline	12-Month	Differences
	M ±S/D	M ±S/D	t (83)
Summary Scales			
Physical Function	30.70 ±11.5	28.96 ±9.8	3.717
Role Physical	33.70 ±10.2	35.90 ±10.7	0.363
Bodily Pain	42.40 ±12.4	41.91 ±12.3	3.142
General Health	34.99 ±10.8	36.63 ±10.5	0.706
Vitality	39.72 ±9.1	40.20 ±10.6	1.892
Social Function	34.57 ±11.1	39.98 ±12.3	-2.637***
Role Emotional	46.76 ±12.9	44.50 ±12.8	4.942
Mental Health	48.72 ±9.1	48.29 ±8.9	2.258
Component Scales			
Physical (PCS)	30.66 ±10.8	31.45 ±9.3	1.201
Mental (MCS)	48.83 ±10.9	49.35 ±11.1	1.565

*p≤.05 **p≤.01 ***p≤.001

A one-way ANOVA was computed comparing the baseline SF-12V PCS scores of participants from LAMP and TCCP. A significant difference was found among the two groups ($F_{(,132)}$=5.86, p<.05). This analysis reveals that LAMP participants reported lower physical functioning at baseline than TCCP participants.

Follow-up PCS scores were then compared between the two groups to determine if significant differences continued to exist following 12 months of intervention. A one-way ANOVA comparing the post 12-months enrollment PCS scores of participants from LAMP and TCCP were computed. At 12-months, no significant differences were found ($F_{(,132)}$= .268, p>.05). This analysis reveals that LAMP and TCCP participants were no longer significantly different in physical functioning following 12-months of the telehealth interventions.

A multiple linear regression was calculated for LAMP participants to determine whether we could predict SF-12V PCS scores at baseline or 12-month follow-up based on age, marital status, pre-enrollment inpatient BDOC, or diagnoses. A significant regression equation was found for baseline SF-12V PCS scores based on age and marital status ($F_{(10,39)} = 2.512$, $p < .05$) with an R^2 of .392). Subjects' predicted SF-12V PCS increased .240 points with each year of age, and were 2.09 points higher for our married population. Multiple regression analyses were then computed for LAMP post SF-12V PCS scores. At 12-months post enrollment, the association between SF-12V PCS scores and age or marital status was no longer significant ($F_{(11,38)} = .1.627$, $p > .05$ with an R^2 of .294).

In comparison, a multiple linear regression was calculated for TCCP participants to determine whether we could predict baseline or 12-month SF-12V PCS scores based on age, marital status, pre-enrollment inpatient BDOC, or diagnoses. No significant regression equation was found for baseline TCCP SF-12V PCS scores ($F_{(8,75)} = .420$, $p > .05$), or 12-months post enrollment SF -12V PCS scores ($F_{(8,75)} = .531$, $p > .05$).

Post-hoc analyses. A post-hoc analysis was performed to address the missing SF-12 data for both LAMP and TCCP participants. As reported earlier, of the 115 LAMP participants, 43 were administered the measurement at baseline but not at 12-month follow-up due to the limited staff available to complete the follow-up testing. Baseline scores were computed for these 43 participants. Comparisons between those with baseline scores who had missing data at 12 months (n=43), and those with baseline and 12-month follow-up scores (n=50) are presented in Table 4-5. Independent samples *t*-tests conclude that there were no significant differences between these two LAMP baseline samples.

Table 4-5. Group differences for SF-12V baseline scores

SF-12V	LAMP (n=50)	LAMP Baseline-only (43)	Individual Differences
	M ±S/D	M ±S/D	t (91)
Summary Scales			
Physical Function	24.17 ±5.9	23.31 ± 3.55	0.868
Role Physical	32.48 ±12.5	32.64 ±13.02	-0.060
Bodily Pain	38.69 ±13.9	35.86 ±14.61	0.948
General Health	33.49 ±13.9	29.75 ±11.30	1.432
Vitality	37.08 ±11.9	35.11 ±9.59	0.882
Social Function	41.22 ±13.7	38.25 ±13.09	1.067
Role Emotional	45.01 ±15.4	44.16 ±15.27	0.280
Mental Health	47.72 ±12.8	47.325 ±11.74	0.185
Component Scales			
Physical (PCS)	26.34 ±8.3	24.44 ±8.08	1.113
Mental (MCS)	50.78 ±12.5	49.42 ±11.14	0.556

*p≤.05 **p≤.01 ***p≤.001

Of the 115 LAMP participants, 11 participants received the measurement at 12-month follow-up only. LAMP reports that on occasion a participant does not receive the SF-12V at baseline due to time factors, the participant has become tired, or the participant declined to be tested further. Table 4-6 presents the difference in scores at 12-months between the 50 participants that received the SF-12V at the two time periods and the 11 participants who only received the SF-12V at their 12-month follow-up assessment. Based on independent samples *t*-tests, significant differences were noted in the general health summary scale only.

Table 4-6. Group differences for SF-12V at 12-month follow-up

SF-12V	LAMP (n=50)	LAMP Follow-up only (n=11)	Individual Differences
	M ±S/D	M ±S/D	t (59)
Summary Scales			
Physical Function	25.03 ±1.1	22.89 ±2.59	1.599
Role Physical	40.23 ±15.0	30.79 ±13.68	2.033
Bodily Pain	42.97 ±14.8	37.98 ±17.32	0.885
General Health	33.36 ±13.6	24.75 ±5.63	3.354*
Vitality	37.28 ±11.5	34.94 ±9.10	0.734

Table 4-6. Continued.

SF-12V	LAMP (n=50)	LAMP Follow-up only (n=11)	Individual Differences
	M ±S/D	M ±S/D	t (59)
Social Function	43.84 ±13.4	36.37 ±16.90	1.375
Role Emotional	46.91 ±14.6	38.80 ±17.59	1.426
Mental Health	46.74 ±13.2	40.71 ±13.75	1.325
Component Scales			
Physical (PCS)	30.59 ±9.3	25.51 ±7.54	1.919
Mental (MCS)	50.32 ±10.7	43.59 ±13.16	1.586

*p≤ .05 **p≤ .01 ***p≤ .001

For our telehomecare group (TCCP), of the 112 participants, 84 completed the SF-12V at baseline and 12-months, 26 completed the SF-12V at baseline only, and the remaining 2 declined to be tested. Table 4-7 presents a comparison between the baseline data of the two TCCP groups. Based on independent samples *t*-tests, no significant differences were observed between these two groups' baseline scores.

Table 4-7. TCCP group differences for SF-12V at baseline

SF-12V	TCCP (n=84)	TCCP Baseline-only (n=26)	Individual Differences
	M ±S/D	M ±S/D	t (108)
Summary Scales			
Physical Function	30.70 ±11.5	27.73 ±10.01	1.278
Role Physical	33.70 ±10.2	35.92 ±7.93	-1.156
Bodily Pain	42.40 ±12.4	44.51 ±10.61	-0.850
General Health	34.99 ±10.8	36.45 ±10.70	-0.607
Vitality	39.72 ±9.1	39.62 ±11.03	0.043
Social Function	34.57 ±11.1	37.92 ±12.68	-1.214
Role Emotional	46.76 ±12.9	46.62 ±11.60	0.054
Mental Health	48.72 ±9.1	48.36 ±7.50	0.202
Component Scales			
Physical (PCS)	30.66 ±10.8	31.29 ±9.13	-0.293
Mental (MCS)	48.83 ±10.9	49.66 ±8.43	-0.406

*p≤.05 **p≤.01 ***p≤.001

The 1999 Large Health Study (LHS) of Veteran Enrollees provides the first large-scale study based on approximately 43 percent of the veteran enrollee population (OQP, 2000). The LHS report provides baseline norms for the SF-36V, and identifies the health status of veteran enrollees by the twenty-two VISNs, including norms based on age and primary medical condition. As a post-hoc analysis, cross-sectional relationships between presence of primary medical condition and PCS scores were explored at baseline and 12-months for our two telehealth groups. These analyses were then compared to the VA PCS norms established from the 1999 LHS for VISN 8. For purposes of this study, both telehealth cohorts were combined. Based on the results, significant differences exist between the telehealth cohorts and the VA VISN 8 average for all primary medication conditions, with the telehealth group presenting with lower PCS scores at baseline and at 12-month follow-up. Although norms were not provided for the diagnosis of amputation, our telehealth cohort with the primary diagnosis of amputation reported significantly higher PCS scores from baseline to 12-month follow-up.

Table 4-8. Cross-sectional relationship between presence of primary medical condition, physical component summary (PCS-12) at baseline and 12 months for two telehealth cohorts (LAMP and TCCP, n=229), and VA PCS norms from 1999 Large Health Study for VISN 8 (n=75,163). Percentage of enrollees with medical condition presented in parentheses.

Medical Condition	PCS-Baseline	PCS-12 Months	1999 LHS Prevalence and PCS Norms
	Mean $\pm$ Standard Deviation		
Arthritis (31%)	25.30 $\pm$8.0	29.96 $\pm$8.4	(34.1%) 38.7 $\pm$10.3***
Hypertension (67%)	28.26 $\pm$10.0	30.33 $\pm$8.7	(44.2%) 44.44 $\pm$10.2***
CHF (13%)	27.26 $\pm$3.3	29.83 $\pm$7.5	(5.6%) 39.16 $\pm$10.6***
COPD (20%)	27.79 $\pm$8.3	29.94 $\pm$10.8	(16.1%) 38.14 $\pm$10.8***

Table 4-8. Continued.

Medical Condition	PCS- Baseline	PCS- 12 Months	1999 LHS Prevalence and PCS Norms
	Mean ± Standard Deviation		
Diabetes (33%)	29.48 ±11.6	31.04 ±8.8	(18.1%) 41.92 ±10.7***
Stroke (21%)	28.83 ±11.5	30.30 ±10.3	(5.9%) N/A
Amputation (4%)	32.56 ±16.1	39.15 ±11.4**	N/A
Total Sample Mean	28.50	31.51	35.99**

*p≤ .05 **p≤ .01 ***p≤ .001

Discussion

The SF-12 Short Form Health Survey was developed to describe mental and physical health status of adults and to measure the outcomes of healthcare services. The SF-12 has been deemed a reliable and valid measure of health status and has been used as both a predictor and an outcome measure (Resnick & Nahm, 2001). Responsiveness to change has been measured with the SF-12 in patients with cerebral aneurysms (Muller-Nordhorn et al., 2005; Pickard, Johnson, Penn, Lau, & Noseworthy, 1999), spinal cord injuries (Andresen, Fouts, & Romeis, 1999), low back pain (Deyo et al., 1998; Riddle et al., 2001), hypertension (Cote et al., 2004), and chronic illnesses (*Haywood et al.,* 2005; Resnick & Nahm, 2001; J. Ware, Jr. et al., 1996).

The 1998 National Survey of Veterans in Ambulatory Care utilized the veteran's version of the SF-36 and developed norms for veteran enrollees, which were determined to be significantly lower than the general non-VA population (Kazis et al., 1998; Kazis et al., 1999b). In 1999, the Large Health Study of Veteran Enrollees (LHS) (OQP, 2000) established updated baseline health status data on approximately one million veteran enrollees. Based on the 1999 LHS, the VA national average for PCS is 36.9, which falls approximately 1.3 standard deviations below the U.S. population. The VA national average for MCS is 45.1, which is approximately 0.50 of one standard deviation below the U.S. population.

The LHS also stratified data in order to provide information pertaining to the twenty-two VA VISNs based on age groups and primary diagnosis. For all age groups (18-49, 50-64, and 65-98), average PCS and MCS scores for veteran enrollees in VISN 8 (n=75,763) fall below the VA national average. VISN 8 veteran enrollees aged 65 to 98 exhibit lower physical health scores (PCS) when compared to younger VISN 8 veterans aged 18-49 and 50-64 years. For all age groups, VISN 8 average scores for PCS were 36.0, with individuals aged 65-98 scoring 34.09. PCS scores for this age group (65-98) are approximately 1.6 standard deviations below the US general population, and 0.2 standard deviations below the VISN-8 average. The l999 LHS reported that most VISNs in the south regions exhibit lower PCS scores, indicating greater disease burden.

Between October 2002 and September 2004, 115 veterans were enrolled in the LAMP telerehabilitation program, and 112 veterans were enrolled in the TCCP telehomecare program. Forty-three percent of LAMP enrollees (n=50) and 63 percent of TCCP enrollees (n=84) completed the SF-36V or SF-12V health survey at baseline and 12-months. The mean age of the LAMP participants (n=50) was approximately 72 years; the mean age of the TCCP patients (n=84) was 70 years. Fifty percent or more of the 50 LAMP and TCCP patients reported they were married, which may signify they had a caregiver at home able to provide assistance if needed.

The SF-12V PCS scores include questions concerning one's ability to participate in daily physical activities, such as climbing stairs, how energetic or vital one fees, as well how their physical abilities affect their social and work roles. Based on results from the LAMP and TCCP cohorts, the veteran enrollees served by these telehealth programs report significantly worse health in the physical domain (PCS) than that of the general population, the overall veteran enrollee population, the overall VISN 8 veteran population, and the VISN 8 veteran population aged 65-98. This demonstrates a highly skewed population, which is not symmetrically distributed about the population mean. Based on baseline and one year follow-up, the SF-12V PCS scores for our veteran telehealth participants fall at least 2 standard deviations below the mean of the general population.

There was a significant increase reported in SF-12V PCS scores for the LAMP participants from baseline to 12-month follow-up. It is difficult to determine whether this increase in scores is clinically relevant or individually meaningful. Stadnyk and colleagues tested the measurement properties of the SF-36 in a frail elderly cohort, and determined that this measurement may not be suitable to detect clinical change in this population (Stadnyk, Calder, & Rockwood, 1998). Additional studies report that the SF-36 may be insensitive to important clinical change since it contains items that are not clinically relevant or typically focused on during treatment (McHorney, 1996; Wright & Young, 1997). In an attempt to discuss and evaluate meaningful change in scores, we estimated the standard error of measurement (SEM) (Wolinsky, Wan, & Tierney, 1998; Wyrwich, Tierney, & Wolinsky, 1999b) and the effect size (Cohen, 1988) in PCS scores for each of our telehealth cohorts.

The standard error of measurement (SEM) was calculated to explore clinical significance in LAMP baseline and 12-month PCS scores, due to the significant difference shown between the pre and post intervention scores. The SEM value can be used as an estimate of significance for a group. The SEM is computed by using the reliability coefficient of the measure, which takes into consideration the possibility that some of the change from baseline to follow-up may be due to random measurement error (Wyrwich et al., 1999b; Wyrwich & Wolinsky, 2000). The SEM is considered sample independent and remains relatively constant across the population tested. McHorney & Tarlov used a value of 1.96 SEM's, reflecting a 95% confidence interval, as the minimal amount of change needed to demonstrate true change (McHorney & Tarlov, 1995). More modest SEM change thresholds have also been used (Wolinsky et al., 1998; Wyrwich, Nienaber, Tierney, & Wolinsky, 1999a), but to date SEM-based criterion for clinically relevant HRQoL change, specifically the SF-36, has not been established (Samsa et al., 1999; Ware, Jr. & Gandek, 1998). Using McHorney & Tarlov's more restrictive threshold, the increase in PCS scores from baseline to 12-month on our LAMP population (+4.25) falls within of the 95% range (2 SEM = 4.38), and therefore does not represent a clinically significant change. It should be noted that some researchers feel that 1 SEM is acceptable to determine clinically significant change (Wyrwich et al., 1999b; Wyrwich & Wolinsky, 2000). Ferguson and colleagues report that the SEM alone does not indicate clinical significance and that any post-intervention score must fall within the range of normative values (Ferguson, Robinson, & Splaine, 2002). We do not meet this criterion as LAMP pre and post PCS scores fall at least two SD below the general norms and approximately one SD below the general veteran norms. Additionally, we would assume that we would see regression to the mean for responses which are clustered at such extreme values.

The use of effect size statistics (Cohen, 1988) has been questioned when evaluating clinical significance in health-related quality of life (HRQoL) measurements, as Cohen's original benchmarks were not derived from any HRQoL or health status measurements (Kazis, Anderson, & Meenan, 1989; Wyrwich & Wolinsky, 2000). Additionally, since effect size statistics use the average change divided by the baseline standard deviation of the sample, effect sizes can vary among samples taken from the same population (Samsa et al., 1999). When evaluating effect size in both LAMP and TCCP PCS scores from baseline to one-year follow-up, the LAMP population had an effect size that was considered small to moderate by Cohen's definition (.425). Unfortunately, we do not have power to justify this effect, as our sample size was 50 subjects and 100 subjects would be required for an effect size of .425 with power at .80.

A one-way ANOVA was computed comparing the baseline PCS scores of participants from LAMP and TCCP. A significant difference was found among the two groups ($F_{(,132)}=5.86$, $p<.05$). This analysis reveals that LAMP participants report lower physical functioning at baseline than TCCP participants. This may be due to that fact that functional disabilities, which may be experienced in individuals with arthritis, stroke and amputations are higher in the LAMP population. LAMP patients also report a higher level of pain, which has been shown to correlate with lower PCS scores (Wright & Young, 1997). This significant difference in SF-12V PCS scores between the two groups was no longer visible at 12 months post-intervention, as LAMP scores increased significantly and TCCP scores remained stable during the 12 months of treatment.

Regression analyses indicate whether or not a significant prediction regarding the variable can be made, as well as the direction of the relationship. Numerous studies have shown correlations between the SF-36 and/or the SF-12 and sociodemographics and morbidities (Cote et al., 2004; Kazis et al., 2004b; Kazis et al., 1999b; King et al., 2005; Weeks et al., 2004). A multiple linear regression was calculated for LAMP participants in an attempt to predict baseline SF-12V PCS scores. The variables of age, marital status, pre-enrollment inpatient BDOC, and diagnoses were used in the model. A significant regression equation was found for LAMP baseline SF-12V PCS scores based on age and marital status, but diagnoses and hospital bed days of care were not significant. At 12-months post enrollment in LAMP, the association between SF-12V PCS scores and age or marital status is no longer significant. In comparison, multiple linear regressions were calculated for TCCP participants at baseline and post-12 months' enrollment to determine whether we could predict SF-12V PCS scores based on age, marital status, pre-enrollment inpatient BDOC, and diagnoses. No significant regression equation was found for baseline or 12-months post enrollment TCCP SF-12V PCS scores. It may be that our samples are too small to detect significant relationships between these variables.

As a post-hoc analysis, we analyzed the missing data for LAMP and TCCP to determine if there were significant differences between the two samples. Of the 115 LAMP participants, we were provided with paired samples on only 50 of the participants. An additional 43 participants received baseline testing, but were not tested at 12-month follow-up, and 11 participants received the measurement at 12-month follow-up, but do not have baseline scores. There were no significant differences noted in the SF-12V PCS scores between the baseline paired samples (n=50) and the baseline only samples (n=43), or the 12-month paired samples (n=50) and the 12-month only samples (n=11). Combining these samples would no longer allow us to use a repeated measures or paired samples design. Yet, the fact that we do not see significant differences in the samples may strengthen our final results, and allow us to uphold our conclusion that there was a significant increase in LAMP SF-12V PCS scores from baseline to12-months, even when considering the large amount of missing data. For our telehomecare group (TCCP), of the 112 participants, 84 completed the SF-12V at baseline and 12-months, 26 completed the SF-12V at baseline only, and the remaining 2 declined to be tested. No significant differences were observed between these two groups' baseline scores, allowing us to conclude that the missing data would not have altered our final outcome.

There are some limitations that need to be addressed. Health surveys, such as the SF-12V, can provide information on quality of care and clinical effectiveness. Yet, the use of the SF-12V as a physical measurement to determine an individual's ability to function within the home has not been validated. The results from this study do not allow us to make clinical judgments about these patients or the effects of either of the telehealth interventions without evidence from a matched comparison group or further long-term follow-up study.

As our intervention groups were not randomly assigned, this is not a true pretest-posttest control group design. Therefore, we cannot determine a cause-and-effect relationship between the intervention and physical functioning based on the SF-12V alone.

Some experts have questioned whether the SF-36/SF-12 is appropriate for a frail elderly population (McHorney, 1996; Stadnyk et al., 1998). We also have to question whether the use of this health outcomes instrument is appropriate for our population of interest. Results from their SF-12V demonstrate that this population is skewed toward illness; therefore it is very difficult to show change.

It is important to note that as this is a frail population, decline would be expected, especially within a 12 month time period. As the SF-12V demonstrates, these two groups were able to at least maintain their scores over time. For this population, staying the same may be seen as a sign of a successful intervention.

CHAPTER 5
PERSONAL INTERVIEWS FROM TELEHEALTH PARTICIPANTS

> Exact sciences give correct answers to certain aspects of life problems, but very incomplete answers. It is important of course to count and measure what is countable and measurable, but the most precious values in human life are aspirations which laboratory experiments cannot yet reproduce (Cousins & Dubos, 1979) [page 279].

Qualitative Research and Healthcare

The application of qualitative studies within healthcare outcomes research is novel, but growing in degree and importance. Qualitative research provides a unique means for assessing a healthcare program or intervention, and has been deemed useful in illuminating the findings of healthcare outcomes studies (Hatch, 2002; Pope & Mays, 1995; Pope, van Royen, & Baker, 2002). There is value in the use of qualitative studies in determining clinical interventions and subsequently assessing the effects of these interventions (Pope et al., 2002; Shortell, 1999).

Qualitative research involves the collection, analysis, and interpretation of personal data which is not easily reduced to numbers (Creswell, 2003). Qualitative research in healthcare is largely concerned with the people who participate in healthcare interventions; the recipients of healthcare services. Interviews are most often used in healthcare research to determine how consumers evaluate their services, including the strengths and weaknesses of an intervention, as well as what personal attitudes motivate consumers to comply with intervention guidelines (Murphy, Dingwall, Greatbatch, Parker, & Watson, 1998). Pope et al. states that, “quality of services can no longer be confined to simply monitoring such aspects as waiting time, but requires an understanding of the patient's experience of waiting for care" [page 148].

Typically, the evaluation of healthcare programs concentrates on cost analyses, yet it is important that program evaluations are not based on cost calculations alone. The larger more complex issue of the patient's perceived value and benefit of the program should also be included. Qualitative research can contribute significantly to our understanding of a patients' experience of chronic illness and disability, and their views on health education and healthcare delivery. Nowhere is this more important than in homecare or interventions that are delivered to the home. As here, control ultimately rests with the patient (Magnusson & Hanson, 2003).

Despite numerous studies reporting on cost savings for telehealth programs, few studies have investigated participant perspectives regarding the home-based intervention or the use of technology to remotely connect with healthcare providers (Dhurjaty, 2004; Hebert & Korabek, 2004; May et al., 2002; Nodhturft et al., 2000). Hebert and Korabek conducted focus groups and personal interviews with frail elders who were currently receiving telehealth services to obtain their initial reactions on the use of telehomecare equipment. Themes included payment for technology, criteria for client selection, and most importantly, the potential loss of human touch, which was seen as essential for care. Most clients felt that telehomecare would not be adequate without the addition of visits by home healthcare staff. Magnusson and Hanson (2003) provided an overview of ethical issues, which arose during the field-study of a telehomecare project. A majority of the families involved reported that they found the technology easy to use and of direct benefit to them in their daily life. Issues of confidentiality and privacy were raised with the use of videophones. As with Hebert's study, fears that the technology would replace healthcare staff were initially raised, but once the positive effect was observed, these opinions changed. Dhurjaty (2004) focused on telerehabilitation and associated costs to patients, providers, payers and corporations. Patients reported that collaboration with their therapists was a positive experience and that telerehabilitation reduced travel time and associated costs. Yet, his focus was on the telehealth systems manufacturers and making a business case for telerehabilitation. Mann et al. (2001) examined frail elders' acceptance of the concept of home monitoring devices. Results suggested the strong acceptance of home health monitoring and the monitoring devices. Further research was suggested regarding patients' actual perceptions of using home monitoring devices. Additional studies focused on evaluating stakeholder readiness and assessing the needs of potential users (Hebert & Korabek, 2004; Jennett et al., 2005).

Given that the VA recognizes the need to have veterans become more actively involved in their healthcare (Nodhturft et al., 2000), the aim of this qualitative study is to explore veterans' satisfaction with healthcare at a distance through enrollment in a telehealth program. To supplement quantitative findings, information was obtained from individuals who have experienced the application of telehealth and have personally used the technology. Personal feelings regarding use of technology in this population affects the individuals themselves and has implications on the success or failure of the intervention.

Role of the principal investigator. I cannot state that I'm impartial to the outcomes of this study, or that I care not what the interviewees have experienced. I believe in the concept of telehealth, and the direct benefit that the VA population may receive from the provision of telehealth services into their homes. This partiality stems from my background as an occupational therapist, and my direct connection with the VA and telehealth.

In the summer of 2002, I was accepted to graduate school to pursue a doctoral degree in rehabilitation science (RSD) at the University of Florida (UF). In the fall of 2002, Dr. William Mann, chairperson of the UF RSD program, was awarded a grant from the VA to conduct a 2-year telerehabilitation clinical demonstration project focused on the use of assistive technology / adaptive equipment (AT/AE) and home monitoring to reduce healthcare costs and increase functional independence for chronically ill veterans. The project was titled the Low ADL Monitoring Project (LAMP). I worked as an occupational therapist and care coordinator for LAMP through the grant funding cycle from October 1, 2002 to September 30, 2004. Having been an intrinsic part of LAMP from its inception is the most obvious bias in this qualitative study.

I, as well as the other LAMP team members, worked very hard to ensure the success of LAMP. It was my job. I worked closely with the veterans, I traveled to their homes, I was their care coordinator, and I assisted them in obtaining the resources they needed to manage their illness, to maintain independence, and to live safely in their home. The rehabilitation aspect of LAMP was the most important to me. The LAMP model allowed for a complete evaluation of a patient within their home environment, provision of AT/AE, training on the equipment, and monitoring or self-care and health related needs. The ability to work one-on-one with each patient, to problem solve and individualize solutions was of ultimate benefit to me, as well as the patient. I believe fully in the LAMP model, as well as the vision of telehealth.

I understand that not every elderly veteran needs a grab bar, or a ramp, or a reacher; many veterans are functionally independent and may only require symptom tracking and medical interventions when their symptoms have progressed. Yet during my interviews, I met veterans enrolled in the telehomecare program (TCCP) who voiced a need for adaptive equipment due to safety issues within their home environments. I believe it's important that these concerns are monitored. That's the personal bias I bring to this project.

I did not interview any LAMP participants for whom I served as their care coordinator. I did not discuss my service to the VA or LAMP with any interviewee, although a few of the LAMP interviewees knew of my association with LAMP, which may have biased their answers to my questions. Through my personal discussions and the signed informed consent, I acknowledged to all participants that nothing they said during the interviews would affect their healthcare or their participation in the telehealth program. I discussed with all participants the importance of hearing their personal stories related to their experience with telehealth. My focus was to learn of the strengths and weaknesses of the telehealth programs; therefore, everything that was said during the interviews, positive or negative, was considered valuable to ensure these telehealth programs were the best they could be.

Methods

Selection of Subjects

To ensure that the sample was consistent with the intention of the inquiry, a purposeful selection of subjects was made. All veterans included in this study met the initial program inclusion criteria, were currently enrolled, and had participated in LAMP or TCCP for at least one year.

Care Coordinators (CC) from LAMP and TCCP initially screened enrollees during regularly scheduled contacts to determine their interest in participating in personal interviews in their homes. If the veteran enrollee verbally agreed to be contacted for a personal interview, a telephone consent form was read, completed and signed by the CC. Following signed and dated telephone consent, I (the principal investigator) then telephoned the veteran to further discuss the purpose of the study and to schedule a convenient time for a personal interview in the veteran's home. Prior to the scheduled interview, I telephoned the veteran a second time to confirm the appointment and to obtain directions to their home.

Table 5-1 presents demographic information from the TCCP and LAMP sample. Aliases have been used in place of real names. Additional information provided includes age, diagnoses, marital status, and type of technology used for remote monitoring.

Table 5-1. TCCP and LAMP sample demographics

Name	Age	Program	Diagnoses	Marital Status	Technology
Jim	69	TCCP	Arthritis Hypertension Diabetes	Married	Health Buddy
Jeff	61	TCCP	CHF Diabetes	Married	Health Buddy
Joseph	83	TCCP	Hypertension	Married	Health Buddy
Jack	63	TCCP	Hypertension COPD	Not Married	Health Buddy
Jessie	80	TCCP	Hypertension CHF Diabetes	Married	Videophone
James	57	TCCP	Diabetes	Not Married	Videophone
John	78	TCCP	COPD	Not Married	Health Buddy
Mary	79	LAMP	Arthritis Hypertension	Married	Smartphone
Mark	77	LAMP	Arthritis Hypertension	Married	Computer

Table 5-1. Continued.

Name	Age	Program	Diagnoses	Marital Status	Technology
Mitchell	81	LAMP	Arthritis Hypertension	Married	Computer
Mike	70	LAMP	Arthritis Hypertension Diabetes	Married	Health Buddy
Martin	74	LAMP	Hypertension CHF Post-Stroke	Not Married	Health Buddy
Mick	79	LAMP	CHF	Married	Computer
Merle	73	LAMP	Arthritis Hypertension	Married	Health Buddy
Mack	53	LAMP	Muscular Dystrophy	Married	Health Buddy
Milton	70	LAMP	Arthritis Post-Stroke	Married	Computer

Data Collection

Semi-structured interviews were conducted with 16 veterans who had been enrolled in one of the telehealth programs for at least one year. Seven veterans enrolled in the telehomecare program (TCCP) and 9 veterans enrolled in the telerehabilitation program (LAMP) were interviewed in their homes. Participants signed an informed consent form prior to the initiation of the interview. Any questions they expressed were answered in full to their satisfaction before they were given the opportunity to sign the informed consent form and be included in the study. If a witness was available, they were asked to verify each subject's signature. The interviewees were given a copy for their personal use, and the principal investigator retained the original signed copy. Prospective data was obtained through single, face-to-face interviews within the veteran's home. Interviews were semi-structured in nature and were digitally recorded. Veterans were contacted by telephone within two months following the interview to ensure that interpretation of their comments was as accurate as possible.

Appendix A presents the Interview Guide, which was approved by the University of Florida Institutional Review Board and the VA Subcommittee for Clinical Investigation. Interview questions were viewed as a list of information to obtain from the interviewees; the particular wording or order in which the questions arose was adapted for each individual interview. Five to 10 minutes was typically spent with each participant prior to beginning the interview in order to develop rapport and, therefore, attempt to solicit more accurate and descriptive answers. During the interview process, answers to certain questions were often acquired through stories or conversations regarding other interview topics.

Coding Process

Data were collected through semi-structured interviews with 7 veterans enrolled in TCCP and 9 veterans enrolled in LAMP (n=16). Personal interviews were held in the participant's homes. Interviews were recorded through a digital recorder, and data were transcribed into Word documents, read thoroughly, and then coded. Codes and coded data were analyzed and interpreted using content analysis. Content analysis has been defined as a systematic, replicable technique for compressing many words of text into fewer content categories based on explicit rules of coding (Creswell, 2003; General Accounting Office [GAO], 1996; Krippendorff, 1980; Weber, 1990). Content analysis is a research tool used to determine the presence of certain words or concepts within texts or sets of texts, such as interviews. Weber (1990) states that content analysis can be a useful technique for discovering and describing the focus of an individual or group, and can be an important component for a program evaluation. Moreover, as these interviews are only one aspect of the telehealth program evaluation, content analysis allows inferences to be made, which can then be supported using other methods of data collection.

To conduct the content analysis, text from each interview was coded into categories on a variety of levels, such as a word, phrase, or sentence. Weber (1990) defines a category as, "a group of words with similar meaning or connotations" [p. 37]. The text was then examined using a basic content analysis method: conceptual analysis. Conceptual analysis establishes the existence and frequency of concepts – most often represented by words or phrases – in a text. The technique of conceptual analysis extends far beyond simple word frequency counts. In conceptual analysis, a concept is chosen for examination, such as connectedness with the care coordinator, and the analysis involves quantifying its presence (Palmquist, Carley, & Dale, 1997). The focus was to search for the occurrence of selected terms, either implicit or explicit, within the interview.

The use of emergent coding allowed for categories to be established following preliminary examination of the data, but specific a priori questions guided the organization and coding of the data (see Interview Guide, Appendix A). Overall, the goal was to gain information regarding the veteran's perception of the telehealth program they were enrolled in, their thoughts on the technology used for remote monitoring, their thoughts on any assistive devices they had received, their understanding of the role of their VA care coordinator, and in general how satisfied they were with the telehealth program.

In order to obtain a general sense of the information and to reflect on the overall meaning of the interviews, I read through the data three times, on varying dates. On the initial reading, notes were written in the margins of the transcribed data and general thoughts about the data were recorded at this stage. General thoughts included both conceptual and concrete ideas of communication, connection, security, independence, satisfaction, education, assistive devices and technology, and role of the care coordinator. A detailed coding analysis was then begun to organize the interviews into sections or coding units, label these units with a term, and provide narrative passages to convey the findings.

Reliability and Validity

Weber (1990) notes: "To make valid inferences from the text, it is important that the classification procedure be reliable in the sense of being consistent: different people should code the same text in the same way" [p. 12]. To validate the coding scheme and accuracy of the findings, two sub-investigators for this project coded a random sampling of 10 interviews each. The appropriate size of the sample used for validation reportedly depends on may factors but should not be less than 10 percent of the full sample, and will rarely need to be greater than 50 percent (Neuendorf, 2002). Therefore, validation coding for this study consisted of approximately 10 (62 percent) of the interviews.

Based on the information available, there is no consensus as to the best index of intercoder reliability. Several recommendations for Cohen's kappa argued that kappa should be "the measure of choice" and this index appears to be commonly used in research (Weber, 1990). Cohen’s kappa of .80 or greater was considered to be acceptable for this exploratory study.

Subcoder training was performed with one personal interview, which was then excluded from the sampling of interviews provided to the subcoders. Training required approximately 2 hours with each subcoder. Subcoder training included discussing the main objectives of the project, reading through the interview together, discussing initial thoughts on themes or categories within the interview, and individually re-reading and finalizing the coding of the interview. Subcoders were provided with the initial themes and were asked to determine whether the theme was present in the interview. A dichotomous rating scale of 1=present and 2=not present was used for coding each interview. Because of its simplicity and widespread use, percent agreement was used for initial intercoder reliability during this training process. Following subcoder training, percent agreement reached 95 percent between subcoder #1 and myself, 92 percent between subcoder #1 and subcoder #2, and 94 percent agreement between subcoder #2 and myself.

Results

Description of Sample

The mean age of our total interview sample (n=16) is 71.7 years old. Ninety-four percent of our sample are male and 75 percent are married. The mean number of chronic diseases is 1.88, with hypertension as the most prevalent chronic condition. Nine of our participants use the Health Buddy (HB) (56.25 percent), 4 individuals use a computer (25 percent), 2 use videophones (12.5 percent), and 1 uses the smartphone (6.25 percent) to remotely connect to their respective telehealth programs.

Descriptions and Themes

Characterizations and quotes from interviewees were used to identify eight main recurrent themes that were refined during the analysis. The initial coded themes were care coordination, connection, communication, education, security, technology, adaptive equipment, and satisfaction with telehealth services. When interviews were re-read, it was observed that many of these themes were closely connected with each other and should not be placed into separate coding categories. Therefore, four primary themes or codes were established, each with secondary themes or subcodes. The coding structure is presented in Table 5-2. A secondary theme may be included under more than one primary theme and a phrase or sentence could be coded under more than one primary or secondary theme. Conceptual analysis was completed to identify phrases and sentences under this coding structure.

Table 5-2. Coding structure for qualitative interviews.

Primary Theme/Code	Secondary Theme/Subcode
Care Coordination	Connectedness Education Personal Security
Technology	Connection Convenience Daily Routine Education Frustration Personal Security
Adaptive Equipment	Security
Satisfaction	Overall (Telehealth Program)

Interpretation / meaning of the data

Care coordination

Care coordination (CC), which includes care coordinators who manage patients through remote technology, emerged as a principal theme in the interviews. CC was broken down into 3 subcodes to increase accuracy and detail of the analysis. The 3 subcodes include connectedness with the VA, education provided by the CC, and personal security through having access to a CC.

Connectedness. Connectedness with the VA was an important theme that fell under the scope of care coordination. **C**onnectedness is defined as the relationship or attachment veterans feel they have with the VA through their care coordination office. Eighty-one percent (13) of our interviewees felt that being enrolled in a telehealth program increased their connectedness with the VA.

For our veteran interviewees, CC meant many different things. Most of our veterans felt that CC was supportive and able to fill in for direct contact with their VA primary care provider (PCP). Joe reports that his CC has, "been very helpful and sometimes more so than my primary care person." CC allowed our participants to stay in close contact with the VA and was viewed as their direct access to care. In fact, a few of our veterans felt that their CC was more personable than their PCP and felt secure because "they're there and will take care of things."

Our veteran interviewees report that connection and staying in touch with their doctor were important aspects of the CC relationship. This requires that care coordinators follow up on phone calls, or computer or Health Buddy flags. Seventy percent of the veterans interviewed remarked that they receive immediate response from their CC. Martin is homebound and requires assistance to get outside of his home. He discussed the fact that his CC telephones him because "she wants to know if I need anything or if things are all right." Martin reported that participating in a telehealth program also connected him with other services, such as meals-on-wheels, which has been essential as he has difficulty cooking for himself secondary to post-stroke hemiplegia. Jim remarks, "the best thing is you stay in touch with your doctor, your healthcare provider; that's the best part." Jack also feels that's important and states, "she's [CC] the only way I can get to my doctor." Mark stated that the computer format allows him to ask his PCP or his CC questions and that the response is always quick and helpful. For Mark, if there is anything that he needs from the VA, "I'll go through my CC and ask them if they could help, and it's taken care of." Merle discussed the connection he has with the VA through his telehealth program and stated, "to have somebody at the VA so to speak going to bat for you and doing things for you, it sure has taken a load off me." Merle feels "it's been one of the best things for me because it gave me a connection with the VA that I wouldn't have otherwise had." For Merle, having this connection to the VA was "part of the healing process." Milton uses his telehealth CC for any question or concern he has about his VA healthcare. Milton stated that, "I don't try to get a hold of anybody now, I just call LAMP and I'm sure they recognize my voice by now, you know, if I need a change of anything, they take care of it for me." James speaks with his CC weekly through a videophone, but also reported that he is able to call her anytime and she's available for him, "I can call her if I really need something and she's my direct connection to my physician." James appreciates that his CC is in also in direct contact with his PCP; he refers to this as, "a loop between the piece of equipment, my CC, my physician and then back to me."

Although quick response and follow-up regarding healthcare needs is an important aspect to care coordination, it appears to be inconsistent. In contrast, a few of our veterans felt frustrated because of the lack of attention from their CC or the sense that the CC was not backing up their HB responses. Nineteen percent (3) of our HB users stated that they've never received any calls from their CC regarding responses they've input into the HB. Jessie was unaware of who his CC was and remarked that their office never calls him; a screen on the HB advises Jessie to call his CC or the VA hospital if he needs assistance. Jeff reported that no matter how high he reports his blood pressure or blood glucose levels are, he does not receive a follow-up telephone call from his CC. His analogy was, “it’s kinda like doing a report card everyday but there is really nobody backing it, you know.” Jeff stated that the HB tells him to call his CC and provides the phone number, but “there isn’t much communication I don’t think, personal communication.” John was initially a HB user, and reported that they “never did, never did” call him in response to his HB answers. John now uses a videophone, which has increased communication and his issues are resolved quickly.

Delays in responding to telephone calls or not enough personal communication appeared to be a concern. Although Joe was very enthusiastic about the program and his CC, he also reported that, “they don’t seem to have the time to do the effort that they used to put into me when I called.” In fact, a few of our veterans were concerned that their telehealth office was too busy and didn’t have the personnel necessary to attend to everyone’s needs. The need for more resources was one of the weaknesses that was expressed during the interviews.

Education. Telehealth CCs were noted to be important educational resources for many of our veteran interviewees. Seventy-five percent (12) of our interviewees stated they use their CC for information about the VA and as a health education resource. Mary reported that when she has a clinic visit, her PCP is very impersonal, and she doesn’t always understand what he tells her. But, when she talks with her CC, “it’s very personable, you know, they can sit and talk with me on the phone as a human being and still look up all my vitals on the screen and explain it to me in layman’s terms.” James reports that his CC is “a very good instructor, she’s the education, she is very good in listening to me, getting a good understanding of where I'm coming from and finding the right place to go or the right information and letting me know that."

Security. Eighty-eight percent of our telehealth interviewees found security and trust in their CC. Jim remarked, "it makes me feel good because if something is wrong, I can get a hold of somebody. In fact, I can call like this morning, and this afternoon I'll see the doctor no doubt. It's that fast." Having a "shortcut" to the doctor was important and provided security for Jim. "If you call them you're gonna hear from somebody. That makes me feel good and secure." Merle was a supporter of telehealth because of the security he felt having someone available to him when he telephoned. It appeared to be important to him that "they are there for you and answer the phone just because you made a call." John stated he uses his CC, "when I get in trouble, if I need something, she can get connected with my doctor and I can't, so I go through her." Mark's story was special, and may demonstrate the impact telehealth has had on his home situation. Mark felt that his CC and the telehealth program "was a godsend" as his wife was planning to retire in order to spend more time at home caring for Mark. Because he enrolled in telehealth and received the adaptive equipment he needed to increase his safety at home, his wife no longer feels retirement is necessary at this time.

Technology

Connection. All of our veteran interviewees viewed their home-based technology as a connection to the VA and their CC office. Our only female veteran interviewee, Mary, uses the smartphone for remote monitoring to LAMP. Mary reports that anytime "I punch in do we need to contact you, LAMP calls, if not two hours later, then the next day." In fact, she reports that even when she doesn't specifically state that she needs someone to contact her or contact her doctor, they do. Mary uses LAMP and the CC services for all her VA needs, "I don't call anybody but LAMP." Merle felt that having the technology in his home, which connected him to the VA and his CC, "has been a great help for me because I wouldn't bother to call if I didn't have it. I wouldn't bother somebody and call them on the phone and say hey I fell today, what do you think I ought to do? But with the HB it asks you, and you're not going to lie about it, if you fell, you fell." James calls his connection with the VA through technology "a lifeline." For James, the security he has being connected directly to his PCP and the VA hospital is one of the most important aspects of telehealth. "That piece of equipment is a big piece of security, I have a lot less stress and a lot less worry."

Convenience. Eighty-one percent of our technology users felt the equipment was easy to use and was not viewed as intrusive. Mitchell states, "It's a pleasure doing it because I have a lot of fun on the computer." Mitchell found that he could use the computer to type in a request or a question and he receives a quick response so he does not need to wait or refer to another office to find the answer.

One important component of telehealth is increased access to services. For our veteran interviewees, many of whom live in rural areas, limiting the drive to the hospital appeared to be an important aspect of the technology. It "helps more than driving all the way to Gainesville and have them say, well you look okay." Jack reports that it's decreased his travel time to Gainesville because of the quick follow-up for an intervention, "That way I don't have to make three trips to the VA you know; I have somebody to communicate with without getting dressed and going to the doctors again." Mick agrees and views his technology connection with the telehealth program as replacing a visit to the VA. Mick is homebound and states, "instead of calling and making an appointment and going in and seeing somebody and having them go through a lot of paperwork and so on, this does it." John also reports that his technology has "saved me trips to Lake City."

Jack feels the technology is beneficial because all he needs to do is input his information everyday and if his CC deems that something needs corrected, "they can do it and call me and tell me what to do; so it's convenient for me." Milton was initially given a computer for remote monitoring, but was having difficulty learning to use the computer and, therefore, was not submitting his personalized dialogue form daily. Milton transitioned to a HB and states, "I think it's great because I don't like the computer, and this thing here I can sit and pump that while I'm eating. It's easier and doesn't take as much time." Mick likes using the computer for his personalized daily dialogue with his CC because of the quick response, "I just leave a little note and someone sees it right there and gets back to me; they're usually very quick at responding."

Daily routine. Interestingly, 8 of our veterans (50 percent) described their part in providing answers to the HB or the computer as their personal role. Reportedly they felt guilty if it was not completed; it appeared to be a part of their daily routine. Although Jeff reported that he "hates doing it every morning." He also stated "it keeps me I guess more alert on what I'm doing." Requiring daily completion of his HB dialogue increased his self-awareness; he reported that it "helps you watch your sugar better knowing you gotta do it; it keeps you doing that." Jessie reports that, "I do it every morning, that's the first thing." Mark has integrated his computerized responses into his morning routine. Mark reports, "

> I think it's great. I get up in the mornings and do my breakfast, and of course it depends on if it's a day to do my blood sugar, then I do that, then I have breakfast, then after I have my breakfast and settle down a little bit then I do my blood pressure and then I go in and run it off. Usually I try to get it to them by 11:00.

Martin stated that there's no pattern to when he answers his HB, "I might answer it at one, two o'clock in the afternoon, some nights I lay in bed and reach over and get it and do it then". But Martin also stated that the daily reminders to take his medication, blood pressure and weight were important. Milton has memory difficulties, and views his HB as a difference in life/death. He reports, "If it was up to me, hell, I'd forget to call you. I would, I would just ignore it and probably die from it."

Education. The HB provides education to the veteran through a branching system that responds to their input. Should a veteran report that his blood pressure is high, the HB responds, tells the veteran he is outside of his parameters, explains the physiologic process of blood pressure, and provides reasons why his blood pressure may be high. Eighty-eight percent of our HB users found the education provided by the HB to be beneficial. Joe states that he's, "written things down what they look for to be a good read out on my vitals" and reports that this is important for him; he clearly follows these parameters. Jim states that he's, "learned you know about the walls of the blood vessels whatever. It explains a lot of stuff that the doctor don't explain to you." Jesse reports that the education he receives from the HB is "a big help to me." In fact, Jesse states that he now knows more about his health and knows "what to expect that's coming up" if his blood pressure is high. Merle is "fascinated" by the information he receives from the HB; "this is information I wouldn't have and it fascinates me that when I put something in like, like you said my blood pressure for instance, I mean it automatically comes back and tells me about my blood pressure, telling me what it amounts to and it gives me information that I wouldn't otherwise have. I'm fascinated that that little box can send so much information back to you and its all on the basis of what you put in there, the answers that you give it." Mark states that he learns something everyday from the HB, especially regarding his diet, and "even the flu".

Some of the veterans were indifferent regarding the education provided through the HB. Mike stated, "it might contribute some but if there's a major concern I don't think so." Martin stated that the HB didn't give him any information that he didn't already know, but stated, "I just don't follow it."

Veterans who are using a computer, smartphone or videophone are not directly provided with this type of information, yet these veterans felt it wasn't a concern as they usually received the information they needed directly from their CC or their PCP. Mitchell initially used a smartphone and was recently transitioned to the computer. He felt that he had learned some things from his CC that he wasn't aware of prior to being enrolled in the program, "there's just no way about it, it has helped me tremendously."

Frustration. Half of our veteran interviewees voiced some type of frustration with the technology. The HB requires that you answer questions daily, but provides only one-way communication. Joe states that, "I get a little frustrated with the Health Buddy and, let's see how I can say this, I feel frustrated because I can't talk to anybody."

Jeff was disturbed because he felt like he had taken the time each morning to input information into the HB, yet if he calls his CC office, they ask him the same questions, "they'll ask me what was my sugar yesterday, well I just gave it to them, they got it on the computer, why do they gotta ask me, you know?" Jack reports that due to the repetition of the questions, and some of the responses given by the HB "they must think we don't have any smarts at all." Jack reports that when he doesn't feel very well, "it just irritates me sometimes." Additionally, it was noted that HB questions do not always apply to individuals and that having more individualized or specific questions would be preferable. One of our veterans reported he was having difficulty with the HB because of his visual impairment, "sometimes I have difficulty seeing and I can't read it." Martin was frustrated by the fact that he may put the wrong information into the HB, and has no way to back-up and correct it. He felt bad that his CC "calls me even if I make a mistake. I just can't go back so I can't fix it." John had recently transitioned from the HB to the videophone, which he finds more personable and prefers over the HB dialogue. He remarked that the HB asked him too many questions that were difficult for him to answer and had nothing to do with his condition. John remarked, "I don't like to answer stuff that I don't know nothing about. She asks about me, that's all she asks me about. I think it's wonderful cause I can talk direct to her instead of that buddy boy."

Personal security. Eighty-one percent (13) of the interviewees found security in the use of technology to connect them with their healthcare provider. Joe felt that the HB provided him a sense of well-being. When asked about the technology, Joe responded, "I do feel a certain amount of help with that thing just sitting there. I think it's wonderful. It gives me a sense of security." Although Jeff reports that he doesn't know how well the HB is working "on their end", he states that he "likes it" and "I feel more secure having it." Mary feels secure because she knows, "if we call, they will take care of it." Mitchell uses the smartphone and finds that it provides him security when he's away from home, "I'm not afraid to go out by myself anymore. If an emergency comes up, I can call even after hours." For Mitchell, the connection with the VA "makes me feel more secure", because he has a place to go and get the information or assistance he needs. Mack's wife works and he's home alone all day; he feels the HB is "there to keep tabs on me." Mack knows that if he answers the HB in a way which creates a flag that his CC will "call me up right away, she calls me and asks what's going on." Mack also knows there is always a voice on the other end of the phone if he needs to call. Mack stated he called his CC one day because, "I just felt I needed to talk to somebody, not that I needed anything, just to call her up. But she didn't say I can't talk to you, I'm busy, she wouldn't do that."

Adaptive equipment

Personal security. By nature of the enrollment criteria for the telerehabilitation program, LAMP enrollees are more functionally impaired. LAMP's goals are to provide the adaptive equipment and monitoring to increase independence and safety within the home environment. Therefore, discussions about adaptive equipment were more relevant to LAMP interviewees. All of the LAMP interviewees (9) voiced the need and importance of having a rehabilitation component to their telehealth program. Mark received equipment specific to mobility, bathing and toileting and reports that, "the fact that LAMP is doing what it's doing is keeping a lot of us out of nursing homes." He reports that he's able to go places he never could go before with his scooter. This is also true for Martin, who suffered a stroke and has basically been homebound until enrolling in his telehealth program. Martin reports that he's able to get outside "everyday in the morning or afternoon" because he received a ramp from the VA, which was initiated through LAMP. For Mitchell, adaptive equipment is a major element of telehealth. Mitchell received equipment for mobility and transferring (rollator, grab bars), for dressing, and a reacher to help him "pick things up off the floor." He reports that the adaptive equipment he received “amazes me” and “has helped me so much.” Merle is enrolled in the telerehabilitation program, and spoke about the home evaluation.

> They [LAMP] checked everything out as far as my mobility to get in and out of the house and everything. They went to the bathroom to check and see what the situation was there as far as any assistance that I would need and in turn they pretty well covered from one end of the house to the other plus the outside even, and in turn they provided me with everything that I needed to make everything more accessible for me. I mean this, at the time I weighed over 300 pounds and there’s no way that my wife could do much to help me, so like I said if it wasn’t for that I couldn’t have gotten around.

Falls are a major concern and one of the focuses of LAMP. When discussing the adaptive equipment that Martin received, he stated that he uses it every day, and that “I haven’t falled in a long time, I can just reach up and grab those bars and they stop me from falling.” Mike reports that his equipment has “been very helpful”, and that he’s only fallen once in many months which was due to exhaustion from a recent trip to South Florida. Mack has muscular dystrophy and many of his difficulties focus on mobility and access within and outside of his home environment. CCs for Mack assisted in his obtaining a ramp, which Mack feels is the “most important” piece of equipment he received. Mack was evaluated for and received other mobility equipment such as a hoyer lift, walker, and chair lift. Milton has a history of falls, but after the provision of adaptive equipment, he states he “feels safer in the bathroom.” Mary received numerous pieces of adaptive equipment focusing on mobility and transferring (rollator, quad cane), bed mobility (bed cane), and safety in the bathroom (grab bars, toilet riser and safety frame, bathtub assist, shower chair, hand-held shower), and reports that the adaptive equipment provided to her has been, “a life saver, an absolute life saver.”

No TCCP interviewees received any adaptive equipment as a result of being enrolled in their telehealth program, but had received some equipment from the VA.

Equipment most often provided was rollators and scooters . When asked about additional needs, five of the seven TCCP interviewees responded that they did not need any additional equipment. During my conversation with Jessie, he reported that he, "couldn't get up and down in the bathroom. I don't have a shower chair, but I need one. I'm afraid I'll fall trying to bathe my legs to reach my feet." Both Jessie and Jack appeared unaware that their CC could assist them with the provision of adaptive equipment to increase safety.

Satisfaction with telehealth

During the interview process, satisfaction was not directly defined for interviewees. In general, they were asked whether they were satisfied with the services they've received from the VA and their respective telehealth program. Beyond any frustration with the technology, or lack of follow-up from the care coordination office, when questioned whether they were satisfied with the services they have received as a part of their telehealth program, all of our veteran interviewees stated they were satisfied. Joe says, "thank God I have them, and they have helped me so many times, so I'm 100 percent satisfied, anything I can do to keep them operating I certainly would like to do." Jim remarked that the telehealth program was "fantastic as far as I'm concerned; I think everybody should have one, period." Mitchell replied, "I never knew what it was but once I've got it I can't do without it." Martin stated that it's, "been beneficial, I can't think of a thing that would be detrimental. I got a wheelchair in there, I got all the things here, that table I use all day long, and this hemi walker is ideal, and the reacher. I'm very well satisfied with everything they've done."

Telehealth is viewed as a system of care; our veterans view it as providing them better care. Mark stated, "I think that care coordinators and nurse practitioners are one of the greatest things that happened to the VA." Martin stated that, "I'm very well satisfied with it and I hope they work forever." Merle responded, "the VA is a huge operation and it would take me a half a dozen phone calls to try to find something and sometimes I still wouldn't find it. I don't have to do that, I call my CC and my CC handles it for me. It sure does make it nice." Mark was "over-satisfied" with being a part of a telehealth program and felt, "it's about the best thing the VA has ever done." Milton reported that, "I wouldn't get any respect if it wasn't for LAMP." John completed his interview by stating that, "The main thing is that I'm satisfied with that and with the service I get at the VA, the whole works." Mary summed up telehealth for most of our veteran interviewees, "It works, it works."

Table 5-3 presents the coding structure and the final coding results based on personal in-home interviews with 16 telehealth participants.

Table 5-3. Coding results from qualitative interviewees

Primary Theme/Code	Secondary Theme/Subcode	Percent
Care Coordination	Connectedness	81%
	Lack of Connectedness	19%
	Education	75%
	Personal Security	88%
Technology	Connection	100%
	Convenience	81%
	Daily Routine	50%
	Education	88%
	Frustration	50%
	Security	81%
Adaptive Equipment	Personal Security	100%
Satisfaction		100%

Reliability and validity

One method to measure reliability is to measure the percent of agreement between raters. This involves simply adding up the number of cases that were coded the same way by the two raters and dividing by the total number of cases. This was performed during the initial training process with the subcoders, whereby agreement reached between all coders was above 92 percent. The problem with a percent agreement approach, however, is that it does not account for the fact that raters are expected to agree with each other a certain percentage of the time simply based on chance (Cohen, 1988). In our study, it may also be based on the fact that all coders were involved with telehealth at the VHA in one way or another. In order to circumvent this shortfall, reliability was calculated by using Cohen's Kappa, which approaches 1 as coding is perfectly reliable and 0 when there is no agreement other than what would be expected by chance. All interviews were coded by the principal investigator (PI); a percentage of the full sample (62 percent) was coded by each of the subcoders. The sample used for subcoder training was not included in the final sample. Following subcoder training, coding was performed independently and without guidance by the principal investigator. All reliability coders evaluated the same set of units. Kappa was determined by be .90 between subcoder 1 and the PI, .88 between subcoder 2 and the PI, and .84 between subcoder 1 and subcoder 2. Values of kappa above 80 percent represent excellent agreement (Cohen, 1988).

Member checking

Member checking for qualitative studies requires that the analysis be presented to the research subjects for feedback on validity of conclusions. Within 2 months following all in-home interviews, participants received a telephone call from the PI to discuss the interview and ensure that the information provided was valid and acceptable. One hundred percent of our interviewees (n=16) accepted the final results presented by the interviewer/PI. No interviewees felt the need to retract any statements or add additional information to their interviews.

Comparison with Quantitative Analysis

Qualitative and quantitative methods used together can be seen as complementary and mutually reinforcing (Creswell, 2003). Shapiro & Markoff (1997) assert that content analysis itself is only valid and meaningful to the extent that the results are related to other measures. The interviewees were compared with their general health information obtained through costs analysis and evaluation of SF-12V pre-post surveys. For this group alone (n=16), hospital bed days of care were reduced by 96 days at a total cost reduction of $89,936. The SF-12V scores for this group demonstrated no significant change within their one-year enrollment period. When LAMP interviewees are separated from the TCCP interviewees, the LAMP interviewees' SF-12V physical component scores (PCS) increased significantly from baseline to post-one year enrollment ($t_{(8)}$=-2.62, $p < .05$).

Discussion

Despite an increased interest in the use of technology for healthcare delivery, it is surprising that little empirical research has been conducted on the topic. Even more surprising is the limited amount of literature that describes the patient's perspective on the use of technology for delivery of healthcare. The primary goal of this portion of our study was to answer the research question, "How do veterans enrolled in a telehealth program describe their experiences with the VA healthcare system". The specific aim was to evaluate the effect of a telerehabilitation and a telehomecare intervention on health and satisfaction with VA services. Semi-structured interviews were used to obtain data on the thoughts and experiences of 7 veterans enrolled in TCCP and 9 veterans enrolled in LAMP. These interviews included discussions on how using technology to connect to their healthcare provider affected their health in general. Prospective data was obtained through one-time only, face-to-face interviews within the participant's home. An interview guide consisting of open-ended questions was used for all interviews.

Care coordinators emerged as a major theme in our interviews, most notably the connectedness with the VA that resulted from having a care coordinator available. Magnusson and Hanson (2003) also reported that a reciprocal relationship developed between telehealth patients and healthcare providers, which was viewed as essential to the project. The provision of a care coordinator, located in a VA central office available via a telephone call or an office visit, appeared to increase the sense of support and personal security patient's the interviewees experienced through telehealth. Care coordinator's provide the patient with a primary VA contact, are aware of their patient's needs, and are able to assist with their healthcare requests. Additionally, a number of articles regarding the use of telehealth technology have raised the concern about fear that technology would be considered impersonal and would replace face to face meetings with healthcare staff (Demiris et al., 2004; Hebert and Korabek, 2004; Frantz, 2003; Magnusson & Hanson, 2003). This was not a concern that arose in any of the personal interviews. Success appears to require the availability of a healthcare provider to respond to the data generated by the technology; this is an integral component of LAMP and TCCP.

Hebert and Korabek (2004) focused on the importance of "fit between type of service needed and the technology, rather than diagnosis or service type" [page 86].

Jennett and colleagues (2005) also found that technology should be efficient and appropriate to the patient's needs. In our study we found a number of veterans who were frustrated with the technology. One veteran had recently switched from a computer to the HB, and another from the HB to the videophone. Although care coordinators assess a patients needs prior to implementation, it may be important to spend more time targeting the technology to each patient rather than providing a general approach to implementation.

Although there were frustrations noted in using the technology, a majority of the interviewees viewed the technology, such as the HB or the computer, as a tool to help access information and support their everyday healthcare needs. Most veterans who participated in the telehealth programs explained that they were happy to use the technology because they saw the direct benefit to themselves. Additionally, because the technology was easy and quick to use, it was not considered a burden or an intrusion into their daily lives.

Education was a major theme that evolved from these personal interviews. The VA views telehealth as integral to the delivery of health education, as well as healthcare services. The HB provides daily reminders and education, which may increase patient compliance, as patients are more aware of their vital parameters (blood pressure, blood glucose levels, body weight and temperature) and able to become actively involved in the process of managing their care and treatment interventions. Each of the veterans interviewed who used the HB for remote monitoring reported that the information provided was important to them, although a few stated that they didn't always adhere to the information. Participants who were using the computer, videophone or smartphone did not receive education directly from the technology, but found the education provided by their CC to be more individualized, and met their educational needs.

Another main objective of telehealth is to remove the barriers of distance, time and travel from healthcare. Dhurjaty (2004) reported that patients view telehealth positively, especially because of the reduction in travel time and associated costs. Eighty-one percent of our veteran interviewees remarked how convenient and beneficial it was to have a CC and the technology in their homes, as it often saved them from driving to the VA hospital for their healthcare needs. Moreover, responses are typically quick and address health concerns in a timely and efficient manner.

Limitations. There are typically inherent biases in qualitative research, particularly in interviewing (Murphy et al., 1998). We have dealt with a number of threats to validity of interviews through member checking and the use of additional subcoders. As well, the interview process may be criticized based on the fact that an individual's answer to a question is highly dependent on the context in which they are presented. In this study, all personal interviews were held in the interviewee's home, which provided a more comfortable and natural context. The home was felt to be an appropriate environment for answering questions regarding telehealth since the interviewees are using the technology and involved with telehealth applications within their homes.

Moreover, possible flaws may be present in the process of content analysis that could diminish its value. Such flaws include faulty definitions of categories or categories that are too restrictive or too far-reaching. Yet, when used properly content analysis is a powerful data reduction technique. Its major benefit is the fact that it is a systematic, replicable technique for compressing text into content categories based on rules of coding. To enhance the efficacy and reliability of the analysis, member checking was carried out with each of the interviewees, and subcoders provided validity to the findings.

Care coordinators from LAMP and TCCP provided a list of possible interviewees for the researcher to contact. As our sample was not randomly selected, selection bias may be present. Although we felt it was important to take cases from where we could learn the most, it may be that the list of interviewees provided would be more apt to report positive comments. Of the 11 potential TCCP participants, 3 never returned telephone calls and 1 was hospitalized in ICU when initially contacted. The researcher was told to contact him again in a few months, but this did not occur because of numerous issues within the VA that began to limit direct contact with veterans and personal interviews. The LAMP care coordinator provided a list of 12 possible participants. Upon telephone contact, 1 potential interviewee withdrew his consent and declined to be interviewed because of health issues, and the remaining 2 LAMP enrollees asked to be contacted at a much later time for a possible interview.

These qualitative interviews have provided essential information and are deemed an important component to the evaluation of LAMP and TCCP. The generalizability of our research findings to a larger population is not the intention of our study. Rather, the aim of this study is to provide additional information on telehealth as a healthcare delivery model using a sample from two telehealth programs and qualitative methods.

CHAPTER 6
DISCUSSION

Telehealth offers opportunities and challenges to the traditional practice of medicine and to the organization of healthcare. Advances in technology and data transmission networks make the delivery of healthcare to the home feasible and accepted, but not without continued efforts and possible economic costs. Along with studies examining the efficacy of telehealth applications, additional studies of the cost-effectiveness and impact on the patient are needed.

The clinical effectiveness and educational benefits of telehealth have been acknowledged in the literature (Bynum et al., 2003; Finkelstein et al., 2006; Grigsby & Sanders, 1998; P. A. Jennett et al., 2004; Kobb et al., 2003; Noel et al., 2004; Taylor, 1998). Yet, controversy continues regarding measuring the costs of these efforts (Bashshur, 2001; Hakansson & Gavelin, 2000; Ohinmaa & Hailey, 2002; Whitten, Kingsley, & Grigsby, 2000). The main challenges to the economic evaluation of telehealth continue to include new and constantly changing technology, limited large scale randomized controlled trials, and the ability to accurately evaluate health and non-health outcomes. Further complications arise when healthcare costs and the benefit to the patient or the healthcare provider are considered together (Agha, Schapira, & Maker, 2002; Bashshur, 2001; Hakansson & Gavelin, 2000; Ohinmaa & Hailey, 2002). Despite these challenges, studies measuring the cost-effectiveness and patient perspectives of telehealth applications compared with standard medical practices are needed.

The purpose of this mixed methods study was to obtain quantitative results from a sample of veterans enrolled in a telerehabilitation program and a telehomecare program, and follow-up with personal interviews to explore the patient's perspective on telehealth. The Low Activities of Daily Living Monitoring Program (LAMP) is a telerehabilitation program that included veterans with functional deficits and chronic illnesses who were at risk for multiple VA hospital and nursing home bed days of care (BDOC). Veterans were eligible for enrollment in LAMP if they presented with impairments in at least two activities of daily living (ADLs), including mobility and transferring. Veterans enrolled had to live at home, have electricity and phone service, and accept remote monitoring technology into their homes. The LAMP model draws on the experience of occupational therapists to coordinate care through remote monitoring in conjunction with environmental modifications and assistive devices to improve function and decrease the impact of chronic illnesses. The Technology Care Coordination Program (TCCP) is a telehomecare program that included veterans with chronic illnesses, who were at risk for multiple VA inpatient and outpatient visits. Veterans were eligible for enrollment in TCCP if they were non-institutionalized, had a history of high healthcare costs and utilization, had electricity and phone service, and accepted remote monitoring technology into their homes. The TCCP model uses telehealth technology in conjunction with nurse practitioners to coordinate medical care for chronically ill veterans.

Cost Analysis

Using retrospective data from veterans enrolled for at least one year in TCCP or LAMP, this longitudinal study examined healthcare costs 12-months pre and 12-months post-intervention. Healthcare costs included expenditures for hospital, clinic, emergency room, and nursing home BDOC, and were summed for these analyses. Matched comparison groups were obtained from a database of veterans who participated in the Veterans Administration's 1999 Large Health Study (LHS), which surveyed over one million veterans on their health and well-being. Using the LHS cohort allowed us to compare the telehealth participants with veterans who were instrumental in establishing baseline health status data for all veterans. Comparison groups were matched on geographic location, age, marital status, chronic illnesses, and number of hospital BDOC 12-months pre-study period. Matching was accomplished by creating a dummy string variable for every participant, whereby the elements of the character string represented the matching variables. Using the dummy string variable, 76 percent of LAMP and 68 percent of TCCP had direct matches with a patient from the comparison pool; the remaining were matched manually on age and pre-BDOC and as many of the diagnostic variables as possible. Following matching, analyses determined no significant differences between LAMP and their matched comparison group or TCCP and their matched comparison group.

Both treatment and comparison groups received their healthcare from the North Florida/South Georgia VA Healthcare System. All groups were enrolled and using services in the VA for the entire 24-month observation. Actual telehealth enrollment dates were used for our treatment groups to determine pre-post costs. An arbitrary enrollment date of October 1, 2003 was used for the comparison groups to determine pre-post healthcare expenditures.

Although selection criteria were stringent for matching of the comparison groups, a difference-in-differences (DiD) approach was used in the cost analysis to allow for the control of any remaining differences, which may result in selection bias and influence the treatment effect. The DiD method has been used in health services research (Tai-Seale et al., 2001; T. H. Wagner et al., 2001), as well as in telehealth studies (T. E. Barnett et al., 2006; Chumbler et al., 2005). Using the DiD approach and actual costs summed for these analyses, we were unable to detect significance between LAMP and their matched comparison group, TCCP and their matched comparison group, or between the two treatment groups, LAMP and TCCP. The point estimate of the DiD treatment effect was extremely large relative to the mean costs, therefore the inability to detect significance was a result of the high variability of the estimate.

Itemized costs revealed that LAMP participants experienced a considerable increase in clinic visits post-intervention. Although inpatient costs were reduced, including both inpatient BDOC and nursing home BDOC, the increase in clinic costs increased LAMP's overall post-enrollment costs. For LAMP participants, the initial enrollment evaluation and home assessment, adaptive equipment provided for self-care and safety, and remote monitoring interventions were considered clinic visits. Approximately 3,300 clinic visits were the direct product of enrollment in LAMP. A primary goal of this telerehabilitation program was to keep veterans out of the hospital and nursing home and at home safe. For the LAMP cohort, this goal was met. An outcome of meeting this goal was increased outpatient visits, which benefited many more veterans. During the 12-months following enrollment for TCCP participants, the number of hospital BDOC decreased, but total inpatient costs (hospital and NHCU) increased slightly post-enrollment. As with LAMP, TCCP's primary goal of remotely monitoring health symptoms and providing increased access to care resulted in a significant increase in clinic visits. The combined effect of higher costs per BDOC and additional clinic visits negatively effected TCCP's post-enrollment costs. An important factor to consider is that telehealth's primary focus is to increase access to care. Consequently, much of the increase in clinic visits was a result of enrollment in a telehealth program, as the increase in clinic visits included services provided by the intervention. Moreover, increases in care coordinator-initiated clinic visits, such as primary and geriatric care, lab and diagnostic visits, and secondary clinic visits such as ophthalmology or audiology are evident, and have been observed in other VA home telehealth studies (Chumbler et al., 2005; Kobb et al., 2003). In comparison, clinic visits for both matched cohorts decreased in the post-study period, demonstrating that when treatment declines, costs decline. Longer observation times would allow us to weigh the impact of this decline in care against the impact of the increase in care provided by the telehealth programs.

A phenomenon that was observed in this study was the significant decrease in hospital costs for both of the comparison groups. This phenomenon may be the result of regression to the mean, which can occur with a nonrandomized sample and two measures that are weakly correlated (T. E. Barnett et al., 2006; Yudkin & Stratton, 1996), such as pre and post-healthcare costs. Our comparison groups were closely matched with our treatment groups and demonstrated high levels of healthcare use at baseline. In regression to the mean, change is often negatively correlated with higher values. This may be why we observe a significant decline in hospitalizations post-study period. While the regression effect complicated this study, we attempted to control for it statistically through the DiD design. Unfortunately, the uses of costs in the design, which were highly variable within and between our study populations, resulted in a high error rate for our regression analyses. The observed decrease in inpatient costs may also be explained by a system-wide secular trend within VA hospitals to decrease inpatient length of stay (BDOC) and transition to more ambulatory care (Payne et al., 2005; Phibbs, Bhandari, Yu, & Barnett, 2003; Yu et al., 2003a). The ability to observe patients over a longer period of time may provide more accurate effects of treatment vs. non-treatment.

This segment of the dissertation attempted to quantify the effect of telerehabilitation and telehomecare in reducing healthcare costs. The analyses observed veterans enrolled in LAMP, veterans enrolled in TCCP, and corresponding matched comparison groups who had never received a telehealth intervention. The hypothesis for this study was that veterans enrolled in LAMP, veterans enrolled in TCCP, and their matched comparison group will differ in their VA healthcare costs. Based on results from the DiD analyses using summed healthcare costs, we reject the hypothesis that our four study arms will differ in VA healthcare costs following one-year enrollment in a telehealth program. Although we were unable to detect significance, the high variability of the estimate reduced the ability to observe a treatment effect. The multivariate analysis determined a large variance of errors in each of the regression equations, therefore, numerous unknown or unidentified factors may account for the remaining variance in the models. Future studies should consider using larger sample sizes or logged costs to reduce the variance in the models.

Health-Related Quality of Life

The second hypothesis in this study was that veterans enrolled in LAMP would demonstrate less decline in physical functioning over 12 months of intervention due to the framework of the telerehabilitation program. The Veteran's version of the SF-12 health survey (SF-12V) was used to measure self-reported physical outcomes. The SF-12V is a subset of identical items from the Veteran's version of the SF-36 (SF-36V), and is a patient-based health-related quality of life questionnaire (HRQoL) designed specifically for use among veterans (Kazis et al., 1998; Resnick & Nahm, 2001; Riddle et al., 2001; Ware et al., 1996). The SF-12V provides a physical component summary score (PCS-12V) and mental component summary score (MCS-12V), but physical outcomes were the primary focus of this study. The SF-12V PCS scores include questions concerning one's ability to participate in daily physical activities, such as climbing stairs, how energetic or vital one fees, as well how their physical abilities affect their social and work roles. Measurements were administered to LAMP and TCCP enrollees at baseline during the initial enrollment and at 12-months follow-up. The analysis focused on differences in health status between the two programs from baseline to post 12-months enrollment based on results from the SF-12V.

Forty-three percent of LAMP enrollees (n=50) and 63 percent of TCCP enrollees (n=84) completed the SF-12V health survey at baseline and 12-months. Based on results from the LAMP and TCCP cohorts, the veteran enrollees served by these telehealth programs report significantly worse health in the physical domain (PCS) than that of the general population, as well as the overall veteran enrollee population (Kazis et al., 1999b; OQP, 2000). The SF-12V PCS scores for our veteran telehealth participants fell at least 2 standard deviations below the mean of the general population and 1 standard deviation below the mean of the veteran population.

Dependent samples *t*-tests demonstrate significant increases reported in SF-12V PCS scores for the LAMP participants from baseline to 12-month follow-up, with no significant differences observed in the TCCP cohort. In an attempt to determine whether the increase in PCS-12 scores for LAMP were clinically relevant, the standard error of measurement (SEM) (Wolinsky et al., 1998; Wyrwich et al., 1999b) as well as the effect size (Cohen, 1988) was estimated. To date, SEM-based criterion for clinically relevant HRQoL change, specifically the SF-36 or SF-12, has not been established (Samsa et al., 1999; Ware, Jr. & Gandek, 1998). Using the threshold of 2 SEMs to demonstrate clinical significance (McHorney & Tarlov, 1995), the increase in PCS-12V scores from baseline to 12-month on our LAMP population (+4.25) falls within of the 95% range (2 SEM = 4.38), and therefore does not represent a clinically significant change. If 1 SEM were used to determine clinically significant change, as some researchers suggest (Wyrwich et al., 1999b; Wyrwich & Wolinsky, 2000), then the increase in LAMP SF-12V PCS may be considered clinically significant. Some researchers report that the SEM alone does not indicate clinical significance and that any post-intervention score must fall within the normal range (Ferguson et al., 2002). LAMP participants do not meet this criterion as pre and post PCS scores fall at least 2 SD below the general norms and approximately 1 SD below the general veteran norms. When evaluating effect size in both LAMP and TCCP PCS-12V scores from baseline to one-year follow-up, the LAMP population had an effect size that was considered small to moderate by Cohen's definition (.425). Unfortunately, we do not have power to justify this effect, as our sample size was 50 subjects and 100 subjects would be required for an effect size of .425 with power at .80.

Comparisons between LAMP and TCCP were computed through a one-way ANOVA. A significant difference was found between the two groups at baseline, with LAMP participants reporting lower physical functioning at baseline than TCCP participants. As LAMP participants are, by nature of enrollment in the program, more functionally impaired, this is not a surprising finding. Yet, following the 12-month intervention, the significant difference in SF-12V PCS scores between the two groups was no longer visible, as LAMP scores increased significantly and TCCP scores declined, although not significantly, during the 12 months of treatment.

A post-hoc analysis was performed in an attempt to increase the power of this study. Missing data for LAMP and TCCP were examined to determine if there were significant differences between their corresponding samples at baseline or 12-month follow-up. In the LAMP cohort, 43 veterans completed the SF-12V at baseline only, and 11 completed the survey at 12-months only. In the TCCP cohort, 26 participants completed the SF-12V at baseline only. These groups were matched with the parallel baseline and 12-month data. There were no significant differences noted in the SF-12V PCS baseline or 12-month scores, allowing us to conclude that the missing data would not have altered the final outcome.

Health surveys, such as the SF-12V, can provide information on quality of care and clinical effectiveness. Results from the SF-12V demonstrate that this population is skewed toward illness. Moreover, it is important to note that because this is a frail, chronically ill population, decline would be expected especially over a 12 month time period. Yet based on the SF-12V PCS scores, physical functioning increased significantly for the telerehabilitation participants, demonstrating that the addition of a rehabilitation component, which focused on independence and safety within the home environment, is beneficial. The TCCP participants were able to at least maintain their scores over time. For this population, remaining stable is also important and may be seen as a positive outcome of the telehealth intervention. Although results from this study are noteworthy, we are limited without evidence from a matched comparison group or further long-term follow-up study.

Personal Interviews

In the third study aim, qualitative interviews were used to probe patient's perspectives of telehealth and the use of technology for remote monitoring and healthcare delivery. The primary goal of this portion of the dissertation was to answer the research question, "How do veterans enrolled in a telehealth program describe their experiences with the VA healthcare system." The specific aim was to evaluate veteran's personal feelings about being enrolled in LAMP or TCCP, and how telehealth impacts their health and satisfaction with VA services. Single, face-to-face, semi-structured interviews were used to obtain information from 9 veterans enrolled in LAMP and 7 veterans enrolled in TCCP.

Based on these personal interviews, a majority of veterans reported an increased sense of connectedness with the VA following enrollment in telehealth, and viewed their care coordinators as integral to the success of telehealth. In contrast, a few of the interviewees felt frustrated because of the lack of attention and limited follow-up they received from their CC. Interviewees considered the technology, such as the Health Buddy or the computer, a tool to help access information and support their everyday healthcare needs. Most veterans who participated in the telehealth programs explained that the technology was beneficial and easy to use, although frustration with the HB was voiced by 50 percent of our interviewees. The HB only provides one-way communication, and questions are repetitive and not individualized to each person's healthcare concerns. Other themes that arose during the personal interviews included the importance of health-related education. Interviewees reported that daily reminders and education received through the technology or directly from the care coordinators improved their ability to self-manage their illnesses. Many of our veteran interviewees remarked how secure they felt having a care coordinator and the technology in their homes. Telehealth was also viewed as increasing access to timely and efficient care. Veterans reported they were more aware of their vital parameters (blood pressure, blood glucose levels, body weight and temperature) and able to more actively involve themselves in managing their care and treatment interventions. As one of the veterans explained, “it’s a loop between the piece of equipment, my CC, my physician and then back to me.”

Specific to LAMP enrollees was the provision of adaptive equipment and environmental modifications for self-care and safety. All of the LAMP interviewees voiced the need and importance of having a rehabilitation component to their telehealth program and appreciated the adaptive equipment provided.

One hundred percent of our interviewees reported that they liked being involved in telehealth and were satisfied with the services they receive through the VA and telehealth.

Summary

The complex health problems of our veterans require complex medical and restorative regimes. The demands associated with the care of individuals with chronic illnesses and disabilities pose a considerable challenge. Chronically ill and aging veterans often require multiple hospital admissions, as well as numerous clinic and urgent care visits. Moreover, costly long-term care provided through nursing home and home healthcare is often necessary. It has been proposed that these costs would begin to decrease if interventions were focused on delivery of medical and rehabilitative care to help elderly live at home safely and independently. Health promotion in older adults should include prevention of disability, maintenance of capacity in those with frailties and disabilities, and enhancement of quality of life (CDC, 2003b). In order to accomplish this, better methods to deliver care and monitor health outcomes related to older adults functioning and quality of life are essential.

The VA has acknowledged through the wide use of telehealth that the development of programs that provide coordination of complex care remotely and extend healthcare services into the home to assist veterans in managing their chronic diseases is essential. Telehealth interventions through the VA are not only designed to reduce costs, but to increase service connection and access to care for veterans and decrease reliance on hospital and nursing home care. Increased patient satisfaction with healthcare is also an important aspect of telehealth. Creative models of care, such as telehealth, can support veterans in acquiring self-management skills and maximizing health potential and outcomes (Nodhturft et al., 2000).

This study targeted community-dwelling veterans with chronic illnesses. Two models of care delivery were explored. TCCP is a telehomecare program, which employs a medical model of care. Care coordinators for TCCP are nurses skilled in the management of chronic illnesses through diagnosis, medical intervention and patient education. Interventions provided through TCCP are typically disease-specific and focus on the monitoring of physiologic parameters. The medical model of care places emphasis on diagnosing and successfully treating a disease, with functioning and health viewed primarily as a consequence of a disease. In comparison, the telerehabilitation model (LAMP) views function as not only an outcome, but also an important component of assessment, intervention, and quality of care (Cieza & Stucki, 2005). Therefore, the severity of an illness can be reduced through the provision of environmental modifications and adaptive devices that remove the limitations that alter functioning. LAMP care coordinators are occupational therapists that focus on the patient's functional difficulties, which represent a major threat to the quality of life in older adults and, therefore, should be addressed concomitantly with disease treatment. LAMP uses the rehabilitation model to coordinate care for chronically ill individuals through assessing personal and environmental factors in order to provide the appropriate technology for remote monitoring, as well as modifying the immediate home environment through the addition of adaptive equipment. From the LAMP perspective, provision of resources and remote monitoring of health, self-care and safety within the home environment assists patients to cope with the impact of their chronic illness.

This study illustrates that telehealth applications do not decrease overall healthcare costs, but may change the configuration of care. For our telehealth participants, costly hospitalizations declined, but clinic visits increased significantly as patients became more aware and compliant with their healthcare treatment plans. Newly scheduled clinic visits enabled more veterans to be treated in an appropriate and timely manner. Clinic visits became an alternative level of care, and the home the alternative place of care. Although we hypothesized cost savings, due to the complex chronic illnesses of our veteran enrollees, frequent follow-up clinic visits were scheduled to ensure there was no decline in condition or to check on progress of an intervention or treatment. Due to these safeguards, clinic visits increased significantly in the telehealth group, increasing overall costs. The short intervention period of one-year may have limited our ability to demonstrate cost savings. Clinic visits have been noted to decline within the second year of a telehealth intervention (T.E. Barnett et al., 2006). Jennett and colleagues (2005) report that institutions should not expect short-term results in cost savings, and should move away from cost-benefit analysis in telehealth to viewing telehealth as a long-term venture with patient utilization considered as success. Success may also be measured by the increase in clinic visits, as patients are receiving access to the intense care their chronic illnesses require.

This study indicates the feasibility of delivering healthcare and rehabilitative services through a telehealth model. Care coordination, combined with technology, allows for the provision of complex care regimens remotely. This is not meant to replace the relationship with the primary care provider, but to extend it into the home. In spite of some limitations, this study and others point to the potential of integrated systems to reduce hospital and nursing home utilization, while increasing satisfaction among patients.

Clearly, the evaluation of telehealth applications is challenging. Future research should consider using a randomized controlled trial design, following the intervention and comparison groups for more than 12 months, considering the impact of differential use of VA services, and collecting adequate information to identify care coordinator-initiated outpatient visits.

APPENDIX
INTERVIEW GUIDE FOR PARTICIPANTS

Below is an outline of topics or issues to be covered. The interviewer is free to vary the wording and order of the questions, keeping the tone of the interview fairly conversational and informal.

1. How did you learn about the LAMP / TCCP program?
2. How do you feel about the LAMP / TCCP program?
3. How has LAMP / TCCP helped you?
4. What do you think about the technology?
5. What do you think about the assistive devices?
6. Was the LAMP / TCCP program what you expected?
7. What do you like most / least about the LAMP / TCCP program?
8. What do you remember most about LAMP / TCCP?
9. What kinds of new information have you gotten from LAMP / TCCP?
10. Where do you go if you need assistance regarding the LAMP / TCCP program?
11. In general, are you satisfied with the services received from LAMP/TCCP?
12. Is there anything else you want to tell me about being in the LAMP / TCCP program?
13. Is there anything you can think of that would make the LAMP / TCCP program better?

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BIOGRAPHICAL SKETCH

Roxanna Bendixen is a doctoral candidate in the Rehabilitation Science Doctoral Program at the University of Florida. She earned her bachelors degree in Occupational Therapy (OT) in 1997. Her clinical experience is in the area of pediatrics, where she focused on OT services for infants, early intervention and young adults, especially in the area of assistive technology. She subsequently obtained her Masters in Health Science in 2001. She received the Lena Llorens Award for Academic Excellence in Research for her thesis on aging and gender differences for vestibular activities. During her doctoral studies, she worked as a research assistant for the Rehabilitation and Engineering Research Center for Successful Aging, National Older Drivers Research and Training Center, and the Rehabilitation Research and Training Center on Independent Living. She has published in *Topics in Geriatric Rehabilitation, Physical and Occupational Therapy in Geriatrics,* and *Clinical Reviews in Bone and Mineral Metabolism.* Her current research focuses on the promotion of independence and quality of life for older people with disabilities through the use of technology and assistive devices that can make daily tasks easier and safer. To augment her research, her dissertation focuses on the use of communications technology for remote monitoring of frail elders in their homes.