Telehealth Technologies for Heart Failure Disease Management in Rural Areas: An Integrative Research Review

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Abstract

Purpose: The purpose of this integrative research review (IRR) is to present evidence of the use and effectiveness of telehealth technologies for improving health outcomes in heart failure (HF) disease management in general as well as the use and effectiveness specific to rural populations. **Background**: HF is the most common chronic disease cause of hospitalization in the U.S. with subsequent high admission rates and cost. Because many rural areas are designated as medically underserved, disease management for patients with HF living in rural areas is challenging and in need of innovative management strategies. Telehealth technologies have capabilities to provide frequent surveillance and improve outcomes in a variety of health conditions. **Methods**: An IRR methodology was used to present evidence of the use and effectiveness of telehealth technologies in the provision of disease management to HF patients in both the general and rural populations.

Findings: Results showed five broad themes of effectiveness: improved knowledge, improved self-care behaviors, improved health outcomes, cost reduction and patient satisfaction. Telehealth technologies have proven effective in the management of HF patients by detecting changes in health status earlier, decreasing the rates of hospital readmission and emergency department visits, decreasing costs, and improving self-care behaviors and quality of care. **Conclusion**: Evidence from clinical trials supports the use of telehealth in disease management in general as well as future development of strategies for management of HF in rural populations.
Keywords: heart failure, telehealth, rural

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Congestive heart failure (HF) is a major chronic disease in the United States. According to the American Heart Association ([AHA], 2009) it is estimated that approximately 5.8 million Americans live with congestive heart failure (HF), leading to approximately 300,000 deaths each year. While HF management can be complex and challenging, there is added level of complexity for rural residents who are known to experience many barriers to health care access and disparities in health status.

The role of telehealth technologies in the delivery of health care, improving access and reducing disparities is gaining attention. The purpose of this integrative research review (IRR) is to present evidence of the use and effectiveness of telehealth technologies for improving health outcomes in HF disease management. With this purpose in mind, the research questions that guided this IRR are as follows: 1.) How have telehealth technologies been used in the management of heart failure patients (in general) and are they effective? 2.) How have telehealth technologies been used in the management of heart failure patients in rural populations and are

they effective? 3.) What are the future implications of telehealth technologies in the management of patients with heart failure in rural areas?

Background

Heart Failure

Heart failure is the most common disease diagnosis among hospitalized adults age 65 years and older. Furthermore, high readmission rates and prolonged length of stay due to HF have contributed to escalating use of resources and health care cost. The estimated cost of HF, direct and indirect, for 2007 in the US was $33.3 billion (AHA, 2009). Over the next decade it is projected that the number of US adults age 65 and older will double to 70 million. Growth of this magnitude will naturally lead to increases in the known risk factors for HF such as atrial fibrillation, sclerotic valvular heart disease, obesity, diabetes mellitus, and renal dysfunction (Lui, 2010). Clinical implications point toward a need for innovative and strategic responses, creating access to clinical treatment and prevention strategies for HF.

Rural Health Disparities

The National Healthcare Disparities Report (Agency for Healthcare Research and Quality [AHRQ], 2010) documents issues within both quality and access in healthcare. From this report it is clear that disparities in healthcare still exist and that many opportunities for improvement remain across racial, ethnic, socioeconomic and geographical groups. One priority population is in rural, medically underserved areas. It is well documented that residents of rural areas experience more health disparities than residents of urban areas (AHRQ, 2010; Bennett, Olatosi, & Probst, 2008; U.S. Department of Health and Human Services [USDHHS], 2007). Patients in rural areas are often challenged and must overcome many obstacles to healthcare access. Barriers

such as finances, sociocultural issues, structural features and geography are known to decrease access to healthcare services in rural environments leading to poor health outcomes (Bennett et al., 2008; USDHHS, 2007).

Rural areas are more likely than urban areas to have higher rates of uninsured and underinsured populations, higher rates of poverty, greater transportation barriers and limited care providers (USDHHS, 2007). Rural populations also experience higher rates of chronic disease and mortality. Rural residents are more likely to report deferred care due to cost and are less likely to have recommended preventative health screenings (USDHHS, 2007). It is well documented that poverty and lack of health care are intertwined; persons without resources cannot afford health services, and communities without resources have difficulty attracting and retaining health care providers. Inherent in rural environments is the obvious issues of distance and access to health care. Transportation also presents as a significant barrier to health care access for rural residents, the poor and other health disparate populations (Bennett et al., 2008; USDHHS, 2007). Furthermore, it is easy to see how rising gasoline prices can compounded this problem.

Telehealth

Telehealth uses communication methods to link patients with health care providers (Artinian, 2007; Bowles & Baugh, 2007). Telehealth technologies such as telephone, tele-videoconferencing, and Internet-based applications, have capabilities to provide frequent surveillance of a variety of health conditions (Dorrian et al., 2009; Spauling, Davis, & Patterson, 2008; Nesbitt, Cole, Pellegrino, & Keast, 2006; Givens & Elangovan, 2003; Glueckauf et al, 2002).

Telehealth has been used extensively for the management of diabetes (Dansky, Bowles, & Palmer, 2003; Davis et al., 2010) and to a lesser degree with other chronic conditions such as chronic obstructive pulmonary disease (COPD) (Horton, 2008), and HF (Chumbler, Mann, Wu, Schmid, & Kobb, 2004; Gardner, Frantz, & Pringle-Sprecht, 2001; Jenkins & McSweeney, 2001). The remote nature of rural environments is an excellent opportunity for the demonstration of the effectiveness of telehealth in disease management.

Rural Health Disparities, Heart Failure, and Telehealth

Current healthcare disparities noted in rural populations coupled with the burden of HF is one opportunity for the use of advanced technologies such as telehealth management systems. The development and application of telehealth interventions for the treatment and prevention of HF events in rural areas could be one link toward eliminating rural health disparities.

Heart failure is a widespread cardiovascular disease in the US (AHA, 2009). Coordination of care and telehealth are two areas critical for quality of life and improved health for individuals with chronic HF living in rural underserved areas. Only a small number of clinical trials have been published in the area of HF management using telehealth technologies in rural populations. A significant gap exists in the current knowledge of the effectiveness of HF management using telehealth interventions in rural populations. Integrating concepts of HF, rural and telehealth can provide a framework to guide the development of interventions in eliminating rural health disparities.

Methods

The overall goal of conducting any systematic research review (SRR) is to bring together studies that answer particular research questions (Brown, 2009). Integrative research reviews (IRR) are one type of SRR that are useful to expand understanding for a particular problem or

topic therefore generating knowledge. Integrative research review methodologies are systematic and use rigorous inclusion and exclusion criteria and repeated sequences to sort research until the highest quality of evidence is found. Narrative summaries of existing studies are used in IRR to draw conclusions that can guide decision making (Brown, 2009; LoBiondo-Wood & Haber, 2010). An IRR methodology was used to review past clinical trial research studies in which telehealth technologies were used to provide management to HF patients in both the general and rural populations. A database search of CINAHL, PubMed, MEDLINE, EBSCOhost, and ProQuest was conducted using the keyword integrations: "heart failure and telehealth" and "heart failure, rural and telehealth". The integrative search inclusion criteria was limited to clinical trial research articles or randomized controlled trials (RCT) in the English language published between January 2000 and April 2010. The RCT is considered to have a high level of rigor and therefore study results afford a high level of evidence to guide future practice (AHRQ, 2002). Only articles with the paired keywords were extracted for full review. This strategy resulted in 25 final articles for review; 14 articles were selected based on relevance. Articles reporting incomplete clinical research were excluded.

Results

Table 1 presents details of the literature search results: author, key words, purpose, sample, outcomes measured, and results. A total of 14 clinical trials were reviewed based on the inclusion and exclusion criteria and relevance (See Table 1)

Table 1
Clinical Trial Research Integrating Heart Failure, Rural and Telehealth

Author/ Year	Keywords	Purpose(s)	Sample	Outcomes	Results
Caldwell, Peters, and Dracup, (2005)	Heart failure, telehealth, rural	To determine whether a simplified education program focused on a single component of disease management (system recognition and management of fluid weight) could improve knowledge, patient-reported self-care behaviors, and HF severity in a rural setting.	36 rural HF patients	knowledge, self-care behaviors, and HF severity (B-natriuretic peptide [BNP]	Knowledge levels and self-reported self-care behaviors improved significantly (p = .01 and .03) and the changes in BNP at 3 months was in the hypothesized direction, yet the difference was not significant
Clark et al. (2007)	Heart failure, rural, telehealth	To determine adherence adaptation and acceptability to a national nurse-coordinated telephone monitoring CHF management strategy	60 elderly HF patients	adherence, adaptation & acceptability	Elderly CHF patients can adapt quickly, find telephone monitoring an acceptable part of their healthcare, and are able to maintain good adherence.
Dansky, Vasey, and Bowles (2008a)	Heart failure, telehealth	To determine the effects of telehomecare on hospitalizatio n, ED use, mortality, and	284 patients with HF	hospitalizatio n, ED use, mortality, and symptoms	On average, patients in the telehomecare groups had a lower probability of hospitalizations and ED visits than did patients in the control group. Differences were

Author/ Year	Keywords	Purpose(s)	Sample	Outcomes	Results
		symptoms related to sodium and fluid intake, medication use, and physical activity.			statistically significant at 60 days but not 120 days. Results show a greater reduction in symptoms for patients using telehomecare compared to control patients.
Dansky, Vasey, and Bowles (2008b)	Heart failure, telehealth	The use of telehealth facilitates patient confidence with subsequent effects on patients' ability to manage their treatment regimen more effectively.	284 home health patients with HF	Confidence	Confidence is a predictor of self-management behaviors. Patients using a video-based telehealth system showed the greatest gain in confidence levels with time. Findings suggest that confidence may be improved by involvement of nurses as part of a telehealth system.
Dansky and Vasey (2009)	Heart failure, telehealth	To determine if the use of a telehealth system after formal home health services would improve clinical outcomes and self-management behaviors.	108 patients with HF	Respiratory status, activities of daily living, hospitalizations, ED events	Patients who continued using telehealth beyond the formal episode of care showed greater improvement in respiratory status and activities of daily living. None of the patients who used telehealth during this stage had any hospitalizations or ED events, while 28.3% of the control group patients required hospitalization and 26.1% had at least one ED visit.
Finkelstein, Speedie, and Potthoff, (2006)	Heart failure, rural, telehealth	To evaluate patient outcomes, cost, and satisfaction with HHC delivered by telemedicine	53 patients with diagnosis of HF, COPD, chronic wound care	Transfer to higher level care, mortality, cost, & satisfaction	Discharge to higher level of care (hospital, nursing home) within 6 months of study participation was 42% for C subjects, 21% for V subjects, and 15% for M subjects. No

Author/ Year	Keywords	Purpose(s)	Sample	Outcomes	Results
		or traditional means for patients receiving skilled nursing care at home.			difference in mortality between groups. Average visit cost = $48.27 for face-to-face home visits, $22.11 for average virtual visits (video group), and $32.06 and $38.62 for average monitoring group visits for HF and COPD subjects, respectively. This study demonstrated that virtual visits for chronically ill patients at home can improve patient outcomes at lower cost.
LaFramboise,Todero, Zimmerman, and Agrawal, (2003)	Heart failure, telehealth	To determine the feasibility of providing a HF disease management program using in-home telehealth devices (Health Buddy) and to compare the effectiveness with traditional home management strategies.	90	Confidence, functional status, depression, & health-related quality of life (HRQL)	Those who received telephonic disease management experienced decreased confidence in their ability to manage HF whereas all other groups experienced increased confidence. Improvement was noted but no group differences in functional status, depression, or (HRQL).
Noel, Vogel, Erdos, Cornwall, and Levin, (2004)	Heart failure, rural, telehealth	To determine whether home telehealth, when integrated with the health facility's medical record	104 frail elderly veterans with CHF, COPD, and/or DM.	clinic/ED visits, and A1C levels, cognitive status, patient satisfaction, functional levels, and patient-rated health status	Compared to control, scores for home telehealth subjects showed statistical significance decrease at 6 months for bed-days-of-care, urgent clinic/ED visits, and A1C levels; at 12 months for cognitive status and at 3 months

Author/ Year	Keywords	Purpose(s)	Sample	Outcomes	Results
		system, reduces healthcare cost and improves quality-of-life outcomes relative to usual home healthcare services for elderly high resource users with complex co-morbidities.			for patient satisfaction. Functional levels and patient-rated health status did not show significant differences for either group.
Radai et al. (2008)	Heart failure, telehealth	To demonstrate feasibility and consistency in lung resistivity measurements using a new bioimpedance telemedicine device for monitoring of CHF patients at home.	5 healthy men 10 elderly patients with pulmonary congestion	lung resistivity measurements	Preliminary results show that measured resistivity values among healthy young patients are consistent and reproducible within. The mean resistivity in patients with pulmonary congestion were lower than those in healthy patients. The system was noninvasive, safe, and portable. This system demonstrated the ability to retrieve unique data correlated with the amount of fluid in the lungs and transmits the data to a medical call center in order to improve treatment and outcomes for CHF.
Wakefield, Ward, et al. (2008)	Heart failure, telehealth	Evaluated the efficacy of a program for patients upon discharge using telehealth technologies in reducing	HF patients	Readmission rates, time to first readmission, urgent care clinic visits, survival & quality of life	Comparison of intervention to usual care resulted in a significant increase in the amount of time until readmission. Mortality rates, readmission rates, hospital days, and urgent care clinic use

Author/ Year	Keywords	Purpose(s)	Sample	Outcomes	Results
		resource use.			remained unchanged. Patient stated quality of life improved with telehealth care via telephone lines. There was little evidence to support video-based telehealth as a better alternative to telephone follow-up.
Wakefield, Bylund, et al. (2008)	Heart failure, telehealth	To determine if differences exist in communication profiles between telephone and videophone interactions & if communication profiles change over time?	28 patients with HF & hospital readmission for HF exacerbation	Home based communication intervention.	Results of the study did not support use of videophone over the telephone.
Wakefield et al. (2009)	Heart failure, telehealth	Evaluated the efficacy of 2 telehealth applications, delivered by telephone and videophone, for improving outcomes of patients following hospital discharge for an acute exacerbation of heart failure	148 patients (Iowa City Veterans Affairs Medical Center)	Self-efficacy, satisfaction with care, compliance using survey specific to telehealth.	No significant differences noted between groups in medication compliance, self-efficacy or satisfaction with care. Knowledge scores improved in the intervention group.
Whitten and Mickus (2007)	Heart failure, telehealth	To determine if patient health outcomes are similar when	67 patients with COPD or CHF	Self-rated health status, care access, disease self-management.	Addition of telehealth to COPD/CHF patient care was not a significant predictor of health and wellbeing.

Author/ Year	Keywords	Purpose(s)	Sample	Outcomes	Results
		supplementing care with telehealth as compared with traditional care only & what is the attitude of patients with COPD/CHF toward home telehealth after they have experience it?		Patient satisfaction	Patients were satisfied with care delivery via this modality.
Woodend et al. (2008)	Heart failure, telehealth	To test the impact of 3 months of telehome monitoring on hospital readmission, quality of life, and functional status in patients with HF or angina.	249 patients with HF or angina	Hospital readmission, health care resource use, morbidity, functional & quality of life.	Telehome monitoring significantly reduced the number of hospital readmissions and days spent in the hospital for patients with angina and improved quality of life and functional status in patients with HF and angina. Patients found the technology easy to use and expressed high levels of satisfaction.

Heart Failure and Telehealth

Dansky and Vasey (2009) conducted a study to determine the effectiveness of the use of a telehealth system after discharge from home health services. Participants with primary or secondary HF were recruited from 10 home health agencies across the U.S. and randomized to either a telehealth or control group upon discharge. The telehealth group received Health Buddy telehealth system monitoring during and after formal home health while the control group received no further monitoring. Results showed that patients who continued using telehealth beyond the formal episode of care showed greater improvement in respiratory status and activities of daily living. None of the patients who used telehealth during this stage had any hospitalizations or emergency department (ED) events, while 28.3% of the control group patients required hospitalization and 26.1% had at least one ED visit.

Dansky et al. (2008a) conducted a randomized field study with heart failure home health patients. Patients in the control group received routine home visits only. At 60 and 120 days, telehomecare patients had fewer hospitalizations; yet, only the 60 day time period was statistically significant. Patients in the control group experienced more emergency department visits and hospitalizations versus the telehomecare patients (including the monitor and video groups). Telehomecare patients also indicated decreased symptoms (i.e., medication effectiveness and sodium and fluid intake) except in relationship to physical activity.

Dansky et al. (2008b) conducted a randomized control study with home health patients diagnosed with HF. Data was collected at three points by telephone interview. Patients were divided into three groups: control, video systems, and asynchronous or monitoring. Over time, each group showed improvement; however, the most improvement was noted in the video group. Significant differences were not noted between the control and monitoring groups. The majority

of patients' self-management behaviors were predicted by confidence in their self-management of their condition. Video group scores showed the most improvement. These findings suggest that confidence levels may be improved by the involvement of nurses and telehealth systems.

Radai et al. (2008) tested a bioimpendace telemedicine, PulmoTrace@Home, system to monitor elderly HF patients. The lung resistivity of patients was measured to identify pulmonary edema. Preliminary analyses indicated that the system can be useful for measuring lung resistivity and monitoring HF patients. Results also showed that the measured resistivity values among healthy young patients are consistent and reproducible within 48 hours. The mean resistivity in patients with pulmonary congestion was lower than those in healthy patients. The system was noninvasive, safe, and portable. This system demonstrated the ability to retrieve unique data correlated with the amount of fluid in the lungs and transmission of the data to a medical call center in order to improve treatment and outcomes for HF.

Wakefield, Ward et al. (2008) conducted a study to evaluate the efficacy of a telehealth-facilitated post discharge support program in reducing resource use in patients with HF. Patients with documented HF were eligible if they had a phone line in the home, the absence of significant communication deficit or cognitive impairment, enrollment in the agency's primary care clinic, and English-speaking abilities. Patients were randomized to telephone, videophone, or usual care for follow-up care after hospitalization for HF. Outcome measures used in the study included readmission rates, time to first readmission, urgent care clinic visits, survival, and quality of life.

The intervention as compared to the usual care resulted in a significant increase in the amount of time until readmission. However, mortality rates, readmission rates, hospital days, and urgent care clinic use remained unchanged. All subjects reported higher quality of life scores at

one year. There was no evidence to support video-based follow-up as a better alternative to telephone follow-up.

Wakefield, Bylund et al. (2008) drew from the previous randomized controlled trials of HF management to compare differences in nurse and patient communication profiles between two telehealth modes: telephone and videophone. Subjects were enrolled in the study if they met the following requirements: a mini-mental status examination score of greater than 22, phone line in the home, diagnosis of heart failure, hospital admission for heart failure exacerbation. After audiotaping, telephone and videophone interactions were analyzed using the Roter Interaction Analysis System and a likert-type scale was used to analyze quantitative measures. Demographics, nurse perceptions, patient perceptions, changes in communication profiles between telephone and video telehealth, and changes in communication profiles over time were all analyzed based on improvements contributed to telehealth. The study found no difference between nurse's perception of telephone and videophone interventions and no significant difference in patient satisfaction. In conclusion, the study did not support the use of videophone over telephone communication.

In a follow-up study Wakefield et al. (2009) analyzed data from a previous study to evaluate the efficacy of two telehealth applications, delivered by telephone and videophone, for improving outcomes of patients following hospital discharge for an acute exacerbation of heart failure. Participants were screened within 24 hours of admission to the hospital with possible heart failure exacerbation. At hospital discharge patients were randomized to the videophone intervention or telephone intervention. Self-efficacy, satisfaction with care and knowledge of and compliance with prescribed medications were all assessed. Outcome measures were all evaluated based on the differences between video and telephone telehealth. No significant difference was

noted between videophone and telephone telehealth communications in medication compliance, self-efficacy or satisfaction with care. The intervention group showed improved knowledge scores and was more likely to have had medications adjustments during the 90-day intervention period. The researchers concluded that it was possible that the noted delayed time to readmission was due to routine monitoring of HF symptoms which led to medication changes.

LaFramboise (2003) conducted a randomized controlled trial with recently discharged heart failure patients. In this study, researchers found that use of a device such as the Health Buddy system was feasible for education and assessment in the majority of study participants with heart failure. Except in the case of telephonic delivery, the heart failure management program improved participants' self-efficacy in relation to heart failure management. Despite the delivery method, functional status was improved in turn affecting the need for institutional care and mortality. There was also a tendency for improvement in depression over time as well as improved quality of life.

Whitten and Mickus (2007) conducted a study to assess the use of telehealth with chronic obstructive pulmonary disease (COPD) and congestive heart failure (CHF) home health patients. Patients were randomized to a control group or experimental group; and health outcomes and patient perceptions of telehealth were evaluated. The experimental group had visits via videoconferencing and face-to-face interactions. Results of the study indicated patient satisfaction with telehealth and care delivery using this mechanism. The majority of participants viewed telehealth as helpful in increasing care access (79%) and improving disease self-management (68%). The findings for the control and experimental groups were similar. The SF-36 general health subscale ratings in the experimental group were poorer post-intervention. Yet, this finding was significant only when a number of variables in the model were controlled.

Woodend et al. (2008) conducted a randomized control trial over a three month period to evaluate the effect of telehome monitoring on patients' hospital readmissions, functional status, and quality of life. Improvements were seen in individuals that participated in the intervention in relation to quality of life and functional status. In patients with angina, emergency department visits, readmissions to the hospital, and days in the hospital were lower. However, this was not found in heart failure patients. Telehome monitoring patients were able to use the technology and levels of satisfaction were high. Angina patients also indicated high levels of satisfaction.

Heart Failure, Rural and Telehealth

Caldwell et al. (2005) conducted a randomized control trial to determine whether a simplified education program focused on a single component of disease management (system recognition and management of fluid weight) could improve knowledge, patient-reported self-care behaviors, and HF severity in a rural setting. Usual care was provided to the control group along with written materials. Participants in the intervention group received the simplified education program in addition to a counseling session with a non-cardiac registered nurse and a follow-up phone call. Study measurements were taken at enrollment and at 3 months and included patient knowledge, self-care behaviors, and HF severity (B-natriuretic peptide [BNP]).

For the intervention group, knowledge levels and self-reported self-care behaviors improved significantly and the changes in BNP at 3 months was in the hypothesized direction, yet the difference was not significant. Findings indicate that knowledge and self-care behavior for the intervention group improved following completion of a simplified education program, counseling session, and follow-up phone call focused on management of fluid weight and recognition of symptoms. Simple education programs with telehealth follow-up can improve outcomes for HF patients in a rural setting.

As observed in Clark et al. (2007) elderly patients with HF can adjust to telehealth strategies for management of chronic disease. Researchers used a mixed methods approach combining quantitative statistics, feedback surveys and qualitative analysis of clinical notes. The purpose was to determine adherence, adaptation and acceptability to a national nurse-coordinated telephone monitoring HF management strategy entitled Chronic Heart Failure Assistance by Telephone Study [CHAT]. The cohort consisted of standard care plus intervention (CHAT). Study results showed adherence to study protocol was 65.8%. In the 60 participants completing the study 12 months follow-up adherence was significantly higher at 92.3%. Only 3% of this elderly group (mean age 74.7 $\pm$ 9.3 years) was unable to learn or competently use the technology. Acceptability rate was 76.45%. Elderly CHF patients can adapt quickly, find telephone monitoring an acceptable part of their healthcare, and are able to maintain good adherence.

Comparison of cost, patient outcomes and patient satisfaction between home-based telehealth and traditional skilled nursing home healthcare (HHC) were the focus of a study by Finkelstein et al. (2006). The sample consisted of patients with an average age of 74 years, a diagnosis of congested heart failure, chronic obstructive pulmonary disease, or chronic wound care management and recent discharge from hospital care. Control group subjects received standard HHC for their underlying condition. Subject in the video group received standard HHC plus 2 supplemental virtual visits (VVs) each week and Internet access. Subjects in the monitoring group received standard HHC, two weekly VVs, and Internet access, plus home-based physiologic monitoring and an electronic diary to report monitoring measurements and symptom management.

Measurements were based on mortality, transfer to differing levels of care, overall satisfaction and cost. No significant difference in mortality was noted between groups. Average visit cost was $48.27 for face-to-face home visits, $22.11 for average virtual visits (video group), and $32.06 and $38.62 for average monitoring group visits for CHF and chronic obstructive pulmonary disease (COPD) subjects, respectively. This study demonstrated improved patient outcomes and lower cost when comparing virtual visits between a skilled healthcare nurse and chronically ill patients at home to traditional face-to-face home healthcare visits.

Noel et al. (2004) conducted a single-blinded, single-site, randomized study to determine whether home telehealth, when integrated with the health facility's medical record system, reduces healthcare cost and improves quality-of-life outcomes for elderly high resource users with complex co-morbidities. The target population was frail elderly veterans with HF, chronic obstructive pulmonary disease, and/or diabetes. The control group received usual home healthcare services plus nurse case management. The intervention group received home telehealth plus nurse case management. Analyses were performed to compare outcomes at 6 and 12 months for subjective and objective quality-of-life measures, health resource use, and cost. When compared to control, scores for home telehealth subjects showed a statistically significance decrease at 6 months for bed-days-of-care, urgent clinic/ED visits, and A1C levels; at 12 months for cognitive status and at 3 months for patient satisfaction. Functional levels and patient-rated health status did not show significant differences for either group. The integration of home telehealth with a healthcare institution's electronic database was shown to significantly reduce resource use, improve cognitive status, treatment compliance and stability of chronic conditions for homebound elderly with complex health problems.

Discussion

An IRR of rigorous research studies (clinical trials) was used to determine the use and effectiveness of telehealth strategies for heart failure management both in the general population as well as in rural populations. From the results of the review future implications and applications are discussed in terms of the research questions.

Of the 14 clinical trials reviewed, nine studies reported on the use of telehealth for HF management in the general population and five reported for rural populations. In the results five themes of effectiveness were noted: improved knowledge, improved self-care behaviors, improved health outcomes, cost reduction and patient satisfaction.

Research Question 1: How have telehealth technologies been used in the management of heart failure patients and are they effective? A variety of applications of telehealth concepts have been used in the management of heart failure patients across the general population. Technologies that have been shown to be effective include telephone interviews; video conferencing; telehomecare systems, one-way and two-way monitoring systems; telephonic devices, Health Buddy; and a bioimpedance telemedical system, PulmoTrace@Home and CardioInspect.

In the general population two studies demonstrated improved knowledge, two studies showed improved self-care behaviors, four studies found improved health outcomes, and two reported patient satisfaction. No studies reviewed demonstrated reduced cost directly, but four studies indirectly implied potential cost savings based on reduced hospitalizations, hospital readmissions, ED/clinic use, and bed-days (Dansk & Vasey, 2009; Noel, et al., 2004; Radai, et al., 2008; Wakefield, Ward, et al., 2008). One study showed no difference between telephonic and videophone interaction for the management of HF (Wakefield, Bylund, et al., 2008) and

another study failed to support that supplemental care with telehealth improve health outcomes when compared to traditional care (Whitten & Mickus, 2007). Two studies demonstrated the ability of telehealth to decrease emergency department visits and hospitalization for HF patients (Dansky & Vasey, 2009; Dansky et al. 2008a) while four studies showed lower readmission rates with the use of telehealth (Wakefield, Ward, et al., 2008; Wakefield, Bylund, et al., 2008; Woodend, et al., 2008; Noel, et al., 2004). Patients utilizing video or interactive systems showed improvement in confidence related to self-care (Dansky et al. 2008b). One study demonstrated the ability to remotely obtain lung resistivity information as a measure of fluid in the lungs of HF patients therefore leading to improved treatment and outcomes (Radai, et al., 2008). Findings from the review indicated that telehealth technologies have been used in varying capacities for the management of heart failure patients and evidence strongly supports the effectiveness of telehealth technologies for improving health outcomes in HF disease management.

Research Question 2: How have telehealth technologies been used in the management of heart failure patients in rural populations and are they effective?

Only four clinical trial studies using telehealth in the management of heart failure in rural settings were found. Studies reviewed were limited to the strategies of telephone follow-up calls and internet-based virtual visits. For rural populations, one study demonstrated improved knowledge, two studies showed improved self-care behaviors, three studies found improved health outcomes, and three studies reported patient satisfaction when telehealth was used. One study demonstrated that a simple educational program delivered by follow-up telephone calls can improve knowledge level and self-care behaviors in HF patients in rural settings (Caldwell, Peters, Dracup, 2005). Another study demonstrated that elderly rural HF patients were accepting of telephone monitoring, adapted quickly, and were able to adhere to the telehealth management

strategy (Clark, et al., 2007). Others studies were able to show patient satisfaction, decreased clinic/ED visits, improved outcomes, and reduced cost using telehealth with rural HF patients (Finkelstein et al., 2006; Noel, et al., 2004). Due to the limited number of studies that focused on rural populations, further research is needed to address the unique needs of this population. Furthermore, telehealth can be an important tool in the management of HF in rural populations, providing access to resources that patients may otherwise have to travel a great distance to access.

Research Question 3: What are the future implications of telehealth technologies in the management of patients with heart failure in rural areas? Utilization of teleheath has been shown to facilitate improvement in self-care behaviors in the general and rural populations (Dansky & Vasey, 2009; Wakefield, Holman, et al., 2009; Whitten & Michus, 2007; Caldwell, et al., 2005). Evidence supported the use of telehealth technologies to decrease the rates of hospital readmission and emergency department visits in patients with heart failure in rural areas and can lead to reduced cost (Dansk & Vasey, 2009; Noel, et al., 2004; Radai, et al., 2008; Wakefield, Ward, et al., 2008). Telehealth increases access to rural populations for the purpose of disease management. Increased access using telehealth allows health care providers to detect changes in health status earlier and in turn improve outcomes with subsequent cost savings.

Evidence provided by this review can inform clinical practice toward improved knowledge, self-care behaviors, health outcomes, patient satisfaction as well as reducing cost. The framework provided can guide the development of interventions toward eliminating rural health disparities in rural HF patients as well as those with other chronic health conditions.

Internet-based telehealth strategies are an important area where future research is needed. Studies are needed to further describe the feasible and potential for improving access for rural

populations where specialized services are lacking. Implementation of these strategies can be cost and time effective for patients and providers.

Conclusion

An IRR methodology was conducted with the integration of key words: heart failure, telehealth and rural populations. Review results present evidence of the use and effectiveness of telehealth technologies in HF disease management in the general population as well as in rural populations. The studies reviewed can provide insight into interventions for the delivery of health care, improving access and reducing health care disparities.

Twelve of the 14 clinical trials reviewed demonstrated that telehealth technology can increase access to and deliver cost-effective healthcare. Results further indicate a variety of telehealth technologies have shown to be effective in the management of heart failure patients. These include bioimpedance telemedical systems, such as PulmoTrace@Home, CardioInspect; telehomecare systems, one-way and two-way monitoring; telephonic devises, Health Buddy; and video conferencing. Drawing from clinical trial research in both general and rural populations, evidence demonstrated the feasibility of telehealth and its potential to provide important healthcare coverage for rural areas where specialized services are lacking. Studies showing improved knowledge, improved self-care behaviors, improved health outcomes, cost reduction, and patient satisfaction with the use of telehealth for the management of HF can be used to design intervention for use in rural populations.

Sufficient evidence is available to support the use telehealth technologies as an effective and efficient approach to improving healthcare access, improving both health outcomes and health status, and reducing overall cost. Further research needs to be conducted to gain insight regarding improvements related to telehealth and self-care behaviors in rural populations. The

combination of effectively utilizing telehealth and improvement in self-care behaviors and health outcomes can decrease hospital readmission rates and increase quality of care. As limited resources is often an issue in rural settings, additional studies regarding what methods work best would be useful in ensuring cost and time effective methodologies are utilized.

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