Outcome Comparison of Telemedicine and Usual Care in Rural Areas

by

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Abstract

Many rural areas have implemented telemedicine programs to address their need to provide access to physicians and quality healthcare. Rural areas account for 2,157 of 6,100 are that are designated Primary Care Health Professional Shortage Areas (HPSA). Residents in rural areas face other unique challenges such as economic concerns, distance to travel for services, lower educational and socioeconomic status, and cultural differences. Access to quality healthcare was cited as a top priority by national experts in rural health as well as those involved in the provision of rural health services. Telemedicine has been shown to produce health outcomes comparable to face-to-face care. This quantitative meta-analysis was designed to investigate whether the management of chronic diseases such as diabetes can be delivered with outcomes comparable to those achieved through traditional forms of care. Several short-term studies suggested telehealth programs used to manage blood glucose levels and cholesterol, risk factors of Type 2 diabetes, can produce outcomes that are comparable to outcomes seen among patients receiving usual care. Further study is needed on the financial costs of telehealth and whether those outweigh the benefits; the variables in training patients to use telehealth; and whether the benefits seen in telehealth can be sustained for long-term use of a program.
Introduction

Rural communities, where residents experience higher rates of chronic disease, face obstacles to achieving good health based on poor access to healthcare facilities, services, and providers. Rural residents are less likely to have insurance provided by an employer and are more likely to be poorer and to have lower educational attainment (NRHA, 2014). As a result, residents of rural areas face a number of chronic conditions such as heart disease, cancer, and stroke at a rate higher than their urban counterparts (National Centers for Health Statistics, 2013). Studies have shown shortages of physicians in rural areas (Bodenheimer & Pham, 2010; Chen, Petterson, Phillips, Mullan, Basemore, & O’Donnell, 2013). As a response to those factors, some communities have implemented telemedicine programs.

Telemedicine, the use of video and audio capabilities to facilitate real-time, two-way communication for medical purposes, provides an alternative approach to address the problems faced by rural residents in accessing professional health services (Gillman & Stensland, 2013). Long-term studies of telemedicine programs in other countries and studies from a small population or geographical focus in the United States have shown mixed results from their analysis of the use of telemedicine to treat chronic conditions. A two-year study of a New York program involving 116 primary care physicians showed that telemedicine was a positive experience in helping to manage patients with diabetes, however program inefficiencies were a concern (Tudiver, Wolff, Morin, Teresi, Palmas, Starren, Shea, & Weinstock, 2007). Telemedicine has been identified as a feasible alternative to face-to-face care when used for screening and follow-up for patients with diabetic retinopathy in rural areas (Yogesan,
Constable, & Chan, 2002) and for diabetes care in rural patients in a Montana study (Ciemens, Coon, & Min, 2011).

Telemedicine provides an alternative to usual care as a means of treating patients with chronic diseases in rural areas. Researchers have studied and noted the efficacy of telemedicine for this purpose compared to usual care in certain populations and geographic regions. A review of the literature has shown that although telemedicine provides comparable care to usual treatment delivery in some populations, access to healthcare in rural areas remains a problem. Therefore, we need to better understand the benefits of telemedicine for a broad population of rural residents before more users can have a positive perceived use of this type of technology.

Existing studies and meta-analyses have looked at specific diseases and populations, which limited the generalizability to all patients in rural areas. The objective of this study is to conduct a meta-analysis to examine the efficacy of telemedicine programs to manage chronic diseases such as diabetes in rural areas. This study will provide a literature review of current studies on rural health, healthcare shortages in rural areas, outcomes of telemedicine for specific diseases, and behavioral theories that explain the acceptance of telemedicine. The meta-analysis will synthesize the quantitative outcomes of studies on the effectiveness of telemedicine programs and indicate whether those outcomes are comparable to usual care in managing diabetes in rural patients by evaluating reductions in risk factors such as blood glucose levels and cholesterol levels.

**Problem Statement**

Healthcare providers are turning to telemedicine programs as a means of providing healthcare to residents of rural areas who may not otherwise be able to access quality care for
management of chronic diseases. Research of short-term programs has suggested that
telemedicine can be used as an alternative to usual care and produce comparable outcomes. The
problems is that a comprehensive review of the literature is needed to establish on a broad scale
whether telehealth programs can be used to effectively manage a chronic disease such as Type 2
diabetes.

Significance

If a solid argument can be made for the quality and effectiveness of telehealth to manage
chronic diseases, more healthcare providers in rural areas could implement such programs in an
effort to reduce health disparities in those areas.
Literature review

Healthcare in rural areas

The accessibility to healthcare in rural areas can be attributed in large part to a workforce shortage of healthcare providers. In 2008, the United States had patient-to-primary-care ratio of 1,475:1 (Petterson, Liaw, Phillips, Rabin, Meyers, & Bazemore, 2012). A Health Professional Shortage Area (HPSA), as designated by the Department of Health and Human Services (HHS) has a population-to-provider ratio of greater than 3,500:1 (Salinsky, 2013). About 25% of graduates from medical education programs become primary care physicians, and less than 5% practice in rural areas, (Chen et al., 2013). Bodenheimer and Pham (2010) state that 21% of the population live in rural areas and 10% of the physicians practice in those same areas. Given that, the patient-to-provider ratios are high for primary care are understandable.

Rural areas also face limitations to specialty providers. Among chief executive officers for rural hospitals in the Rocky Mountain area, 81.3% reported a need for more physicians care in their community (MacDowell, Glasser, Fitts, Nielsen, & Hunsaker, 2013). MacDowell et al. reported that hospital leaders nationwide responded that the specialty most in demand was psychiatry (46%), and in the Rocky Mountain area 37.5% of CEOs said it was obstetrics/gynecology. When an area lacks the physical presence of a healthcare specialist, the primary care physician is forced to refer patients to a tertiary care center that is often geographically distant.

Geographic distance and socioeconomic disparities limit access to healthcare for residents in rural America. Rural residents are less likely to have insurance provided by an employer, are more likely to be poorer and more likely to have educational shortcomings
Because of higher age, lower economic status and lower education, chronic diseases including heart disease and cancer are reported at higher rates in rural areas (Gamm, Hutchison, Dabney, & Dorsey, 2003). The physical challenges combined with socioeconomic disparities and physician shortages combine to increase the health disparity for rural residents compared to urban counterparts. The adoption of telemedicine is a viable solution to address healthcare workforce shortages in rural areas.

**Quality of care in telemedicine**

In specific cases, telemedicine has been shown to provide care that is comparable to face-to-face care for patients with chronic diseases. In a study of patient-centered team approach to diabetes care, patients in the telemedicine group and usual care group exhibited similar improvement in control of risk factors over the three-year period (Ciemins et al., 2011). At one and two years post-intervention, the study showed no significant differences in increases between the patients treated via telemedicine and those receiving usual care in measurements for American Diabetes Association-recommended preventive services including dilated eye exams and renal screenings (Ciemins et al., 2011). In self-management, patient satisfaction, communication, self-efficacy, self-reported symptoms and diabetes knowledge, patients in the two groups showed no differences in the first two years of the study (Ciemins et al., 2011).

Malasanos (2006) reviewed a Florida program for pediatric patients with diabetes and found that it provided care that previously was not available. The Florida Initiative in Telehealth and Educational Program extended care to children with diabetes in underserved areas via telemedicine. The children benefitted from more frequent visits that adhered to the American Diabetes Association recommendations (Malasanos, 2006). They also received education via
telemedicine that previously was not offered, and they reported a reduction in HbA1c values and hospitalizations (Malasanos, 2006).

**Prevalence and application of telemedicine**

Telemedicine programs have been shown to increase accessibility to healthcare services in rural areas. Telemedicine can be used in multiple ways and disciplines. It has higher use in mental health and neurology with some research showing that clinical outcomes are similar with telemedicine patients compared to patients at in-person visits (Gilman & Stensland, 2013). Telepharmacy and tele-emergency applications have allowed professionals to provide expertise to rural areas where staff is limited or consultations are in demand. The North Dakota Telepharmacy Project allowed 50 retail pharmacies and 25 critical access hospital pharmacies to receive support through teleconferencing and operate at much lower costs in areas that could not support a traditional, independent operation (Gillman & Stensland, 2013). Rural hospitals use teleconferencing to connect with trauma specialists in urban centers. A consultation with a specialist about a patient’s condition via telemedicine can help to avoid costs associated with transporting patients to the trauma center (Gillman & Stensland, 2013).

Telemedicine also engages the patients in their care. Another study found that physicians reported that patients treated via telemedicine have shown an increased knowledge of diabetes and self-care (Tudiver et al., 2007). One study reviewed linking a remote endocrinologist with an on-site nurse-educator and diabetes patients in rural areas. The providers and patients reported high levels of satisfaction, and patients saw decreases in their previously uncontrolled HbA1c levels (Toledo, Triola, Ruppert, & Siminerio, 2012). The increased access to healthcare and the high satisfaction shown by physicians and patients correlates with the perceived usefulness
Theories for telemedicine adoption

The Technology Acceptance Model (TAM) and Social Cognitive Theory (SCT) help to explain how people make decisions regarding the adoption of technology and the adoption of a specific behavior that will produce a specific outcome. TAM, first proposed by Fred Davis in 1985 (Legris, Ingham, & Collerette, 2003), is used to gauge a user’s intent related to the adoption of use information technology (Croteau & Vieru, 2012). The two constructs in TAM are the perceived ease of use and perceived usefulness (Croteau & Vieru, 2002). TAM has been used in a broad manner to explain the adoption of information technology (IT) by healthcare providers (Holden & Karsh, 2010). TAM highlights the importance of the relationship between perceived use and the intent to use or actual use of health information technology (Holden & Karsh, 2010).

SCT was proposed by Albert Bandura and explained how learning is a process that takes place in a social context (DiClemente, Salazar, & Crosby, 2013). Within this social context, the individual learns by observing, modeling, reinforcing, and being aware of the behaviors (DiClemente et al., 2013). One construct of this theory is self-efficacy, a belief that a person can adopt and successfully carry out a behavior that will produce a specific outcome. Computer self-efficacy is important in the use of telehealth (Tsai, 2014). The construct of knowledge is a precondition for behavior change (DiClemente et al., 2013). The construct of outcome expectations explains what the person anticipates receiving if he or she adopts the behavior. Sociostructural factors such as the world around the individual will allow or limit that individual’s ability to engage in the behavior (DiClemente et al., 2013). Suter, Suter, and
Johnston (2011) found that home health patients who received support from nurses through telemedicine programs built self-efficacy toward telemedicine and achieved health benefits in disease management.

As applied to telemedicine, TAM and the SCT help explain why physicians and patients use telemedicine. Croteau and Vieru proposed a model using TAM for the use of telemedicine. They removed the attitude construct from the model because it was not noted to be significant, and they added a link between perceived ease of use and intentions to adopt the behavior (Croteau & Vieru, 2002). Within the construct of perceived ease of use, Croteau and Vieru added situational support and perceived effort and persistence (Croteau & Vieru, 2002). These theories also can extend to the patients. Ease of use and usefulness has been linked to intention to use telemedicine among elderly rural residents, and perceived usefulness was the most significant predictor of intent to adopt the new technology (Tsai, 2014).

**Summary and conclusion**

The use of telemedicine in rural areas can help address workforce shortages while engaging patients in their care and improving health outcomes for those users. Rural areas face significant shortages of primary care and specialty providers. According to Technology Acceptance Model, the adoption of telemedicine programs to address existing disparities in healthcare access in rural areas will be driven by removing barriers for physicians such as licensing issues, ease of use and usefulness and payment processes. Additionally, following the Social Cognitive Theory physicians and patients can understand how the program can be used and the benefits it brings to each party in terms of improved access to care by avoiding travel and better engagement of the patient. Once physicians and patients have adopted the technology, they
will play a key role in sharing that information for other providers and patients to understand the benefits.

Although the literature has shown that telemedicine can produce positive outcomes for many of the services offered, healthcare providers in rural areas have turned to telemedicine on a limited basis (Toledo et al., 2012). In 2006, there were 26,000 telemedicine visits, which equates to less than one visit per 300 rural Medicare participants (Toledo et al., 2006). Further research is needed to show the efficacy of telemedicine in treating patients with chronic diseases that are prevalent in rural areas in order for those residents and their care providers to adopt these types of programs and experience improved health status.
Methods

The objective of this study is to review existing research systematically and conduct a meta-analysis to compare telemedicine to usual care in managing patients with diabetes. A meta-analysis was chosen to combine results from five studies that included samples from specific populations. Some studies focused on specific rural areas such as a single county or state. Studies chosen examined the management of diabetes care with data for changes to HbA1c, blood pressure, BMI and adherence to specified treatment protocols which are risk factors of diabetes. Studies that focused on home monitoring telemedicine programs or telemedicine used in hospital settings were excluded.

Assumptions

Assumptions made in this thesis include that the publications analyzed are valid within the field of study; that the measures for diabetes risk factors are evidence based and comparable across all of the studies; that the tools and methods used to complete those measures were accurate and valid; and that the results of these studies can be generalized across the population.

Delimitations

Delimitations for this thesis are studies that focused on telemedicine programs for Emergency rooms, intensive care units and basic telephone system programs. Studies on chronic diseases other than diabetes also are excluded due to the different dependent variables evaluated. This study excludes research that evaluated the qualitative measures of physician or patient perspectives on the quality of the telemedicine program. Studies included in the meta-analysis also faced loss to follow-up in control and experimental groups. The ability to use telemedicine equipment caused some people to drop out. Patients who had a history of not following treatment
protocols or who had a history of drug and alcohol abuse, dementia or active malignant processes were not eligible to participate, which could impact the generalizability of the study.

**Data analysis plan**

This study was conducted using the MetaEasy software. The fields used to conduct the analysis were blood glucose and LDL cholesterol. Results are presented in tables and forest plots to provide consolidated evidence in support of telemedicine as a substitute to traditional patient care in rural areas of the United States. The results of each study for the mean reduction of blood glucose levels and cholesterol levels among the control groups and the intervention groups were summarized and analyzed with the effect of each study measured, and the heterogeneity of the five studies was evaluated.
Results

Telemedicine has been proposed as an alternative to the usual delivery of medical care in a face-to-face setting between clinician and patient for people in rural areas. This alternative was proposed to address provider shortages in those areas. This meta-analysis provides a systematic review of studies that looked at the impact of telemedicine on care for people with diabetes answering the question of whether this delivery method can provide comparable care to the usual care model.

**Hypothesis, Null Hypothesis** The hypothesis proposes that telemedicine can provide care for the management of diabetes that is comparable to usual care. The null hypothesis is that there is a statistically significant difference between the outcomes from telemedicine and the outcomes seen in usual care.

**Inclusion and exclusion criteria**

This study included random controlled trials that compared the use of telemedicine to manage patients with diabetes to usual care for patients with diabetes. Articles were gathered from searches on MEDLINE, Google Scholar and through Link Library on the Concordia University website. Search terms used were *telemedicine, telehealth, chronic disease, rural healthcare, access to healthcare*, and *diabetes*.

The focus of this study is on management of diabetes for patients in rural areas through the use of telemedicine. Telemedicine is used widely in a variety of areas ranging from response to emergency needs including stroke to providing critical care expertise in Intensive Care Units. Because of this diversity, I excluded studies that examined telemedicine programs other than clinical care in an outpatient setting including home monitoring.
Inclusion and exclusion criteria as well as the number of studies reviewed are presented in Figure 1.

Figure 1: Process to select studies for inclusion in the meta-analysis.

Data collection

Data was collected for this meta-analysis from five studies that conducted random control trials. The studies focused on telemedicine programs used in an outpatient clinical setting rather than inpatient hospital units or emergency department settings. Participants were excluded if they had a history of non-compliance with care instructions, a history of drug or alcohol abuse, dementia or active malignant processes. The studies involved 1,279 individuals who were assigned to usual care and telemedicine groups. The effects for two separate variables in two studies were not calculated due to insufficient information. The data sets gathered included changes in
glycemic control (HbA1c), low-density lipoprotein (LDL), glycated hemoglobin (GHb) and change in the percent of participants who controlled HbA1c and LDL levels shown in Table 1.

Table 1

*Included Studies and Effects*

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Date</th>
<th>Sample Size</th>
<th>Variables</th>
<th>Effects Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shea et al.</td>
<td>2006</td>
<td>723</td>
<td>LDL; HbA1c</td>
<td>Difference in means of LDL and HbA1c</td>
</tr>
<tr>
<td>Izquierdo et al.</td>
<td>2003</td>
<td>48</td>
<td>LDL; HbA1c</td>
<td>Difference in means of LDL and HbA1c</td>
</tr>
<tr>
<td>Davis et al.</td>
<td>2010</td>
<td>165</td>
<td>GHb; LDL</td>
<td>Difference in means of GHb and LDL</td>
</tr>
<tr>
<td>Ciemins et al.</td>
<td>2011</td>
<td>206</td>
<td>Percent control HbA1c; Percent control LDL</td>
<td>Change in percent of people who controlled their HbA1c and LDL</td>
</tr>
<tr>
<td>Stone</td>
<td>2010</td>
<td>137</td>
<td>HbA1c; LDL</td>
<td>Difference in means of HbA1c and LDL</td>
</tr>
</tbody>
</table>

**Results**

A meta-analysis is a systematic analysis of existing studies and takes the outcome measures from those studies to find an overall mean difference between the experimental and control groups of those studies which are weighted based on the number of participants in each of those studies. This meta-analysis compared results taken before and after interventions in both the various control and experimental groups which are described for each study below. The review calculated effects for change in mean LDL, change in mean HbA1c, change in percent of participants who controlled HbA1c and change in percent of participants who controlled LDL, and change in mean GHb. Not all measures were calculated for each study.

The independent effects of the studies and the confidence intervals measured at 95% included in this meta-analysis are detailed in Table 2.
Table 2

Independent Effects of Included Studies

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Study Design</th>
<th>Variables</th>
<th>Effect Measured</th>
<th>Effect Size</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Izquierdo et al.</td>
<td>RCT</td>
<td>LDL</td>
<td>Difference in means</td>
<td>0.5819</td>
<td>0.0033</td>
</tr>
<tr>
<td>Shea et al.</td>
<td>RCT</td>
<td>HbA1c</td>
<td>Difference in means</td>
<td>0.2260</td>
<td>0.0805</td>
</tr>
<tr>
<td></td>
<td>RCT</td>
<td>LDL</td>
<td>Difference in means</td>
<td>0.0691</td>
<td>-0.0767</td>
</tr>
<tr>
<td>Ciemins et al.</td>
<td>RCT</td>
<td>% control HbA1C</td>
<td>Change in percent of participants who controlled HbA1C</td>
<td>-0.1163</td>
<td>-0.3923</td>
</tr>
<tr>
<td></td>
<td>RCT</td>
<td>% control LDL</td>
<td>Change in percent of participants who controlled LDL</td>
<td>-0.0431</td>
<td>-0.3191</td>
</tr>
<tr>
<td>Davis et al.</td>
<td>RCT</td>
<td>GHb (mg/dl)</td>
<td>Difference in means</td>
<td>-0.4548</td>
<td>-0.7610</td>
</tr>
<tr>
<td></td>
<td>RCT</td>
<td>LDL</td>
<td>Difference in means</td>
<td>-0.3660</td>
<td>-0.6713</td>
</tr>
<tr>
<td>Stone</td>
<td>RCT</td>
<td>LDL</td>
<td>Difference in means</td>
<td>0.1655</td>
<td>-0.2740</td>
</tr>
</tbody>
</table>

Izquierdo et al. conducted a random control trial comparing diabetes education delivered by a diabetes nurse educator in person to the education delivered by a diabetes nurse educator via telehealth to remote clinic location. The nurse met with patients for a one-hour consultation followed by two 30-minute appointments at 4-6 weeks and 8-12 weeks after the initial visit. The study showed an LDL mean effect of 0.5819 95% CI (0.0033, 1.1604).

Shea et al. differed from the other studies included in this meta-analysis because of its size. The study included 723 participants in the follow-up assessments of this random control trial. The study compared telemedicine case management to usual care for patients with diabetes. The intervention group received a home telemedicine unit while the control group participants remained under the care of their primary care physician. Measurements were collected at baseline with a one-year follow up. For the change in HbA1c, Shea had a mean effect of 0.2260.
95% CI (0.0805, 0.3714). For change in LDL, Shea had an effect of 0.0691 95% CI (-0.0767, 0.2149).

Ciemens et al. conducted a random control trial using the Promoting Realistic Individual Self-Management (PRISM) diabetes program to compare patient-centered team care delivered via telehealth to face-to-face visits. The measurements were taken at baseline, one, two and three years. The study measured the change in percent control of HbA1c with a mean effect of -0.1163 95% CI (-0.3923, -0.1598). Results showed a mean effect for change in percent control of LDL of -0.0431 95% CI (-0.3191, 0.2330).

The Davis study involved a one-year random control trial on self-management of diabetes. The intervention consisted of 13 sessions delivered over 12 months via telehealth by a nurse/certified diabetes educator and a dietitian. The control group involved usual care which consisted of a 20-minute diabetes education session. Patients assigned to the control group had access to existing services at the community health centers including a diabetes collaborative in the community. The study measured the change in GHb and had a mean effect of -0.4548 95% CI (-0.7601, -0.1495). Davis results showed a mean effect for change in LDL of -0.3660 95% CI (-0.6713, -0.0607).

Stone compared the short-term efficacy of monitoring glycemic control and other measures related to diabetes through home telehealth and medication management directed by a nurse practitioner to care coordination via monthly telephone counseling sessions. The patient population included veterans with Type 2 diabetes over an 18-month period. Measures were taken at baseline, 3 months and 6 months. Stone measured change in LDL and showed a mean effect of -0.2740 95% CI (-0.5984, 0.0504).
Combined effects for the variables measured in each study are shown in Table 3.

Table 3

Combined Effects

<table>
<thead>
<tr>
<th>Variable</th>
<th>Combined Sample Size</th>
<th>Effect Measured</th>
<th>Combined Effect Size</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDL</td>
<td>46</td>
<td>Difference in means</td>
<td>0.5819</td>
<td>0.0033, 1.1604</td>
</tr>
<tr>
<td>HbA1c, LDL</td>
<td>1,450</td>
<td>Difference in means</td>
<td>0.1475</td>
<td>0.0019, 0.2932</td>
</tr>
<tr>
<td>Control of HbA1c, LDL</td>
<td>412</td>
<td>Change in percent control of HbA1c, LDL</td>
<td>-0.0797</td>
<td>0.1964, 0.2761</td>
</tr>
<tr>
<td>GHb, LDL</td>
<td>330</td>
<td>Difference in means</td>
<td>-0.4104</td>
<td>-0.1051, 0.3053</td>
</tr>
<tr>
<td>LDL</td>
<td>146</td>
<td>Difference in means</td>
<td>-0.2740</td>
<td>0.0504, 0.3244</td>
</tr>
</tbody>
</table>

The combined effects for the studies are the following: Izquierdo had a mean effect of 0.5819 95% CI (0.0033, 1.1604). Shea showed 0.1457 95% CI (0.0019, 0.2932). Ciemins resulted in -0.0797 95% CI (-0.3557, 0.1954). Davis was -0.4104 95% CI (-0.7157, -0.1051). Stone had a combine mean effect of -0.2740 95% CI (-0.5984, 0.0504).

The fixed model mean effect was 0.0077, 95% CI (-0.1017, 0.1172). Heterogeneity was assessed at 77.54% with the I2 test and determined that the studies lacked heterogeneity, which is cited as a limitation of the meta-analysis.
Figure 2: A forest plot shows the effect sizes for each variable included in the studies as well as the confidence intervals at 95%.
Discussion

I performed this meta-analysis using five randomized controlled trials to compare telehealth to usual care in the treatment of Type 2 diabetes among patients in rural areas. The goal was to analyze evidence that telehealth used to treat Type 2 diabetes produces outcomes that are similar to usual care. The findings of this meta-analysis suggest there is no statistical difference between telehealth and usual care as a method to treat Type 2 diabetes in rural areas.

This is consistent with other studies that have suggested telemedicine provides care that is comparable to usual care, but was unavailable in certain rural areas (Malasanos, 2006). Similar results have been found when telemedicine is used to treat other conditions such as mental health and neurology (Gilman & Stensland, 2013). In one mixed-methods study of the perceptions of primary care providers’ toward telemedicine, Tudiver et al., found that providers saw more patient involvement and motivation, however, they cited a number of inefficiencies with telemedicine that could be improved upon. Studies suggested patient satisfaction, adherence to treatment protocol, and patient knowledge of the disease were similar among patients treated with telehealth and patients in usual care (Ciemens et al., 2011).

The Technology Adoption Model (TAM) and Social Cognitive Theory (SCT) help explain why patients adopted and benefitted from using telehealth to receive care to manage Type 2 diabetes. Patients who were provided resources to participate in the telehealth model saw the benefits of the program and understood how those benefits would improve their outcomes (Shea et al., 2006). With that knowledge patients would be more likely to adhere to care guidelines and achieve quality outcomes. The telehealth programs also kept remote patients engaged through regular follow-up visits and educational sessions which help explain outcomes.
that were as good as those seen in patients who had face-to-face visits for care (Davis et al., 2010). One study (Shea et al., 2006) did not require patients to have a certain level of computer literacy prior to joining, so it was more representative of the population.

Randomized controlled trials included in this research used interventions including home monitoring equipment and local visits with nurse practitioners and certified diabetes educators. These focused on providing clinical analyses of the health indicators for diabetes including blood sugar levels and cholesterol levels. For example in Shea et al., (2006), patients in the intervention group used home monitoring units for glucose and blood pressure. Information collected at home by the patient was transmitted electronically to case managers. The results of this meta-analysis indicated that giving the patient the responsibility of collecting his own information and transmitting it may lead to better engagement in care and adherence in the care protocols.

The frequency of interactions between the patient and the providers through the telehealth programs corresponded with outcomes that were as good as if not better than outcomes for patients in usual care. In the Davis study, patients in the control group could access outside education resources on their own, independent of the care provider. The intervention group interacted via telehealth with a nurse/certified diabetes education and a dietitian. The results of that study suggested the telehealth interactions allowed patients to control their blood glucose levels as well if not better than patients receiving usual care (Davis et al., 2010).

The duration of the several of the studies indicates that on the short-term of less than three years patients are able to benefit from telehealth to gain control of Type 2 diabetes risk factors such as blood glucose levels and cholesterol. Counseling sessions with healthcare providers conducted via telehealth were held on a regular basis, and patients were required to
self-monitor on a regular basis and report those results back to the healthcare providers. The results of the meta-analysis indicate that on the short term, telehealth does allow those patients to change their behavior to impact the risk factors.

**Limitations**

Changes among participants in the studies from the study design to the end of the follow-up reduced the generalizability of these studies. Shea et al., noted significant loss to follow up because participants found it difficult to use the home telehealth units. Another factor that impacted participant rate was the quality of telephone lines in a region. Patients randomized to the intervention group who lived in areas with poor telephone line quality were not able to continue because the data could not reliably be transmitted to the care providers. Those participants were not statistically representative of the overall study participants, so the results of the study – the largest in this meta-analysis – may have been skewed.

Another study saw a rural clinic withdraw from participation which prohibited researchers from establishing a control group among rural participants to compare them to their urban counterparts. Because distance to travel to face-to-face appointments is one of the concerns prompting the investigation into alternative care delivery models, not having proper rural representation is a limiting factor.

My ability to access a wider database of peer-reviewed journal articles limited the scope of this analysis. My initial inquiry to find relevant articles found 42 possibilities. However, I lacked the resources to review restricted-access articles which impacted the sampling of articles for the analysis.
My professional employment also can be considered a limitation in that it introduces possible bias. I am professionally employed in a public relations capacity for a large healthcare system that owns and operates hospitals in nine rural communities. The company also employs telehealth programs with an emphasis on technology used in acute care settings. While I have not worked directly to promote the use of telehealth to treat diabetes in rural areas, my employer’s potential expansion into that area constitutes a potential bias on my involvement in research.

The use of meta-analysis as a method of evaluating data also presents a limitation. Summary scores to find the effect of quality may be limited in value if individual studies excluded data from participants, and the exclusion was not random (Jüni, Witschi, Block, and Egger, 1999). This was seen in Shea et al., (2006) in this meta-analysis when participants who were unable to properly use or access the telehealth units dropped out of the study. In addition, meta-analyses may present problems because of the varying degrees of quality of the individual studies (Jüni et al., 1999).
**Recommendations**

The results of this meta-analysis suggest the importance of ongoing research in this area. Three areas worth future investigation include the effect of frequency of telehealth appointments for diabetes management, additional longer-term studies on the use of telehealth to monitor diabetes, and the efficacy of different methods to equip patients who have limited knowledge or skills for using telehealth tools.

Studying the use of telehealth to manage diabetes for a longer period can help determine the efficacy of such programs. The studies in this meta-analysis looked at durations ranging from 12 weeks to three years. Three studies were for one to 1-1/2 years. By following patients for a longer time, researchers can learn more about whether the costs of keeping up with technology changes outweigh the benefits of reduced travel to care.

Several studies mentioned that the frequency of patient interaction correlated with better outcomes among patients in telehealth and in usual care. Further research can be done to compare what types of interaction support patients such as nurse practitioner counseling, support group settings, or physician and patient appointments. Studies also could compare mixed models of telehealth and in-person care.

More research is needed into the demographics and education levels of patients. This could provide helpful information on the effect of socioeconomic status on a patient’s ability to adopt the technology knowledge, skills and confidence. This has a direct impact on their ability to adhere to plans of care.
Implications for social change

Research into alternative delivery methods of care for people who live in remote locations has the ability to improve the health and well-being of those residents as well as the care providers. In-person clinical care for the treatment of chronic disease traditionally has been performed through a few methods. A patient may be required to travel great distances to see care providers, which is a hardship on the patient in time, expense and quality of life. If the patient chooses to disregard plans of care and miss appointments, the patient’s condition may worsen. Alternatively, a provider may travel great distances to see as many patients as possible in remote communities. This causes increased travel costs for the provider and lowers the provider’s ability to provide efficient care for a greater number of patients. The duty of providing rural outreach also may be a disincentive for providers and negatively impact providers to the position.

Telehealth is an alternative to address the workforce shortage of healthcare providers in rural areas.

Because the investment in technology including the infrastructure needed to support telehealth connections is costly, the government and healthcare entities must rely on accurate peer-reviewed research to support or rebut proposed telehealth programs. At the individual level, this research illustrates the efficacy of telehealth programs to manage Type 2 diabetes. At the policy level, it provides information on which to base programming, policy, and investment decisions.
Conclusion

The use of telemedicine to treat patients with Type 2 diabetes can serve as a conduit for providers to reach those patients and deliver care that in some cases may not be available otherwise. That care can be as effective as usual, face-to-face treatment in a clinic setting. A literature review has shown the need for alternative care delivery models to serve people in rural areas who have increased incidence of chronic disease and demands for health management. A shortage of healthcare providers to serve those areas makes the need for alternative care models more acute.

The Technology Adoption Model and Social Cognitive Theory show that people will be more likely to use the telehealth care model for their Type 2 diabetes care if they understand the benefits offered by the system, how those benefits apply to them, and that they can use the system properly. When those elements are in place, the patient is more likely to achieve success.

This meta-analysis provides evidence of a higher effect to support the hypothesis that telehealth to manage Type 2 diabetes provides care that is comparable to usual care for patients in rural areas. The fixed model mean effect of this meta-analysis indicated that there is no statistically significant difference in the change of health indicators for Type 2 diabetes patients treated via telehealth compared to those treated in usual care settings. However, the lack of heterogeneity is a limitation. The results of this study and gaps in the literature do show the importance of ongoing research in this area.
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