Journal of
Community & Public Health Nursing
Research Article Open Access

Telehealth Interventions for Medically Underserved Populations with Diabetes in the Community Primary Healthcare Setting: An Integrative Literature Review

Jeehyun Y Lim*

Denver Public Schools, Colorado Christian University, Lakewood, USA

Abstract

This review highlights the best recommendable interventions by appraising evidence of the effectiveness of telehealth interventions for glycemic control in medically underserved patients in the community. Searches of literature published from 2009 to 2020 were conducted using electronic databases including Cochrane Library, CINAHL Complete, PubMed, and manual search. The final thirteen studies were selected for analysis and integration, narrowing down from among a total of 687 studies found in databases. Findings showed significant and effective glycemic control in most studies reviewed through that the telehealth interventions using telemonitoring with frequent self-measured blood glucose data transmission, patient interactions with telehealth managers, and healthy goal attainment. This review provides important insights that the development of a telehealth management platform is needed to increase the care quality and access of for medically underserved patients with diabetes in the community.

Keywords: Diabetes; Diabetes mellitus; Telehealth; Telemedicine; Glycemic control; Hemoglobin A1c; Medically underserved; Multi-ethnic; Culturally diverse

Introduction

Diabetes is a priority in public health, with a prevalence rate of more than 425 million people worldwide and an annual mortality rate of 1.6 million [1,2]. As part of the 2030 Agenda for Sustainable Development Goals (SDG), the United Nations has announced a goal to reduce the premature mortality rate caused by chronic diseases, including diabetes, by one-third. This global effort aims to diagnose diabetes early, improve the quality of life for patients, and prevent or reduce the human and social health costs associated with complications through appropriate monitoring [3,4]. Worldwide diabetes-related health care costs exceed $700 billion per year [1]. In the United States in 2017, the total estimated care costs associated with diabetes were $327 billion [5]. As of 2018, about 34.2 million people, or 10.5% of the total U.S. population, have diabetes. However, the prevalence of diabetes, and subsequent complications of this disease, are strongly influenced by demographic, social, and economic factors, which contribute to health disparities among medically underserved multi-ethnic minorities in the United States [6,7].

The burden of diabetes-related health costs and complications is disproportionally higher in low and middle-income countries around the globe. In particular, individuals in Southeast Asia, the Western Pacific, Africa, and the Middle East develop diabetes earlier than those in other regions and are more likely to experience premature death from diabetes and diabetes-related complications [1,8]. Also, when individuals in this region migrate to a host country to form minority groups, these populations tend to have a higher incidence, prevalence, morbidity, and mortality than the host country population. This trend is most often caused by poverty, lack of access to health care, language barriers, changed lifestyles, adaptation, and genetic predisposition [9-12].

These circumstances cause medically underserved migrant populations to experience social exclusion as well as administrative and financial hurdles. Furthermore, these challenges create a vicious circle of limited access, insufficient preventive interventions and routine health care, and increased risk of communicable and non-communicable diseases in these populations [13]. Access to medical care has declined further as a result of the Coronavirus Disease 2019 (COVID-19) pandemic, which has had a more significant impact on the social determinants of health in high-risk people with diabetes and vulnerable populations of minorities [14]. The spread of COVID-19 has required coordination of communication strategies, particularly among vulnerable multi-ethnic populations, and a transition to culturally appropriate healthcare approaches [14]. Therefore, evidence-based telehealth intervention platform, structured monitoring, and improvement of health care access in the primary care setting can be an essential format for long-term intervention in medically underserved multi-ethnic groups.

Significance and Purpose of this Review

Individuals with diabetes from medically underserved multi-ethnic groups face additional barriers that impact the ability to manage their disease effectively. Such barriers include different socio-cultural norms, poverty, stigma, social exclusion, language, cultural differences, financial challenges, and lack of legal status [13]. As a result of these barriers, this population tends to ignore their diabetes, leading to serious complications secondary to poor glycemic control. Therefore, lifestyle changes, frequent interventions, and structured monitoring in such a population with a high prevalence of diabetes require considerable medical expenditures, time, and a culturally competent approach that must utilize teamwork. Failure to cooperate in delivering structured monitoring and culturally competent care by providers, organizations, and targeted systems can lead to adverse health events and poor-quality outcomes in multi-ethnic patients. Furthermore, studies show that providing comprehensive and structured care in this population has been challenging due to weak quality patient-provider interactions and low engagement in patient partnerships [15-19].

Despite these challenges, telehealth platforms have emerged as one of the methods to monitor and interact with diabetic patients. Telehealth

***Corresponding author:** Jeehyun Y Lim, Denver Public Schools, Colorado Christian University, Lakewood, USA, Tel: 917-213-7062, E-mail: karis4christ@gmail.com

Received April 17, 2021; **Accepted** May 12, 2021; **Published** May 12, 2021

Citation: Lim JY (2021) Telehealth Interventions for Medically Underserved Populations with Diabetes in the Community Primary Healthcare Setting: An Integrative Literature Review. J Comm Pub Health Nursing 7: 283.

approaches have the potential to meet these factors in a culturally competent manner, to empower patients, improve outcomes, and save money in a comprehensive, personalized system [20-22]. Also, due to the COVID-19 pandemic, low-income, multi-ethnic populations with diabetes have experienced more challenges and vulnerabilities related to in-person care. Structured telehealth interventions, then, have the potential to improve self-management of diabetes in medically underserved populations. In light of this, the purpose of this integrative literature review is to provide a basis for developing an evidence-based practice platform through telehealth interventions to support the effective management of diabetes in medically underserved populations in the community.

Methods

Search strategies

For the selection of literature for review, the following question developed in PICOT (Participant, Intervention, Comparison, Outcomes, Timing) format was used to determine the inclusion and exclusion criteria of the literature: In medically underserved populations with diabetes in the community (P), what is the effect of utilization of telehealth management (I), compared to usual diabetic care (C), on glycemic control (O) within the intervention period (T)?

Inclusion criteria for evidence search

Participants included all medically underserved adult populations with diabetes, including multi-ethnic minorities, underserved urban or rural area communities, ethnically diverse people, low-income adults, refugees, asylees, and immigrants who have type 2 diabetes. Intervention criteria include all types of telehealth or telemedicine programs for diabetes management in the community primary care settings. In terms of comparison, the inclusion criteria included all intervention studies that were compared with non-intervention, usual diabetes care group, and non-treatment groups. In terms of the criteria of outcomes, glycemic control, hemoglobin A1c levels, blood pressure, lipids, cholesterol levels, body mass index (BMI), waist circumference, albumin-to-creatinine ratio, compliance of self-management, and qualitative descriptions from participants were included. For timing, the period of all telehealth programs and both pre and post-test until follow-up studies were included. In the study design, systematic reviews with meta-analysis, systematic reviews with network meta-analysis, randomized controlled trials (RCTs), quasi-experimental study, cross-sectional exploratory study, and protocol for the experimental study were included in the search. The language included only published studies in English, but the inclusion criteria in the research environment and settings were international.

Exclusion criteria for evidence search

The exclusion criteria for the literature search were as follows. All evidence for children with type I diabetes and women with gestation diabetes were excluded from this search. In telehealth practice, all the studies on continuous glucose monitoring devices, closed-loop systems, and artificial pancreas for type I and II diabetes were also removed. Among the telehealth interventions for adults with diabetes, evidence focusing on secondary and tertiary medical institutions was also excluded. Lastly, among telehealth interventions for diabetes management, studies focusing on patients with other chronic diseases as comorbid were also eliminated.

Keywords and search engines

This literature review was conducted using search databases, including the Cochrane Library, Cumulative Index of Nursing and Allied Health Literature (CINAHL) Complete, and PubMed. For the gray literature, a manual search was conducted through Google Scholar, the Clifton Fowler Library of Colorado Christian Library (CCU), and the American Diabetes Association Research site. Databases were searched for articles that were published in scholarly journals from 2009 to 2020. Medical Subject Headings (MeSH) were used to select search terms. Keywords to search for evidence were diabetes, diabetes mellitus, telehealth, telemedicine, glycemic control, hemoglobin A1c, medically underserved, multi-ethnic, culturally diverse, and migrants. The final thirteen studies were selected for analysis and integration, narrowed down according to inclusion and exclusion criteria from a total of 687 studies found in databases (Table 1).

Levels of Evidence

The purpose of the appraisal of this literature review was to evaluate and appraise the strengths, limitations, and value of evidence searched and narrowed down from databases to incorporate the best evidence for evidence-based implementation for diabetic patients through telehealth intervention. For this appraisal, the Johns Hopkins Nursing Evidence-Based Practice (EBP) Levels of evidence [24] was used for rating the levels and quality of evidence. The final thirteen pieces of literature were presented with rated levels and quality of evidence for this integrative literature review in Table 2. Article numbers presented in this table 2 were listed according to the alphabetical order of the author's last names. The final thirteen studies included four systematic reviews and meta-analyses, five experimental studies with randomized controlled trials (RCTs), two quasi-experimental studies, one cross-sectional exploratory research, and one protocol for a randomized controlled trial study. The nine studies in the narrowed evidence appraised for the telehealth interventions were rated at level I, two studies at level II, one study at level III, and one study at level IV. Therefore, by integrating evidence of a high level of reviews and qualities, there was a possibility of showing effective evidence-based interventions and outcomes in projects based on substantial evidence (Table 2).

Results

Synthesis of critically appraised literature

Of the thirteen pieces of literature included in this review, 12 studies were designed with a focus on glycemic control as a primary outcome in the adult population with diabetes through a variety of telehealth approaches in medically underserved communities in the United States. The other study investigated the willingness and readiness of the use of tele-technology in diabetic adults in Saudi Arabia's public health setting [25]. One study [26], as a protocol for randomized controlled trials, suggested the possibility of improvement in glycemic control and the quality of life measured by hemoglobin A1c as a primary outcome in low-income patients with diabetes. The intervention periods for telehealth programs suggested in studies included in this literature review reported an intervention time frame ranging from 3 months to 5 years. In particular, the self-data upload platform for patients who used telehealth intervention methods of 3 and 6 months showed a significant decrease in hemoglobin A1c [27,28]. Telehealth approaches for diabetes management in medically underserved populations have improved access to health services and show beneficial results from patient-provider partnerships [29].

Characteristics of telehealth intervention programs in studies

In each study included in this review, the characteristics of telehealth interventions for diabetes management in medically underserved patients were reviewed and analyzed by dividing them

Table 1: Study Selection.

Identification	Studies identified through databases: (n=687) Cochrane (n=11), PubMed (n=542), CINAHL (n=134)
Screening	Record after duplicates eliminated: (n= 404)
Eligibility	Full text articles assessed for eligibility: Add studies from manual search: (n= 61)
Included	Studies included in the final review: (n=13)
Note: The Mendeley Reference Manager was used for tracking and organizing evidence through a literature search in databases [23].	

Table 2: Level and Strength of Evidence Summary.

Author (Year)/ title	Study methods/ sample size/setting	Study purpose/intervention	Study findings/outcomes	Evidence Level (I~V)/ Quality (A~C)
Edge et al. [26]	Randomized Controlled Trial (RCT) Among medically underserved African American population with type 2 diabetes living in Washington D.C., USA, total 47 participants were randomized into intervention groups (n=26) and control groups (n=20).	The purpose of this study was to examine the achievement of positive outcomes of HbA1c, body mass index (BMI), and blood pressure through a pilot telehealth self-management intervention in medically underserved and vulnerable ethnic minorities with type 2 diabetes in an urban area. Intervention: Biweekly telehealth nurse visit for 30 minutes, reviewing patients' uploaded biometric data as well as culturally competent health education through a portal	The result of HbA1c in the telehealth intervention group was 9.0% at baseline, significantly reduced to 6.82% at the endpoint after 9 months (the baseline of HbA1c in the control group was 8.8%, and the endpoint was 7.9%). Telehealth intervention increased access to health care and empowered patients to take charge of their health. Regular reinforcement through the telehealth by nurses has been found to improve the effectiveness of self-management and education for patients with diabetes.	Level I B
Davis et al. [27] Telehealth improves diabetes self-management in an underserved community	Randomized Controlled Trial (RCT) Diabetes TeleCare group (n=85) and usual care group (n=80) were randomly sampled from the underserved population (n=165) recruited from three Federally Qualified Health Centers (FQHC) in rural areas of South Carolina, USA	The purpose of this study was to evaluate a year (13 sessions) of a telehealth diabetes self-management education (DSME) intervention in the setting of a Federally Qualified Health Center (FQHC) provided by a nurse, dietician, certified diabetes educator (CDE). Intervention: Group and Individualized goal setting at each session, completed logs recording the results of self-monitored blood glucose, diet, and physical activity with track steps (using pedometer)	HbA1c in the TeleCare group was significantly lower than in the usual care group, with a result of 9.4 ± 0.3 at baseline, 8.3 ± 0.3 at 6 months, and 8.2 ± 0.4 at 12 months. The level of LDL cholesterol in the TeleCare group also significantly decreased the usual care group from 103.0 ± 6.5 at baseline to 89.7 ± 6.9 at 12 months. Although it was not the original study design, the HbA1c of the TeleCare group extended to 24 months for a population of 2/3 of the original sample decreased from 8.7 ± 0.4 at baseline to 7.6 ± 0.5 at 24 months. Multicomponent Telehealth intervention provided by Nurse CDE and dietician showed positive outcomes of modification of materials for cultural competency, personalized interaction, control of management functions in primary-care, and high participant retention (90.9% at 6 months and 82.4% at 12 months)	Level I A
Egede et al. [28] Effectiveness of technology-assisted care management in low-income adults with type 2 diabetes (TACM-DM): Study protocol for a randomized controlled trial	Protocol for a Randomized Controlled Trial Planning: Two hundred (n=200) male and female participants with type 2 diabetes, living in an underserved and low-income community in Coastal South Carolina, were randomized into an intervention group receiving six months of nurse case management through the Innovative I-telehealth system and a usual care group.	The purpose of this study was to propose a protocol for developing technology-assisted case management (TACM) using the I -2-in-1 telehealth system to optimize care in rural low-income populations with type 2 diabetes. Intervention: Technology-Assisted Case Management (TACM): Nurse case manager (RN or CDE) reviewed patients' blood glucose (BG) and blood pressure (BP) daily. The nurse case manager titrated medications by contacting the patient in real-time based on the data and by contacting the provider as needed. This protocol planned the 6 months evaluation of HbA1c, BP, and the quality of life (SF-12 score) at baseline, 3 months, and 6 months in TACM intervention.	This study serves to suggest the protocol for telehealth planned in this study without presenting the results. This evidence provides a practical and sustainable remote diabetes management system to help low-income patients achieve and maintain their health goals within established treatment guidelines regardless of geographic location. The study expects to use novel and innovative information technologies to improve communication between patients and providers and increase patient compliance with self-management. This evidence expects patients to improve compliance through positive reinforcement and feedback in real-time for six months. The results of this study are expected to increase the effectiveness of diabetes care, accelerate the implementation of effective treatment plans, and bring about continuous improvement in blood sugar control.	Level IV B

Egede et al. [28] Randomized controlled trial of Technology-Assisted Case Management in low-income adults with type 2 diabetes	Randomized Controlled Trial (RCT) One hundred and thirteen adults with HbA1c ≥8% living in rural areas of South Carolina were randomly assigned to the Technology-Assisted Case Management (TACM) group (n=54) and a usual care group (n=59) to evaluate the results of HbA1c of each group at baseline, after 3 months, and after 6 months	The purpose of this study was to examine the effectiveness of nurses' telehealth intervention with facilitating medication titration algorithms through Technology-Assisted Case Management (TACM) in low-income rural adults with poorly controlled type 2 diabetes. Intervention: Participants self-measure blood glucose (BG) and blood pressure (BP) daily with a I-D15g machine and upload it to a central server. The nurse case manager was based on the patient's data uploaded through the web based I-telehealth system for six months to correspond with the patient and titrate the patient's medication according to the pre-designed algorithm.	At the end of 6 months of TACM, the level of HbA1c in the intervention group was significantly lower than that of the usual care group by 0.99%. HbA1c in the intervention group was significantly reduced at 3 and 6 months compared to the 10.1±1.8% at baseline. The levels of each average HbA1c in the intervention group and usual care group were significantly different at three months (P = 0.013) and six months (P = 0.041). TACM (telehealth intervention) through medication titrate by a nurse under the supervision of a physician provides a feasible and sustainable diabetes management system that can be implemented in an effective, safe in resourceless clinical environment. The role of the solitary nurse case manager with telehealth intervention proved to be a model that provides quality care for a substantially large number of patients with diabetes with over 100 people and maintains patient safety.	Level I A
Heitkemper et al. [30] Do health information technology self-management interventions improve glycemic control in medically underserved adults with diabetes? A systematic review and meta-analysis	Systematic review with meta-analysis This review analyzed 13 studies (n=3257 participants) designed with RCT that measured HbA1c as a primary outcome by intervening in health information technology among medically underserved populations with type 2 diabetes. Settings: Most studies were conducted in primary care settings: Federally Qualified Health Centers, public clinics, and community health centers	The purpose of this systematic review and meta-analysis was to investigate the effect of health information technology (HIT) diabetes self-management education (DSME) on glycemic control in medically underserved adults with diabetes. Intervention: 13 studies, designed with RCT focused on interventions in health information technology (HIT) for diabetes self-management to improve the glycemic control in the medically underserved population with type 2 diabetes, were systematically reviewed and were meta-analyzed. The technical applications used in the studies included for this review were internet-based applications, telehealth/ telemedicine intervention, cell phone/ automated telephone, and computer software without internet.	When applied to health information technology (HIT) diabetes self-management education (DSME) intervention, glycemic control is statistically significantly improved, and this result is most effective after six months of intervention. The follow-up period ranged from 3 months to 5 years. The reduction after six months of HbA1c was -0.36, and the follow-up after 12 months was presented as -0.27. The broadening by sensitivity analysis showed that the maximum decrease in HbA1c in Internet-based intervention was -0.50 after six months. Cell phones and automated telephone messages showed the least reduction of HbA1c. The integrated intervention and interaction through telehealth from providers (educator) and clinical providers is the most successful. HIT DSME has potential in medically underserved patients when it focuses on individual tailoring, personalized feedback, and meaningful engagement.	Level I A
Lee et al. [32] Comparative effectiveness of telemedicine strategies on type 2 diabetes management: A systematic review and network meta-analysis	Systematic review with network meta-analysis Telemedicine strategies for care improvement in patients with type 2 diabetes were included in the review, including 107 studies with a randomized controlled trial (RCT): This review used a network meta-analysis to evaluate the effectiveness of treatment in intervention groups and traditional care groups. A total of 16,978 patients included from the studies reviewed.	The purpose of this study was to determine the relative effectiveness and impact of various telemedicine strategies on glycemic control management in patients with type 2 diabetes. Intervention: Ninety-three studies with sufficient information as outcomes by tracking HbA1c or fasting plasma glucose were used for a permutation-based meta-analysis with a random-effects model and network meta-analysis. For other variables passed to the model, the mean of each variable was used in the meta-regression analysis. The interventions included in the studies were tele education, teleconsultation, telemonitoring, tele case-management, and tele mentoring.	The median of the follow-up for telemedicine intervention was six months, and the reduction in a median HbA1c through these interventions was 0.43%. According to the subgroup analysis, the study showed that the reduction of HbA1c was 0.65% in the studies where the duration of intervention was three months and under. Primary outcomes were glycemic controls based on absolute changes in HbA1c, and secondary outcomes were CVD risk factors (blood pressure, serum lipid profiles, fasting blood glucose, and body mass index). All telemedicine strategies were effective in significantly reducing HbA1c compared to usual treatment, with mean difference ranging from 0.37% to 0.71%. The top three most effective telemedicine strategies were teleconsultation, tele case-management plus telemonitoring, and tele education plus tele case-management in order. In intervention providers through Telehealth, nurses accounted for 50% the most.	Level I A
McLendon et al. [31] Enhancing diabetes care through care coordination telemedicine and education: Evaluation of a rural pilot program	Quasi-experimental study with pre/posttest A Retrospective program evaluation of the 12-month rural pilot diabetes care program Provided telehealth intervention and diabetes self-management education (DSME) to medically underserved adults aged 21-76 (n= 55) in a rural area of Southeast Georgia. HbA1c, DSME test score, satisfaction score, and focus group evaluation were presented as outcomes.	The purpose of this study was to provide a comprehensive evaluation of a grant-funded telehealth intervention pilot program targeting rural adult patients with poorly controlled diabetes (HbA1c: greater than 8%). Also, the purpose was to evaluate the establishment of programs in primary care practices focused on improvement in structures and processes affecting patients and organizational outcomes. Intervention: Public Health Clinical Nurse Specialist (PHCNS) provided telehealth nurse case management with the network endocrinology consultation, and provision of diabetes self-management education (DSME). Additionally, the monthly patient telephone follow-up of a bilingual nurse care manager was included in the intervention.	Intervention showed statistically significant reduction in HbA1c (baseline: 10.10%, endpoint: 9.27%, p=0.002). Reduction of mean total cholesterol and blood pressure: clinically significant with a mean of 1.07 mmHg systolic and 0.98 mmHg diastolic improvement. Improvements were made in the diabetes self-management education (DSME) test score (76.23 *vs.* 96.04). There was also a decrease in the use of the Emergency Department (ED) (0.86 *vs.* 0.40), a 51.4% decrease in the cost of using ED. The rate of inpatient admissions was reduced (0.09 *vs.* 0.02), which also showed a 96% reduction in inpatient costs.	Level II B

Saddik, Al-Dulaijan [25] Diabetic patients' willingness to use tele-technology to manage their disease-A descriptive study	Cross-sectional exploratory study The Ministry of National Guard Health Affairs (MNGHA) in the Eastern region of Saudi Arabia conducted a survey measuring the willingness and readiness of using telehealth technology in self-management of diabetes in 102 patients.	The purpose of this study was to investigate the willingness and readiness of diabetic patients in Saudi Arabia to use telehealth monitoring as a tool in the management of diabetes prevalent as a public health problem. Intervention/ Survey: This study is a questionnaire modified version of the Buysse, De Moor, and De Maeseneer (2010), and collected data about willingness to use tele technology to manage their diabetes self-care.	Many patients indicated that they are willing to monitor diabetes data on their own using tele technology: 11.3% of participants reported using telehealth technology daily. 53.8% of participants said they would use it only once a week. Patients recognized that telehealth technology could improve communication (94%), provide a better understanding of diabetes (94%), and help communicate with other patients (82.3%). Patients with high literacy are more likely to manage diabetes on their own. Patients with younger, higher education attainment, Internet access, and type 2 diabetes are more likely to report a willingness to use this technology.	Level III C
Shea et al. [21] A randomized trial comparing telemedicine case management with usual care in older, ethnically diverse, medically underserved patients with diabetes mellitus: 5-year results of the IDEATel study	Randomized Controlled Trial (RCT) Among the medically underserved Medicare beneficiaries with type 2 diabetes in New York State, 1665 participants were included in this study. The IDEATel intervention group (n= 844) and usual care group (n= 821) were randomized and followed up for 5 years. All participants living in a federally designated medically underserved area were enrolled at primary care practice at Columbia University Medical Center, NY or State University of New York (SUNY) Upstate Medical University at Syracuse.	The purpose of this study was to identify changes in HbA1c, LDL cholesterol, and blood pressure levels, clinical management goals demonstrating the effectiveness of the tele nurse case management and home telemedicine units in ethnically diverse, medically underserved Medicare patients with diabetes. Intervention: The Informatics for Diabetes Education and Telemedicine (IDEATel) study interventions are tele nurse case management and home telemedicine unit system. The system consisted of a web-enabled computer with a modem connection to an existing telephone line for video conferencing with nurse case managers. The intervention group received glucometer and BP cuff connected to the home telemedicine unit to upload data into a clinical database. Participants accessed the particular education web page of the American Diabetes Association in regular and low-literacy versions. The intervention was delivered by four nurse case managers applying intervention management algorithms under endocrinologist supervision.	In the intervention group, the average HbA1c decreased from 7.43% to 7.08% (0.35% decrease: adjusted) in one year. HbA1c, after five years in the intervention group, decreased by 0.27% (adjusted) compared to the usual care group. Systolic BP in the intervention group decreased by 4.51 mmHg, and diastolic BP decreased by 4.22 mmHg over five years in adjusted results. The change in 5-year follow-up LDL cholesterol in the usual care group was -13.14 mg/dl, and the reductions in systolic and diastolic BP were 1.70 mmHg and 2.06 mmHg, respectively. Multifactorial improvement is of more considerable clinical significance than the improvement of single risk factors. Larger reductions were observed in studies whose participants had higher baseline HgbA1c. This study observed greater intervention effects in subgroups with an average HgbA1c level >7%.	Level I A
Weinstock et al. [22] Glycemic control and health disparities in older ethnically diverse underserved adults with diabetes	Randomized Controlled Trial (RCT) This study was presented after being approached and analyzed from different angles by researchers from the same group as the intervention in the IDEATel study (Shea et al., 2009) above. Intervention—same as the study (Shea et al., 2009) above	The purpose of this study was to attempt a new analysis to compare outcomes regarding ethnic disparities in the low-income population with diabetes after applying the IDEATel intervention. Intervention: IDEATel intervention provided video conferencing through tele nurse case management every 4-6 weeks, intervening with individual goal setting, self-management training, self-data uploading, and access to the American Diabetes Association education website.	Results of HbA1c by ethnic group at baseline differed: 7.02 ± 1.25% in Non-Hispanic Whites, 7.58 ± 1.78% in non-Hispanic blacks, and 7.79 ± 1.68% in Hispanics. Blacks and Hispanics over time had far fewer uploads than non-Hispanic Whites. Compliance with more data uploads is associated with lower HbA1c values, reflecting improved compliance and success in setting goals. The study found that there was a difference between ethnic/ethnic disparities and ethnic groups due to intervention in low-income people with diabetes. However, comorbidities were similar between racial/ethnic groups. IDEATel intervention can benefit from continued glycemic control in groups with very uncontrolled blood sugar levels, very low-income levels, and low education attainment. The most common goal setting in this group was related to monitoring.	Level I B
Welch et al. [33] Telehealth program for type 2 diabetes: Usability, satisfaction, and clinical usefulness in an urban community health center	Quasi-experimental study with pre/posttest Thirty patients (n=30) diagnosed with uncontrolled type 2 diabetes in an urban community health center participated in a telehealth program for 3 months.	The purpose of this study was to examine the usability and clinical value of the telehealth intervention program provided to improve clinical outcomes in poorly controlled type 2 diabetes patients in urban areas. Intervention: A telehealth program that integrates an electronic pillbox for a remote home monitoring (RHM) was provided for 3 months. RHM has an automatic machine connected to a cellular hub for data upload from the glucometer and automatic BP cuff. The telehealth nurse interventionist received regular RHM data alarms, talked to the patient biweekly. Patient data, a graphic report was sent to their primary care provider.	At 3 months, glycemic control clinically and statistically significantly improved HbA1c -0.6% from a baseline level of 8.3% ($p < 0.05$). The usability of the electronic pillbox was strongly agreed by 90% of the participants. The medication adherence during the 12-week intervention period was 80%. In the use of glucometer and BP monitoring connected to RHM, 88.4% and 84% of participants were strongly agreed. The monthly cost per patient for three months ($220) reached 78% of the total cost for early RHM devices and hub hardware. If the program is extended to one year, the average monthly fee is calculated at $92. As a result, the program can create low cost of care delivery and can be easily integrated into the primary care environment.	Level II C

Wu et al. [34] Evaluation of the clinical outcomes of telehealth for managing diabetes: A PRISMA-compliant meta-analysis	Systematic review with meta-analysis Through a comprehensive search using five databases, this study analyzed the results of 19 randomized controlled trials (n=6294) published between 2005 and 2017. Of the 6294 participants, 3269 were telehealth groups, and 3025 participants were randomly assigned to the usual care group.	The purpose of this study was to provide rigorous evidence to policymakers through a systematic review of a meta-analysis of how diabetes management through telehealth affects clinical outcomes compared to usual care. Intervention: This review focused on the analysis, including large sample size (n>100) of patients with type 1 and type 2 diabetes and RCTs using long-term interventions of telehealth (duration> 6 months). Telehealth strategies analyzed evidence, including tele-education, telemonitoring,teleconsultation, tele case-management, and tele mentoring. Outcomes were evaluated for changes in HbA1c, blood pressure, blood lipids, BMI, and quality of life	Telehealth is more effective than usual care in controlling HbA1c (glycemic index) in people with diabetes (Weighted mean difference=−0.22%; 95% confidence intervals, −0.28 to −0.15; p<.001) Telehealth intervention helped reduce systolic BP and diastolic BP. Telehealth was similar or superior to that in usual care in the results of blood lipids and quality of life. The participants selected in most studies were those who could self-monitor BG and use technology to interact with intervention providers. Targeting patients with higher HbA1c (≥ 9%) levels and providing more frequent interventions (more than six times per year) is likely to confirm a more significant improvement: Change in the reduction in mean of HbA1c in the telehealth group was approximately -1.22% when baseline was above 9.0%, and -0.35% when the baseline was lower than 9.0%.	Level I A
Zhai et al. [35] Clinical- and Cost-effectiveness of telemedicine in type 2 diabetes mellitus: A systematic review and meta-analysis	Systematic review with meta-analysis Thirty-five studies up to 2014 using RCT for telehealth intervention reporting HbA1c as a quantitative outcome were meta-analyzed according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.	The purpose of this study was to analyze the 35 RCT studies to evaluate the clinical and cost-effectiveness of glycemic control in emerging telemedicine patients with type 2 diabetes. Intervention: Intervention: The studies included in this meta-analysis were randomized controlled trials that include telemedicine-based interventions as defined by the WHO definition of telehealth/ telemedicine. Each study included telehealth interventions performed on adult patients diagnosed with type 2 diabetes and taking insulin or oral glycemic agents. The primary outcome was assessed as HbA1c, and the secondary outcome was determined by measuring the incremental cost-effectiveness ratio to assess cost-effectiveness.	After using a random-effects model of analysis, the overall analysis showed a small but significant decrease in HbA1c in the intervention group compared to the control group (pooled difference in means=−0.37%). The difference in HbA1c between the two groups in telephone-based interventions was significantly lower in the intervention group than in the control group (pooled difference in means=−0.53%). Compared to the usual care group, patients receiving Internet-based intervention showed the most significant decrease in HbA1c (pooled difference in means= -0.62%). Cost-effectiveness analysis showed ICERs of $491 and $29,869 per capita for each unit reduction in HbA1c, for the telephone-based interventions and internet-based interventions, respectively (cost efficiency was assessed in only two studies).	Level I A
Note: The evidence level and strength of articles in this summary table are classified according to the Evidence Level and Quality Guide from the Johns Hopkins Nursing Evidence-Based Practice. Adapted from 'Johns Hopkins Nursing Evidence-Based Practice: Models and Guidelines (3rd ed.),' by D. Dang, Dearholt S [24].				

into the program structures and intervention contents. Carter et al. [29] included a culturally competent health education portal and system of uploading self-measured biometric data in a nine-month telehealth self-management program. This intervention was provided for 30 minutes to the intervention group every other week by telehealth nurse visits. Davis et al. [27] provided 13 sessions of telecare intervention to the telecare group for 12 months and compared outcomes with the control group. The intervention included diabetes self-management education, the setting of individual and group goals at each session, and the completion of a recorded log. This program was provided by a nurse, dietician, and certified diabetes educator. Egede et al. [26,28] organized two studies by planning protocols and interventions for research on telehealth systems. They planned and intervened in the use of the Innovative FORA telehealth system for coastal low-income adults with type 2 diabetes. This intervention evaluated the effectiveness of technology-assisted case management (TACM) at 3 and 6 months. The blood glucose and blood pressure data that patients self-measured and transmitted to the FORA telehealth system were reviewed daily by the nurse case manager. Patients' medications were titrated according to an algorithm. Patients received positive reinforcement and feedback in real-time.

In a systematic review with a meta-analysis conducted by Heitkemper et al. [30], they analyzed RCT studies that performed diabetes self-management education through health information technology based on community primary health care settings for medically underserved populations with type 2 diabetes. The intervention contents used in the studies included in this review were internet-based applications, telehealth or telemedicine intervention, cell phone intervention, automated telephone, and computer software without the internet. McLendon et al. [31] provided diabetes self-management education (DSME) through a 12-month telehealth intervention for rural adults with hemoglobin A1c greater than 8%. In the Intervention contents, a public health clinical nurse specialist (PHCNS) performed nurse case management through the telehealth system and incorporated DSME. Also, the monthly telephone follow-up was performed by a bilingual nurse care manager. Saddik and Al-Dulaijan [25] conducted a survey at Saudi Arabia's Ministry of National Guard Health Affairs (MNGHA) to investigate the willingness and readiness of telehealth use of adults with diabetes in the public health sector. This was not an experimental study that conducted an intervention.

This study reported the potential of active diabetes management to improve patient communication using telehealth technologies on self-management of diabetes in public health.

Shea et al. [21] provided a telehealth nurse case management and home telemedicine unit system for five years of IDEATel (Informatics for Diabetes Education and Telemedicine) intervention for ethnically diverse and medically underserved patients with diabetes. The intervention group received a glucometer and blood pressure device to transfer the data to the clinical database. Patients also received regular and low-literacy versions of the American Diabetes Association (ADA)'s education web pages. Patients' medications were titrated using intervention algorithms by nurse case managers under endocrinologist supervision. Weinstock et al. [22] analyzed the results of IDEATel interventions conducted in Shea et al.'s [21] study from a different

angle and found the impact of telemedicine interventions every 4-6 weeks on the ethnic disparity in the low-income population. Welch et al. [33] integrated a type II diabetes medication electronic pillbox and remote home automated glucometer and blood pressure device into the telehealth intervention.

A telehealth nurse interventionist provided the intervention in this program. The telehealth nurse interventionist provided minimal diabetes education every other week, and patient data and graphic reports were sent to each primary care provider. Wu et al. [34] included telehealth interventions for more than six months, including tele-education, tele-monitoring, tele-consultation, tele-case management, and tele-monitoring, as strategies in a study in which meta-analysis was performed through 19 randomized controlled trials. They demonstrated that more frequent interventions in patients with hemoglobin A1c above 9% were associated with improved glycemic control. Zhai et al. [35] reviewed the cost-effectiveness of telehealth intervention in patients with type 2 diabetes through meta-analysis. Telephone-based and internet-based interventions showed significant improvement in hemoglobin A1c levels (pooled difference in means= -0.53% and pooled difference in means= - 0.62%, respectively).

The telehealth solutions included in the thirteen studies used in this review introduce the comprehensive potential for patient-centered care by enhancing patient self-management and empowerment. In telehealth platforms used in most community primary care settings reported by the studies in this review, nurses, clinical nurse specialists, or certified diabetes educators provide intervention or programs with patient engagement and empowerment as telehealth interventionists or managers. Also, the interventions included in this review demonstrate success in achieving goals and improving interactions, medication adherence through remote monitoring, and communication between patients and telehealth providers [22]. The use of the telehealth platform in medically underserved populations with diabetes has been reviewed and integrated into this section by the literature to support the recommendations of evidence-based interventions with the outcome of effective glycemic control via improved hemoglobin A1c levels.

Best Practice Model Recommendations

The participant samples included in thirteen studies used in this review ranged from as little as 47 participants [29] to as many as 16,978 in a meta-analysis [32]. Hemoglobin A1c levels were the primary outcome for diabetes telehealth interventions, and these levels were significantly improved in all eleven studies. In particular, telehealth intervention for uncontrolled diabetic patients with hemoglobin A1c, which was higher than 9%, reported that endpoint hemoglobin A1c decreased to lower than 7% in glycemic control, resulting in a more significant outcome [29]. In medically underserved patients with diabetes, the telehealth interventions displayed care quality, care coordination with patient healthcare access, as well diabetes self-management compliance, which have been reported in most literature.

Care quality: telemonitoring and frequent data reporting

Best practice in telehealth methods presented in these studies is the use of telemonitoring, which provides medication compliance, frequency of blood glucose testing, and enhanced empowerment in lifestyle changes in terms of patient self-care quality. This telemonitoring practice procedure involves a process by which patients with diabetes upload or report biometric data, including their blood glucose from a home remote care unit device, and transmit or report it to a central telehealth system. Many studies have demonstrated that each patient's efforts to measure and report this self-data make significant improvement in glycemic control [21,22,28,29,32,33]. The telemonitoring platform requires the establishment of a hub-type remote monitoring device. It needs Bluetooth compatibility that allows frequent reporting of biometric data, including blood glucose, to be placed on the individual patient's side. A better hemoglobin A1c level can be expected by reflecting the success of compliance and goal achievement [22]. Telemonitoring interventions with data transmission or reporting showed significant improvement in hemoglobin A1c levels, ranging from -0.22% to -2.28%, but differences are dependent on the intervention periods [21,29,33].

Healthcare access: patient interactions through telehealth manager

From this literature review, the best practice in terms of effective improvement of health care access has focused on motivating patients through patient interactions with telehealth managers or interventionists and regular reinforcement. Additionally, telehealth interventions improved care access through increased patient self-management efficacy, generation of the care partnership between patient and provider, and active achievement of health goals [25,29,30,34]. Studies presenting interactions, including regular real-time two-way video visits between patients and telehealth managers, reported meaningful descriptive patient satisfaction with a decrease in hemoglobin A1C levels. These continued patient-provider interactions were designed as a practice platform in which self-measured blood glucose levels were reviewed for each video visit, drugs were adjusted according to the provider's instructions if necessary, and mutual goals were set up again [21,22,28,29,32,33]. The interaction intervals of the studies included in this review were planned from as little as two weeks to as long as six weeks. For regular and robust reinforcement, most studies set up patient interaction intervals every two weeks, and intervention periods showed the most significant improvement in hemoglobin A1C at three or six months [28-30,32,33].

Clinical outcomes: goal attainment and glycemic control

The goal of lowering hemoglobin A1c levels by improving clinical outcomes in diabetic patients has been suggested in almost all of the reviewed literature as the primary outcome to improve symptoms and minimize diabetic complications. It has been reported that diabetes management in a community primary care setting is more effective when telehealth interventions are used for self-monitoring habits and adherence to diet and exercise in low-income patients [26]. The results of the above interventions reflected that telehealth intervention can improve diabetes self-management habits and outcome monitoring in relation to glycemic control resulting from hemoglobin A1c levels [27].

Discussion

Best practice recommendations

The best practices regarding telehealth infrastructure recommended through this literature review provide definite answers to the PICOT question presented before. The effectiveness of a telehealth care platform for medically underserved multi-ethnic patients with diabetes in the community primary care setting has been confirmed through an integrated literature review that increases care quality, promotes access to culturally competent medical services, and improves glycemic control as clinical outcomes. In medically underserved populations, it has been confirmed that diabetes care quality can be supported through frequent blood glucose data reporting and telemonitoring infrastructure [21,29]. Therefore, continued telemonitoring for this population is worth considering as an EBP intervention. This telemonitoring is a method

of providing participants with Bluetooth glucometers that can transmit or report blood glucose data to the central telehealth system. Telehealth interactions can also be planned where the participants are taught how to use telehealth system, and self-measured blood glucose data is obtained, analyzed, and returned as feedback. Those interventions are expected to improve patient compliance with oral diabetic agents or insulin, blood glucose monitoring, and diabetes self-care quality.

Implications for advanced practice nursing

Improving healthcare access in the medically underserved multi-ethnic population with diabetes is expected to be a culturally competent approach through continuous patient interactions, regular reinforcement, and improved self-management efficiency through individual real-time interactive video visits between patients and telehealth managers. According to the best practice recommendations from the reviewed literature, many studies recommend providing an appropriate time interval of every other week to provide reinforcement for patients through telehealth visits. Also, the intervention periods in various studies were set up for 3-6 months for strong patient motivation. In addition, the intervention of bilingual interpreters, telehealth interventionists, and personalized feedback provided through advanced nurse case management offers the potential to improve healthcare access in multi-ethnic, vulnerable, or non-English speaking patients [30,32]. In order to improve the ultimate patient outcome, glycemic control, most of the researchers proceeded by attempting to improve hemoglobin A1c in the telehealth intervention group. Improving individual hemoglobin A1c can be a primary clinical outcome through telehealth intervention and a short-term goal set by patients. Also, if the patient sets goals focusing on self-measured blood glucose, outcomes of improved glycemic control and more detailed diabetes support according to self-diabetes management habits can be expected [22].

Through the telehealth platform development in the community, effective diabetic management in the primary health care setting can be expected using a meaningful transaction of patient relationships obtained from the interactions between patients and providers through advanced practice nursing with mutual goal set-up in medically underserved multi-ethnic populations.

Limitations

There were several limitations in the literature reviewed. Some studies mentioned that it was difficult to show consistency in surveys and data collection as well as interpretation for participants in the community due to various circumstances. In addition, other studies report that medical care was hampered by limitations in technology, staff resources, and cost for case management.

Conclusion

The purpose of this integrative literature review was to examine a basis for developing an evidence-based practice platform through telehealth interventions to support effective management of diabetes in medically underserved populations and improve care access and glycemic controls as patient outcomes. Almost all telehealth intervention platforms for vulnerable populations in the community influenced glycemic control through improving care access and self-monitoring compliance. Therefore, this literature review highlighted the evidence for the best telehealth practice model and recommendable interventions that could be implemented in community health practice based on comprehensive integration of the best relevant evidence. In medically underserved patients with diabetes, the telehealth interventions displayed care quality, care coordination with patient healthcare access, as well diabetes self-management compliance, which have been reported in most literature.

References

1. International Diabetes Federation (2017) IDF diabetes atlas: (Eighth edn) 2017.
2. https://www.who.int/news-room/fact-sheets/detail/diabetes
3. https://www.un.org/sustainabledevelopment/health/
4. United Nations (2016) Sustainable goals development: UN health agency calls for global action to halt rise in and improve care for people with diabetes.
5. American Diabetes Association. (2020) The cost of diabetes: The staggering costs of diabetes.
6. Centers for Disease Control and Prevention. (2020). National diabetes statistics report 2020: Estimates of diabetes and its burden in the United States.
7. Spanakis EK, Golden SH (2013) Race/ ethnic difference in diabetes and diabetic complications. Curr Diabetes Rep 13: 814-823.
8. Sivaprasad S, Gupta B, Gulliford MC, Dodhia H, Mohamed M, et al. (2012) Ethnic variations in the prevalence of diabetic retinopathy in people with diabetes attending screening in the United Kingdom. PLos One 7:e32182.
9. Berkowitz S, Fabreau G, Raghavan S, Kentoffio K, Chang Y, et al. (2016) Risk of developing diabetes among refugees and immigrants: A longitudinal analysis. J Community Health 41:1274-1281.
10. Montesi L, Caletti MT, Marchesini G (2016) Diabetes in migrants and ethnic minorities in a changing world. World J Diabetes 7:33-44.
11. Sun C (2015) Immigrant health and the intersection of type 2 diabetes and non-endemic infectious diseases in the United States. J Global Health 5: 18–23.
12. World Health Organization (2018) Report on the health of refugees and migrant in the WHO European region: No public health without refugee and migrant health.
13. www.who.int/entity/migrants/about/mh-factsheet.pdf?ua=1.
14. https://www.cdc.gov/coronavirus/2019-ncov/community/health-equity/race-ethnicity.html
15. Dallo FJ, Borrell LN, Williams SL (2008) Nativity status and patient perceptions of the patient-physician encounter: Results from the commonwealth fund 2001 survey on disparities in quality of health care. Medical Care 46:185-191.
16. Dallo FJ, Wilson FA, Stimpson JP (2009) Quality of diabetes care for immigrants in the U. S. Diabetes Care 32:1459-1463.
17. Health Policy Institute. (n.d.). Cultural competence in health care: Is it important for people with chronic conditions? Georgetown University. https://hpi.georgetown.edu/cultural/
18. Schmittdiel JA, Gopalan A, Lin MW, Banerjee S, Chau CV, et al. (2017) Population health management for diabetes: Health care system-level approaches for improving quality and addressing disparities. Curr Diabetes Rep 17:31.
19. Truong M, Paradies Y, Priest N (2014) Interventions to improve cultural competency in healthcare: A systematic review of reviews. BMC Health Services Res14:99.
20. Institute of Medicine Committee (2002) The future of the public's health in the 21st century: The healthcare delivery system. National Academies Press.
21. Shea S, Weinstock RS, Teresi JA, Palmas W, Starren J, et al. (2009) A randomized trial comparing telemedicine case management with usual care in older, ethnically diverse, medically underserved patients with diabetes mellitus: 5-year results of the IDEATel study. J Am Med Inform Assoc 16:446-456.
22. Weinstock RS, Teresi JA, Goland R, Izquierdo R, Palmas W, et al. (2011) Glycemic control and health disparities in older ethnically diverse underserved adults with diabetes: Five-year results from the informatics for diabetes education and telemedicine (IDEATel) study. Diabetes Care 34:274-279.
23. https://www.mendeley.com/reference-management/referencermanager
24. Dang D, Dearholt S (2018) Johns Hopkins nursing evidence-based practice: Model and guidelines (3rd ed.). Sigma Theta Tau International.
25. Saddik B, Al-Dulaijan N (2015) Diabetic patients' willingness to use tele-technology to manage their disease- A descriptive study. Online J Public Health Inform 7:e214.

26. Egede LE, Strom JL, Fernandes J, Knapp RG, Rojugbokan A (2011) Effectiveness of technology-assisted case management in low-income adults with type 2 diabetes (TACM-DM): Study protocol for a randomized controlled trial. Trials 12:231.

27. Davis RM, Hitch AD, Salaam MM, Herman WH, Zimmer-Galler IE, et al. (2010) Telehealth improves diabetes self-management in an underserved community: Diabetes telecare. Diabetes Care 33:1712-1717

28. Egede LE, Williams JS, Voronca DC, Knapp RG, Fernandes, JK (2017) Randomized controlled trial of technology-assisted case management in low-income adults with type 2 diabetes. Diabetes Technology & Therapeutics, 19:476-482.

29. Carter EL, Nunlee-Bland G, Callender C (2011) A patient-centric, provider-assisted diabetes telehealth self-management intervention for urban minorities. Perspect Health Inf Manag. 8(1b).

30. Heitkemper EM, Mamykina L, Travers J, Smaldone A (2017) Do health information technology self-management interventions improve glycemic control in medically underserved adults with diabetes? A systemic review and meta-analysis. J Am Med Inform Assoc 24:1024-1035.

31. McLendon SF, Wood FG, Stanley N (2019) Enhancing diabetes care through care coordination, telemedicine, and education: Evaluation of a rural pilot program. Public Health Nur 36:310-320.

32. Lee SWH, Chan CKY, Chua SS, Chaiyakunapruk N (2017) Comparative effectiveness of telemedicine strategies on type 2 diabetes management: A systematic review and network meta-analysis. Scientific Reports 7:12680.

33. Welch G, Balder A, Zagarins S (2015) Telehealth program for type 2 diabetes: Usability, satisfaction, and clinical usefulness in an urban community health center. Telemedicine e-Health 21:1-9.

34. Wu C, Wu Z, Yang L, Zhu W, Zhang M, et al. (2018) Evaluation of the clinical outcomes of telehealth for managing diabetes: A PRISMA-compliant Meta-Analysis. Medicine 97:e12962.

35. Zhai Y, Zhu W, Cai Y, Sun DD, Zhao J (2014) Clinical- and cost-effectiveness of telemedicine in type2 diabetes mellitus: A systematic review and meta-analysis. Medicine, 93:e312.