Telemedicine for Disparity Patients With Diabetes: The Feasibility of Utilizing Telehealth in the Management of Uncontrolled Type 2 Diabetes in Black and Hispanic Disparity Patients; A Pilot Study

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Abstract

Background: Non-Hispanic Black (NHB) and Hispanic/Latinx (H/L) patients bear a disproportionate burden of type 2 diabetes and associated complications. Regular visits to a primary care doctor or diabetes specialist are warranted to maintain glycemic control, but for a myriad of reasons disparity populations may have difficulties receiving diabetes care. We seek to determine the feasibility of telehealth added to care as usual and secondarily to improve health outcomes (hemoglobin A1c [HbA1c]) in NHB and H/L with uncontrolled type 2 diabetes managed with two or three noninsulin agents.

Methods: Twenty-nine patients were randomized to monthly phone calls or weekly to biweekly telehealth visits. Feasibility outcomes were summarized descriptively for the telehealth arm. Differences scores for A1C level and surveys were computed between baseline and three months and compared across arms using a two-sample t test or Mann-Whitney U test.

Results: Patients in the telehealth arm completed a median of eight visits (IQR: 5, 8), and 53% of those in the telephone arm completed 100% of their calls. Change in HbA1c was greater for those in the telephone arm (−2.57 vs −2.07%, $P = .70$) but the mean baseline HbA1c was higher in the telephone group (11.1% vs 10.3%). Although the change in HbA1c was not statistically different across arms, it was clinically significant.

Conclusions: Augmenting care as usual with telehealth provided by telephone or tablet can be of benefit in improving glycemic control in NHB and H/L with type 2 diabetes. Larger studies need to explore this further.

Keywords

diabetes, disparities, outpatient, telehealth

Introduction

In 2020, the prevalence of type 2 diabetes (T2D) is 34.2 million or 10.5% of the US population, with roughly 20% of persons being undiagnosed.¹ Diabetes disproportionately affects non-Hispanic Blacks (NHB: 16.4%) and Hispanic/Latinx (H/L: 14.7%) when compared to non-Hispanic Whites (NHW: 11.9%).¹ These increased rates of diabetes also correlate with higher rates of retinopathy, end-stage renal disease (ESRD), and limb amputation in NHB and H/L patients as compared to NHW.² This occurs for a myriad of biological reasons, including genetic predisposition and variance in fat distribution.³ Furthermore, psychosocial variables contribute to poor diabetes care, which in part

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arise from limited financial resources,⁴ lower health literacy rates,⁵ diet,⁶ language barriers,⁷ poor self-management practices,⁸ and limited access to care.⁹

One way to circumvent limited access to care is by using telehealth to augment care as usual. Telehealth is defined as “the use of electronic information and communications technologies to provide and support health care when distance separates the participants.”¹⁰ Telehealth offers flexibility to underserved disparity patients who may have difficulty accessing traditional health care services and possibly reduce cost of disease burden and hospitalizations while increasing convenience and access to care. Systematic reviews of telehealth use in diabetes have been associated with improvements in glycemic control, blood pressure, and/or foot care.^{11–15} Telephone calls, videoconferencing, online portals, and mobile applications can potentially be used for diabetes-related health services such as diabetes self-management education and support, retinal examination, blood glucose pattern management, and participation in motivational support groups.¹¹

Despite the successes of telehealth, there have also been challenges, including: equipment cost,¹⁶ connectivity issues,¹⁷ privacy concerns,¹⁸ lack of perceived benefit by the patient,¹⁹ and the depersonalization of the experience.²⁰ Another limitation is evidence of efficacy in disparity populations: NHB and H/L patients tend to be underrepresented in telehealth trials despite their higher rates of diabetes.²¹ The largest and longest trial of diabetes telehealth in a diverse sample is The Informatics for Diabetes Education and Telemedicine (IDEATel) Project, which evaluated the long-term health outcomes of telemedicine provided by a registered nurse compared to care as usual over a five-year period to 1655 NHB, H/L, and NHW patients.²² Although the telehealth intervention was successful in facilitating glycemic control, with significant hemoglobin A1c (HbA1C) improvements in the intervention arm compared to care as usual at years four and five,²³ it also found that NHB and H/L patients had significantly fewer glucose uploads than NHW. In addition, the cost of the equipment at \$622 per person per month made it prohibitively expensive. In the decade since the IDEATel trial was published, the cost of technology has decreased and the technology itself has become more accessible; it is therefore important to revisit the issue of usability in disparity populations.

In this pilot, we seek to explore the usability of an in-home telehealth program with endocrine consultation for NHB and H/L patients with T2D to evaluate its effects on health outcomes and quality of life measures. Based on previous studies, our hypothesis is that patients in the telehealth intervention arm will have statistically greater improvements in adherence and health outcomes relative

Table 1. Patient Demographics (N=22) of Those Included in the mITT.

	Telehealth N=9	Telephone N=13
Gender, n (%)		
Male	5 (50.00)	5 (50.00)
Female	4 (33.33)	8 (66.67)
Age (years)		
Mean (SD)	56.56 (7.97)	58.69 (11.80)
Race/ethnicity, n (%)		
Black/African American	8 (47.06)	9 (52.94)
Hispanic/Latino	1 (20.00)	4 (80.00)

to the telephone arm, as well as greater improvements in quality of life measures. Positivity of these outcomes would suggest that telehealth is a feasible method of diabetes control.

Methods

Design

Written consent was obtained and patients were told that their data would be used anonymously for future publication. Subjects who consented to the study were randomized by a 1:1 ratio to either the telephone or intervention (telehealth/video call) arms using REDCap software. The total participation time for each subject was three months.

Participants

This pilot study sought to enroll a total of 30 participants with T2D who are either Black or Hispanic, 22 of which were included in the modified intention-to-treat (mITT) analysis (Table 1). Enrollment began in October 2016 and ended June 2019. Patients were recruited from six general internal medicine practices located in Queens and Nassau—New York counties that are affiliated with a large health system located in the New York metropolitan area. Eligible participants were defined as adult male and female 18 years or older who identified as Black/African American or Hispanic/Latino, English speaking, active diagnosis of T2D, last known HbA1c level of $\geq 9\%$, currently prescribed two or more anti-diabetes, noninsulin agents, and had access to a phone. Patients who had a history of type 1 diabetes (T1D), active pregnancy or history of cognitive impairment were excluded from participation. IRB approval and patient consent were acquired prior to the start of any research-related activities. Potential subjects were identified through the Allscripts® Electronic Medical Record (EMR), weekly data reports, and provider referrals.

Intervention

Patients who were randomized to the intervention group received a telehealth unit from a third party vendor, Health Recovery Solutions (HRS). The telehealth unit consisted of a Samsung® Tablet with 4G LTE connectivity provided by AT&T as well as Bluetooth wireless peripherals: blood pressure monitor, scale, and pulse oximeter (Figure 1). Subjects were trained by the research coordinator and also received handouts with instructions. HRS also provided 24/7 technical support to subjects. Subjects received a total of eight video calls with an endocrinology attending or fellow (once a week for month one and then biweekly for months two and three). They were asked the same scripted questions (Table 2). Subjects were asked to upload their blood pressure, weight, pulse oximetry, blood glucose, physical activity, and complete a brief risk survey (Figure 2) on a daily basis. They also had a daily medication reminder. Using the tablet, subjects were able to contact the research team through audio calls, video calls, and text-messaging. The research team would then review the data and interface with subjects using the HRS ClinicianConnect™ desktop software. A subject's primary care provider (PCP) was contacted on a need-only basis if there were any significant complaints or changes that needed to be made (ie, modification to medication regimen).

Care as Usual

Those who were randomized to the telephone arm received a phone call once a month (three total) from an attending endocrinologist or endocrinology Fellow. Subjects were asked about their current medications, diet, and lifestyle (Table 3), and recommendations were made as necessary.

Clinical End Points

The primary goal of this study was to assess the feasibility of using telemedicine to aid patients from disparity communities in managing their diabetes. Feasibility was determined by assessing the number of scheduled telemedicine visits, number of glucose uploads per week, and the Telehealth Satisfaction and Usefulness Questionnaire (TSUQ). Secondary goals for the study were to compare clinical outcomes (HbA1c and hypoglycemia) for patients receiving telemedicine versus telephone call at baseline and three months, and to compare patient satisfaction and quality of life in patients receiving telemedicine versus telephone calls. Both groups were also asked to complete a series of self-reported survey measures at baseline and three months. Measures included the Patient Health Questionnaire-9 (PHQ-9), Short-Form Patient Satisfaction Questionnaire (PSQ-18), Problem Areas in Diabetes Questionnaire (PAID), Diabetes Quality of Life (DQOL), and Diabetes Distress Scale (DDS).

Figure 1. Telehealth tablet and peripherals.

Statistical Methods

TSUQ,²⁴ PHQ-9,²⁵ DDS,²⁶ PAID,²⁷ DQOL,²⁸ and PSQ²⁹ questionnaires were summarized according to prior literature. Difference scores between study initiation and study end were computed for A1C level and PHQ-9, DDS, PAID, and DQOL scores (difference = end-initiation). Analyses were based on a modified mITT population. The mITT population was defined as at least one visit. For the treatment arm, this was one telehealth visit and for the telephone arm this was one phone call.

Baseline characteristics (age, sex, race, HbA1C) were summarized descriptively across arms for the mITT population. To assess feasibility, the primary goal, feasibility outcomes (number of telemedicine visits, number of glucose uploads), and TSUQ scores were summarized using mean, standard deviation, min, and max for the telehealth arm. To assess clinical outcomes, the secondary goal, difference scores for A1C level, and PHQ-9, DDS, PAID, and DQOL scores were summarized using mean and standard deviation and compared across arms using the two-sample t test or Wilcoxon Rank Sum test. All analyses were performed using SAS Studio version 3.8.

Results

Feasibility

Of the 25 patients randomized, one participant in the telehealth arm and two participants in the telephone arm did not complete any calls and therefore did not meet the mITT criteria and were excluded from analysis (10% and 13%, respectively). Of patients who completed at least one call in the telehealth arm, the median number of telemedicine calls completed was eight of eight possible calls (IQR: 5, 8). 75% (six of eight) of those who completed the TSUQ indicated a high level of satisfaction (Table 4). The median number of calls completed in the telephone arm was three of three

Table 2. Telehealth group phone script.

Subject ID	
Name	
Group	Telehealth

Calls	Date	Time	Completed (Y/N)	Number of Calls	Answer (Y/N)	Duration
I						

Questions	Answer	Recommendations
Do you have any complaints?		
How is your experience with the Telehealth Device		
How are things with taking your medications?		
Any issues? Side effects?		
Have you been eating at least 3 meals a day?		
Are you eating at least every 4-6 hours?		
What does your diet consist of?		
Do you eat after 8pm?		
Are you engaging in any physical activity?		
How many hours do you sleep on average?		
Do you snore?		
Are you experiencing any Hyper or Hypoglycemia more than 2x a week?

Figure 2. Check-in survey on the tablet.

possible calls (IQR: 2, 3). Eight of those in the telephone arm completed all three of their calls, and another three completed two of three calls.

Clinical Outcomes

The mean HbA1c change at three months was greater for the telephone arm (−2.57%) than that in the intervention arm (−2.07%), but the difference was not statistically significant. It does, however, have clinical significance, as the telephone arm on average had a higher baseline HbA1c (10.3% vs 11.1%). Men had a greater mean change in HbA1c at three

months when compared to women (−2.84% vs −1.58%), which—although clinically significant—was not statistically significant. The sample was too small to assess a difference between NHB and H/L.

Hypoglycemia was only experienced by one patient in the telehealth arm who was taking sulfonylurea and metformin, so he was advised to take a half tablet and not go more than six hours without eating.

Quality of Life Measures

There were no differences in the average scores for depression as measured by the PHQ-9, in diabetes distress as measured by the DDS and PAID, or in the QOL scales.

Discussion

NHB and H/L have largely been underrepresented in studies with regard to telehealth and T2D.²¹ This study not only adds to this limited literature but was unique in that it included NHB and H/L persons who were both American and foreign-born.

Feasibility/Attrition

Overall, 30 patients were consented to participate in the study and 29 were randomized. Of the remaining 29 patients,

Table 3. Telephone arm phone script.

Name	
Group	Control

Calls	Date	Time	Completed (Y/N)	Number of Calls	Answer (Y/N)	Duration
I						

Questions	Answer	PI Recommendations
Do you have any complaints?		
How are things with taking your medications?		
Any issues? Side effects?		
Have you been eating at least 3 meals a day?		
Are you eating at least every 4-6 hours?		
What does your diet consist of?		
Do you eat after 8pm?		
Are you engaging in any physical activity?		
How many hours do you sleep on average?		
Do you snore?		
Are you experiencing any Hyper or Hypoglycemia more than 2x a week?		

seven patients did not meet mITT criteria. The median number of visits in the telehealth arm was eight (out of eight), which is higher than seen in other studies.³⁰ Also in some studies, the number of telehealth visits were not reported and instead only health outcomes were given.³¹

Fourteen of those consented either declined to participate, prematurely terminated their participation in the study, or demonstrated poor adherence to the study protocol. These patients were invited to participate in semi-structured interviews about the study. Eight of these agreed to engage in semi-structured interviews about the study. As documented in our previous study, the most common reasons for not completing the study were: disinterest, inconvenience, lack of perceived benefit, lack of awareness of T2D diagnosis, and perceived lack of ability to do the study¹⁹ (Table 5). Other studies have shown the same results as well as other causes for dropping out including: technology issues, irrelevant and incomprehensible content, or preferring face-to-face visits.³¹

Tablet/Peripherals

The tablet was delivered to subjects with several peripherals: blood pressure cuff, scale, and pulse oximeter. Patients used their own meter and uploaded their levels. Participants had mixed reviews about the peripherals. One noted that her long nails prevented her from using the pulse oximetry device.

Another asked if she could purchase the blood pressure cuff whereas two did not like how it felt.

One of the disadvantages of using a tablet is that if patients left their tablet at home, they were not able to keep up with the daily uploads. One participant who dropped out after three visits noted that he travelled frequently and would leave his tablet at home. In addition, he did not have a meter so he never provided any blood sugar uploads. Connectivity issues were also problematic. One patient would take his tablet with him to work and due to the poor reception in his building the connection was often poor. Three others had issues at home. A couple of participants had problems with the tablet shutting off; for one participant this occurred as he was not charging his tablet daily.

Satisfaction

Those in the telehealth arm were overall satisfied with the tablet. One patient noted: "It made me more knowledgeable. Checking sugar helped a lot." Another participant noted: "I love it. I am going to miss it. And to get a live person even once a week." Six of the 10 in the telehealth arm completed the TSUQ. Overall, the satisfaction and usefulness of telehealth was high. On a scale of one to five with five being the most favorable, there was a median score of five for satisfaction and 4.24 for usefulness, respectively. The telehealth

Table 4. Telehealth Feasibility/TSUQ Outcomes (Telehealth Arm Only).

	Median (IQR)	Mean (SD)
Number of telemedicine visits (8 possible) (<i>n</i> = 9)	8.00 (5.00, 8.00)	6.56 (2.24)
Number of glucose uploads (<i>n</i> = 7)	61.00 (2.00, 68.00)	42.14 (33.48)
TSUQ satisfaction score (<i>n</i> = 6)	4.24 (3.76, 4.90)	4.25 (0.65)
TSUQ usefulness score (<i>n</i> = 6)	5.00 (4.67, 5.00)	4.72 (0.53)

Abbreviation: TSUQ, Telehealth Satisfaction and Usefulness Questionnaire.

Table 5. Patient-Perceived Barriers or Benefits of Telehealth.

Benefits	Barriers
Greater access to their provider	Connectivity
Seeing their provider visually	Too much effort
Appointment flexibility	Having to carry the tablet to work or on vacation
The tablet stores all values	Asymptomatic disease
Being technologically advanced	Cost/Insurance reimbursement

group gave a higher score for satisfaction in response to time with the doctor (Table 6).

Health Outcomes

Surprisingly, the telephone arm had a 0.50% greater reduction in HbA1c (2.07% vs 2.57%, $P = .70$) than the telehealth group. Although this finding was not statistically significant, it would be considered clinically significant, as the Food and Drug Administration (FDA) required a 0.3%-0.4% non-inferiority margin in drug trials for diabetes.³² It is important to note that those in the telephone arm had a higher HbA1c at baseline than those in the telehealth group: 11.1% versus 10.3%. Also, ethnic minorities are noted to have falsely elevated HbA1c due to variations in hemoglobin.³³

Overall, patients in both arms had minimal depressive or diabetes distress symptoms. Interestingly, there was a discrepancy between the two surveys used for diabetes distress in the telephone arm, as noted by their average decrease on the DDS but average increase on the PAID. There were significant differences in the changes of these items from baseline to three months (Table 7).

Cost

Cost has been an ongoing issue in telehealth studies. The cost of having telehealth equipment and the use of a nurse cost up

Table 6. Baseline to Three-Month Change in Outcomes by Arm (Extended Secondary Outcomes).

Variable (difference) (<i>n</i> telehealth, <i>n</i> telephone)	Telehealth arm mean (SD)	Telephone arm mean (SD)
<i>DDS subscores</i>		
Change in DDS emotional burden (<i>n</i> = 6, <i>n</i> = 4)	-0.47 (1.06)	0.05 (0.66)
Change in DDS physician-related distress (<i>n</i> = 6, <i>n</i> = 4)	-0.08 (0.26)	0.13 (0.25)
Change in DDS regimen-related distress (<i>n</i> = 6, <i>n</i> = 4)	-0.23 (0.83)	-0.35 (0.66)
Change in DDS interpersonal distress (<i>n</i> = 6, <i>n</i> = 4)	-0.11 (0.66)	-0.42 (0.63)
<i>DQOL subscores</i>		
Change in DQOL satisfaction (<i>n</i> = 5, <i>n</i> = 3)	-0.05 (0.57)	-0.44 (0.57)
Change in DQOL impact (<i>n</i> = 6, <i>n</i> = 2)	-0.10 (0.29)	-0.15 (0.28)
Change in DQOL worry (social/vocational) (<i>n</i> = 6, <i>n</i> = 2)	-0.45 (0.55)	-0.21 (0.10)
Change in DQOL worry (diabetes related) (<i>n</i> = 6, <i>n</i> = 4)	-0.04 (0.84)	0.25 (0.54)
<i>PSQ subscores</i>		
Change in PSQ general satisfaction (<i>n</i> = 6, <i>n</i> = 4)	-0.25 (0.42)	0.13 (0.48)
Change in PSQ technical quality (<i>n</i> = 6, <i>n</i> = 4)	0.04 (0.37)	0.13 (0.32)
Change in PSQ interpersonal manner (<i>n</i> = 6, <i>n</i> = 4)	0.17 (0.26)	0.25 (0.29)
Change in PSQ communication (<i>n</i> = 6, <i>n</i> = 4)	0.42 (0.80)	0.63 (0.95)
Change in PSQ financial aspects (<i>n</i> = 6, <i>n</i> = 4)	0.50 (1.26)	-0.13 (0.25)
Change in PSQ time with doctor (<i>n</i> = 6, <i>n</i> = 4)	0.58 (0.80)	-0.13 (0.63)
Change in PSQ accessibility/convenience (<i>n</i> = 6, <i>n</i> = 4)	-0.42 (0.26)	-0.06 (0.38)

Abbreviations: DDS, Diabetes Distress Scale; DQOL, Diabetes Quality of Life; PSQ, Patient Satisfaction Questionnaire.

to 117% more than those who had outpatient care as usual.³⁴ The per person expense of having the telehealth device was up to \$8000/year.³⁴ In this study, the HRS device cost \$112.50

Table 7. Outcomes by Telehealth Versus Telephone Arm.

Variable (n telehealth, n telephone)	Telehealth arm mean (SD)	Telephone arm mean (SD)	P value
<i>Primary</i>			
Change in A1C (n = 6, n = 6)	−2.07 (1.99)	−2.57 (2.44)	.7051
<i>Secondary</i>			
Hypoglycemic event, n (%) (n = 8, n = 8)	1 (12.50)	0 (0.00)	1.0000
Follow-up with PCP, n (%) (n = 8, n = 8)	6 (75.00)	6 (75.00)	1.0000
Change in PHQ-9 total score (n = 6, n = 3)	0.00 (5.29)	−0.33 (3.51)	.9253
Change in DDS total score (n = 6, n = 4)	−0.25 (0.63)	−0.13 (0.51)	.7743
Change in PAID total score (n = 6, n = 4)	−1.67 (24.78)	5.63 (5.54)	.5142
Change in DQOL total score (n = 5, n = 2)	−0.10 (0.29)	−0.21 (0.32)	.6848

Abbreviations: DDS, Diabetes Distress Scale; DQOL, Diabetes Quality of Life; PAID, Problem Areas in Diabetes Questionnaire; PCP, primary care provider; PHQ-9, Patient Health Questionnaire-9.

per month, which included the use of hardware, software, wireless peripherals, 24/7 service help, and data storage. Those in the telephone arm bore no expense, as they were called from the hospital landline or the providers' cell phone. Due to the impact of SARS-CoV-2 (COVID-19), our health system (and many others across the country) has since implemented the use of its own telehealth technology so future studies in this area will not be of such a high cost.

Conclusion

Patients in the telehealth arm were generally satisfied with telehealth but their glycemic control improved less than the telephone arm, suggesting that tablets are not the only means of use to obtain glycemic control in those with uncontrolled diabetes. This feasibility study, although limited by a small number of participants shed light on some of the strengths and pitfalls of using telehealth in a group of persons not commonly studied in diabetes telehealth studies. It is imperative to include NHB and H/L in such studies given a disproportionately high burden of diabetes in these patients. The use of telehealth has grown to be even more necessary in the setting of the recent COVID-19 pandemic. The data collected from this study can be used to devise a larger study powered to show the benefit of telehealth use in NHB and H/L persons with diabetes.

Declaration of Conflicting Interests

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References

- Centers for Disease Control and Prevention. National diabetes statistics report. <https://www.cdc.gov/diabetes/data/statistics/statistics-report.html>. Accessed April 23, 2020.
- Chiou T, Tsugawa Y, Goldman D, Myerson R, Kahn M, Romley JA. Trends in racial and ethnic disparities in diabetes-related complications, 1997-2017. *J Gen Intern Med*. 2020; 35(3):950-951.
- Golden SH, Brown A, Cauley JA, et al. Health disparities in endocrine disorders: biological, clinical, and nonclinical factors—an endocrine society scientific statement. *J Clin Endocrinol Metab*. 2012;97(9):E1579-E1639.
- Harris MI. Racial and ethnic differences in health care access and health outcomes for adults with type 2 diabetes. *Diabetes Care*. 2001;24(3):454-459.
- Rubin DJ, Donnell-Jackson K, Jhingan R, Golden SH, Paranjape A. Early readmission among patients with diabetes: a qualitative assessment of contributing factors. *J Diabetes Complications*. 2014;28(6):869-873.
- Oldroyd J, Banerjee M, Heald A, Cruickshank K. Diabetes and ethnic minorities. *Postgrad Med J*. 2005;81(958):486-490.
- Nam S, Chesla C, Stotts NA, Kroon L, Janson SL. Barriers to diabetes management: Patient and provider factors. *Diabetes Res Clin Pract*. 2011;93(1):1-9.
- Levine DA, Allison JJ, Cherrington A, Richman J, Scarinci IC, Houston TK. Disparities in self-monitoring of blood glucose among low-income ethnic minority populations with diabetes, United States. *Ethn Dis*. 2009;19:97-103.
- Peek ME, Ferguson MJ, Roberson TP, Chin MH. Putting theory into practice: a case study of diabetes-related behavioral change interventions on Chicago's South Side. *Health Promot Pract*. 15(2_Suppl):40S-50S.
- Institute of Medicine (US) Committee on Evaluating Clinical Applications of Telemedicine. Introduction and background. In: Field MJ (ed.) *Telemedicine: A Guide to Assessing Telecommunications in Health Care*. Washington, DC: National Academies Press; 1996.
- Bashshur RL, Shannon GW, Smith BR, Woodward MA. The empirical evidence for the telemedicine intervention in diabetes management. *Telemed E-Health*. 2015;21(5):321-354.
- Polisena J, Tran K, Cimon K, Hutton B, McGill S, Palmer K. Home telehealth for diabetes management: a systematic review and meta-analysis. *Diabetes Obes Metab*. 2009;11(10):913-930.

13. Worswick J, Wayne SC, Bennett R, et al. Improving quality of care for persons with diabetes: an overview of systematic reviews - what does the evidence tell us? *Syst Rev*. 2013;2(1):26.
14. Faruque LI, Wiebe N, Ehteshami-Afshar A, et al. Effect of telemedicine on glycated hemoglobin in diabetes: a systematic review and meta-analysis of randomized trials. *CMAJ*. 2017;189(9):E341-E364.
15. Marcolino MS, Maia JX, Alkmim MBM, Boersma E, Ribeiro AL. Telemedicine application in the care of diabetes patients: systematic review and meta-analysis. *PLoS One*. 2013;8(11):e79246.
16. Palmas W, Shea S, Starren J, et al. Medicare payments, healthcare service use, and telemedicine implementation costs in a randomized trial comparing telemedicine case management with usual care in medically underserved participants with diabetes mellitus (IDEATel). *J Am Med Inform Assoc*. 2010;17(2):196-202.
17. ClinicalKey. Telehealth for diabetes self-management education and support in an underserved, free clinic population: a pilot study. <https://www.clinicalkey.com/#!/content/playContent/1-s2.0-S1544319117300201?returnurl=null&referrer=null>. Accessed April 23, 2020.
18. George S, Hamilton A, Baker RS. How do low-income urban African Americans and Latinos feel about telemedicine? A diffusion of innovation analysis. *Int J Telemed Appl*. 2012;2012:715194.
19. Tong T, Myers AK, Bissoonauth AA, Pekmezaris R, Kozikowski A. Identifying the barriers and perceptions of non-Hispanic black and Hispanic/Latino persons with uncontrolled type 2 diabetes for participation in a home Telemonitoring feasibility study: a quantitative analysis of those who declined participation, withdrew or were non-adherent. *Ethn Health*. 2020;25(4):485-494.
20. Benefits and drawbacks of telemedicine. *J Telemed Telecare*. 2005;11(2):60-70.
21. Isaacs T, Hunt D, Ward D, Rooshenas L, Edwards L. The inclusion of ethnic minority patients and the role of language in telehealth trials for type 2 diabetes: a systematic review. *J Med Internet Res*. 2016;18(9):e256.
22. Shea S, Starren J, Weinstock RS, et al. Columbia university's informatics for diabetes education and telemedicine (IDEATel) project rationale and design. *J Am Med Inform Assoc*. 2002;9(1):49-62.
23. Shea S, Weinstock RS, Teresi JA, et al. 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*. 2009;16(4):446-456.
24. Bakken S, Grullon-Figueroa L, Izquierdo R, et al. Development, validation, and use of English and Spanish versions of the telemedicine satisfaction and usefulness questionnaire. *J Am Med Inform Assoc*. 2006;13(6):660-725.
25. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. *J Gen Intern Med*. 2001;16(9):606-613.
26. Fisher L, Hessler DM, Polonsky WH, Mullan J. When is diabetes distress clinically meaningful?: establishing cut points for the diabetes distress scale. *Diabetes Care*. 2012;35(2):259-264.
27. Polonsky WH, Anderson BJ, Lohrer PA, et al. Assessment of diabetes-related distress. *Diabetes Care*. 1995;18(6):754-760.
28. Burroughs TE, Desikan R, Waterman BM, Gilin D, McGill J. Development and validation of the diabetes quality of life brief clinical inventory. *Diabetes Spectr*. 2004;17(1):41-49.
29. Marshall GN, Hays RD. *The patient satisfaction questionnaire short form (PSQ-18)*. Santa Monica, CA: RAND Corporation; 1994. <https://www.rand.org/pubs/papers/P7865.html>.
30. Lie SS, Karlsen B, Oord ER, Graue M, Oftedal B. Dropout from an ehealth intervention for adults with type 2 diabetes: a qualitative study. *J Med Internet Res*. 2017;19(5):e187.
31. Carter EL, Nunlee-Bland G, Callender C. A patient-centric, provider-assisted diabetes telehealth self-management intervention for urban minorities. *Perspect Health Inf Manag*. 2011;8(Winter):1b.
32. U.S. Food and Drug Administration. October 24-25, 2018: meeting of the endocrinologic and metabolic drugs advisory committee meeting announcement. 2019. <https://www.fda.gov/advisory-committees/advisory-committee-calendar/october-24-25-2018-meeting-endocrinologic-and-metabolic-drugs-advisory-committee-meeting>. Accessed May 27, 2020.
33. Nathan DM. International expert committee report on the role of the A1C Assay in the diagnosis of diabetes. *Diabetes Care*. 2009;32(7):1327-1334.
34. Moreno L, Dale SB, Chen AY, Magee CA. Costs to medicare of the informatics for diabetes education and telemedicine (IDEATel) home telemedicine demonstration: findings from an independent evaluation. *Diabetes Care*. 2009;32(7):1202-1204.