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Timothy Xu March 28th, 2017

Telemedicine in the Management of Type 1 Diabetes

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An abstract of
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Abstract

Telemedicine in the Management of Type 1 Diabetes
By Timothy Xu

Background: Veterans with Type 1 Diabetes who live in rural Alabama and Georgia face barriers to receiving specialty diabetes care due a lack of endocrinologists in the Central Alabama VA Health Care System. Telemedicine is a promising solution to help increase access to needed health care. We evaluated the effectiveness of telemedicine in delivering endocrinology care from Atlanta-based endocrinologists to patients in Central Alabama VA clinics that lack endocrinology specialty care.

Methods: We conducted a retrospective chart review of patients who were enrolled in the Atlanta VA Telehealth Endocrine Clinic from June 2014 to October 2016. Outcomes of interest include diabetes outcomes, changes in glycemic control, time-savings for patients, cost-savings for the Veterans Health Administration, telehealth appointment adherence rates, and patient satisfaction with telehealth.

Results: 32 patients with Type 1 Diabetes received telehealth care, and in general received the recommended processes of diabetes care. Patients trended toward a decrease in mean hemoglobin A1c and glucose variability, as well as an increase in hypoglycemic episodes (p = n.s.). Patients saved 78 minutes of travel time (one-way) and the VA saved $72.94 in travel reimbursements per patient visit. Patients adhered to 88% of scheduled telehealth appointments on average, and 100% of surveyed patients stated they would recommend telehealth to other veterans.

Conclusions: Diabetes specialty care delivered via telemedicine to veterans in rural Alabama and Georgia was safe and non-inferior to in-person care. Telemedicine is also associated with time-savings, cost-savings, high appointment adherence rates, and high patient satisfaction. Our findings suggest that the Veterans Health Administration should implement telemedicine on a broader scale.

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Introduction

Background:

The epidemic of diabetes is continuously growing in the United States, affecting 29.1 million Americans (9.3% of the US population), 27.8% of whom are undiagnosed (1). Approximately one in every three adults is expected to have diabetes by 2050, and the estimated annual cost of diabetes in the United States was $245 billion in 2012 (1). Along with the increasing prevalence of diabetes, the health care demand for these patients has also grown. At times, busy primary care providers lack the time and resources to effectively manage their patients' diabetes. One study evaluating resident-staffed general medicine clinics found that residents spent an average of 5 minutes out of 25 minutes on diabetes, and glycated hemoglobin (HbA1c) levels, which are used to screen for and diagnose diabetes, were addressed only 40% of the time (2). As a result, patients with diabetes oftentimes require consultation from specialty medical providers, specifically endocrinologists, to adequately manage their diabetes. However, studies have found that there is currently a shortage of approximately 1,500 full-time endocrinologists nationwide (3). Thus, there is currently a disparity between diabetes care and specialty diabetes providers.

Patients with diabetes who live in rural areas, which is nearly 20% of the U.S. population, face even greater barriers to receiving specialty care (4). Rural patients face long distances and costly travel expenses to urban areas, where specialty care is oftentimes available (5). Thus, Americans with diabetes living in rural communities face heightened challenges in achieving good health, which is consistently demonstrated by poor rankings on health indicators (5).

Telemedicine, the use of medical information exchanged via electronic communications such as clinical video telehealth (CVT) (6), has emerged as a promising solution to help increase

access to needed health care. CVT is real-time videoconferencing between patients and providers, and has become increasingly utilized to increase access to health care for patients who face barriers to care (7). Since health care consumers are becoming increasingly tech-savvy, the implementation of telemedicine is inevitably bound to expand as patients demand more flexibility in the way they receive health care.

The Veterans Health Administration (VHA) has been on the forefront of the telemedicine initiative in the past decade, and has created the Telehealth Services Program to improve patient care and increase access to specialty medical care for veterans with limited access (8). In 2014, the Atlanta Veterans Affairs Medical Center (VAMC) Endocrinology Telehealth Clinic was established to deliver specialty diabetes care to patients with Type 1 Diabetes Mellitus (T1DM) in the Central Alabama VA Health Care System (CAVHCS), where specialty diabetes care is inaccessible since the CAVHCS serves rural communities in Alabama and west Georgia. Since its inception, the Atlanta VAMC Endocrinology Telehealth Clinic has expanded to also serve patients with Type 2 Diabetes Mellitus (T2DM) and other endocrine disorders such as hypothyroidism.

Despite its numerous potential benefits, telemedicine still faces concerns about its clinical and cost effectiveness. Most studies to date have focused on telemedicine's feasibility and accessibility rather than its patient-centered outcomes (9). More studies are needed to determine whether telemedicine delivers the same outcomes as in-person medical visits, and how telemedicine may be integrated into our existing health care system. Here, we aim to delineate the Atlanta VAMC Endocrinology Telehealth Clinic's effectiveness in improving diabetes outcomes for patients with T1DM and to elucidate telemedicine's impact on health care delivery.

Specific Aims:

The Atlanta VAMC Endocrinology Telehealth Clinic has not been studied previously. Our first objective was to determine whether management of T1DM via CVT from the Atlanta VAMC leads to improvements in diabetes outcomes. At 6 and 12 months after initial CVT consultations, we measured changes in glycemic control. Our second aim was to determine telemedicine's capacity to save costs for the VHA and time for patients with T1DM within CAVHCS. Cost and time-savings were calculated based on the difference between costs associated with in-person visits and costs associated with telemedicine visits. Our third objective was to evaluate patient adherence to telemedicine appointments. We calculated the ratio of CVT appointments in which patients showed up and CVT appointments in which patients scheduled. Lastly, our fourth aim was to determine whether patients were satisfied with the care they receive via telemedicine. We administered a patient satisfaction survey, which was created by the Veterans Affairs Telehealth Services program, by telephone.

Hypotheses:

We hypothesized firstly that management of T1DM via CVT leads to improvements in diabetes outcomes and glycemic control. Secondly, we hypothesized that CVT is cost-saving for the Veterans Health Administration and time-saving for patients. Thirdly, we hypothesized that patients with T1DM from CAVHCS who participate in CVT have a high adherence to their telehealth appointments. Lastly, we hypothesized that patients are highly satisfied with the care they receive via CVT.

Methods

Atlanta Veterans Affairs Medical Center Endocrinology Telehealth Clinic Structure

The Central Alabama Veterans Health Care System (CAVHCS) serves over 134,000 veterans in 43 counties of Alabama and Georgia (10). CAVHCS is comprised of two main facilities located in Montgomery, AL and Tuskegee, AL, as well as three outlying primary care Community-Based Outpatient Clinics (CBOCs) in locations such as Columbus, GA. Patients enrolled in CAVHCS have not had access to a local endocrinologist since 2013, so a pharmacist (PharmD) was hired within CAVHCS to assist with the management of patients with diabetes using or needing an insulin pump, which delivers insulin via continuous subcutaneous infusion. Without telehealth, patients enrolled in CAVHCS would need to travel to either the Birmingham VA Medical Center or Atlanta VAMC to receive in-person specialty diabetes care from an endocrinologist.

In 2014, a telehealth agreement between CAVHCS and the Atlanta VAMC was implemented so that the PharmD in CAVHCS would work with an endocrinologist based at the Atlanta VAMC to better manage CAVHCS patients with T1DM. CAVHCS patients are initially referred to the PharmD by primary care providers (PCP) if PCPs feel that their patients would benefit from diabetes management via an insulin pump. The PharmD then assesses the patient to determine whether the patient requires further evaluation and management by an endocrinologist. If a referral is deemed necessary, the PharmD places a referral to the Atlanta VAMC Endocrinology Telehealth Clinic to allow scheduling of a Telehealth Endocrine appointment between the Atlanta VAMC endocrinology provider and the CAVHCS patient. With telemedicine, patients travel to their local CBOC in Montgomery, AL, Columbus, GA, or Carrollton, GA for their specialty diabetes care appointment, which would be conducted by

CVT. Health care providers at local CBOCs, such as Pharmacists and Licensed Practical Nurses, assist patients as they videoconference with Atlanta-based endocrinologists.

Study Design

We conducted a retrospective chart review of patients who participate in the Atlanta VAMC Endocrinology Telehealth Clinic. We collected data from endocrinology CVT visits between June 2014 and October 2016. Data were stored in REDCap, a secure web database application. The use of REDCap for this study was sponsored by the Atlanta Clinical and Translational Science Institute (ACTSI). This study was approved by the Emory Institutional Review Board (IRB) and the Atlanta VA Research and Development (R&D) Committee.

Diabetes Management, Clinical Outcomes, and Glycemic Control

To characterize patients served by the Atlanta VAMC Endocrinology Telehealth Clinic, we collected data on patient demographics and maintenance of standard recommended processes of care, specifically blood pressure management, eye screening, urine microalbumin-to-creatinine ratio, and lipid panels. We also assessed whether patients had received prescriptions for drugs they were eligible for, specifically statins and aspirin. Eligibility criteria for statin use was greater than 40 years old or history of cardiovascular disease, and eligibility criteria for aspirin use was greater than 50 years old or history of cardiovascular disease.

To assess diabetes outcomes, we collected data on change in glycemic control, specifically hemoglobin A1c levels, frequency/severity of hypoglycemia per two weeks, frequency/severity of hyperglycemia per two weeks, and plasma glucose variability. Hemoglobin A1c levels indicate average plasma glucose concentration over two or three months, and is a

strong predictor for diabetes complications (11, 12). Hypoglycemia is defined as low plasma glucose concentration, and may lead to unconsciousness if plasma glucose levels severely fall (11). We defined hypoglycemia as plasma glucose levels less than 70mg/dL, and severe hypoglycemia as less than 40 mg/dL. Conversely, hyperglycemia is defined as high plasma glucose concentration, which may lead to long-term complications such as diabetic retinopathy, nephropathy, and neuropathy (13). We defined hyperglycemia as plasma glucose levels greater than 250mg/dL, and severe hyperglycemia as greater than 300 mg/dL. Frequency of hypoglycemia and hyperglycemia was determined by review of glucose data collected over a two week period either from insulin pump downloads or patients' glucose logs. Lastly, average glucose variability was defined as the standard deviation (S.D.) of all plasma glucose levels in the two-week period prior to telehealth clinic visits.

Glycemic control data were collected at baseline visits, 6 month follow-up visits (plus or minus one month), and 12 month follow-up visits (plus or minus one month).

Veterans Health Administration Cost-Saving and Patient Time-Saving

To evaluate whether diabetes management via telemedicine is an efficient method of health care delivery, we collected data on cost-savings for the VHA and time-savings for patients. Cost-savings for the VHA were calculated based on the difference between patient travel reimbursement costs associated with in-person visits at either the Birmingham VA or Atlanta VA medical centers and costs associated with telemedicine visits at local CBOCs in either Montgomery, AL or Columbus, GA. Travel reimbursements were calculated using reimbursement rates published by the VHA's Beneficiary Travel Benefits program, which was 41.5 cents per mile with a $6 patient deductible (14). For patients who were eligible for VA

reimbursed overnight lodging, lodging costs for one night of $75 were added to the travel cost for an in-person specialty visit to either the Atlanta or Birmingham VA facility.

Time savings were calculated using Google Maps and were based on the difference in estimated time to travel to a Community-Based Outpatient Clinics (CBOC) versus the nearest VA medical center with specialty medical care, specifically the Atlanta VA or Birmingham VA Medical Center.

Patient Adherence to Telehealth Appointments

To evaluate telemedicine's effectiveness in increasing access of health care and patient appointment adherence, we recorded the number of CVT appointments missed (patient did not show up), cancelled, and scheduled. Telemedicine appointment adherence was reported as the ratio of the number of CVT appointments in which the patient showed up to the number of CVT appointments scheduled, excluding the number of appointments cancelled by the patient in advance.

Patient Satisfaction with Telemedicine

To assess whether patients with T1DM are satisfied with telemedicine care via CVT, we administered via telephone a satisfaction survey published by the VA Telehealth Services Program (Figure 1). Patients were asked twelve questions regarding telemedicine's usability and convenience, and their satisfaction was measured using a Likert Scale (1-5), where 1 indicated "strongly agree" and 5 indicated "strongly disagree."

Statistical Analysis

Data analysis was performed using Microsoft Office Excel 2010 (Microsoft Corporation, Redmond, WA), SPSS Statistics Version 23.0 (IBM Corporation, Armonk, NY), and SAS Version 9.4 (SAS Institute Inc., Cary, NC). To analyze changes in diabetes and glycemic control outcomes, we conducted paired t-tests from baseline data, 6 month follow-up data, and 12 month follow-up data. A p-value < 0.05 was considered statistically significant. To analyze results from the patient satisfaction survey, we calculated the median, mean, and standard deviations of patient responses to each survey question.

Results

Demographics:

Among 54 patients were enrolled in the Atlanta VAMC Endocrinology Telehealth Clinic, 32 patients had T1DM (Figure 2). Of the 32 patients with T1DM, 17 had 6 month follow-up visits and 9 had 12 month follow-up visits. Telehealth patients with T1DM were predominately male (N = 29 [91%]) and white (N = 27 [84%]) (Table 2). They had a mean age of 53.5 years old and mean BMI of 27.6 kg/m^2 (Figure 3). Furthermore, comorbidities and diabetes complications were highly prevalent at baseline in this patient population. Most patients presented with hyperlipidemia (N = 26 [81%]) and diabetic neuropathy (N = 23 [72%]).

In general, patients had received the standard processes of diabetes care recommended by the American Diabetes Association (Figure 4) (15). At baseline, 94% patients (N = 30) had had a diabetic retinopathy eye screening within the preceding two years, and 100% (N = 9) received the recommended eye screening by 12 months of follow-up. Furthermore, 81% patients (N = 26) had their urine microalbumin-to-creatinine ratio measured, which increased to 89% (N = 9) after a 12 month follow-up period. In terms of medication use at baseline, 89% patients who were

eligible for statin use (N = 24) were prescribed a statin and 66% patients who were eligible for aspirin use (N = 14) were prescribed aspirin. After 12 months of follow-up, 88% of eligible patients (N = 7) were prescribed a statin and 50% of eligible patients (N = 1) were prescribed aspirin. When seen at their baseline, 6 month follow-up, and 12 month follow-up visits, all patients had received the recommended blood pressure measurements and lipid panels.

Diabetes Outcomes and Glycemic Control

As summarized in Figure 5, there was a trend toward a mean decrease in hemoglobin A1c levels after 6 months and 12 months of follow-up. Mean hemoglobin A1c levels decreased from 8.7% A1c at baseline to 8.2% after 6 months to and 8.1% after 12 months, which was not statistically significant.

As shown in Figure 6, patients had a mean increase in average frequency of hypoglycemia per two weeks after 6 months and 12 months. This trend was observed in hypoglycemic episodes of blood glucose less than 70 mg/dL and less than 40 mg/dL, though these trends were not statistically significant. The mean frequency of hypoglycemia of glucose under 70 mg/dL was 3.3 at baseline, 3.3 at 6 month follow-up, and 6.2 at 12 month follow-up. Furthermore, the average frequency of hypoglycemic episodes per two weeks of glucose under 40 mg/dL was 0.2 at baseline, 0.2 at 6 month follow-up, and 0.6 at 12 month follow-up. Clinically, the difference in severe hypoglycemia was not significant, but the hypoglycemia for glucose less than 70 mg/dL demonstrated a trend toward higher frequency.

As shown in Figure 7, the average frequency of hyperglycemic episodes per two weeks trended upwards after the 6 month follow-up period compared to baseline, but was relatively stable after 12 months of follow-up compared to baseline. This trend was observed in

hyperglycemic episodes of blood glucose greater than 250 mg/dL and 300 mg/dL. The mean frequency of hyperglycemia greater than 250 mg/dL was 16.3 at baseline, 22.5 at 6 month follow-up, and 16.2 at 12 month follow-up. For hyperglycemic episodes greater than 300 mg/dL, the mean frequency was 4.0 at baseline, 5.4 at 6 month follow-up, and 3.8 at 12 month follow-up. The changes in average frequency of hyperglycemia for both glucose levels greater than 250 mg/dL and greater than 300 mg/dL were not statistically significant.

Lastly, there was a trend toward a decrease in mean standard deviation of two-week blood glucose levels after 6 months and 12 months of follow-up. The mean standard deviation of daily blood glucose levels was 79.2 (S.D. = 20.4, N = 27) at baseline, 76.2 (S.D. = 15.7, N = 16) at 6 months of follow-up visits, and 76.4 (S.D. = 19.7, N = 9) at 12 month follow-up visits. The change in mean standard deviation of two-week blood glucose levels was not statistically significant.

Patient Time-Saving and Veterans Health Administration Cost-Saving

Time-savings for telehealth patients with T1DM and cost-savings for the Veterans Health Administration (VHA) were substantial. Patients saved a median of 78 minutes of traveling time one-way, and the VHA saved a median of $72.94 per patient visit in travel reimbursement. Assuming telehealth patients visit their endocrinology provider every three months, which is the recommended interval for follow-up visits, each patient saved 624 minutes of traveling time per year, which is associated with VHA savings of $9,336.32 per year in reimbursements to the 32 patients with T1DM served by the Atlanta VA Telehealth Endocrinology Clinic.

Telehealth Appointment Adherence

Telehealth patients had a median of 5 scheduled appointments. Number of appointments scheduled ranged from 1 appointment to 10 appointments. Patients were highly adherent to their telehealth appointments, with a median appointment adherence of 100% and a mean adherence rate of 87.8% (S.D. = 17.8%, range = 50.0%).

Patient Satisfaction with Telemedicine

22 telehealth patients with T1DM completed the survey regarding their satisfaction with telehealth care, yielding a 68.8% response rate. As shown in Figure 8, patients favorably perceived the endocrinology care they received during their telemedicine appointments, as 100% of respondents either agreed or strongly agreed with the statement, "Overall, I am satisfied with the telehealth session." Furthermore, when asked whether they would recommend telehealth to other veterans, 90.9% respondents strongly agreed. Lastly, when asked whether they would rather use telehealth than travel long distances to see their providers, 90.9% respondents either agreed or strongly agreed. It is interesting to note that the few patients who did not agree with the statement that they would rather use telehealth than receive in-person care stated that seeing their physician in person was important to them, and that "telehealth is just not the same."

Discussion

Our findings suggest that telemedicine in the management of T1DM is a safe, non-inferior method of health care delivery. Telehealth patients in our study trended toward a decrease in mean hemoglobin A1c levels and glucose variability, though our findings were not statistically significant likely due to our small sample size and limited statistical power.

Telehealth patients also had a relatively stable mean frequency of hyperglycemic episodes. However, telehealth patients trended toward an increased mean frequency of hypoglycemic episodes, which may be due to improvements in glycemic control, as blood glucose levels are better controlled and closer to target range (80 to 130 mg/dL). This hypothesis is consistent with literature that suggests better glycemic control, indicated by lower hemoglobin A1c levels, is correlated with an increased frequency of hypoglycemic episodes (25).

We also demonstrate that telemedicine results in significant time-savings for patients living in rural areas, leads to substantial cost-savings for the VHA, and is correlated with high appointment adherence. Telemedicine saves patients served by the Atlanta VAMC Telehealth Endocrinology Clinic an average of over ten hours of travel time per year, and also saves the VHA approximately $10,000 in travel reimbursements associated with in-person appointments. Furthermore, patients adhered to on average 88% of their scheduled telehealth appointments, and were highly satisfied with their telehealth care. Over 90% of surveyed patients stated that they would recommend telemedicine to other patients. Our findings suggest that telemedicine should be further implemented into contemporary health care systems, particularly in systems that serve patients from rural areas and face barriers to receiving in-person health care.

Previous studies have also demonstrated the effectiveness of telemedicine in delivering diabetes care to patients in rural areas. Wood et al described the use of telemedicine in pediatric T1DM care for patients in rural Wyoming, demonstrated equivalency between telemedicine and in-person visits for diabetes, and found that patients received on average one more follow-up visit in one year after telemedicine's implementation (17). Similarly, Wagnild et al described the use of telecommunications for patients with diabetes in Montana, and found that patients showed improvements in hemoglobin A1c levels, blood pressure, and knowledge of diabetes (18). Our

study is consistent with current literature that suggests telemedicine may be successfully utilized to deliver diabetes care to patients living in remote areas.

Limitations:

Our findings may have been confounded by several factors. First, the referring diabetes specialty pharmacist at CAVHCS also independently manages the diabetes treatment for many of the patients enrolled in the telehealth clinic, in some cases just prior to referral to the telehealth clinic, but mostly with select patients between telehealth visits as needed. Thus, telehealth patients' glycemic control prior to their baseline visits and afterwards may have been better than that of patients who receive care only from primary care providers. However, use of midlevel providers, such as pharmacists and nurses, is common across the VA health system, and is an integral part of the VA-established PACT (Patient Aligned Care Team) model, and, therefore, may actually represent the patient-centered medical care model already in use.

Another significant limitation of this study was loss of follow-up. Many patients had follow-up visits that did not fall within our study criteria of 6 and 12 month follow-up periods. Thus, we evaluated follow-up data of only 17 of 32 patients at 6 month follow-up and 9 patients at 12 month follow-up. This apparent loss of follow-up may have been due to the fact that the Atlanta VA Telehealth Endocrinology Clinic is available only once a week. As more patients enrolled in the clinic over time, the intervals between follow-up appointments necessarily increased. Thus, patients may have not been able to get the follow-up visits at the preferred three-month intervals, leading to follow-up visits which did not fall into the expected 6 month and 12 month follow-up time points for study eligibility. Our follow-up data may have been further confounded by the possibility that patients with worse glycemic control needed more

frequent follow-up, and thus were more likely to have 12 month follow-up data, leading to apparent worsening of some of the diabetes outcomes of interest.

Additionally, our findings may not accurately represent T1DM patients in the general population since all of our patients were veterans seen at the VA, and the majority had insulin pumps, which have been associated with better glycemic control compared to patients who use insulin injections (19). Lastly, our evaluation of aspirin usage may have been limited by inconsistent documentation of its use since many patients purchase it over-the-counter at local drug stores, leading to an underestimation of its use.

Strengths:

One of telemedicine's most important benefits is its ability to increase access to health care and improve patient care. Distance is a significant factor for many remote and rural veterans seeking health care, as illustrated by Burgess and DeFiore's study that travel distance is negatively correlated with usage of outpatient services (20). The VHA has mitigated this issue by providing travel reimbursement and bus services for patients (16), but further implementation of telemedicine can contribute to improving access to health care for rural patients. Our findings support telemedicine as a safe method of health care delivery that saves significant amounts of travel time for patients.

Another important aspect of telemedicine is its acceptance from patients. Our study demonstrates that most patients are highly satisfied with telemedicine care, believe that telemedicine appointments are convenient, and would recommend telemedicine to other veterans. Our findings are consistent with current literature, which reports that 70-100% patients prefer to continue using telemedicine after their initial telemedicine consult (21, 22).

Lastly, our findings support the concept that telemedicine may lead to substantial cost-savings on a systems level. While the Atlanta VAMC Telehealth Endocrinology Clinic serves 54 patients, telemedicine's cost-saving capacity has been demonstrated in larger health care systems. For example, the use of telemedicine in seven rural hospital emergency departments in Mississippi decreased the hospitals' expenditures from $7.6 million to $1.1 million during a 5-year period with no apparent effect on clinical outcomes (23). Furthermore, Kaiser Permanente Health, a health system based in Oakland, California that serves 10.2 million health plan members, found that the implementation of telemedicine in patients' homes resulted in reduction of total health care costs (24). If the VHA implements telemedicine on a broader scale, veterans would receive more accessible patient-centered care, and the VHA could benefit from substantial cost-savings.

Conclusion:

Though based on a relatively small sample size, our findings suggest that telemedicine care delivers safe, non-inferior diabetes care to veterans living in rural Alabama and Georgia. Additionally, telemedicine is associated with cost-savings for the Veterans Health Administration, travel time-savings for patients, high appointment adherence, and high patient satisfaction. Our findings are consistent with literature that suggests telemedicine effectively delivers health care to patients who lack access to care. Future studies with larger, more representative samples of T1DM patients are needed to support the conclusion that telemedicine should be implemented on a broader scale in existing health care systems.

Figure 1: Telehealth Patient Satisfaction Survey

Patient Satisfaction Survey: Clinical Video Telehealth

	Strongly Disagree 1	2	Do not agree or disagree, *or* N/A 3	4	Strongly Agree 5
I felt comfortable with the equipment used					
I was able to see the clinician clearly					
I was able to hear the clinician clearly					
There was enough technical assistance for my meeting with the clinician					
My relation with the clinician was the same during this session as it is in person					
The location of the telehealth clinic is convenient for me					
My needs were met during the session					
I received good care during the session					
The telehealth clinic provided the care I expected					
Overall, I am satisfied with the telehealth session					
I would recommend this type of session to other veterans					
I would rather use telehealth to receive this service than travel long distance to see my provider					

Figure 1: Patients were contacted via telephone and asked twelve survey questions, which were published by the VA Telehealth Services program (26). Patient satisfaction was evaluated using a Likert Scale from 1 to 5, from "Strongly Disagree" to "Strongly Agree."

Figure 2: Consort Diagram

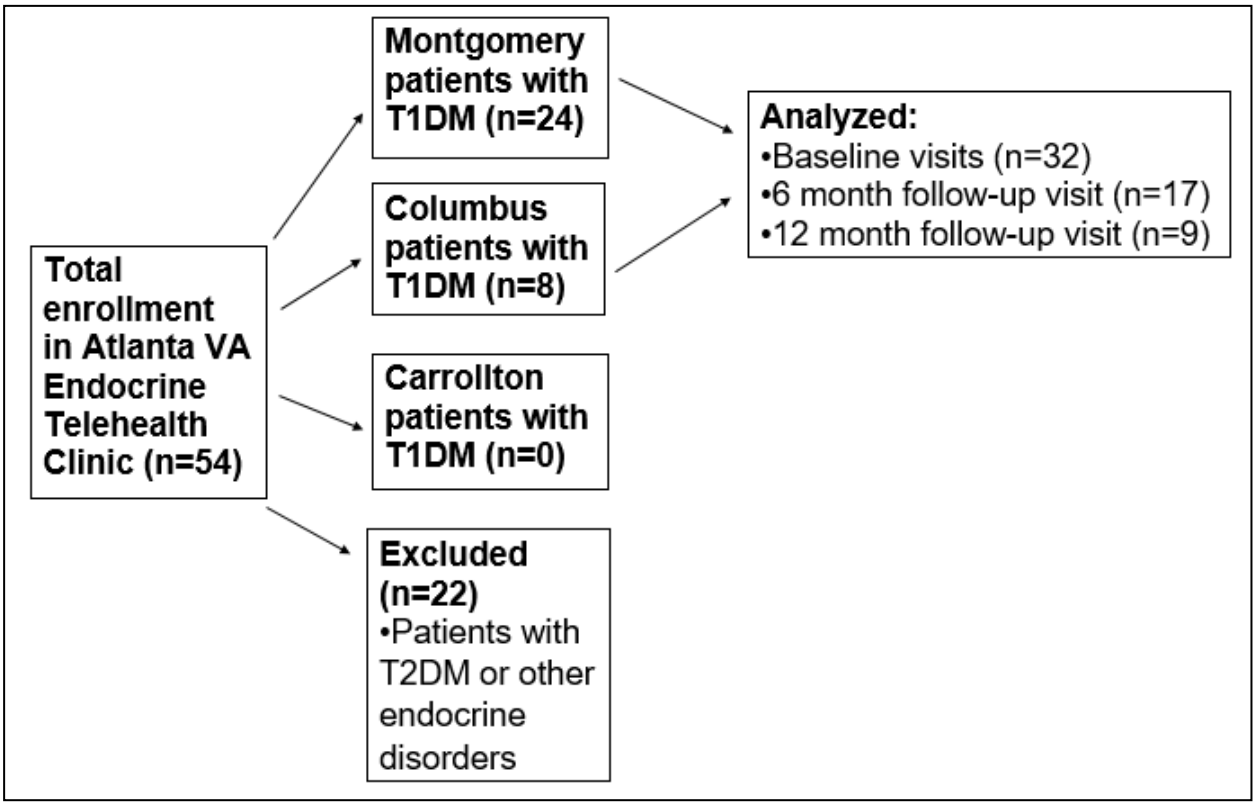

Figure 2: 54 patients were enrolled in the Atlanta VA Endocrinology Telehealth Clinic as of October 2016. 32 subjects with Type 1 Diabetes Mellitus (T1DM) were eligible and included in our study. 17 eligible subjects had 6 month follow-up visits, while 9 eligible subjects had 12 month follow-up visits.

Figure 3: Patient Demographics

	T1DM Telehealth Patients at Baseline (N = 32)
Mean Age (years)	53.5
Sex	
Male	90.6%
Female	9.4%
Race	
White	84.4%
Black	15.6%
Primary Care Location	
Montgomery	75%
Columbus	25%
Carrollton	0%
Mean BMI (kg/m^2)	27.6
Mean Duration of Diabetes (years)	24.7
Insulin Pump Use	75%
Continuous Glucose Monitor Use	18.8%
Hypertension	46.9%
Hyperlipidemia	81.3%
Hypothyroidism	28.1%
Tobacco Use	21.9%
Microvascular Diseases	
Neuropathy	71.9%
Nephropathy	21.0%
Retinopathy	40.6%
Macrovascular Disease	
Coronary Artery Disease	25.0%
Cerebrovascular Disease	12.5%
Peripheral Vascular Disease	3.1%

Figure 4: Maintenance of Standard Processes of Diabetes Care

ADA 2016 Guidelines	Monitoring	Baseline: % patients with recommended care	6 months: % patients with recommended care	12 months: % patients with recommended care
Blood Pressure	Every routine visit	100% (32/32)	100% (17/17)	100% (9/9)
Diabetic Retinopathy eye exam	Every 1 year	93.75% (30/32)	94.12% (16/17)	100% (9/9)
Urine microalbumin-to-creatinine ratio	Every 1 year	81.3% (26/32)	88.2% (15/17)	88.9% (8/9)
Lipid Panel (Triglycerides, HDL, LDL)	Every 1 year	100% (32/32)	100% (17/17)	100% (9/9)
Statin Use	Eligibility: >40 years old, or history of cardiovascular disease	88.89% (24/27)	100% (15/15)	87.5% (7/8)
Aspirin Use	Eligibility: >50 years old, or history of cardiovascular disease	65.64% (14/22)	69.23% (9/13)	50% (1/2)

Figure 5: Change in Hemoglobin A1c: Baseline, 6 month follow-up, 12 month follow-up

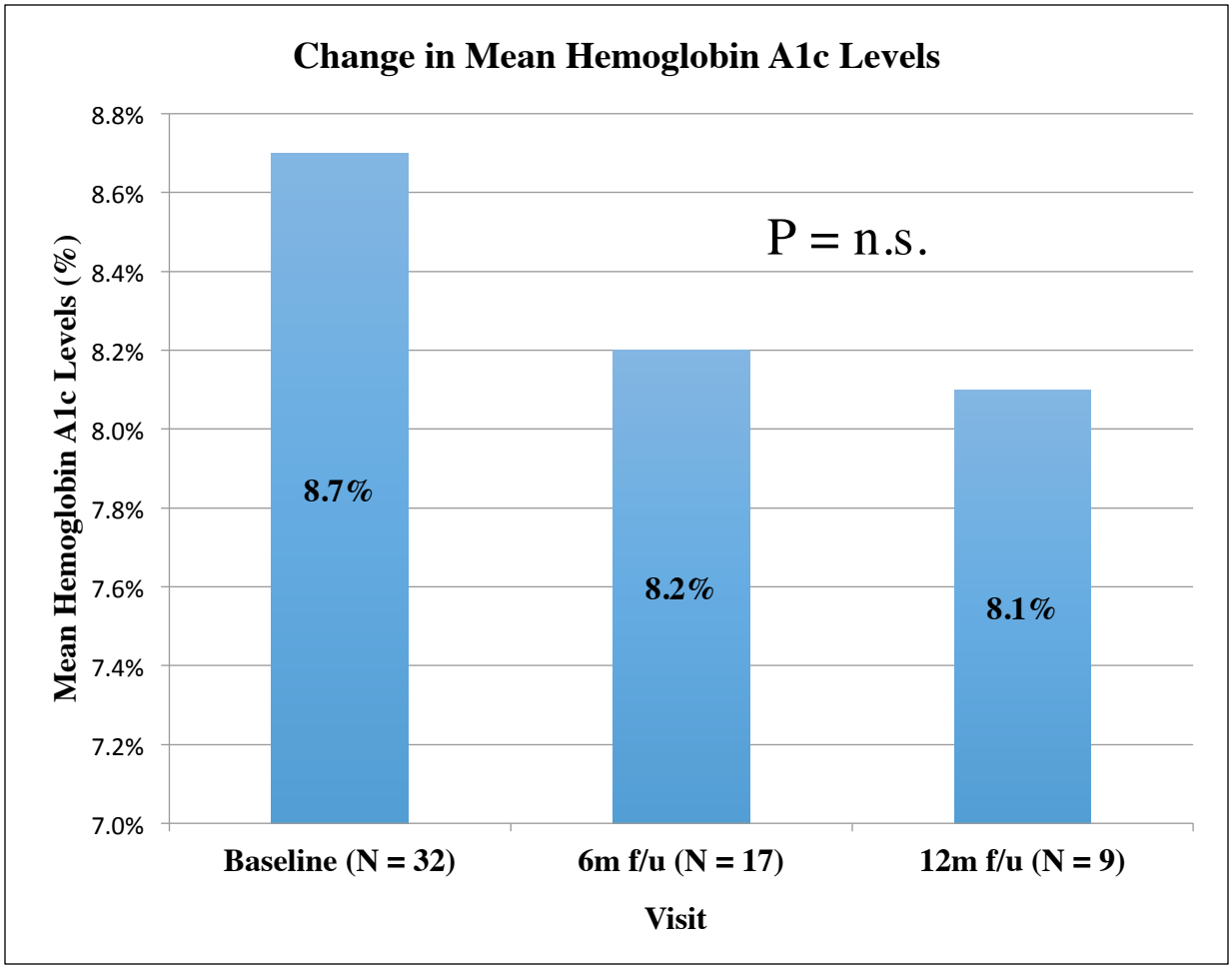

Figure 5: Hemoglobin A1c levels trended toward a mean decrease from baseline to 6 month and 12 month follow-ups, though the change was not statistically significant.

Figure 6: Hypoglycemia Frequency per 2 Week Period

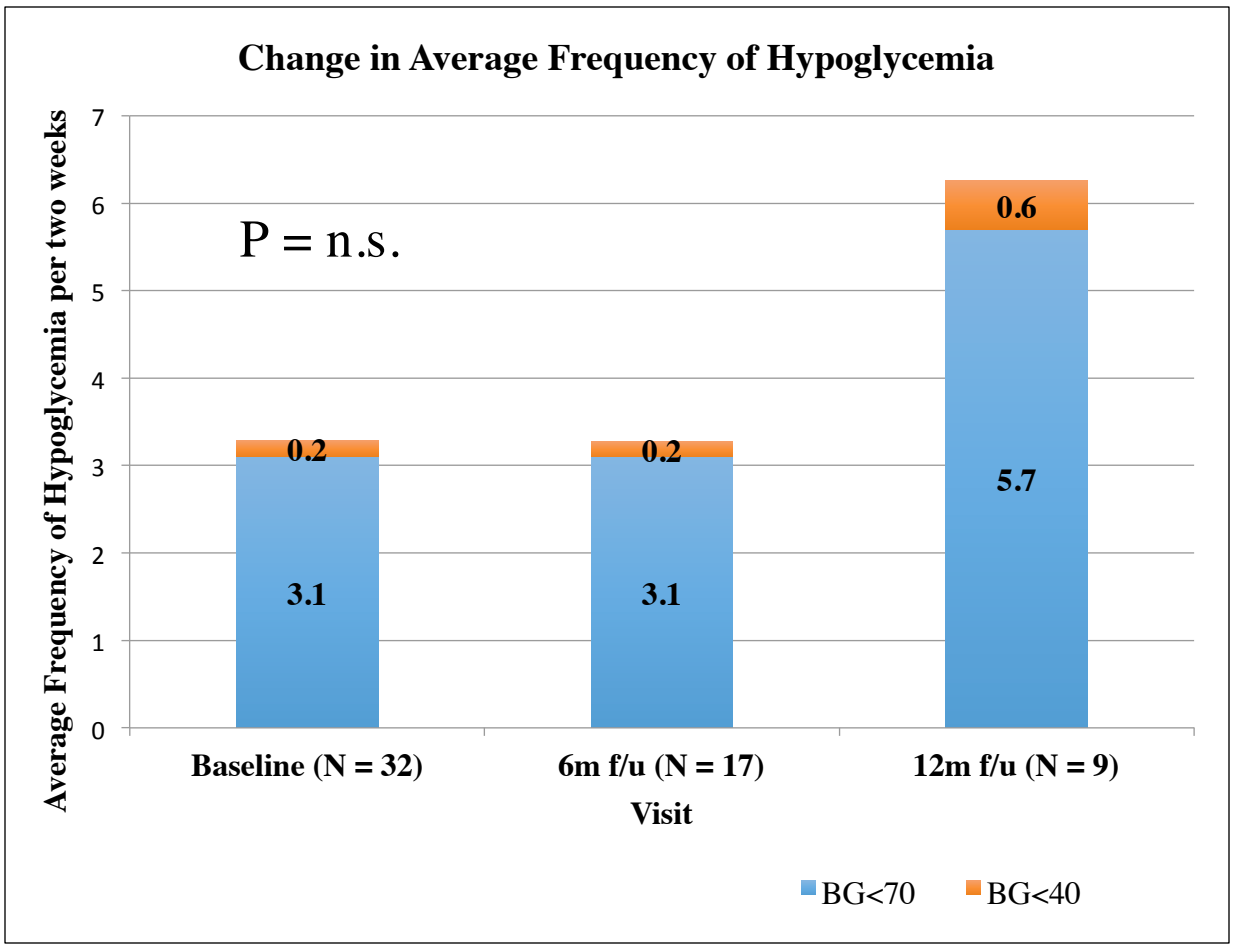

Figure 6: Hypoglycemic episodes of both blood glucose less than 70mg/dL and 40mg/dL trended toward a mean increase in frequency, though the change was not statistically significant.

Figure 7: Hyperglycemia Frequency per 2 Week Period

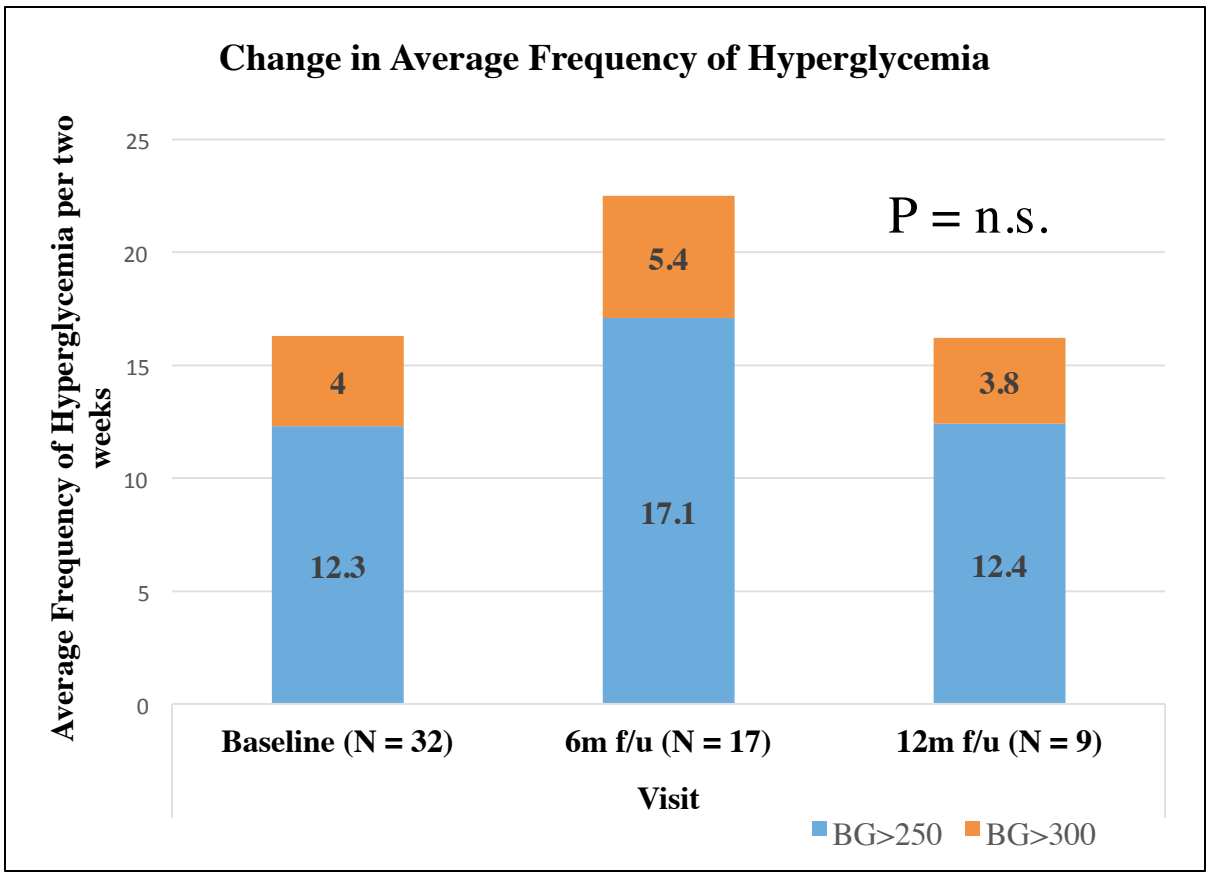

Figure 7: Hyperglycemic episodes of both blood glucose greater than 250 mg/dL and 300 mg/dL trended toward a mean increase in frequency after 6 months compared to baseline, and was relatively stable after 12 months compared to baseline. Changes in average frequency were not statistically significant.

Figure 8: T1DM Patient Responses to Telehealth Satisfaction Survey

Telehealth Patient Satisfaction Survey Questions	Median	Mean	S.D.
I felt comfortable with the equipment used	5.00	4.91	0.29
I was able to see the clinician clearly	5.00	4.95	0.21
I was able to hear the clinician clearly	5.00	5.00	0.00
There was enough technical assistance for my meeting with the clinician	5.00	4.95	0.21
My relation with the clinician was the same during this session as it is in person	5.00	4.18	1.01
The location of the telehealth clinic is convenient for me	5.00	4.68	0.65
My needs were met during the session	5.00	4.95	0.21
I received good care during the session	5.00	4.95	0.21
The telehealth clinic provided the care I expected	5.00	4.95	0.21
Overall, I am satisfied with the telehealth session	5.00	4.91	0.29
I would recommend this type of session to other veterans	5.00	4.77	0.75
I would rather use telehealth to receive this service than travel long distance to see my provider	5.00	4.59	1.05

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