Telemedicine Slashes 'No Show' Rates and Achieves Comparable Outcomes in Diabetes Care

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Telemedicine Slashes ‘No Show’ Rates and Achieves Comparable Outcomes in Diabetes Care

Thesis Submitted to the Faculty of the Yale School of Medicine, Physician Associate Program  in Candidacy for the Degree of Master of Medical Science

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Conflict of Interest

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Abstract

Telemedicine Slashes ‘No-Show’ Rates and Achieves Comparable Outcomes in Diabetes Care

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Background

Patients with type 2 diabetes (T2D) require continuous management to achieve optimal outcomes. Patients confronting barriers to care face higher risks of complications. Socioeconomic barriers including inability to afford transportation, work release, childcare or parking fees are factors affecting patient attendance. During the Covid-19 pandemic, telemedicine likely reduced common barriers affecting patient attendance compared to in-person visits. This study investigated the impact of telemedicine on no-show rates and diabetic outcomes in publicly insured patients and the potential link to reduced socioeconomic barriers.

Methods

This retrospective study analyzed records of 819 patients with T2D at the Yale Diabetes Center from June 2019 to December 2020 where in-person and telehealth visits were conducted. No-show rates, glycemic control metrics, and other biomarkers were analyzed and compared in the same patients during distinct in-person and telehealth visit intervals.

Results

Patients utilizing telemedicine averaged no-show rates of 0.34 ± 0.69 compared to 1.19 ± 1.30 (P<0.001) for in-person visits. Average HbA1c for telemedicine visits was 7.93 ± 1.95 compared to 7.91 ± 1.90 (P=0.6489) for in-person visits. Average time in range above 70% on ambulatory glucose profiles was 43.90% for telehealth and 45.42% (P=0.7614) for in-person visits.

Conclusion

Telemedicine visits demonstrated a significant reduction in no-show rates and comparable glycemic control to in-person visits in publicly insured patients with T2D. Telemedicine may be associated with lower no-show rates due to a reduction of socioeconomic barriers compared to in-person visits. Future studies are warranted to further clarify potential associations of specific socioeconomic barriers.

Keywords: Telemedicine, Type 2 Diabetes, Ambulatory Glucose profile, Hemoglobin A1C.
Introduction

In 2019, 37.3 million Americans, or 11.3%, of the population were diagnosed with type 2 diabetes (T2D).\textsuperscript{1} It is projected that by 2050, the prevalence of diabetes will increase to 25% of the U.S. adult population.\textsuperscript{2} Additionally, existing estimates indicate that 1 out of every 4 dollars in U.S. healthcare costs is spent on caring for people with diabetes.\textsuperscript{3} Alongside the significant rise in the incidence of diabetes, there is an extreme shortage of primary care clinicians in the U.S.\textsuperscript{4,5}

Primary care providers face significant challenges due to the increasing patient population and ever-advancing diabetes interventions available. Given these challenges, patients struggle with the management of their T2D and experience worse health outcomes.\textsuperscript{6} Additionally, Patients of low socioeconomic status (SES) and the elderly encounter additional socioeconomic barriers that can prevent the achievement of their healthcare goals.\textsuperscript{7,9} Many studies have investigated the drivers of socioeconomic health outcome disparities experienced by patients of low SES.\textsuperscript{7-9} Affordability of medication, lack of transportation, childcare, inability to take medical leave from work, and food insecurity are some of the major barriers to healthcare access and positive health outcomes.\textsuperscript{8} The elderly population faces many of the same barriers when it comes to the management of chronic diseases, including transportation and financial hardship.\textsuperscript{10-13}

Chronic disease management, like diabetes, requires regular clinical visits, medication access, and treatment plan adjustments. Without transportation, patients experience delays in clinical intervention resulting in negative health outcomes.\textsuperscript{14} Patients experiencing income or food insecurities were associated with increased HbA1c levels, increased BMIs, and worsened complications.\textsuperscript{15} Several approaches are being investigated to reduce socio-economic barriers to diabetes care.\textsuperscript{16} Telehealth visits have the potential to reduce transportation-related expenses and other socioeconomic barriers for patients with T2D.

During the COVID-19 pandemic, telemedicine became a mainstream model of care to prevent the spread of SARS-COV-2. Telemedicine includes a combination of both video and phone visits where patients can meet with their healthcare providers remotely.\textsuperscript{17} These visits include annual visits, follow-up appointments, sick visits, laboratory result discussions, or medication changes. Telemedicine allows patients to access medical care from their location of convenience, without having to manage transportation, medical leave from work, childcare, or other undue financial costs. The use of virtual care delivery models has been shown to provide flexibility to clinicians and to increase access to care in rural areas.\textsuperscript{18} Several studies have suggested that telehealth models for diabetes care would also be cost-effective for patients.\textsuperscript{17} While other pre-pandemic studies conducted show the effectiveness of telemedicine in managing T2D and lowering HbA1c, they lack a sufficient sample size to achieve validity.\textsuperscript{17,19-21}

The COVID-19 pandemic created an opportunity to analyze the effectiveness of telemedicine in managing T2D using a large sample size. Furthermore, there have been limited studies on the effectiveness of telemedicine in achieving positive health outcomes for T2D patients most marginalized by traditional models of healthcare, including patients of low SES and the elderly population.\textsuperscript{22} For this reason, we conducted a retrospective cohort study to analyze the impact of telemedicine in the management of publicly insured patients with T2D served by the Yale Medicine Diabetes Center. The study aimed to evaluate the impact of telemedicine visits on patient no-show rates, HbA1c, ambulatory glucose profile, and lipid profile compared to in-person visits before the COVID-19 pandemic.
Methods

Setting and Study Population

Patient records were obtained from the Yale Medicine Diabetes Center, the joint clinical practice of the Yale School of Medicine and Yale New Haven Health. The study subjects were patients with type 2 diabetes who received care exclusively from endocrinologists or diabetes specialists at the Yale Medicine Diabetes Center. Patients included in this retrospective study were known to have had type 2 diabetes for at least one year prior to 2019 and were on oral medication or insulin regimens for glycemic control. The final inclusion criteria included all patients who were publicly insured through either Connecticut (CT) Medicaid or Medicare. Insurance status was used as a proxy to select patients of low SES, covered by Medicaid, and the elderly population, covered by Medicare. There were no exclusion criteria for baseline glycemic control as measured by Hemoglobin A1c or blood glucose levels. The exclusion criteria included: patients with Type 1 diabetes, under the age of 21, private insurance status, and deceased at the start of data collection. All patient data were obtained between June 2019 and December 2020 via electronic medical records (EMR). There was no follow up period for this study and no patients were lost to follow up.

Study Design

This research study was conducted as a retrospective cohort study of 819 patients at the Yale Medicine Diabetes Center (YMDC) using EMR data from June 2019 to December 2020. The control group was composed of patients with T2D who attended in-person visits at the YMDC from June 2019
to March 2020. The intervention group was composed of the same patients who attended telehealth visits at the YMDC from March 2020 to December 2020 during the Covid-19 pandemic. Patients were matched by MRN (medical record number), across control and interventional group. The in-person, control group arm was compared to the telehealth arm to evaluate for differences in T2D management outcomes.

The intervention consisted of at least one telemedicine visit with their diabetologist, including physician associates (PA), nurse practitioners (NP), or physicians (MD). The telemedicine visits occurred every three months on average, or a frequency decided by the provider based on the patient’s needs. Electronic medical records were used to obtain critical data such as HbA1c, average glucose time in range, and lipid profiles. Average glucose time in range was obtained by analyzing ambulatory glucose profiles (AGP) from continuous glucose monitors (CGM), as available, for both in-person and telehealth visits.

**Outcomes**

The primary outcome measure was the percentage change in hemoglobin A1c and time in range (TIR) during the intervention phase compared to the control phase. TIR is a measurement tool for patients with continuous glucose monitoring (CGM). TIR is defined as a percentage of time a patient’s blood glucose level was in the range of 70-180 mg/dL. Additionally, patient “No Show” rates were recorded. A no-show was recorded if the patient did not appear for their visit without rescheduling or canceling. Other outcome measures BMI, LDL, HDL, total cholesterol, and triglycerides were also collected. These data points were obtained by electronic medical record extraction or manual chart review via Joint Data Analyst Team (JDAT) at Yale University. All data was stored on a secured Yale Box drive. The study was carried out under IRB protocol #2000033766 and JDAT ID #2381293.

![Sample Ambulatory Glucose Profile](image)

**Statistical Analyses**

All demographic data are expressed as numbers and percentages (table one). All continuous data are expressed as mean (M) ± standard deviation (SD), including the primary and secondary outcomes of the study. The primary outcome, change in hemoglobin A1c, was used to determine the power of the study, with an expected difference in two populations to be 1.0 with a standard deviation of 0.5. Based on a paired t-test model, a sample size of 819 patients revealed the power of the study at 100%. Statistical analyses consisted of paired t-tests, for all primary and secondary outcomes (Tables 2-4). This method of analysis incorporates paired cohort across all continuous variables. A p value of <0.05 was considered statistically significant. All data were analyzed using SAS v9.4. The study did not analyze
subgroups interactions. Since this was paired cohort study, regression analyzes was not conducted for confounding factors.

**Results**

Table 1 demonstrates the baseline characteristics of 819 patients in the retrospective study. There is no difference between the intervention and control group as patients are paired to self across time in this study. This cohort represents a diverse population with an average age of 60.41 ± 14.56 years. The study has 56.53% female and 43.41% male with an average duration of diabetes of 7.61 ± 2.83 years. Our study represents the diverse population of New Haven County, with 50% White, 28.32% African American, and 3.17% Asian. Our cohort also includes patients holding public insurance with 52.64% of patients with Medicaid and 44.51% with Medicare.

**Table 1. Sample Characteristics of 819 (N) Patients**

<table>
<thead>
<tr>
<th>Clinical features</th>
<th>Value (cohort group)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years), M±SD</td>
<td>60.41 ± 14.56</td>
</tr>
<tr>
<td>Gender: Female n (%)</td>
<td>463 (56.53)</td>
</tr>
<tr>
<td>Gender: male n (%)</td>
<td>356 (43.41)</td>
</tr>
<tr>
<td>Duration of diabetes (years) M±SD</td>
<td>7.61 ± 2.83</td>
</tr>
<tr>
<td>Race n (%)</td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>232 (28.32)</td>
</tr>
<tr>
<td>White</td>
<td>410 (50.06)</td>
</tr>
<tr>
<td>Asian</td>
<td>26 (3.17)</td>
</tr>
<tr>
<td>Native American</td>
<td>10 (1.23)</td>
</tr>
<tr>
<td>Other</td>
<td>141 (17.22)</td>
</tr>
<tr>
<td>Comorbidities n (%)</td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>551 (67.28)</td>
</tr>
<tr>
<td>Cardiovascular disease (excluding hypertension)</td>
<td>239 (29.18)</td>
</tr>
<tr>
<td>Diabetic Ketoacidosis</td>
<td>23 (2.81)</td>
</tr>
<tr>
<td>Nephropathy</td>
<td>164 (20.02)</td>
</tr>
<tr>
<td>Diabetic Neuropathy</td>
<td>149 (18.19)</td>
</tr>
<tr>
<td>Diabetic Retinopathy</td>
<td>114 (13.92)</td>
</tr>
<tr>
<td>T2D medications n (%)</td>
<td></td>
</tr>
<tr>
<td>Insulin therapy</td>
<td>499 (60.93)</td>
</tr>
<tr>
<td>Metformin</td>
<td>431 (52.63)</td>
</tr>
<tr>
<td>GLP-1 agonists</td>
<td>318 (38.83)</td>
</tr>
<tr>
<td>SGLT2i</td>
<td>248 (30.28)</td>
</tr>
<tr>
<td>Insurance Status n (%)</td>
<td></td>
</tr>
<tr>
<td>Medicaid</td>
<td>1792 (52.64)</td>
</tr>
<tr>
<td>Medicare</td>
<td>1515 (44.51)</td>
</tr>
<tr>
<td>None</td>
<td>97 (2.85)</td>
</tr>
</tbody>
</table>

*Continuous data reported as mean with standard deviation (M±SD)

Based on paired t-test analysis, the in-person arm had a no-show rate of 1.19 ± 1.30 visits compared to a no-show rate of 0.34 ± 0.69 visits during the telehealth period with P values of <0.001.
The no-show rate was recorded as the average number of missed appointments for each patient during each arm of the study. This represents a 71.4% reduction in the no-show rate during the telehealth period compared to the in-person period. (See table 2).

Furthermore, the average hemoglobin A1C (HbA1c), was measured between the in-person arm (control) and telehealth arms (intervention) of the study. The paired T-test revealed an average HbA1c of 7.91 ± 1.90 during in-person visits and 7.93 ± 1.95 for telehealth visits with a p value of 0.65. The study also investigated the ambulatory glucose profiles (AGP) for time in range (TIR), defined as a blood glucose level of 70-180 mg/dL, for 70% of the time. Guidelines indicated that TIR above 70% correlates to HbA1c of <7%.24 The chi-square test showed 45.42% had TIR above 70% during the in-person visits and 43.90% during telehealth visits with a p value of 0.76.

Table 2: Primary Outcomes in T2D care in-person vs telemedicine visits.

<table>
<thead>
<tr>
<th>n</th>
<th>In-Person visits</th>
<th>Telehealth visits</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No-show rate (M±SD)</td>
<td>819</td>
<td>1.19 ± 1.30</td>
<td>0.34 ± 0.69</td>
</tr>
<tr>
<td>Average HbA1c (M±SD)</td>
<td>819</td>
<td>7.91 ± 1.90</td>
<td>7.93 ± 1.95</td>
</tr>
<tr>
<td>AGP TIR (&gt;70%)</td>
<td>245</td>
<td>45.42%</td>
<td>43.90%</td>
</tr>
</tbody>
</table>

*HbA1c represents the average hemoglobin A1C. AGP TIR (>70%) represents the percentage of patients whose time in range (TIR) was above 70% for ambulatory glucose profile (AGP).

When analyzing lipid profile changes during in-person versus telehealth visits using paired t-test analysis, the average LDL during in-person visits was 89.21 ± 38.98 for in-person visits and 84.90 ± 36.22 for telehealth visits, with a p value of 0.006. The average HDL remained unchanged during the in-person visits, 46.27 ± 14.22, compared to in-person visits, 45.82 ± 13.96, with a p value of 0.45. Triglycerides were significantly lower during in-person visits, 185.19 ± 199.96, compared to telehealth visits, 219.87 ± 318.99, with a p value of 0.002. Total cholesterol remained unchanged from in-person visits, 165.59 ± 46.80, compared to 163.94 ± 54.79, with a p value of 0.45 (see table 3).

Table 3: Lipid profile analysis in T2D care in person vs telemedicine visits

<table>
<thead>
<tr>
<th>Average</th>
<th>In-person Visits</th>
<th>Telehealth Visits</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDL</td>
<td>89.21 ± 38.98</td>
<td>84.90 ± 36.22</td>
<td>P = 0.006</td>
</tr>
<tr>
<td>HDL</td>
<td>46.27 ± 14.22</td>
<td>45.82 ± 13.96</td>
<td>P = 0.45</td>
</tr>
<tr>
<td>TRIGS</td>
<td>185.19 ± 199.96</td>
<td>219.87 ± 318.99</td>
<td>P = 0.002</td>
</tr>
<tr>
<td>Total Cholesterol</td>
<td>165.59 ± 46.80</td>
<td>163.94 ± 54.79</td>
<td>P = 0.45</td>
</tr>
</tbody>
</table>

*Low-density lipoprotein (LDL), High-density lipoprotein (HDL), Triglycerides (TRIGS). Lipid profile was analyzed using paired t-test. N=819.

Table 4 shows changes in Weight and BMI between the in-person visit and telehealth visit period. During the in-person visits, the average weight was 214.94 ± 58.89 pounds, and during telehealth visits 212.89 ± 56.23 (P= 0.5259). The average BMI during the in-person visits was 34.69 ± 8.38, while during telehealth visits was 34.50 ± 8.35 (P=0.6828). It should be noted that limited data on weight was available in EMR for telehealth visits reflected by sample size (n) of 439 during telehealth compared to
sample size of 1282 during in-person visits. This limitation was based solely on the lack of self-weight checks conducted by patients during telehealth visits.

Table 4: Changes in Weight and BMI in person vs telemedicine visits

<table>
<thead>
<tr>
<th>Average</th>
<th>N</th>
<th>In-person Visits</th>
<th>N</th>
<th>Telehealth Visits</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (lbs.)</td>
<td>1282</td>
<td>214.94 ± 58.89</td>
<td>439</td>
<td>212.89 ± 56.23</td>
<td>P=0.53</td>
</tr>
<tr>
<td>BMI</td>
<td>1282</td>
<td>34.69 ± 8.38</td>
<td>439</td>
<td>34.50 ± 8.35</td>
<td>P=0.68</td>
</tr>
</tbody>
</table>

*N represents the number of individual data points available during each arm of the study.

Discussion

Our study is among the first to assess the impact of telehealth on diabetic health outcomes for patient populations who may encounter socioeconomic obstacles to accessing healthcare. The study examined records of Medicaid and Medicare patients as a proxy for patients of low SES and elderly patients, respectively. Patients were paired to themselves, and each period of study, in-person vs telehealth, was 9 months in duration. The study found a remarkable 71.4% reduction in no-show rate with telemedicine visits compared to in-person visits in publicly insured patients with T2D. Similarly, various studies conducted during the pandemic across different specialties of medicine have also found a significant reduction in no-show rates and an improvement in patient satisfaction. The study also found no significant differences in average HbA1c metrics between patients during in-person and telehealth visit periods. Additionally, there were no significant differences in the percentage of patients whose glucose time in range (TIR) was above 70%. Previous research has demonstrated that TIR equal to or above 70% correlates to HbA1c under 7%. HbA1c and glucose time in range percentages are well-studied standards in diabetes care to prevent microvascular complications in patients with T2D.

Our study demonstrates a drastic improvement in patient compliance in terms of medical visits with telehealth compared to in-person visits. In addition, telehealth visits were equally effective in achieving positive diabetic outcomes compared to in-person visits. The reduction of transportation and financial barriers with the transition to telehealth explains the significant improvement in patient compliance. These socioeconomic barriers have been well established to delay medical care in patients with chronic diseases such as T2D. Based on the results of this study, telemedicine may be one solution to reduce socioeconomic barriers and improve long-term disease management in patients of low SES and the elderly. Reduction in no-show rates overall can lead to better glycemic control, quicker adjustments to medical regimens, and early screening for microvascular complications.

Our secondary outcomes analyzed the lipid profiles of patients during the two arms of the study. American Diabetes Association (ADA) guidelines recommend LDL of <100 mg/dL, HDL >50 mg/dL, TRIGS <150 mg/dL, and total cholesterol <200 mg/dL to optimize cardiovascular complications in diabetic patients. Our results showed statistically significant reductions in LDL during telehealth visits compared to in-person visits. However, in both arms of the study, the average LDL was below 100 mg/dL as recommended by ADA guidelines. On the other hand, triglycerides (TRIGS) were found to be above the level of 150 mg/dL as recommended by ADA in both arms of the study, with higher triglyceride levels in the telehealth period. The HDL and total cholesterol had no significant change...
between the in-person and telehealth period. Overall, the lipid panel indices revealed mixed results between the in-person and telehealth visits.

We also measured BMI and Weight changes, which revealed no average difference between the telehealth and in-person visits. However, the analysis was restricted by limited data available during the telehealth visits, as noted in Table 4. Due to the significant difference in sample size between the two periods, weight and BMI fluctuations cannot be accurately determined for this study.

This study showed a clear association between a reduction in no-show rates and telehealth visits, especially focused on patients of low SES status and the elderly population. This study can help develop hybrid clinical models, consisting of both in-person and telehealth visits, for patients facing socioeconomic barriers to maximize their healthcare goals. Additional studies are warranted to confirm a similar reduction in no-show rates with telehealth, in a post-pandemic world where most patients are not isolated to their homes. Further research is warranted to establish a clear association between specific socioeconomic barriers and telemedicine. In the future, telemedicine can become an important tool for providing equitable healthcare for all patient populations.

**Strength and Limitations**

One of the biggest strengths of this study is the sample size of 819 patients and well as the diversity of the cohort. Many previous studies have been conducted showing the benefits of telemedicine but with smaller cohort sizes. The Covid-19 pandemic caused a surge in the use of telemedicine, allowing for a large sample size for our retrospective analysis. Another strength is that our study population matched the demographics of the New Haven population at large in terms of race, sex, and disease comorbidities, as well as insurance status for potentially broader generalizability. Furthermore, our study specifically looked at populations most hindered by socioeconomic barriers, people of low SES, and the elderly.

The main limitation of this study is that the telehealth visits occurred during the height of the Covid-19 pandemic. The pandemic resulted in social isolation, improper dietary habits, and an increase in stress for the patient population. These are potentially confounding factors, which could have minimized the effects of telemedicine on T2D outcomes, especially HbA1c and TIR. Further studies are warranted to gain a better understanding of the impacts of telemedicine in combination with in-person visits in the post-pandemic period. Furthermore, our studies include patients of both low SES and elderly patients, so a direct association cannot be established between telehealth and specific socioeconomic barriers. However, this study establishes an improvement in diabetic outcomes in both populations, with each facing several socioeconomic barriers. Finally, the digital gap and access to technology are established barriers with the elderly and patients of low SES. Further studies are warranted to resolve the digital gap.
Conclusion

Our retrospective cohort study of 819 publicly insured patients with T2D reveals that telemedicine drastically reduces no-show rates while achieving comparable effective glycemic control when compared to in-person visits. Analysis of lipid profile indices reveals a reduction in LDL but increase triglycerides during the telemedicine period. Telemedicine visits for T2D care may be one solution to reduce socioeconomic barriers in patients of low-income status and improve long-term T2D management by reducing risk for complications. Future studies are warranted to develop the most optimized and balanced model of telehealth and in-person services for diabetes management in the post-pandemic era.
References


