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# Telemedicine and Type 2 Diabetes

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**Telemedicine and Type 2 Diabetes**

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**Abstract**

Recent and continuing advances in technology are impacting the practice of healthcare worldwide. Facilities are utilizing technology to provide patients with education, treatment options, consultations, and more. In the face of limited resources, emerging telemedicine programs offer opportunities for providers to connect with patients through videoconferencing, patient portals, etc. Telemedicine holds the potential to significantly impact glycemic control and self-management in patients with type 2 diabetes. The purpose of this article is to research the efficacy and cost-effectiveness of telemedicine programs for patients with type 2 diabetes. Using terms related to telemedicine and type 2 diabetes, PubMed, Google Scholar, and The Cochrane Database of Systematic Reviews were used to identify relevant studies for the literature review published within the past ten years. For this article, the topics of type 1 diabetes and gestational diabetes were generally avoided. Information was gathered via personal correspondence from two healthcare professionals with experience working with patients with diabetes and telemedicine. Telemedicine, in various modalities, may be an effective means to provide patient care and allow for self-management for patients with type 2 diabetes; however, there are several limitations in the research. No clear conclusions can be drawn regarding the cost-effectiveness of telemedicine due to limited data. Further advancements in technology and research needs to be conducted to demonstrate significant results regarding telemedicine for future use.

Keywords: hemoglobin A1c (HbA1c), type 2 diabetes, telemedicine, healthcare

## Introduction

Diabetes is a complex group of metabolic conditions involving chemical balances and energy production.<sup>1</sup> It is estimated that approximately four hundred million adults in the world have diabetes while half are undiagnosed.<sup>2</sup> By 2040, this number is estimated to rise to over six hundred million.<sup>2</sup> The largest number of individuals diagnosed with diabetes are between 40 and 59 years of age. Type 2 diabetes is the most prevalent. It can be a devastating diagnosis, as well as an economic burden for every country with an estimated twelve percent of the global health expenditure dedicated to diabetes treatment and related complications.<sup>2</sup>

In type 2 diabetes, the body does not properly respond to insulin, which regulates blood glucose used for energy and homeostasis. Glucose levels rise in the blood, leading to hyperglycemia. Hemoglobin A1c (HbA1c) is the gold standard for monitoring long-term blood glucose control, also called glycemic control. Hemoglobin A1c, or glycated hemoglobin, is a blood test reflecting the average blood glucose concentration over the course of 120 days compared to daily glucose concentrations.<sup>3</sup> For patients with type 2 diabetes, target goals are individualized; however, the American Diabetes Association advocates for a target at or below 6.5 percent. Hemoglobin A1c is used to assess the quality of care and predict the development of long-term complications. It prompts primary care providers to intervene earlier and treat patients more effectively. However, due to several factors such as provider's fear of hypoglycemia, patient nonadherence, and cost, strict glycemic control is not achieved.<sup>4</sup>

The incidence of diabetes continues to rise, along with the need for healthcare resources. With approximately 20 percent of Americans living in rural areas, many patients live out of reach of appropriate medical care due to provider shortages, transportation, and cost.<sup>5,6,7</sup> To provide patients with adequate care, technology is being utilized to connect with patients through

videoconferencing, patient health portals, and mobile applications; however, very little is known of the clinical efficacy and cost-effectiveness of such programs. Telemedicine may be an effective strategy for diabetes monitoring and intervention to achieve optimal glucose control.

This paper analyzes the use of telemedicine for management of type 2 diabetes through hemoglobin A1c results and cost-effectiveness. The objectives include determining the methods of telemedicine, analyzing hemoglobin A1c outcomes compared to standard care, identifying the benefits and challenges to implementation, and developing a conclusion for the future of telemedicine.

## **Background**

Telemedicine is being accepted at hospitals and clinics worldwide, increasing 3.5 percent annually.<sup>8</sup> Data from the HIMSS Analytics 2016 Telemedicine Study shows that telemedicine technology adoption will continue to grow.<sup>8</sup> The number of U.S. hospitals that have installed telemedicine technology has grown to approximately 45 percent, leaving several hospitals potential targets for implementation.<sup>8</sup> As stated during a recent correspondence on June 29, 2017 with Jennifer Freitag a certified nurse practitioner (CNP) at Mayo Clinic, “as we [healthcare providers] continue to embrace technology we can play a more active role in patients’ daily lives. Many of the patients I work with require support especially at diagnosis and when starting insulin therapy. Portals, apps can give patients reminders to take medicine, monitor blood glucose etc.”

### *Outcomes: Hemoglobin A1c*

Telehealth and technology based interventions combined with standards of care may be associated with improved glycemic control and improved clinical outcomes for diabetes

patients.<sup>1,4,5,9-17</sup> However, the type of intervention and duration are important considerations.<sup>9</sup> Several systematic reviews, meta-analyses, and randomized control trials investigate the role of telemedicine in the treatment and management of type 2 diabetes.<sup>1,4,5,9-17</sup>

Diabetes education, counseling, and medication management is provided via videoconferencing, telephone conversations, e-mail, or secure websites, such as patient portals.<sup>3,11</sup> Patients connect with providers or nurses to report blood glucose values and receive treatment options without scheduling and attending appointments. In addition, patients have access to education through a team of nurses, dietitians, and pharmacists. Education focuses on medication usage, nutrition, exercise, and controlling blood glucose through various circumstances, such as episodes of hypoglycemia which can affect patients' health and wellbeing.<sup>4,11</sup> Lastly, telemedicine includes wireless transmission of data from the patients' home glucometer. The blood glucose readings are transmitted to providers who then analyze the reports and provide the patients with individualized feedback with medication management.<sup>4,11,13</sup>

Overall, the data demonstrates a general improvement in overall HbA1c results.<sup>1,4,5,9-17</sup> For patients participating in videoconferencing, the average HbA1c result after three months improved significantly from 8.6 percent to 7.8.<sup>11</sup> Patients receiving education and counseling demonstrated a significant reduction in HbA1c levels at three and six months.<sup>4</sup> The mean HbA1c was 8.5 percent at the initial visit and was reduced to 6.3 percent at six months.<sup>4</sup>

Methods of telemedicine that include text messaging, web portals, automated voice reminders, computer software, and/or telephone calls showed that telemedicine lowered HbA1c by 0.57 percent within three months and by 0.28 percent beyond four months; however, no other clinically relevant outcomes were apparent among patients with diabetes.<sup>14</sup> There is a tendency of a larger HbA1c reduction with interventions that lasted six months as compared to ones that

lasted year.<sup>1</sup> During correspondence with Jennifer Freitag CNP, she states, “I have worked with patient portals. I find this beneficial to patients that are new to insulin therapy and need frequent insulin dose adjustments.”

Patients in telemedicine programs that include weekly education phone calls from nurses for medication review and adjustment, in addition to mobile telehealth equipment for diabetes management (e.g. blood glucose meters, blood pressure monitors, and mobile phones), showed a lack of significance for HbA1c results between groups at baseline, three, and nine months.<sup>13</sup> On the contrary, a similar study focusing on wireless data technologies showed a reduction in HbA1c values of 1.32 percent at six months.<sup>13</sup> The study also noted extra efforts to help patients better understand the relationship between the blood glucose values and risk of long term complications.<sup>13</sup> Interventions that involve expanding and changing the roles of healthcare professionals were associated with improvements in glycemic levels.<sup>10</sup>

According to a recent survey, patients feel comfortable with telemedicine and find it convenient. Concerns regarding privacy are low and lack of physician contact is generally acceptable. Improvement in quality of life and emotional well-being leads to better diabetes self-management.<sup>11</sup> Diabetes education via telemedicine or in-person reduces distress and promotes positive behavior change, which can lead to higher morale and essentially better diabetes outcomes. Results indicate that regardless of HbA1c change, patients enrolled in telemedicine reported increase awareness of diabetes and fluctuations in blood glucose. Patients also report that telemedicine with nurses provided accountability and increase their motivation for self-telemonitoring.<sup>18</sup>



### *Telemedicine Programs*

Several programs have been created to assist patients with advanced type 2 diabetes to improve their health and delay complications.<sup>14</sup> Three programs were specifically noted in the literature.<sup>14,16,17</sup> The Telemedical Lifestyle Intervention Program (TeLiPro) combines telemedical coaching, telemonitoring, self-monitoring of blood glucose, and structured lifestyle programs that include nutrition education and motivational training by trained professionals.<sup>14</sup> While enrolled in this program, patients continue to have access to communication with their providers. Goals related to behavior change regarding nutrition, activity, diabetes health maintenance and/or use of the home telemedicine unit was established at the conclusion of each visit.<sup>14</sup> The results showed a significantly higher HbA1c reduction in the TeLiPro group with 0.7 percentage points compared to 0.2 in the control group and reported on the clinical effectiveness of the interventions on glycemic control in patients.<sup>14</sup> The Informatics for Diabetes Education and Telemedicine project (IDEATel) provides patients a computer with internet access and a webcam to conduct videoconferencing with providers for diabetes management. Over five years, results demonstrated a 0.31 percent reduction in average HbA1c results from baseline compared to 0.06 percent receiving usual care.<sup>16,17</sup>

Data received via correspondence with Jaime Schlomann, RD on July 11, 2017, show results from diabetes education classes (see Table 1). The programs provide education to patients through group in-person and videoconferencing. These sessions include education on self-management, nutrition, exercise, and behavior change for type 2 diabetes. The research from 2016 demonstrated that 78.8 percent of patients completed all four sessions. The average HbA1c value decreased from 7.85 percent before classes to 6.35 percent after completion, a decline of

1.5 percent. Over 81.5 percent of patients achieved a HbA1c result of less than seven percent at the completion of classes.

# of participants	71
Completion Rate	78.8%
Avg. HbA1c before classes	7.85%
Avg. HbA1c after classes	6.35 (-1.5%)
HbA1c < 7% before class	56.5%
HbA1c < 7% after class	81.5%

### *Cost Considerations*

Research focusing primarily on cost-effectiveness reveals limited data with mixed results.<sup>5,19,20</sup> One study estimated the cost of telemedicine enrollment at 9.66 dollars per month, compared to traditional health care visits and testing at 5 to 15 dollars per visit.<sup>4</sup> The direct cost savings is the expense and time needed for provider visits at the clinic. Indirect savings include potential economic costs of future complications from uncontrolled diabetes.<sup>4</sup> Zhai et al.<sup>20</sup>, found “no clear conclusions could be drawn regarding the cost-effectiveness... especially in hard-to-treat populations, where treatment gaps arise from patient isolation, due to geographic, socioeconomic, or other constraints.”<sup>20</sup>

Type 2 diabetes outcomes were observed to determine the effectiveness of telemedicine. Improvement with time was significant overall, regardless of the method of delivery of education.<sup>11</sup> Telephone coaching and communication via electronic health record had less of an effect on HbA1c reduction.<sup>9</sup> Telemedicine is practical and reliable; however, diversity in study design and reported findings are apparent.<sup>21</sup>

## **Methods**

The methods used to conduct this research included a literature review where databases were used. These included PubMed, Google Scholar, and The Cochrane Database of Systematic Reviews. Specific terms used for the search included “telemedicine and diabetes”, “telehealth and diabetes”, “telemedicine and type 2 diabetes outcomes.” The search intentionally focused on articles that were published within the past five years to ten years, due to evolving methods of technology.

The primary outcome for the search was HbA1c results; however, articles that addressed the cost-effectiveness of telemedicine were also included. Articles with main topics other than type 2 diabetes were excluded, such as type 1 diabetes, gestational diabetes, and pediatrics. The research was not restricted to one specific form or method of telemedicine. The terms for “telemedicine” vary between articles and often include “telehealth” or “e-health”. I received additional information for my research through e-mail correspondence with two professionals providing diabetes care. Jennifer Freitag is a board-certified nurse practitioner with seven years of experience working with patients with diabetes. Jaime Schlomann is a registered dietitian (RD) and certified diabetes educator. She works in an outpatient clinic and administers group diabetes classes with videoconferencing.

## **Discussion**

Throughout the research several themes emerged regarding the benefits and challenges of telemedicine for type 2 diabetes. Synthesis of evidence regarding the efficacy of telemedicine is challenging because methods are still evolving and a variety of approaches are being used. The research demonstrates that telemedicine can provide education, resources, and tools for routine monitoring of blood glucose levels in efforts to reinforce positive behaviors and improve

glycemic control and HbA1c.<sup>1,4,5,9-15,17</sup> Several studies further demonstrate the benefits of telemedicine through a reduction in HbA1c after implementation.<sup>1,4,5,9-15,17</sup> However, telemedicine can be challenging to implement with consideration to the demographics, setting, and time commitment. Unfortunately, limited evidence is available regarding the cost-effectiveness of providing telemedicine programs that include data analysis, counseling, and action plans.<sup>10,20,21</sup> Further research is needed to fully understand the direct and indirect costs associated with telemedicine for programs worldwide.

### *Benefits of Telemedicine*

Telemedicine offers opportunities for patients to engage in consistent blood glucose monitoring, diabetes education, and medication adherence by interacting with diabetes educators and providers. Telemedicine is an opportunity for patients to receive care when traditional healthcare is not an option. It incorporates patient-centered care as it engages patients to take responsibility and focus on specific health needs.<sup>12</sup> Data gathered through telemedicine aid providers in decision making and treatment plans, which ultimately affect patient outcomes. Lastly, it serves as an additional method of communication between patients and healthcare providers.

Telemedicine uses telecommunication strategies to deliver health care from a distance. It involves using new technology to aid elderly patients, veterans, and rural populations.<sup>5</sup> Telemedicine is an option to improve access to healthcare, improve diabetes outcomes, and reduce costs.<sup>1,4,5,9-17,19,20</sup> Patients with increased access to telemedicine can engage in health care remotely through a wide range of applications.<sup>6</sup>

Telemedicine includes options for patients to interact with providers through outpatient and hospital-based modalities. Methods of interventions include telephone coaching, electronic

medical records, distance learning, mobile health, and telemedicine. Examples of areas currently utilizing telemedicine includes emergency departments for remote video consultations, hospitals for post-discharge monitoring to reduce admissions, and psychiatry consultations.<sup>22</sup> (see Figure 1) Options for telemedicine for patients with diabetes involve the transmission of blood glucose values by patients via phone or computer, allowing healthcare providers to review and provide feedback by phone, videoconference, or other means.

Telemedicine utilized with electronic devices has the capacity to collect, store, and process the data provided by the patient. This data can be used to establish trends in the progression of the disease for each patient.<sup>10</sup> These systems have the potential to transmit large volumes of complex data quickly.<sup>13</sup> Devices provide automated linking between patients and providers. Some programs require the patient to collect and transmit data to a clinic, where they are stored and processed. Systems may contain educational materials that are tailored to the individual patient needs, focusing on glycemic control, activity, weight, and smoking cessation.<sup>9</sup> Patients receiving ongoing feedback from providers through telemedicine compared to traditional in-person visits demonstrate the greatest reduction in HbA1c results.<sup>4</sup>

Establishing follow-up to discuss the goals is an important component of diabetes education, which is often completed in face-to-face sessions. However, many patients living in underserved rural areas do not have access to care and the necessary support systems. One of the most popular methods of telemedicine is videoconferencing, which includes audio and visual between sites.<sup>10</sup> It is being used to fill in gaps in patient care and offer services not otherwise available. During correspondence with Jennifer Freitag CNP she states,

“benefits of telemedicine include expanding access to care. This allows patients to access specialties that may require travel to see. Challenges can include losing that face-to-face

contact, however I work with many patients that may live more than a one-hour drive from a primary care clinic and this can open up options for patients to interact with specialty care.”

The transmission of feedback can happen in any place and from patients’ personal devices, allowing providers the luxury of not having to travel daily. Providers can fine-tune treatment plans for patients. Patients receiving quick responses to their needs with better outcomes, often leads to an increase in patient satisfaction and improvement in quality of care.<sup>4</sup> According to correspondence with Jennifer Freitag CNP, “as financial concerns continue to loom in healthcare, telemedicine may be a way to provide cost-effective care. This may allow a provider, such as an endocrinologist, to work from a central location and maximize the amount of patients that provider may see.”

Telemedicine becomes more effective when the patient assumes responsibility for managing his or her own health.<sup>12</sup> In a recent study, patients’ HbA1c values decreased by an average 1.32 percent in six months when telemedicine was designed to focus on helping patients better understand the relationship between their blood glucose data and the risk of long term complications.<sup>12</sup> This demonstrates the effectiveness of actively involving patients in their health through telemedicine.<sup>13</sup>

The length of telemedicine is an important factor. Although there was an overall reduction in HbA1c results, telemedicine that spanned six months, compared to one year, showed a greater reduction in HbA1c results.<sup>1</sup> This may be due to several factors, such as short-term goals, changes in lifestyle, along with medication adjustments.<sup>1</sup> The findings suggest that contact through telemedicine and positive motivation can positively impact patients.

Telemedicine incorporates patient-centered care as it engages patients to take responsibility and focus on specific health needs.<sup>12</sup> Patient monitoring facilitates pattern analysis, reinforcing behaviors, promoting setting goals, problem solving, and action planning. Telemedicine serves as additional communication between patients and health care providers and aids in decision making.<sup>12</sup> When designing telemedicine programs, studies emphasize the importance of matching the appropriate mode of technology to the patient and his or her needs. For example, patients whom have difficulty remembering to check blood glucose or take medications may benefit from frequent reminders or messages that are easily conducted through telemedicine portals.<sup>10</sup> Patients engaging in group education and counseling sessions can learn from each other which may increase motivation and satisfaction compared to patients enrolled in individual telemedicine.

### *Challenges for Implementation*

As healthcare facilities expand and integrate telemedicine, potential barriers and challenges arise. Unfortunately, technology and support systems can fail, negatively impacting patients and providers.<sup>9</sup> During recent correspondence, Jaime Schlomann RD reports “the technology frequently does not work as planned. [The patients] may see the speaker but not the presentation, and may not connect without 30 minutes of help from [technology personnel].” In turn, patients may become frustrated and withdraw from telemedicine programs, negatively impacting their care.

Patients report on the inconvenience and stress of using telemedicine compared to traditional care, which then reduced their willingness to engage with the intervention.<sup>18</sup> Patients’ daily commitments interfere with the ability to accommodate to intervention components.<sup>18</sup> This

can impact the patients' motivation to maintain healthy lifestyle interventions, consistent blood glucose monitoring, and medication adherence – all factors that lead to improved HbA1c.<sup>3</sup>

When considering telemedicine for diabetes, an important factor is the patient demographic. Despite an increasing number of type 2 diabetes diagnoses in young adults, many patients are older, with complex medical histories and difficulty with self-management. Older patients tend to have limited technology skills compared to young adults.<sup>9</sup> Difficulties utilizing telemedicine and other mobile resources can create anxiety and lead to decreased adherence and discontinuation of programs.<sup>1</sup> For example, research demonstrates that patients with type 1 diabetes, compared to type 2, show a greater reduction in HbA1c.<sup>1</sup> These patients are typically diagnosed younger and are managed using insulin agents, which greatly reduces HbA1c results. Younger patients tend to be more familiar with technology which can lead to increased adherence and improved outcomes.<sup>1</sup> It is critical for the success and sustainability of telemedicine for providers and healthcare professionals to work with patients on how to integrate telemedicine into their lives.<sup>18</sup>

With the use of telemedicine, the role of healthcare providers changes, which presents with benefits and challenges. Additional training is often required to adequately perform telemedicine compared with traditional care. For example, during videoconferencing providers must adequately assess and manage a patient without performing a complete physical exam. In addition, the roles of multidisciplinary healthcare personnel change to include education and management of patients with diabetes through telemedicine. While discussing challenges of telemedicine compared to traditional appointments during correspondence, Jaime Schlomann, RD states



“it is a challenge connecting with patients through a screen. [Telemedicine] involves less class participation, and the patients ask very few questions. There is an increase in time for documentation of large groups and difficulty documenting on patients that I have never met.”

### *Limitations*

Recent studies provide evidence of the benefits of telemedicine for type 2 diabetes, yet several limitations to achieving high quality outcomes are discussed in the literature. Due to expanding technology, various forms of telemedicine are utilized and reviewed in the studies with inconsistent cohorts, designs, and outcomes, making it difficult to synthesize the data. Limitations exist for telemedicine when considering patient demographic and the method of delivery. Lastly, telemedicine implementation involves individualized research regarding cost and health insurance coverage for patients and facilities.

Heterogeneity is a main limitation of the research. Factors, such as diversity among studies, are difficult to address. The research involving telemedicine is conducted in a variety of countries and settings with various patient populations and technology modalities, making it difficult to narrow down the most effective form of technology and resources.<sup>12</sup> The research for telemedicine tends to contain small sample sizes, which presents challenges when detecting trends and limits the ability to detect differences when variables are present.<sup>3</sup> Further research with studies utilizing consistent methods of telemedicine with larger populations is needed in order to determine significant conclusions.

Numerous variables exist that can contribute to improvements in HbA1c results, such as medication adjustments, changes in blood glucose monitoring, episodes of hypoglycemia, and improvements in lifestyle interventions - all of which can be a direct result of education and

communication received through telemedicine. Despite the research demonstrating a reduction in patients' HbA1c through telemedicine,<sup>1,4,5,9-17</sup> the incidence of hypoglycemia is often unspecified or is unknown to patients and/or providers. Research conducted by Kesavadev et al.<sup>4</sup>, discussed how frequent telemedicine follow-up based on self-monitoring of blood glucose reduces the risk of hypoglycemia by enabling slow and steady titration of medication.<sup>4</sup> This is an important factor when considering how hypoglycemia can inadvertently lower HbA1c values and skew the results of the research.

Bias from patient and provider regarding positive responses to surveys or improvement in self-management may have altered the interventions and results.<sup>11</sup> Patients that are optimistic about technology and telemedicine may be more likely to participate in the research. In addition, candidates for telemedicine research are likely to take an active role in their health, leading to increased participation and improved outcomes. Although studies show that diabetes education via telemedicine is effective, further studies are needed with larger numbers of patients to conclusively determine that diabetes education through telemedicine is equally effective as diabetes education administered in person.<sup>11</sup>

### *Cost-effectiveness*

The use of data uploaded from mobile devices and telemedicine for the management type 2 diabetes is increasing, which allows providers the ability to target the data and work on improving glycemic control and other quantitative elements of diabetes.<sup>23</sup> Clinics are searching for additional ways to reach, treat, and engage patients while improving outcomes.<sup>8</sup> The inpatient market is growing rapidly as healthcare organizations continue to expand their reach to patients and fellow providers, moving beyond just aiding rural or medically underserved communities.<sup>8</sup>

Outpatient telemedicine is growing; yet more awareness and education is needed around reimbursement and regulations.

Research has shown benefits of telemedicine in relation to HbA1c results, thus improving glycemic control and preventing or delaying the long-term complications of type 2 diabetes; however, the economic impact of telemedicine is a collaborative and complex process in which various economic, social, and political players are involved.<sup>1,4,5,9-17</sup> Telemedicine systems are effective for diabetes outcomes; however, this is not an explicit conclusion in terms of cost-effectiveness.<sup>4,19,20</sup> There are extra costs involved in blood glucose monitoring and telemedicine, yet money and time is saved in physical visits to the clinics.<sup>4</sup> Reports on the cost of telemedicine programs are limited and difficult to analyze. There is a lack of consistency among the data along with numerous factors, making it difficult to form a precise conclusion. For example, reports focus on the cost to implement telemedicine, while not considering the cost of hospital admission, healthcare, social, and personal costs. There is a lack of research on the cost savings secondary to reducing complications of poorly controlled diabetes. In addition, the cost of telemedicine and prevention of complications should be reviewed not only for the facility but also the patient. Currently, there are too few articles that accurately investigate and discuss the cost effectiveness of telemedicine systems in the literature.<sup>19</sup>

### *Health Insurance Coverage*

Despite the expanding use and effectiveness of telemedicine, health plans may not cover these types of visits with providers. According to an article in the Journal of Diabetes Science and Technology, fee for service healthcare professionals currently receive lower reimbursement rates for telemedicine visits than for in-person visits.<sup>23</sup> They are not reimbursed for non-real-time

communication via telemedicine.<sup>23</sup> This decreases providers' abilities to support and utilize telemedicine interventions, despite the research demonstrating positive outcomes.<sup>1,4,5,9-17</sup>

Medicare, through Part B, covers specific telemedicine services such as office visits and consultations in certain rural areas and under specific conditions.<sup>22</sup> Medicare may cover wellness visits, psychotherapy, and extended office visits provided by telemedicine; however, specific geographic restrictions remain.<sup>22</sup> This serves as a major barrier for telemedicine when approximately fifteen percent of the population is enrolled in Medicare. Coverage and reimbursement through Medicaid differs between states, which creates confusion among hospitals, providers, and patients. Twenty- four individual states have enforced parity laws, requiring health insurers to cover and pay for telemedicine consultations the same as they would for in-person health care visits.<sup>22</sup> However, not all applications have been approved for use or are recommended in clinical guidelines.<sup>23</sup> Trends such as expanding reimbursement and payment, greater facilitation of telemedicine access by state governments for licensing, proliferation at health centers, and greater adoption of telemedicine will result in increased utilization of telemedicine.<sup>23</sup>

### *Future Research*

It is important to recognize the gaps that exist in telemedicine and establish quality improvement strategies for the future.<sup>10</sup> More research is needed to establish conclusions regarding the impact of telemedicine versus traditional methods on the quality of care provided to patients with diabetes. It is important to determine if the level of care provided through telemedicine is thorough and precise compared to traditional methods, or if additional training is appropriate. Facilities and providers should develop ways to optimize resources that are easy to use and that will reduce tension caused by using technology. Future research must focus on

developing alternative technology interface for delivery of telemedicine that are more satisfactory to patients, such as mobile applications.

Organizations implementing telemedicine for diabetes should consider developing interventions that focus on telemonitoring, regular self-management support, and frequent medication management, which comprehensively address factors that contribute to poor diabetes control.<sup>18</sup> Further research is needed to focus on direct comparisons of delivery methods for telemedicine interventions and the type of telemedicine intervention that has the largest impact on diabetes management. In addition, future studies must investigate how to adapt systems to the individual patient needs and resources of specific health care systems. Evaluating the cost-effectiveness of the intervention should also be addressed, which is relevant to decision makers and impacts on the applicability of the evidence in clinical practice.<sup>1</sup>

## **Conclusion**

As technology improves, healthcare continues to adapt and change to provide optimal patient care. Telemedicine has many guises, from remote videoconferencing to patient portals. It has moved into the mainstream and may improve patients' health and reach those in rural communities. It has the potential transform the management of type 2 diabetes by providing timely education. Studies have shown that telemedicine can be an effective mode of delivering healthcare for patients with type 2 diabetes; however, the studies contain several limitations.<sup>1,4,5,9-</sup>  
<sup>17</sup> The evidence aids healthcare decision makers when considering policies for telemedicine interventions to improve diabetes outcomes. Interventions, such as patient education and support, improve diabetes outcomes and need to be considered.<sup>10</sup> There are a lack of randomized controlled trials and long-term research and no clear conclusions regarding the cost-effectiveness of telemedicine for type 2 diabetes. Demographics, method of telemedicine, and health insurance

are factors that can affect the cost and need to be considered. Due to the nature of telemedicine studies, it is also difficult to discern if the reduction in HbA1c was primarily due to telemedicine, adherence to regimens, increase in medication use, or combination of several factors

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## Appendix

Figure 1: Telemedicine Platforms<sup>6 (p.4)</sup>

Platform	Description
Telestroke	Remote evaluations, diagnoses and treatment recommendations are transmitted to emergency medicine doctors at other sites using advanced telecommunications technologies.
Teleradiology	Images and associated data are transmitted between locations for the purpose of primary interpretation or consultation and clinical review.
Tele-ICU	Networks of audiovisual communication and computer systems are linked with critical care physicians and nurses to ICUs in other, often remote hospitals.
Telemental Health	Mental health and substance abuse services are provided from a distance (e.g. using videoconferencing and other advanced communication technologies).
Telepathology	The practice of pathology is performed at a remote location by means of video cameras, monitors, and a remote-controlled microscope.
Cybersurgery	Surgeons use surgical techniques with a telecommunication conduit connected to a robotic instrument to operate on a remote patient.
Remote Monitoring	Patients are subject to continuous or frequent periodic clinical monitoring via advanced communication technologies.
Telepharmacy	Pharmaceutical care for patients (or supervision to technicians) is provided at a distance using advanced telecommunications technology.
Consultations	Remote consults are conducted with remote specialists, primary care providers, counselors, social workers and other health care professionals.

Interviewer: Erin Ness

Interviewee: Jennifer Freitag Certified Nurse Practitioner, Diabetes Consulting Service  
Mayo Clinic, Rochester Minnesota

June 29, 2017

E-mail correspondence

Erin: What is your experience with use of telemedicine and technology for diabetes? (e.g. videoconferences, applications on smartphones, patient health portals, etc.)

Jennifer: I have worked with patient portals. I find this beneficial to patients that are new to insulin therapy and need frequent insulin dose adjustments. This technology is also beneficial when working with women with diabetes that are pregnant and require frequent dose adjustment and support.

Erin: Has the use of telemedicine improved patient outcomes? (e.g. HbA1c, glucose monitoring, medication adherence)

Jennifer: I do not have hard data to prove this but if we continue to embrace technology we can play a more active role in patients' daily lives. Many of the patients I work with require support especially at diagnosis and when starting insulin therapy. Portals, apps can give patients reminders to take medicine, monitor blood glucose etc.

Erin: What do you think are the benefits of telemedicine? Challenges?

Jennifer: Benefits of telemedicine include expanding access to care. This allows patients to access specialties that may require travel to see. Challenges can include losing that face-to-face contact, however I work with many patients that may live more than a one hour drive from a primary care clinic and this can open up options for patients to interact with specialty care.

Erin: What are your thoughts on the future of telemedicine and use of technology?

Jennifer: As financial concerns continue to loom in healthcare telemedicine may be a way to provide cost-effective care. This may allow a provider, such as an endocrinologist to work from a central location and maximize the amount of patients that provider may see.

Erin: What resources are available to providers and/ or patients for telemedicine education?

Jennifer: I am not aware of education resources at this time. This will likely need to be addressed. It will be important to explain to patients this model of care.

Interviewer: Erin Ness

Interviewee: Jaime Schlomann, RD, LD, CDE at Affiliated Community Medical Center, Willmar Minnesota

July 11, 2017

E-mail correspondence

Data Collection:

Erin: Do you know the Hemoglobin A1c outcomes for patients in classes vs. one-on-one? (generally better or worse?)

Jaime: Diabetes BASICS Classes for 2016

Willmar (location #1)

Completion rate: All 4 classes- 47/55- 85.5%

3 classes- 4/55- 9% (94.5% completion rate for 3 and 4)

2 classes- 1/55- 1.8%

1 class- 3/55- 5.4%

Average A1c before BASICS classes- 8.1%

Average A1c after completing BASICS classes- 6.4%

Number of class participants with A1c of 7% or lower before class- 24/54- 44%  
Number of class participants with A1c of 7% or lower after class- 42/51- 82%

Marshall data (location #2)

Completion rate: All 4 classes: 9/16- 56%

3 of 4 classes: 4/16- 25% (81% completion rate of 3 and 4)

2 of 4 classes: 2/16- 12.5%

1 of 4 classes: 1/16- 6.3%

Average A1c before BASICS= 7.6%

Average A1c after BASICS= 6.25%

Number of class participants with A1c of 7% or lower before class- 11/16- 69%

Number of class participants with A1c of 7% or lower after class- 13/16- 81%

Erin: Benefits and challenges to videoconferencing group diabetes classes?

Jaime: Benefits: Financial benefits- less staff time, larger class sizes, still can offer a group atmosphere even when number of patients is small (like only 1 per site).

Challenges:

- 1) Technology- frequently does not work as planned- may see the speaker but not the presentation, may not connect without 30 minutes of IT help
- 2) Not able to connect with the patients as well through a screen. Less class participation on the telehealth side- very few questions or answers, typically just observe.
- 3) Difficult to document on patients I have not ever met before.
- 4) Increase staff time on documentation since the potential is there to have large groups.



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