Telemedicine in Glycemic Control in Diabetes during COVID-19

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Telemedicine can be an effective tool for managing chronic diseases. The disruption in traditional diabetes care resulting from the COVID-19 pandemic led to global interest in telemedicine.

Keywords: COVID-19 ; diabetes ; glycemic control ; pandemic

1. Introduction

Diabetes is one of the most prevalent diseases worldwide. According to the CDC, from 2001 to 2020, the prevalence of diabetes significantly increased among adults in the United States. Furthermore, the CDC estimated that 37.3 million people, representing 11.3% of the US population, have diabetes [1]. Notably, the global prevalence is expected to rise to 578 million by 2030 [2]. Following COVID-19 pandemic declaration, patients with diabetes were found to be at particularly high risk of intensive care admission (ICU) and mortality from COVID-19 infection, representing a vulnerable population [3][4][5][6]. The advent of the pandemic ushered in a new era in medical care, especially for diabetes, by allowing telehealth to become a key alternative tool that can help modernize care through the use of tools such as continuous glucose monitors, smart pens, and smart phones [7]. The outbreak of the COVID-19 pandemic created an additional challenge in providing care for chronic diseases such as diabetes. Given its highly contagious nature and propensity to spread from one person to another through direct transmission, measures such as social distancing, lockdowns, and travel restrictions were implemented to mitigate virus spread and reduce hospitalizations in different parts of the world, which led countries to adapt different strategies [8]. In the United States, there was a significant drop in in-person outpatient visits, prompting a shift towards the use of telemedicine as a consequence [9]. However, the impact of the pandemic extended beyond the United States and had a major repercussion in care across different countries around the world and medical specialties [10].

Overall, the change in the landscape of medical care posed a challenge to the way healthcare was delivered. Consequently, institutions increasingly utilized virtual clinics and telemedicine interventions to provide appropriate care for patients, including those with diabetes, to protect against COVID-19 infections. Despite the sudden change in care, telemedicine was positively received by patients [11][12]. Telemedicine is defined by the Institute of Medicine as “the use of electronic information and communications technologies to provide and support health care when distance separates the participants” [13]. The Centers for Medicare and Medicaid Services (CMS) describes telemedicine as “the exchange of medical information from one site to another through electronic communication to improve a patient’s health” [14]. Telemedicine can be an effective tool for more than just patients with an established diabetes diagnosis. It can also be used to navigate challenging situations such as insulin pump training through virtual clinics or management of new-onset diabetes, circumstances where in-person care were traditionally deemed necessary [15][16]. Although telemedicine was not broadly used prior to the onset of the pandemic, it swiftly became an instrumental tool for the care of patients with diabetes; that, in conjunction with the use of technology such as continuous glucose monitors (CGM), allowed physicians to provide adequate care and makes telemedicine feasible [17].

2. Evidence from Retrospective Studies

Among the retrospective studies published, three of them assessed patients exclusively with type 1 diabetes (T1D) and included patients who used insulin pumps or MDI as methods of treatment and either CGM or FGM as glycemic monitoring methods [18][19][20].

A study conducted with 30 T1D patients on hybrid closed loop (HCL) insulin pumps [18] evaluated glycemic control through telemedicine across four different time points during the pandemic lockdown period (two weeks before the lockdown, Time 0), during the first two weeks of lockdown (Time 1), last two weeks of lockdown (Time 2), and first two weeks after the lockdown (Time 3) [18]. The study found an improvement in mean glucose value (155 mg/dL in Time 0 vs. 153 mg/dL in Time 3, $p = 0.004$), a significant improvement in TIR (68.5% in Time 0 vs. 73.5% in Time 3, $p = 0.012$) without an increase in level 1 (54–69 mg/dL) and level 2 (<54 mg/dL) hypoglycemia. The improvement in TIR was instead associated with a reduction in TAR.

Another study by Boscari et al. [19], which enrolled 71 T1D patients managed by either MDI or CSII, analyzed the efficacy of telemedicine by comparing CGM/FGM combined data gathered four weeks before and four weeks after patients attended a telephone visit. This showed a reduction in GMI from 7.16 to 7.05%, $p = 0.002$, a reduction in mean glucose value from 161.1 mg/dL to 156.3 mg/dL, $p = 0.001$, a reduction in TAR (>180 mg/dL) from 33.4 to 30.5%, $p = 0.002$, with an improvement in TIR (70–180 mg/dL) from 63.6 to 66.4%, $p < 0.001$. Furthermore, among those managed by CSII, there was a reduction in mean glucose value from 157.9 mg/dL to 152.6 mg/dL, $p = 0.003$ [19]. No changes were observed in TBR (<70 mg/dL) with 3.0 vs. 3.2% $p = 0.6$, respectively.

Alharthi et al. [20] evaluated patients with T1D and compared glycemic control from FGM device data in a total of 101 patients who attended a specialized diabetes clinic during the six-week lockdown period 61 patients attended a telemedicine visit (TM) and a total of 40 patients did not [20]. The study showed improvements in average blood glucose from 180 mg/dL to 159 mg/dL, $p < 0.01$ in those who attended a TM visit vs. 159.5 to 160 mg/dL $p = 0.99$ in those who did not. An improvement in TIR (70–180 mg/dL) from 46.0% to 55.0%, $p < 0.01$ vs. 58.0 to 57.0%, $p = 0.20$, was also observed. The authors also found a reduction in GMI from 7.7 to 7.2%, $p = 0.03$ vs. 7.3 to 7.2%, $p = 0.65$ in those who attended a TM visit vs. those who did not attend a TM visit, respectively. Additionally, a reduction in TAR (>180 mg/dL) was noted, without any significant change in TBR (<70 mg/dL) or in hypoglycemic events [20].

Four studies explored the impact of telemedicine on glycemic control in patients with type 2 diabetes (T2D) [21][22][23][24]. These studies monitored glycemic control through SMBG, fasting, or postprandial blood glucose. Unlike the studies mentioned above, none of the subjects used a continuous or flash glucose monitor. In addition, a wide range of medications, such as insulin, GLP-RA, and SGLT2i, were used for glucose control in these studies; insulin pumps in patients with type 2 diabetes were not explored.

Scoccimarro et al. [21] evaluated 269 patients and assessed the difference in HbA1c and body weight between the pre-lockdown and post-lockdown periods (from November 2019 to February 2020 vs. May to June 2020). They found no deterioration in metabolic profile but rather a slight improvement in HbA1cHbA1c% (7.3% ± 3.1% pre-lockdown vs. 7.2% ± 3.2% post-lockdown, $p < 0.01$) and in weight (83.2 ± 16.8 kg vs. 81.6 ± 16.4, $p < 0.01$) in the entire cohort.

In another study, Dutta et al. [22] compared glycemic control among a cohort of 96 patients with T2D who were followed for a six-month period through telemedicine or in-person visits [20]. The study found a reduction in HbA1c from baseline 8.7% ± 1.8 to 6.9 ± 1.1 in the telemedicine compared to the in-person group, which had a reduction in HbA1c from baseline 8.6% ± 2.1% to 7.0% ± 1.0%, $p = 0.88$ at six months follow-up. A reduction in FPG (fasting plasma glucose) and PPPG (post prandial plasma glucose) was noted in both groups as well [22].

The clinical effectiveness of telemedicine vs. a traditional care model was evaluated in 200 patients with uncontrolled T2D (HbA1c > 9%) who attended an outpatient diabetes clinic [23]. The telemedicine arm included patients that attended a virtual clinic between March and June 2020 and the traditional care model included patients who received in-person care between August and November 2020. The telemedicine group had a reduction of 1.82% ± 1.35% (95% CI = 1.56–2.09, $p < 0.001$) when compared to the traditional care model, which had a mean reduction of 1.54% ± 1.56% (95% CI = 1.23–1.85, $p < 0.001$ [23].

Another study explored the impact of telemedicine on HbA1c in high-risk patients (HbA1c > 8%) with T2D before and after the implementation of a pharmacist-led telehealth service [24]. The study evaluated the change in HbA1c between the pre-COVID-19 group (August 2019–February 2020) and the COVID-19 group (March 2020–October 2020). The study showed an HbA1c reduction of 1.3% in the pre-COVID-19 group vs. 2% in the COVID-19 group at three months follow-up, $p = 0.305$. An HbA1c reduction of 1.2% in the pre-COVID-19 vs. 2.2% in the COVID-19 group, $p = 0.249$ at six months follow-up, was also observed [24].

Finally, three retrospective studies enrolled both T1D and T2D patients to analyze the efficacy of telemedicine during the state of emergency [25][26][27]. Of these studies, one evaluated outpatient diabetes care and HbA1c levels during the 2020 pandemic to 2019 by comparing the 13 weeks before (pre-period) and after (post-period) the lockdown period (26 May–24 August 2020) with the same time frame in 2019 [25]. This found a post-period HbA1c of 7.2% in 2020 and 7.2% in 2019 ($p = 0.43$) with a change in HbA1c of −0.1 and −0.2 from the pre-period, respectively ($p < 0.001$). A propensity analysis done between clinic visits vs. telemedicine visits in 2020 showed a reduction in HbA1c from baseline 7.6 to 7.5%, $p = 0.023$, with a difference reduction of –0.15 in the telemedicine compared with the clinic visit group that showed a reduction of HbA1c from 7.6 to 7.4%, $p = 0.023$ with a reduction of −0.23, $p = 0.019$ favoring clinic visit over telemedicine [26]. The second study conducted a multiple regression analysis of patients with T1D and T2D (N = 2727), which showed that following adjustment for sex and type of diabetes, lower pre-BMI, lower pre-HbA1c, younger age, and clinic visit and/or telemedicine visit were associated with a higher chance of achieving an HbA1c < 7% [26]. Lastly, a study conducted by Wong et al. analyzed a cohort of 504 patients with both T1D and T2D) [27]. The study assessed telehealth consultations that took place between 1st April 2020 and 1st September 2020 (Visit A) and compared it to the proportion of patients that attended a face-to-face encounter during the same months in the year 2019 (Visit B) and finally compared it to patients that attended the clinic between April and September 2020 and had been attending the clinic face-to-face for at least 12 months prior to the onset of the pandemic (Visit C). When assessing HbA1c available at all patients, the study found improvements in HbA1c of 7.8% ± 1.6% at Visit A when compared to 8.1 ± 1.4 at Visit B and 8.2 ± 1.7% at visit C ($p < 0.001$). Patients with T2D also had a lower HbA1c at visit A compared to visit B and visit C. However, in patients with T1D, there was no significant difference in glycemic control between visit A, visit B, and visit C, with an HbA1c of 8.3 ± 1.4%, 8.4 ± 1.7, and 8.4 ± 1.8, respectively [27].

3. Evidence from Prospective Studies

Three prospective studies evaluated the effect of telemedicine in improving glycemic control in individuals with T1D and T2D. Two of the three studies enrolled patients with T1D and one enrolled patient with T2D [28][29][30].

A pilot study, which included 166 patients with T1D, aimed to evaluate different glycemic outcomes collected during two virtual visits during the lockdown period [26]. The study considered different methods of insulin delivery and glucose monitoring for its assessment (CSII + CGM, MDI + CGM, and CSII or MDI + SMBG), showing that TIR increased from baseline to follow-up visits in all patients). There was a non-statistically significant improvement in TBR and GMI compared to baseline and statistically significant improvements in TAR and mean daily glucose [28]. Notably, the CSII and MDI+SMBG group displayed better improvements in the TAR from baseline compared to follow-up visits (40.0% ± 18.0% vs. 28.0% ± 15.0%, respectively; $p = 0.03$), a reduction in mean daily glucose (176± 49 mg/dL vs. 150 ± 25 mg/dL; $p = 0.04$), and improvement in GMI (7.5% ± 1.1% vs. 6.9% ± 0.6%; $p = 0.04$), and CV (36.0% ± 8.0% vs. 42.0%± 9.0%; $p = 0.04$) compared to the other groups. In a subgroup analysis, the authors found a significant improvement in TIR in those with a GMI > 7.5% as compared to those with a GMI < 7.5% [28].

Another study enrolled 87 patients with uncontrolled T1D diabetes (GMI > 9%) and followed patients between March and June 2020 through online visits, conferences, and group sessions [29]. The authors evaluated the number of hospitalizations for DKA and severe hypoglycemia causing loss of consciousness or seizures and, as a secondary endpoint, reduction in GMI. The participant's outcomes were compared to patient data from patients with HbA1c > 9% in the TID exchange. The study found fewer hospitalizations for DKA in the enrolled patients vs. T1D exchange (2.2 vs. 6.71%), fewer episodes of severe hypoglycemia in telemedicine vs. T1D exchange (1.1% vs. 7%) and change in mean GMI of −0.66% (reduced from 9.91 to 9.25%) during this period [29].

Finally, a study assessed 130 T2D patients with HbA1c > 9% who attended a virtual integrated care clinic over four months during the pandemic. Using Hb1Ac as a marker for glycemic control, this single-arm observational study showed a decrease in pre-intervention HbA1c from 9.98 ± 1.33 to 8.32 ± 1.31 ($p < 0.001$) post-intervention [30].

References

1. Centers for Disease Control and Prevention. By the Numbers: Diabetes in America. Available online: https://www.cdc.gov/diabetes/health-equity/diabetes-by-the-numbers.html (accessed on 25 October 2022).
2. Saeedi, P.; Petersohn, I.; Salpea, P.; Malanda, B.; Karuranga, S.; Unwin, N.; Colagiuri, S.; Guariguata, L.; Motala, A.A.; Ogurtsova, K.; et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. Diabetes Res. Clin. Pract. 2019, 157, 107843.
3. Spanakis, E.K.; Yoo, A.; Ajayi, O.N.; Siddiqui, T.; Khan, M.M.; Seliger, S.L.; Klonoff, D.C.; Feng, Z.; Sorkin, J.D. Excess Mortality in COVID-19-Positive Versus COVID-19-Negative Inpatients with Diabetes: A Nationwide Study. Diabetes Care 2021, 44, e169–e170.
4. Zhou, F.; Yu, T.; Du, R.; Fan, G.; Liu, Y.; Liu, Z.; Xiang, J.; Wang, Y.; Song, B.; Gu, X.; et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: A retrospective cohort study. Lancet 2020, 395,

1054–1062.

5. Guan, W.J.; Ni, Z.Y.; Hu, Y.; Liang, W.H.; Ou, C.Q.; He, J.X.; Liu, L.; Shan, H.; Lei, C.L.; Hui, D.S.C.; et al. Clinical Characteristics of coronavirus disease 2019 in China. N. Engl. J. Med. 2020, 382, 1708–1720.
6. Wang, D.; Hu, B.; Hu, C.; Zhu, F.; Liu, X.; Zhang, J.; Wang, B.; Xiang, H.; Cheng, Z.; Xiong, Y.; et al. Clinical Characteristics of 138 Hospitalized Patients with 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China. JAMA 2020, 323, 1061–1069.
7. Aberer, F.; Hochfellner, D.A.; Mader, J.K. Application of Telemedicine in Diabetes Care: The Time is Now. Diabetes Ther. 2021, 12, 629–639.
8. Agarwal, K.M.; Mohapatra, S.; Sharma, P.; Sharma, S.; Bhatia, D.; Mishra, A. Study and overview of the novel corona virus disease (COVID-19). Sens. Int. 2020, 1, 100037.
9. Patel, S.Y.; Mehrotra, A.; Huskamp, H.A.; Uscher-Pines, L.; Ganguli, I.; Barnett, M.L. Trends in Outpatient Care Delivery and Telemedicine During the COVID-19 Pandemic in the US. JAMA Intern. Med. 2021, 181, 388–391.
10. Dupraz, J.; Le Pogam, M.-A.; Peytremann-Bridevaux, I. Early impact of the COVID-19 pandemic on in-person outpatient care utilisation: A rapid review. BMJ Open 2022, 12, e056086.
11. Mann, D.M.; Chen, J.; Chunara, R.; Testa, P.A.; Nov, O. COVID-19 transforms health care through telemedicine: Evidence from the field. J. Am. Med Inform. Assoc. 2020, 27, 1132–1135.
12. Scott, S.N.; Fontana, F.Y.; Züger, T.; Laimer, M.; Stettler, C. Use and perception of telemedicine in people with type 1 diabetes during the COVID-19 pandemic—Results of a global survey. Endocrinol. Diabetes Metab. 2020, 4, e00180.
13. Telemedicine: A Guide to Assessing Telecommunications in Health Care; Field, M.J. (Ed.) National Academies Press: Washington, DC, USA, 1996.
14. (CMS) CfMaMS. Medicare Telemedicine Health Care Provider Fact Sheet. 2020. Available online: https://www.cms.gov/newsroom/fact-sheets/medicare-telemedicine-health-care-provider-fact-sheet (accessed on 6 June 2023).
15. Garg, S.K.; Rodbard, D.; Hirsch, I.B.; Forlenza, G.P. Managing New-Onset Type 1 Diabetes during the COVID-19 Pandemic: Challenges and Opportunities. Diabetes Technol. Ther. 2020, 22, 431–439.
16. Pinsker, J.E.; Singh, H.; Malloy, M.M.; Constantin, A.; Leas, S.; Kriegel, K.; Habif, S. A Virtual Training Program for the Tandem t:slim X2 Insulin Pump: Implementation and Outcomes. Diabetes Technol. Ther. 2021, 23, 467–470.
17. de Kreutzenberg, S.V. Telemedicine for the Clinical Management of Diabetes; Implications and Considerations after COVID-19 Experience. High Blood Press. Cardiovasc. Prev. 2022, 29, 319–326.
18. Longo, M.; Caruso, P.; Petrizzo, M.; Castaldo, F.; Sarnataro, A.; Gicchino, M.; Bellastella, G.; Esposito, K.; Maiorino, M.I. Glycemic control in people with type 1 diabetes using a hybrid closed loop system and followed by telemedicine during the COVID-19 pandemic in Italy. Diabetes Res. Clin. Pract. 2020, 169, 108440.
19. Boscari, F.; Ferretto, S.; Uliana, A.; Avogaro, A.; Bruttomesso, D. Efficacy of telemedicine for persons with type 1 diabetes during Covid19 lockdown. Nutr. Diabetes 2021, 11, 1.
20. Alharthi, S.K.; Alyusuf, E.Y.; Alguwaihes, A.M.; Alfadda, A.; Al-Sofiani, M.E. The impact of a prolonged lockdown and use of telemedicine on glycemic control in people with type 1 diabetes during the COVID-19 outbreak in Saudi Arabia. Diabetes Res. Clin. Pract. 2021, 173, 108682.
21. Scoccimarro, D.; Giove, G.; Silverii, A.; Dicembrini, I.; Mannucci, E. Effects of home confinement during COVID-19 outbreak on glycemic control in patients with type 2 diabetes receiving telemedicine support. Acta Diabetol. 2021, 59, 281–284.
22. Mithal, A.; Dutta, A.; Mahendru, S.; Sharma, R.; Singh, A.; Jain, A.; Jevalikar, G. Video consultation versus in-person clinic visit for glycemic control in type 2 diabetes during COVID-19 pandemic (VIP-CD study). Indian J. Endocrinol. Metab. 2021, 25, 427–431.
23. AlMutairi, M.F.; Tourkmani, A.M.; Alrasheedy, A.A.; Alharbi, T.J.; Bin Rsheed, A.M.; Aljehani, M.; AlRuthia, Y. Cost-effectiveness of telemedicine care for patients with uncontrolled type 2 diabetes mellitus during the COVID-19 pandemic in Saudi Arabia. Ther. Adv. Chronic Dis. 2021, 12, 20406223211042542.
24. Woodhouse, A.G.; Orvin, C.; Rich, C.; Crosby, J.; Keedy, C.A. Diabetes outcomes before and during telehealth advancements surrounding COVID-19. J. Am. Pharm. Assoc. 2022, 62, 214–217.
25. Onishi, Y.; Ichihashi, R.; Yoshida, Y.; Tahara, T.; Kikuchi, T.; Kobori, T.; Kubota, T.; Iwamoto, M.; Hamano, S.; Kasuga, M. Substitution of telemedicine for clinic visit during the COVID-19 pandemic of 2020: Comparison of telemedicine and clinic visit. J. Diabetes Investig. 2022, 13, 1617–1625.

26. Onishi, Y.; Yoshida, Y.; Takao, T.; Tahara, T.; Kikuchi, T.; Kobori, T.; Kubota, T.; Shimmei, A.; Iwamoto, M.; Kasuga, M. Diabetes management by either telemedicine or clinic visit improved glycemic control during the coronavirus disease 2019 pandemic state of emergency in Japan. J. Diabetes Investig. 2021, 13, 386–390.
27. Wong, V.W.; Wang, A.; Manoharan, M. Utilisation of telehealth for outpatient diabetes management during COVID-19 pandemic: How did the patients fare? Intern. Med. J. 2021, 51, 2021–2026.
28. Parise, M.; Tartaglione, L.; Cutruzzolà, A.; Maiorino, M.I.; Esposito, K.; Pitocco, D.; Gnasso, A.; Irace, C. Teleassistance for Patients With Type 1 Diabetes during the COVID-19 Pandemic: Results of a Pilot Study. J. Med. Internet Res. 2021, 23, e24552.
29. Zeller, W.P.; DeGraff, R. A novel telemedicine protocol improved outcomes for high-risk patients with type 1 diabetes: A 3-month quality improvement project during the COVID-19 pandemic. J. Clin. Transl. Endocrinol. Case Rep. 2021, 19, 100078.
30. Tourkmani, A.M.; Alharbi, T.J.; Rsheed, A.M.B.; Alrasheedy, A.A.; Almadani, W.; Aljuraisi, F.; AlOtaibi, A.F.; AlHarbi, M.; AlAbood, A.F.; Ibn Alshaikh, A.A. The impact of telemedicine on patients with uncontrolled type 2 diabetes mellitus during the COVID-19 pandemic in Saudi Arabia: Findings and implications. J. Telemed. Telecare 2021, 29, 390–398.