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Review

Telemedicine interventions in the management of diabetes mellitus in special epidemiological conditions

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Abstract

The COVID-19 pandemic, an unprecedented epidemiological context, has brought multiple swift changes in public policies, healthcare facilities and the daily life of individuals worldwide. While the management of infections with SARS-CoV-2 has become a priority in most medical settings, a drastic reduction in the outpatient visits for non-communicable diseases, an avoidance of hospitals and also a limitation in non-urgent medical appointments with delayed diagnosis and treatment have been reported. Diabetes mellitus (DM) is a lifelong condition that requires continuous non-pharmacological and pharmacological interventions to achieve and maintain adequate control of glycemic levels and of other cardiovascular risk factors. The COVID-19 pandemic has contributed to increased difficulty in patients' access to state-of-the-art diabetes care, a situation that has found its solution through the inclusion of telemedicine into routine clinical practice. These interventions have been shown to improve glycemic control, mental health, and the communication between patients with DM and their healthcare providers, while also lowering the risk of potential infections with SARS-CoV-2. The aim of this review is to describe the epidemiological context that has led to the increased usage of telemedicine in diabetes and the diversity and benefits of these interventions.

Keywords: diabetes mellitus, technology, telemedicine, special epidemiological conditions, COVID-19.

Diabetes mellitus (DM) is a major public health issue worldwide due to its high and continuously increasing prevalence and to its significant morbidity burden caused by its acute and chronic complications. The International Diabetes Federation (IDF) reported in the 2021 10th Edition Diabetes Atlas that an estimated 537 million adults aged 20–79 years were living with DM, accounting for about 10.5% of the world's population in that age group. However, the numbers are predicted to increase in the following decades up to a total number of 643 million (11.3%) by 2030 and 783 million (12.2%) by 2045 [1]. Moreover, these numbers have already increased since the previous 9th Edition IDF Diabetes Atlas that estimated that in 2019, approximately 463 million adults were living with DM worldwide, while the predictions for the year 2030 have mentioned a total of 588 million and for the year 2045 a total of 700 million adults with DM [2]. The impact of DM can also be observed in younger populations – in 2021, it was reported that over 1.2 million children

and adolescents had been living with diabetes, of which 54% were under 15 years of age. Also, the number of newly diagnosed cases of type 1 diabetes each year reached 184,100, while about 1 in 6 live births (16.7%) are affected by hyperglycemia in-utero [1].

DM is also known to be generating major direct and indirect costs to countries, healthcare systems, people with diabetes, and their families – the IDF estimates that in 2007, the global health expenditure due to diabetes was at 232 billion USD, with a dramatic increase up to 966 billion USD in 2021 and with an even further rise, up to over one trillion USD by 2030. One of the major causes of the high costs of managing DM is the high complications rate in patients that lack adequate management of hyperglycemia and of associated cardiovascular risk factors. It is noteworthy that about half of the individuals that are living with DM are not aware that they are suffering from this condition, leading to potentially unfavorable outcomes [1].

DM is a chronic and complex disease that requires continuous pharmacological and non-pharmacological interventions that start from the diagnosis, considering the lifelong nature of the condition [3]. The management of DM is recommended to consist of a multifactorial, interdisciplinary approach that includes glycemic control and also control of all the existing risk factors in order to prevent or delay the onset of complications, to increase life expectancy, and to improve the quality of life [4]. Alongside pharmacological treatment, non-pharmacological treatment is of paramount importance for patients with DM. The main interventions include diet, physical activity, smoking cessation, psychosocial care, education, and continuous support for disease self-management [5]. For optimal outcomes, current guidelines are recommending patient-centered management of DM that should take into consideration patients' comorbidities, prognoses, preferences, needs and values in a personalized approach to the condition [6, 7].

Chronic care models have been developed in order to improve adherence to the recommended guidelines and algorithms. The Chronic Care Model (CCM) for improving the quality of diabetes care has proven a reduced incidence of diabetes-related complications, a reduced rate of all-cause mortality, and reduced costs per individuals' healthcare. The model includes multiple aspects that can influence the outcomes of patients with DM. The components of this model include specific improvements of healthcare systems, self-management, and decision support, with changes in the delivery system design, clinical information systems, and community resources and policies [8–10]. Moreover, recent guidelines have also included the recommendation of avoiding therapeutic inertia, a phenomenon encountered across all medical specialties, through regular reassessment and optimization of the management of each patient, preferably once every 3–6 months [11].

However, these frequent visits to the diabetologist or to other healthcare practitioners could be difficult to attain in real-life scenarios for some patients for a diversity of reasons such as distance, transportation, time-related issues or socioeconomic barriers [12]. It is then more than clear that the existence of a special epidemiological context that can fundamentally change even usual day-to-day activities would also contribute to a decreased regularity in these aforementioned medical visits, with negative health outcomes for patients with non-communicable diseases such as DM. One of these examples is the current COVID-19 (coronavirus disease) global pandemic, as it was declared on the 11th of March 2020 by the World Health Organization (WHO) – a public health emergency of international concern that has led to swift changes in public policies worldwide [13, 14]. In order to control the spread of transmission and infection with SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2) and also the impact of this pandemic, countries all across the globe have adopted sets of measures that ranged from basic hygiene intervention to wearing face masks in public spaces, to physical (social) distancing, to travel restrictions, to home quarantine and even to lockdown [15–18].

However, although these interventions have proven to be beneficial in the evolution of COVID-19 cases and on their significant burden on the healthcare system, especially if they

were adopted early and coordinated through geographical territories, they have also been associated with several negative outcomes [19]. Firstly, a drastic reduction in the outpatient and laboratory visits for patients with DM has been noticed early during the pandemic [20]. Secondly, the lockdown has led to several unhealthy habits such as hypercaloric meals with low physical activity followed by weight gain, insufficient sun exposure with decreased levels of vitamin D and also impaired mental health with fears, frustration, information overload, lack of trust, and feelings of isolation that have led to anxiety, insomnia, stress disorders, and depression [21–26]. Thirdly, the treatment of COVID-19 has become a priority in most healthcare facilities with consequences in limiting non-urgent medical and surgical appointments and, therefore, in delayed diagnosis of asymptomatic or mildly symptomatic diseases, comorbidities or complications, and lower rates of adherence to recommended interventions for patients with chronic diseases including DM [21]. Lastly, avoidance of hospitals has been noticed, derived largely from patients' fear of infection, with a negative impact on the diagnosis and treatment of multiple acute conditions [27].

Nevertheless, several studies have shown that the glycemic control of patients with DM was similar before and during the pandemic. One of the explanations for this phenomenon is considered to be the increased usage of telemedicine that has allowed uninterrupted access to diabetes care [20, 28, 29]. The possibility of using remote interventions in the management of patients with DM has already been used and studied years before this particular epidemiological context. However, the COVID-19 pandemic has suddenly increased the need of incorporating telemedicine in daily medical practice transforming this modern, but exceptionally utilized approach of healthcare into an essential component of the management of patients with diabetes.

Telemedicine, a term firstly used in the 1970s, is defined as the usage of information and communication technologies to improve patient outcomes by increasing access to care and medical information. This type of clinical support, which literally means "healing at a distance" is constantly evolving by incorporating new technologies and adapting to the changing needs of society, traits through which it became even more relevant in the current epidemiological context [30]. Telemedicine is associated with a multitude of advantages that could also have favorable effects on diabetes care such as efficiency and cost-efficiency, improvement of patients' health behavior, medication adherence and quality of life, and optimization in the management and self-management of chronic conditions. Moreover, telemedicine overcomes distance barriers, contributes to a better flow in patients' care, and reduces the costs of healthcare, while also reducing the time requirements for a medical visit and improving the patient-healthcare professional interaction [30, 31].

Specifically, telemedicine used in diabetology or "telediabetology" adds value to the standard approach to patient care through its diversity, ranging from screening to documentation and intervention, including not only the possibility to diagnose retinopathy, to assess foot ulcers or to calculate risk scores but also to monitor glycemic values and to perform therapeutic adjustments, lifestyle interventions and implement decision support systems [32]. Regarding the barriers that interfere with the regular usage of telemedicine in chronic diseases, in general, and in diabetology, in particular, several publications have identified, among others, intervention- and content-related barriers such as technical issues, connectivity, language, and inadequate information, context-related barriers such as costs, security concerns, incompatibility with the patients' lifestyle or their lack of trust and also user-related barriers such as literacy, health status or the general attitude towards technology [31, 33].

However, despite these barriers, telemedicine was already being used in the management of DM, especially in type 1 DM, in augmenting traditional medical consultations since various technological advancements have been made in this field. The development of modern glucose-meters, continuous glucose monitoring (CGM) devices, continuous subcutaneous insulin infusion (CSII) systems, and of sensor-augmented insulin pumps has led to the possibility

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of remotely monitoring biological parameters and patient-driven interventions by specialized healthcare providers and to offering real-time recommendations for addressing specific situations [34]. This possibility of constantly assessing glycemic levels and interventions, alongside other characteristics of DM itself such as the chronic and usually predictable and stable evolution of the disease, with visits made at the same physician, contribute to the inclusion of this metabolic disease among the non-communicable conditions that are extremely suited for telemedicine.

The beneficial effects of augmenting on-site visits through teleconsultations or even of offering remote-only consultations for patients have been proven throughout recent years by an array of studies that have shown efficacy in improving glycemic control in patients with DM. A systematic review that included 107 studies and a total of 20,501 participants has shown that different telemedicine interventions reduced hemoglobin A_{1c} (HbA_{1c}) by a mean of 0.43%, with teleconsultation, tele-case-management plus telemonitoring and tele-education plus tele-case-management being the most effective strategies [35]. Other studies had similar or even more significant results with a reduction in HbA1c of up to 0.86% in patients with type 1 DM and up to 1.13% in those with type 2 DM [36, 37].

Alongside the previously mentioned reductions of HbA_{1c}, telemedicine in diabetes has been proven to contribute to significant reductions in both systolic blood pressure and diastolic blood pressure values in patients with arterial hypertension and also to improve lifestyle habits, with inconsistent results regarding the lipid profile and body weight. Among all the different methods that have been used, the most effective intervention is considered to be one that offers the possibility of two-way communication between patients and healthcare professionals and includes patient-generated health data, transmission and analysis of this information, education, and individualized feedback [38–40].

The inclusion of telemedicine in routine diabetes care has become extremely important during the COVID-19 pandemic because of its ability to facilitate access to continuous diabetes care and to improve glycemic control while further improving the prognosis of the patients in case of a potential SARS-CoV-2 infection. Also, this approach ensured the necessary physical distancing in individuals, with a subsequent limitation of exposure of these potentially high-risk patients, as the bidirectional relationship between the two diseases was rapidly discovered [41]. Furthermore, it was shown that telemedicine has benefits on mental health and that it contributes to maintaining continuous and reassuring communication between patients with DM and their healthcare professionals regarding recommendations about diet, physical activity, stress management, titration of pharmacologic agents dosage, improvements in cardiovascular risk factors and also in transmitting valuable information about the pandemic itself [42]. During the pandemic, some studies have reported a remarkable increase in the proportion of individuals with DM that have received telemedicine consultations, from less than 10% to more than 50% [43]. Regarding the effects of telemedicine strategies on glycemic control during the COVID-19 pandemic, these were similar to the ones reported before this unprecedented epidemiological context, showing reductions in HbA_{1c} and blood glucose levels, as previously mentioned [20, 44].

Telemedicine in diabetes has become one of the largest and swiftest healthcare delivery transformations worldwide through the possibilities that were offered to patients in different countries across the globe. This included medical consultation at home from the patients' perspective, while being secure and physically distanced, but also noteworthy benefits for healthcare facilities that could continue offering state-of-the-art medical assistance while avoiding overcrowding and epidemiological accidents [45–48]. In this context, telemedicine has also become easily available to patients with DM from Romania through a dedicated free-access online platform that was made possible through several measures adopted by national authorities. For example, the telediabet.ro website offered and is expected to continue to provide access to telemedicine consultations through telepresence services via a video conferencing platform, through document

sharing and also through using a call-center, e-mail messaging, or a direct contact form in order to reach connect specialized healthcare professionals to their patients. The feedback that was collected from the users regarding the desirability, acceptability, and adherence to this type of intervention has been encouraging and suggests that the role of telemedicine will possibly increase in the near future.

This positive impact of using telemedicine-related instruments in the management of patients with DM, not only regarding the glycemic control but also control of other cardiovascular risk factors have brought attention to this type of healthcare intervention, especially in times of exceptional epidemiological conditions such as the COVID-19 pandemic. It has been shown that telemedicine can contribute to improving clinical and biological outcomes pertaining to patients' metabolic condition and also to their psychological and emotional well-being during uncertain times by offering an active and reassuring communication between patients with DM and their healthcare providers, while also ensuring a safe environment and lowering infectious risks for both sides. Therefore, the care continuation and further development of telemedicine platforms in diabetes in countries all across the globe should be considered beyond this pandemic in order to improve the current management and self-management of patients with DM, to aid in preventing the development of complications and also to increase patient life quality.

Conflict of interest

The authors declare no conflict of interest.

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