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REVIEW ARTICLE

Reducing the Cost of Diabetes Care with Telemedicine, Smartphone, and Home Monitoring

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Abstract | The effect of an increasing diabetes population has resulted in escalated costs and overburdened physicians. The increase in cost is not due to the disease per se, but because of its largely preventable complications. Patient-friendly technologies are proven to significantly reduce complications and thereby cost, but seldom practised. Telemedicine is increasingly being utilized in diabetology to improve access to health care, quality of care, and clinical/psychosocial outcomes in patients with diabetes (PWD). In PWD, patient–physician interactions are essential for improving health outcomes and preventing long-term complications. Smartphones are one of the basic modalities for telemedicine application. Mobile phone messaging applications, including text messaging and multimedia message service, could offer a convenient and cost-effective way to support desirable health behaviors. There are diabetes-related mobile apps mainly focusing on self-management of diabetes, lifestyle modification, and medication adherence motivation. With the widespread availability of high-speed Internet, remote monitoring has also become popular. Home monitoring of blood glucose and blood pressure, wearable devices, and continuous glucose monitoring also play a vital role in bringing down the long-term vascular complications of diabetes and thereby reduce the overall cost and improve the quality of life of patients. There are hundreds of tech platforms for diabetes management, of which only a few with proven efficacy and safety are recommended by physicians.

Keywords: *Diabetes, Telemedicine, Smartphone, Glycemic control, m-Health apps, Cost-effectiveness*

1 Introduction

Diabetes mellitus and its costly complications have attained epidemic proportions across the globe and are currently considered one of the most challenging public health concerns (1). In India, we have around 80 million people affected with diabetes[2]. The disease is associated with several health-related complications and high morbidity and mortality rates and thus imposes substantial social and economic burdens worldwide[3]. The effect of an increasing diabetes population has resulted in increased costs and overburdened physicians[4].

Existing diabetes treatment strategies have not completely been able to prevent disease-related complications. 50–85% of people with diabetes develop one or more complications despite following medication advice. The average glucose remains high in those people with diabetes, raising concerns of these complications affecting the working age population, since the age of onset of diabetes is now relatively early.

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To help resolve this puzzle, digital technologies to improve diabetes self-management are being established. The review shed insights into the currently available digital technologies for diabetes care, such as mobile apps, smartphone-based retinal screening, significance virtual COVID IP, and significance of Electronic Medical Records (EMR.) w*Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.* hich would aid health-care professionals and patients to become aware of the potential benefits and cost-effectiveness of these technologies[5]. But there is a standard perception among the common men that technologies increase the cost of diabetes care and this has been the experience in the past. For example, when mobile phones were launched, it was too expensive for the common man during the initial few years, and when more and more people started using mobile phones, the cost came down. The story was similar with other devices and technologies which are now being used in our daily lives. Even automobiles were once unaffordable to the common man. New therapies, monitoring, and technologies applied to health care represent a historic opportunity to improve the lives of people with diabetes. Connected care will supplement more expensive, less convenient face-to-face clinic visits by enabling new models of care that increase the velocity to control with more aggressive and frequent interventions that speed up the achievement of glycemic goals.

Electronic Medical Records (EMR): An electronic health record is the systematized collection of patient and population electronically stored health information in a digital format

2 Telemedicine in Diabetes Care

WHO defines telemedicine as "The delivery of health-care services, where distance is a critical factor, by all health-care professionals using information and communications technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and the continuing education of health-care workers, with the aim of advancing the health of individuals and communities"[6]. Telemedicine Telemedicine includes timely transmission and remote interpretation of patient data for follow-up and preventive interventions. The main purpose of this approach is to facilitate a productive interaction between the patient and the health-care provider to achieve improved treatment results and lower treatment costs. Reducing outpatient clinic visits and doctor office visits through the use of telemedicine allows patients to save time, money, and other resources.

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3 Telehealth

"The delivery and facilitation of health and health-related services including medical care, provider and patient education, health information services, and self-care via telecommunications and digital communication technologies"[7].

4 Components of Telemedicine

The five essential components of a sound telemedicine system include (Fig. 1) the following.

The widespread utilization of telemedicine during COVID-19 pandemic not only legalized, but also proved its overall superiority and cost-effectiveness in many specialities[8]. For instance, a study conducted by Anjana et al., on the effects of a prolonged lockdown due to COVID-19 on the adoption of newer technologies and changes in glycemic control on patients with type 2 diabetes (T2D) in India had revealed that 82% of the study cohort who utilized the telemedicine facility ($n = 117$) were happy with their experience and 58.1% were willing to continue to use the facility in the future[9]. Even 'after the pandemic', telemedicine still prevails. Telemedicine has proven benefits in diabetes treatment by improving the short-term and long-term outcomes even though it is not a replacement for face-to-face consultations[10]. The technology of telemedicine is beneficial in non-emergency/routine care and in cases where services do not require direct patient–provider interactions. Mohan et al., in the Chunampet Rural Diabetes Prevention Project (CRDPP), had explored the possibility of comprehensive diabetes screening, prevention, and treatment using a combination of telemedicine and personalized care in 42 clusters of rural India. The study shows that among the 27,014 adult population living in 42 villages, 86.5% were screened for diabetes, of which 4.9% had diabetes and 14.6% had prediabetes. A total of 1001 diabetes subjects were screened for complications. Diabetic retinopathy was detected in 18.2%, neuropathy in 30.9%, microalbuminuria in 24.3%, peripheral vascular disease in 7.3%, and coronary artery disease in 10.8%. The mean hemoglobin A1c levels among the diabetes subjects in the whole community decreased from $9.3 \pm 2.6\%$ to $8.5 \pm 2.4\%$ within 1 year. The study

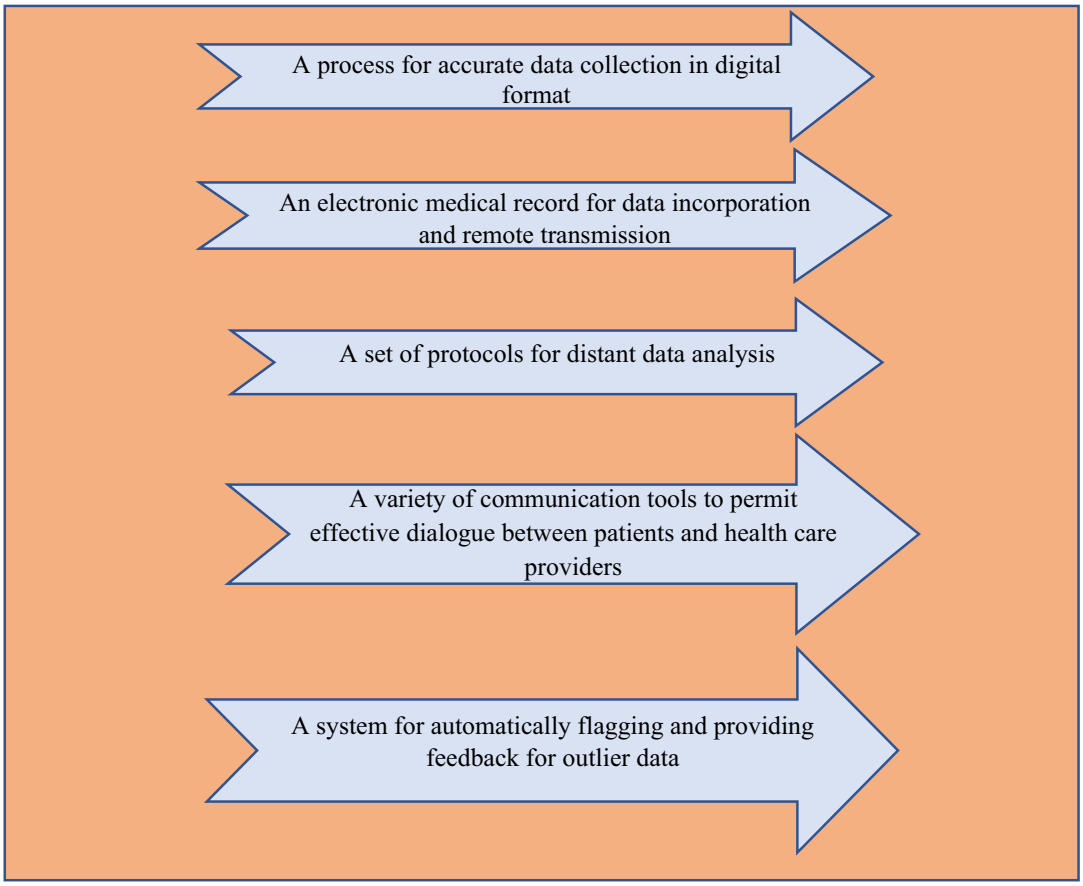

Figure 1: Components of telemedicine.

outcomes emphasize the significance of adopting telemedicine for effective diabetes care in India[11]. The Chunampet model is found to be successful and can be applied in people residing in remote areas, where specialized diabetes care facilities may not be available[12]. Remote care reduces the use of resources in health centers and improves access to care, while minimizing the risk of direct transmission of the infectious agent from person to person. Telemedicine thus provides numerous possibilities for diabetes care such as to create awareness among urban and rural population about the risk factors and prevention of diabetes, to facilitate patient monitoring, remote diabetic retinopathy screening, and in diabetes prevention at the primary, secondary, and tertiary level[13]. Thus, telemedicine is an attractive, effectual, and affordable adoption of technology.

Treatment of diabetes fails in the majority of patients due to non-adherence to the advice on medications, diet, and exercise. Self-monitoring of vital parameters along with self-management techniques cannot be taught only during face-to-face visits to hospital.

The above-mentioned challenges can be overcome with frequent telemedicine consultations.

Successfully overcoming these barriers requires motivation, acceptance, encouragement of the use of health-care providers, political and structural adjustments, collaborations with companies working in diabetes technology, and most notably patient awareness of the need to adopt diabetes care in an outpatient setting.

5 Guidelines for Telemedicine

The professional judgment of a Registered Medical Practitioner (RMP) should be the guiding principle for all telemedicine consultations. An RMP is well positioned to decide whether a technology-based consultation is sufficient or an in-person visit is needed. Seven elements need to be considered before beginning any telemedicine consultation (Fig. 2. should be the guiding principle for all telemedicine consultations. An RMP is well positioned to decide whether a technology-based consultation is sufficient or an in-person visit is needed. Seven elements need to be

considered before beginning any telemedicine consultation (Fig. 2).

Registered Medical Practitioner (RMP): Registered Medical Practitioner is a person who is registered under state medical register of state medical council after finishing the undergraduate medical course in a college recognized by state government and approved by medical council of India.

Telemedicine is increasingly being utilized in the field of diabetology to improve access to health care, quality of care, and clinical/psychosocial outcomes in people with diabetes. In patients with diabetes, patient–physician interactions are essential for improving health outcomes and preventing long-term complications. Frequent traveling to clinic appointments is inconvenient for patients with busy schedules and particularly burdensome for patients living in rural areas, those with low financial background, the elderly, and people with disabilities[14]. Virtual telemedicine appointments are becoming increasingly common to enable patients to interact with physicians and educators without the barriers of distance and commute time. In diabetes, telemedicine has been proven to have phenomenal benefits in preventing long-term complications by ensuring adherence to medications and lifestyle advice.

The use of telemedicine visits has been well studied in populations with limited access to specialized clinicians, registered dietitians, and diabetes educators. Telemedicine programs with visits that match usual care models for diabetes treatment have already demonstrated success in helping patients maintain or improve their health[15]. In a diabetes center in Kerala, telemedicine in diabetes care, termed Diabetes Tele Management System (DTMS®), is a simple and cost-effective tool, practiced since 1997. DTMS® consists of a multidisciplinary team of physicians, nurses, dieticians, diabetes educators, pharmacists, and psychologists, who with the help of a customized software and user-friendly interface titrates the dosages of medications and provides advice on diet, lifestyle, etc. to all enrolled and willing patients irrespective of the distance from the hospital.

The successful treatment of diabetes requires normalization of fasting blood glucose, postprandial blood glucose, glycosylated hemoglobin (HbA1c), blood pressure, low-density lipoprotein (LDL) cholesterol, body weight, and waist circumference. To attain multiple goals of therapy in a single patient, continuing education, motivation, empowerment, and advice on healthy food habits, physical activity, and accurate use of monitoring and injection devices are required[16].

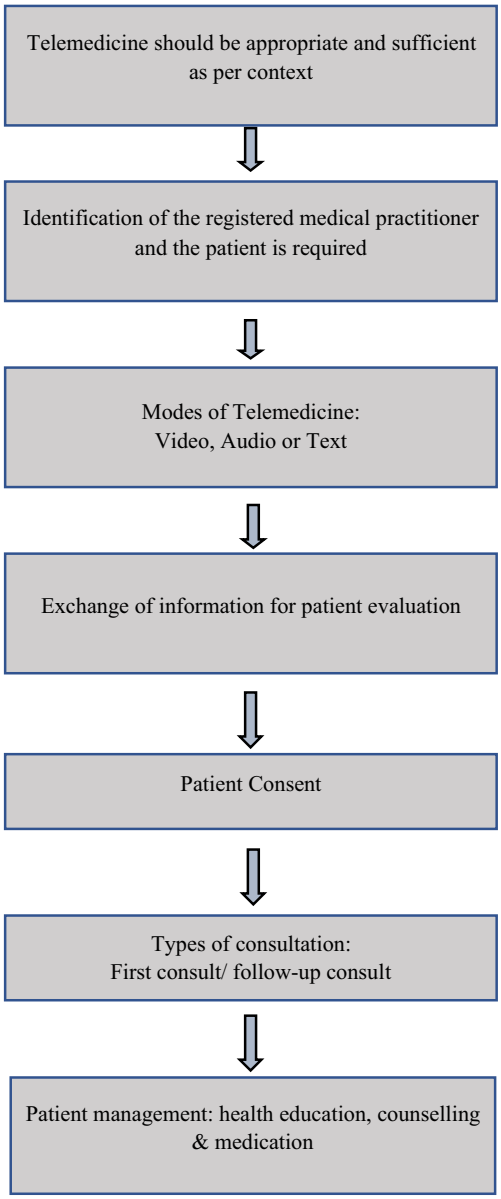

Figure 2: Seven elements to be considered before any telemedicine consultation.

6 Telediabetology

Current diabetes guidelines recommend diabetologist or general practitioner consultations at least every 3 months to evaluate HbA1c and, if applicable, adjust the diabetes therapy and optimize the treatment of cardiovascular risk factors[17]. It should be noted that regular patient visits and examinations in the outpatient setting are necessary not only to optimize diabetes control, but also to effectively treat associated comorbidities (diabetic foot syndrome, diabetic retinopathy, hypertension, CKD, CAD, etc.). A study conducted by Rajalakshmi et al., [18] on the sensitivity and specificity of "fundus on phone" (FOP) camera, a smartphone-based retinal imaging system, as a screening tool for diabetic retinopathy (DR) detection and DR severity in

Table 1: Benefits and challenges of telemedicine in diabetes.

Benefits of telemedicine	Challenges of telemedicine
● Cost-effective, safe and time saving	● Communication errors, inefficiency to respond to questions, unavailability of the physician to attend the phone, etc., can cause discomfort to patients
● Counseling for hypoglycemia prevention and management	● Lacks a universally recommended telemedicine protocol or consensus guidelines to implement recommendations for telemedicine in diabetes
● Special care for individuals having insulin in treatment regimen	● One-to-one and group patient education programs should be included to gain the confidence of patients
● Ensures long-term multidrug compliance for treatment of glycemia and other comorbidities	● Lack of ownership and/or knowledge of use of digital platforms (smartphones, etc.) for video consultation or transmitting images/records by a significant proportion of patients
● Exchange of data and necessary advice is possible via audio/video/text messages	● Alternative funding resources and mode of payment are to be sought in case patients are not willing to pay extra for the teleconsultation
● Reduces frequent hospital visits	● Slightest error in communication during a telemedicine consultation can result in serious consequences
● Counseling on blood glucose monitoring	● Doctor has to take extra efforts for medical record maintenance, arriving at a clinical judgment for treatment decisions and management of complicated cases
● Provides better adherence to exercise, diet, and lifestyle recommendations	
● Reduces microvascular and macrovascular complications	

comparison with seven-standard field digital retinal photography shows that it is effective for screening and diagnosis of DR. Another study by the group on the effectiveness of tele-ophthalmology over face-to-face DR screening in 30 diabetic care centers shows that it is feasible and effective for STDR detection in India and hence urges for a wider adoption[19]. The role of artificial intelligence (AI)-based automated software for detection of diabetic retinopathy (DR) and sight-threatening DR (STDR) by fundus photography taken using a smartphone-based device was assessed by Rajalakshmi et al.[20], showed that it has very high sensitivity and thus can be a primary tool for retinal screening in people with diabetes. However, it has been hypothesized that the majority of individuals with diabetes, which is a chronic and mostly incurable disease, do not necessarily need to regularly present themselves physically at outpatient clinics or doctors' offices, especially when alternative services that can guide disease management are available.

7 Benefits and Challenges of Telemedicine in Diabetes

The benefits and challenges of telemedicine in the management of diabetes are discussed below (Table 1).

8 Use of Smartphones in Diabetes care

Smartphones are one of the modalities for telemedicine application. Smartphones can be used to communicate with patients via text messages, Facebook Messenger, WhatsApp messages, and video platforms for telemedicine consultations with the doctor, nurse, and patient care provider participating in a conference call and sharing the screen from electronic medical records.

Increasing patient contact, by including more frequent telephone calls, has been shown to improve patient motivation, therapy adherence, and metabolic control[21]. Due to the widespread availability and usage of (mobile) phones, such interventions to monitor treatment goals can be established easily and flexibly. For instance, calls can be planned as an add-on after an outpatient clinic appointment. Clinical recommendations, such as the frequency of self-monitoring of blood glucose values (SMBG), recommendations for insulin therapy, and physical activity or dietary advice, can be given to evaluate the effectiveness and adherence of these measures during later telephone visits. A therapy management plan diary that includes dates of telephone visits can be distributed during the onsite visit. Web-based psycho educational interventions have helped adults with both type 1 and type 2 diabetes to cope up with depression and emotional distress[22].

Frequent video consultations, used as a supplement to routine care in the pediatric setting, have been found to reduce disease burden and increase treatment satisfaction in patients with scant evidence of improved glycemic control[23],[24], and they have shown encouraging levels of acceptance among diabetes professionals[25].

Video calls are essential for selected patients who need to see the face of the health-care professional to build up trust and confidence in those guiding their daily therapy[26]. Similarly, the health-care professional can better assess the mood and motivation of the patient during a video call. A further advantage of video calls is the chance to properly inspect glucose data documented in a conventional paper diary.

In clinical practice, virtual training sessions via telephone or video calls have been introduced, enabling remote training on specific diabetes-related aspects such as handling technical devices, dietary advice, or behavioral recommendations[27].

Despite this, the evolution of mobile technology provides a large number of health-related smartphone applications (apps), aiming to increase the self-management skills of the patient in chronic diseases, facilitate the communication between the patient and health-care providers, increase the patient's compliance with the treatment, and reducing the cost of treatment. There are numerous diabetes-related smartphone apps, most of which emphasize incentive for medication adherence, lifestyle modification, and diabetes self-management[28].

9 m-Health Applications in Diabetes Self-Management

To continuously engage patients in their diabetes care, mobile devices have become convenient and effective instruments[29]. Numerous smartphone applications exist with the aim at improving patients' glycemic control and control of other parameters through diabetes education, coaching, and blood glucose monitoring. The DM m-Health applications include Glucose Buddy, mySugr, Diabetes: M, Blood Glucose Tracker, and OneTouch Reveal[30].

mySugr is a diabetes management app that helps to record the blood glucose data, along with meals, exercise, and medicines. It provides daily, weekly, and monthly reports that can be shared directly with the doctor. It also provides help calculating insulin doses, and the new coaching features turn it into a full-service learning and support program. It also provides an estimated A1C value. It helps in including the images of pretty much anything, be it a plate of food or a bag of snacks or a drink bottle and thereby helps to better visualize the records. It can be used in both T1D and T2D.

mySugr Coach helps to connect with a diabetes educator who can offer support, tips, and help through the app, via email or text message. This health-care professional can help analyze the diabetes data and offer insights based on the goals or specific questions. By simply tapping into mySugr on the smartphone, it is guaranteed to get a notification and personalized answer within one business day[31]. This helps to manage diabetes much better than when compared to meeting the doctor once every 3 or 4 months. Even in the absence of a doctor, there is a virtual live educator to help assist patients with diabetes 24×7. Patients feel comfortable and it is convenient to interact with a user-friendly popular app.

The mySugr Pump Control is designed to enable people with diabetes to control an insulin pump directly via a smartphone: import its data, view its status, and remotely deliver a standard bolus. mySugr Pump Control is able to get support from the mySugr Bolus Calculator, which calculates the needed amount of insulin for meal and correction boluses. It considers current blood glucose level, estimated carbohydrate amount, and previous insulin injections (active insulin) based on data from the mySugr Pump Control[32].

Health data gained via mobile applications can usually also be converted to transferable data, which can be shared with health-care providers with the user's consent (commonly via the acceptance of email-based invitation links).

10 Home Monitoring of Diabetes Patients

Home monitoring can be done by Glucose meters or continuous glucose meters for glucose. Co-monitoring in diabetes patients also includes monitoring blood pressure, body weight, waist circumference, and if possible other parameters related to diabetes care. This depends on the level of education and motivation of the person. It is preferable to use connected devices for home monitoring so that when measuring body weight, it will be automatically recorded via Bluetooth on the phone and cannot be altered, preventing errors and manipulations. For example; when a patient is using a digital glucose diary, corrections cannot be made, whereas if the patient is using a diabetes diary or paper, which is a conventional method, readings are often incomplete and potentially incorrect. It has been shown in many studies that there is a chance of manipulation by

more than 30–50% of patients. Therefore, manipulations can be avoided while using technology-assisted devices in home monitoring[33].

Virtual COVID Inpatient (VCIP) program was an innovative model designed to deliver in-patient level care at the patient's own home virtually during the COVID-19 pandemic. The main advantage of this program was treating patients in their homes eliminating the mental stress of hospitalisation and at minimal costs thus decreasing the burden on local hospitals and making beds available for much sicker patients. A hospitalization for 10–14 days is 20 times as expensive as VCIP management for the same period [34]. Figure 3 shows the workflow of VCIP.

Virtual COVID Inpatient (VCIP) program: An innovative model designed to deliver in-patient level care at the patient's own home virtually during the COVID-19 pandemic.

11 Continuous Glucose Monitoring (CGM) Systems

Most people with diabetes can make use of continuous glucose monitoring CGM systems: These systems provide glucose values from the interstitial fluid. Through the real-time transfer of glucose values to a reader or smartphone or by deriving glucose data from scans (intermittently scanned glucose monitoring), the frequency of capillary glucose measurements can be substantially reduced. The use of these systems has also significantly improved glycemic control, treatment adherence, and quality of life. These systems provide glucose values from the interstitial fluid. Through the real-time transfer of glucose values to a reader or smartphone or by deriving glucose data from scans (intermittently scanned glucose monitoring), the frequency of capillary glucose measurements can be substantially reduced. The use of these systems has also significantly improved glycemic control, treatment adherence, and quality of life[35],[36]. CGM sensors provide the current glucose concentration and its rate of change for improving the determination of exogenous insulin administration and the prediction of forthcoming adverse events, such as hypo-/hyperglycemia. Nowadays, smartphones (iPhone, Android phone) act as receivers either through a cloud or a Bluetooth interface. Software on a smartphone interprets the incoming sensor data, along with other data from a personal health record and detects various patterns.

The usual approach to assessing glycemic control is for the patient to regularly (generally every 3 months) meet their treating physician, who will then gauge glycemic control based on HbA1c results and paper-based diaries. However, with the increasing use of CGM systems, glycemic control can be evaluated remotely via CGM reports which include data on time spent in different target ranges, the glucose management indicator (GMI, a substitute for HbA1c), and the percentage of the sensor used in a given time without the need to perform a HbA1c test. CGM system recorders can also be used to document insulin injections, meal intake, or other events such as sports or illness. CGM reports can be quickly delivered to the treating physician (via email or directly via the platform with the user's permission) and then discussed during a telephone call between health-care professionals and the person with diabetes.

FreeStyle Libre Flash Glucose Monitoring System (Abbott Diabetes care, Alameda, CA, USA) helps to automatically measure glucose day and night for up to 14 days. Studies with FreeStyle Libre have shown that empowering the patients results in control of fasting and postprandial glucose, HbA1c, and improvement in time in range (TIR) irrespective of type of diabetes or use of insulin[37]. MiniMed Medtronic Guardian sensor 4, though more expensive, is a real-time factory-calibrated CGM and the glucose is visible on the mobile phone without the need of any scanning. These devices can provide alerts before the onset of high glucose or low glucose. For those who can afford and are motivated, continuous use of CGM transforms diabetes care. A South Asian consensus panel has recommended CGM every 6 months even in controlled diabetes and more frequently if the TIR is not achieved.

Continuous glucose monitoring: Continuous glucose monitoring automatically tracks glucose levels throughout the day and night.

12 Lifestyle Modification for patients with diabetes

In diabetes treatment, understanding the carbohydrate content of individual diets and how carbohydrates affect blood glucose level is one of the cornerstones. To appropriately adjust an insulin dose, the total amount of carbohydrates ingested by the patient must be calculated. Software applications that use graphic analysis technologies to quickly and directly analyze dietary content are under development. This software allows patients to quickly obtain relevant nutrition information, including carbohydrate content and calories, by taking smartphone photos and will thereby help in their nutritional choices. Nutritional intervention through automated artificial intelligence (AI) assistance delivers similar results as direct nutrition intervention support from a dietitian. Therefore, these methods can greatly reduce the load on the workforce of human experts along with enhancing the effectiveness of dietary guidance for diabetics.

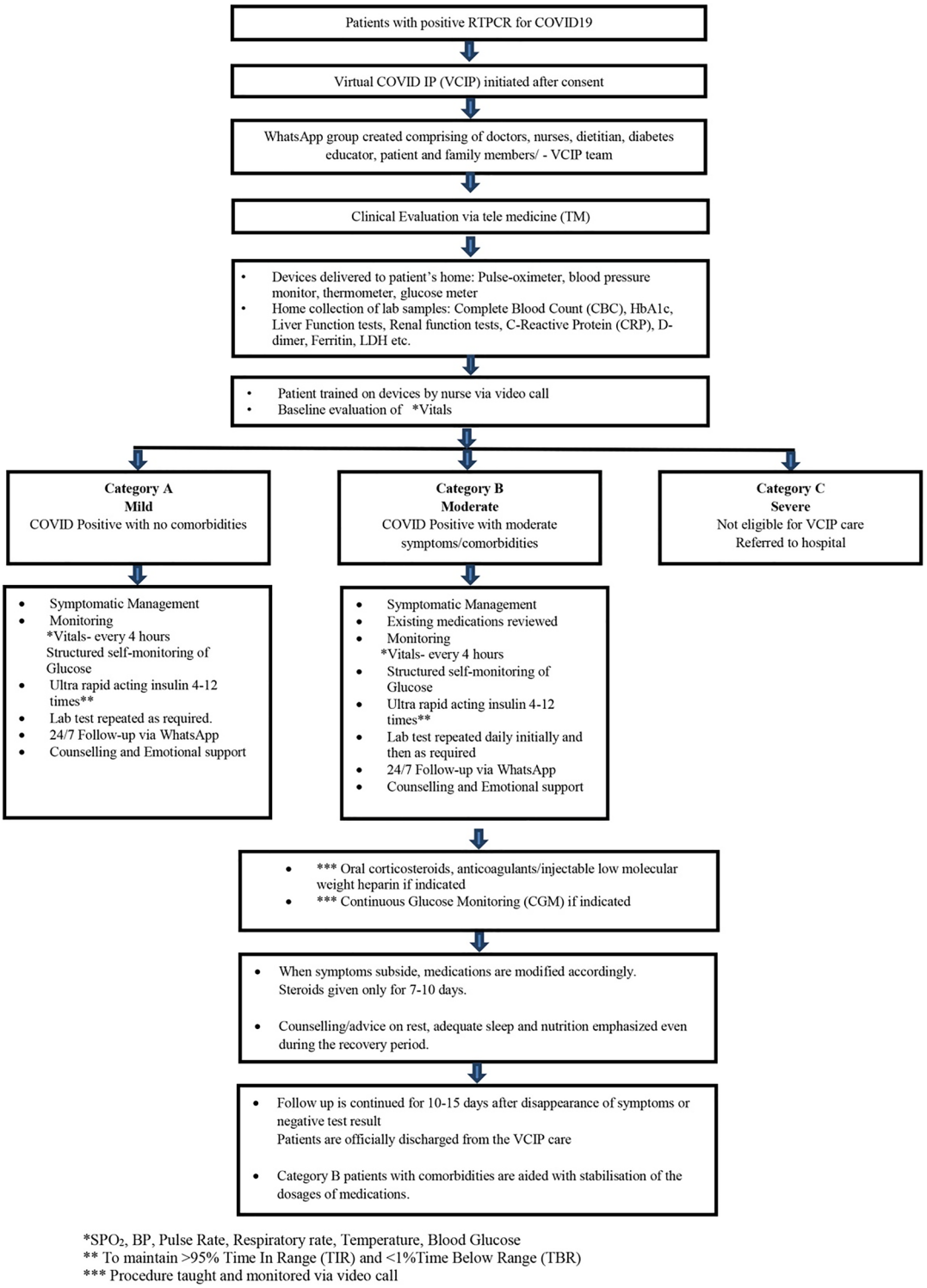

Figure 3: VCIP flowchart.

Proper exercise plays an important role in blood sugar control and reduces the risk of cardiovascular events. AI involves automatically analyzing the exercise levels of patients wearing accelerometers and heart monitors and monitor changes in glucose levels while exercising[38]. Also there are various exercise apps for diabetes patients including exercise videos with personalized guidance[39]. Apple Watch series 8, in addition to heart rate, HRV, VO2 max, AFib detection,

single-lead ECG, and insights into physical activity, provides detailed information on the type and quality of sleep and wrist temperature etc.[40]. Wearable sensors are also evolving as integral components in aiding doctors in managing lifestyle disorders.

13 Cost-Effectiveness of Digital Diabetes Care

In our current health-care system, chronic disease care leads to substantial health-care expenditures. Medical expenditures for people diagnosed with diabetes are approximately 2.3 times higher than that for people without diabetes. Over 50% of health-care expenditures for patients with T2D are due to the complications of diabetes[41]. Studies frequently report that telemedicine and m-health use in diabetes care result in the prevention of complications, decreased time spent by physicians on patient visits, decreased time spent by patients to commute and wait for their appointments, and reduced loss of productivity at work for adults with diabetes and their caretakers[42]. Cost-effectiveness would be especially important in developing economies, where digital health may be used in medically underserved populations to improve access to health care and to help patients engage in their diabetes self-management.

14 Challenges with Digital Diabetes Care

There are instances where patients consider telemedicine consultations as casual and as a 'free service', but each telemedicine consultation, even if it is a brief telephone call, will help in future reduction in cost and complications and are time and life-saving. Unless and until patients are willing to pay for every telemedicine consultation, hospitals are unlikely to adopt this model.

Recently, there has been proliferation of digital platforms promising diabetes reversal/diabetes remission at a prohibitively high cost for the clients. Physicians and the public should be cautious in recommending and using such platforms, since most of them provide a CGM sensor, dietitian, and advice for weight loss. Diabetes is a chronic progressive disease where treatment is customized based on multiple parameters and the so-called remission of diabetes may not be sustained in the vast majority[43].

While procuring devices for home monitoring of glucose, blood pressure, etc., physician advice should be sought to ensure reliability and accuracy. The benefits and challenges of technology in diabetes care are mentioned below (Table 2).

Table 2: Benefits and challenges of technology in diabetes care.

Benefits	Challenges
● Mobile health applications offer to provide coaching and behavioral advice for all PWD	● Not all PWD have access to a diabetes care and education specialist (DCES) and dietitian services
● Algorithms to analyze data and present therapeutic options to physicians can reduce the burden of managing complex diabetes care	● Physicians' time to educate PWD in addition to conducting tests is limited during appointments
● Interconnected devices can communicate with each other and adjust insulin dosing on a continuous basis (e.g., advanced hybrid closed loops), reducing PWD time and effort required to input data into multiple devices for insulin dosing	● Current technologies are often not interconnected, leading to the need for PWD to manage multiple devices
● Metrics such as time in range can be assessed more frequently with further CGM proliferation. This can promote understanding of blood glucose fluctuations and their impact and identify approaches to reduce HbA1c	● Even if tests are conducted regularly, a clear set of steps to achieve target HbA1c levels is lacking
● Mobile health applications and digital care providers offer support and coaching programs to relieve PWD anxiety and stress	● Frequent monitoring through CGMs may not be feasible for all
● PWD remote visits with specialists using mobile health software can reduce costs	PWD face a number of challenges self-managing their condition, such as: ● Difficulty navigating complex self-dosing equations ● Limited access to blood glucose data to monitor daily fluctuations ● Anxiety that they may be mis-dosing ● Fear of hypoglycemia

PWD patients with diabetes.

15 Conclusion

Diabetes technologies are as important as, or more important than, medications in preventing long-term disabling complications. Telemedicine is particularly well suited for treating diabetes, as compared to other diseases, because diabetes requires interpretation and predetermined responses to many types of data that can be measured at home by the patient. As many aspects of our lives have become automated and addressed online, so will routine medical care of chronic diseases. Mobile phone messaging applications, including text messaging or short message service (SMS) and multimedia message service, could offer a convenient and cost-effective way to support desirable health behaviors for preventive health care by providing educational and motivational advice. This was clearly tested during the COVID-19 epidemic. These models involve multidisciplinary approaches that were not traditionally available for patients living in rural or remote areas. These methods are effective, convenient, secure, and financially sustainable. It has proven that the home monitoring of vital parameters and use of telemedicine can bring down the long-term vascular complications of diabetes and thereby reduce the overall cost and improve the quality of life of patients.

Publisher's Note

Declarations

Conflict of Interest

The authors declare no conflict of interest.

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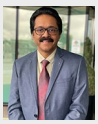

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