

Digital Health Services among Patients with Diabetes during the COVID-19 Pandemic: A Scoping Review

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Abstract

Background and Aims: COVID-19 pandemic causes massive disruption of the global health system. The diabetic patients are the vulnerable parts population who are predicted to have a significant issue during the pandemic regarding the conventional type of consultation by face-to-face which may result in the higher risk of COVID-19 exposure. This study aims to observe the use of digital health services for diabetes management during COVID-19 pandemic. **Methods:** A scoping review was conducted in PubMed, ScienceDirect, and Google Scholar during August until September 2020. The keywords that are used on the searching process are diabetes AND digital service OR telemedicine OR technology AND COVID-19. The criteria included the selection of scientific publication as an original research and reviews. **Results:** All published articles were gathered from 3 search engines; PubMed, Science Direct, and Google Scholar. The discussion explicates the practical considerations that are in accordance with the current condition of each country. In order to do so, the evidence is classified based on the level of global digital health framework in the developed and developing countries. It was found that the minimal level of digital health that connects diabetes patients with healthcare providers was at level 2, which is by using the video mode. The most advanced is at level 3B, which is applied by using the CGM devices, which provide active monitoring, diagnosis, and treatment based on timely clinical judgment. **Conclusion:** It is feasible to utilize the digital health service during the COVID-19. This review is projected to be beneficial for the patient and health care providers to select the most feasible approach of digital health that merits the contextual resource.

Keywords: Counselling, COVID-19, diabetes management, digital health, education

BACKGROUND

The massive disruption in the world caused by the COVID-19 pandemic brought a significant impact among the noncommunicable disease (NCD) patients. One of the sustainable development goals (SDGs) targeted by the World Health Organization (WHO) is the reduction of premature death before the age of seventy. There is a probability that this goal cannot be successfully reached due to the global COVID-19 pandemic.^[1] Data from the recent study in Italy revealed that hospitalized COVID-19 patients had hypertension (64,8%), cardiovascular disease (37,7%) and malignant neoplasm (13,6%),^[2] another study also emphasized 30% mortality rate of COVID-19 Italy is related to diabetes as comorbid.^[3] However, during the period of 31 March to 23 April 2020, there were 47 countries that have switched their diabetes care services into the virtual model.^[4] It is a considerable challenge for health-care provider in the

low-middle-income countries to deal with the new approach in delivering services during the pandemic. Limited resources such as financial reimbursement system, Information and Communication Technology (ICT) health standard, and national health policy, are considered not able to fit all countries' condition in reshaping the future of health delivery service.^[5]

Diabetes as a pre-existing condition, which can lead to the worst clinical outcome among COVID-19 patients.^[6] The

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pathophysiological mechanism is related to short-term hyperglycemia inhibits the immune system, increases coagulation activities and direct pancreatic islet cell injury.^[7] Another review highlights the poor outcome, which occurs among COVID-19 patients with diabetes comorbidity. It is related to multifactorial aspects such as age, sex, ethnicity, comorbidities (i.e., Hypertension and cardiovascular diseases, obesity, and a pro-inflammatory and pro-coagulated state).^[8] There are three predictors of COVID-19 fatality among diabetes patients related to blood glucose such as glycemic control prior to admission, plasma glucose during admission, and glycemic control in hospital. Type 1 diabetes (T1D) or type 2 diabetes (T2D) patients with HbA1c more than 86 mmol/mol (10%) have higher risk of mortality compared with those who have HbA1c less than 48 mmol/mol (6.5%).^[9] Hyperglycemia at hospital admission is also the best predictor of the worst chest radiographic imaging results on COVID-19 patients.^[10] During hospitalization, the cytokine storm could trigger acute diabetes complication such as ketoacidosis and hyperosmolar syndrome.^[11] Additionally, this acute condition increase the risk of thrombosis which makes the COVID-19 infection even worsen.^[12]

Regarding the current pandemic situation, people with diabetes need timely integrated interventions to enhance the self-care management and to get the supportive education and medical supplies.^[13] Diabetes patients and families should be well equipped to deal with dietary adherence, regular exercise, stress management, medication adherence, and routine blood glucose monitoring.^[6,14] Regular medication should be continued and the insulin dose may require a consultation. On the other hand, COVID-19 pandemic resulted in limited access to health care facilities, including the communication between patients and health care providers. An online or virtual approach should be conducted to reduce face-to-face consultation.^[6] There are many terminologies that are interchangeable such as telehealth and telemedicine^[15] and it seems to be applicable for diabetes education during the COVID-19 pandemic.^[6] Telehealth is a broader spectrum of distance health care services, including telemedicine, tele-education, and teletherapy.^[16] Telemedicine includes specific diagnostic and monitoring using remote monitoring, video conference for physical examination, or medical test using remote devices (i.e., electronic stethoscopes, tele-ophthalmoscopes, video otoscopes, etc.).^[17] Tele-education includes delivering information to the learner using synchronized or unsynchronized method in the form of text, audio, or video mode.^[18] Teletherapy means replacement or complement of clinical treatment by increasing the access to the health provider who can guide the clinical practice from the distance such as by conducting teletherapy for aphasia among stroke patient.^[19] A digital health services include the use of health information technology, telehealth, and medical apps and wearable devices.^[20] The limited information on the application of digital health services among patients with diabetes requires a new knowledge for this point of view. Thus, the aim of this study was to explore the recent approach

of digital health services among diabetic patients during COVID-19 pandemic.

METHODS

Study design

A scoping review was applied to collect the broader information of the latest evidence about the digital health services for diabetes patients.^[21] The methodological framework for scoping review consisted of 5 stages; identify the research question; identify relevant studies; study selection; extracting the data; summarizing, and reporting the data.^[6,22]

Searching strategy

Literature searching was conducted in three electronic databases; PubMed, ScienceDirect, and Google Scholar, from August 28 to September 14, 2020. The keywords and Boolean operators were used as below: diabetes AND digital service OR telemedicine OR technology AND COVID-19. The inclusion criteria of the study were defined as scientific publications in English such as original research and reviews, and starting from early 2020, when the COVID-19 occurred. The commentary reports, letters to editor, and conference abstracts will be excluded.

Identification and selection the articles

At the beginning, the duplicated items were removed and then, the articles were screened by its title and abstract. The eligibility was determined using inclusion and exclusion criteria. All in all, there were 6 articles included for qualitative review [Figure 1]. All the steps were guided by using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standard.

Data extraction

The selected articles were gathered in a worksheet table. Data extraction was compiled based on author, country, research design, research finding, and other specific considerations.

Summarizing the finding

All the included articles were summarized on the table of extraction. It contents the authors, titles, study designs, settings, results, and specific finding of practical consideration. Practical consideration was added to explore further information to enrich the effectiveness of digital health services for diabetes management during the self-confinement of COVID-19 pandemic. Methodological characteristics of the articles evaluated quantitatively and presented in percentage Table 1.

RESULTS

Characteristic of the articles

The included articles were published in the Diabetes Technology and Therapeutics (50%, $n = 3$), the Diabetes and Metabolic Syndrome: Clinical Research and Reviews (33,33%, $n = 2$) and Acta Diabetologica (16,67%, $n = 1$). The majority of included articles are from the USA. Half of the findings (50%, $n = 3$) discussed about the use of CGM

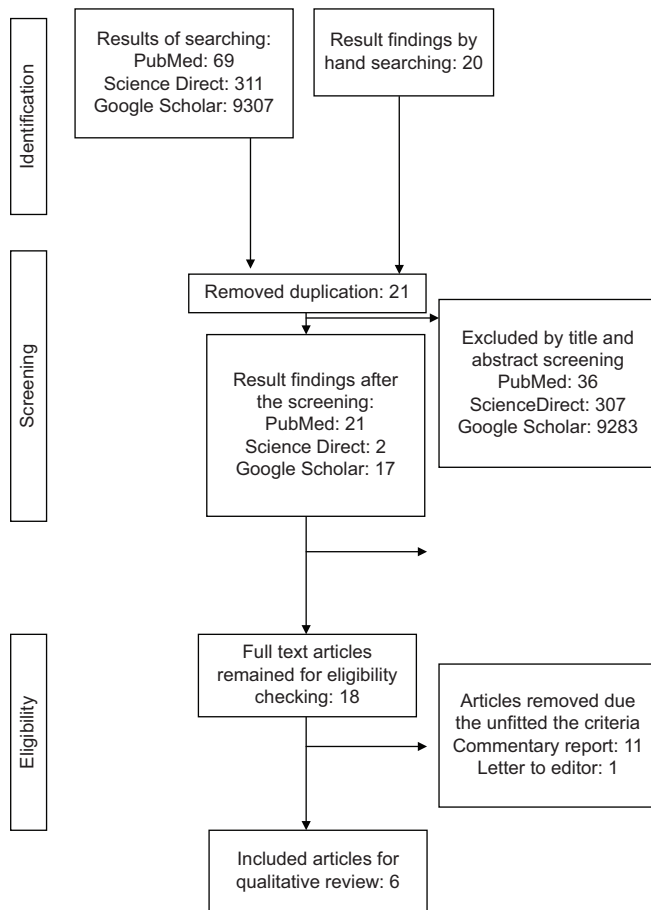


Figure 1: The flow chart for a scoping review

through virtual education approach. Other recommendations were the need of advanced telemedicine among limited skills on digital use for patients and accessibility of Internet. Most articles (66, 67%, $n = 4$) presented the vulnerable diabetes patients who may experience emergency complication such as hypoglycemia or ketoacidosis. Thus, closed observation and consultation to understand the CGM data were required. The articles from India^[23] and Brazil^[25] highlighted the alternative of telemedicine using simple communication tools such as television, radio, or social media that can access widely. One article suggests the use of teleservice in a specific domain of diabetes management.

Data extraction of the articles

Summary of the findings was available in Table 1. The table covered the information about authors, title, research design, results, specific findings and practical consideration for the included articles.

DISCUSSION

Minimal standard of digital health services for diabetes care

Development of digital health implies that in dealing with diabetes there is a demand to establish a standard as guidance. Standard of digital health technology should fulfill aspects

of functionality, contextually, effectiveness, and economic efficiency.^[28] Level of evidence in functional aspects divided into three levels. Level 1 is noticed when there is no direct user benefit such as electronic health records that can be connected to the wards and emergency room. Level 2 is noticed when the information related to healthy living and illness prevention behaviors is provided. At this level, digital health service may provide information; do monitoring, and conduct two ways communication. Level 3A refers to the use of digital health service in preventing and managing diseases by self-management behavior with measurable patient's outcome. Level 3B, which the most advanced medical device takes role in treating, activating, monitoring, calculating and diagnosing the patient. In summary classification of digital health technology described in Table 2.^[28]

Besides functional aspects, contextual aspects should also be contemplated among the vulnerable population such as children and elderly who have limited digital literacy. Adding to that, digital health service should provide factual information and clinical judgment to prevent misdiagnosis. This approach could support health care professional deliver their practical treatment.^[29] Hence, to anticipate the contextual issue even in low digital skill of patient, legal and ethical consideration of digital health service should be declared by the national government in the following country. It also relates to economic consideration when the higher level functional digital health service the higher cost should be spent to cover the budget impact, cost utility, and cost consequences.^[30]

Validating digital health products requires a complex domain which is time-consuming during its development process. There are 4 domains to construct the rigor of digital health known as digital health scorecard.^[31] The first domain is technical to ensure the precision of the device of the digital product as valid as the gold standard of clinical examination. Technical validation was also constructed by security and interoperability aspects. The examples of technical validation of CGM in diabetes management that the device could check the blood glucose accurately, easily transfer to the health care provider, safely encrypted and provide data privacy for the patient.^[32] The second is clinical aspect to make sure the digital health product feasible in real-world settings. In this stage, there will be critical appraisal of the simulation to determine a true clinical judgment.^[33] An example of clinical validation in diabetes mobile apps using Mobile App Rating Scale (MARS) scoring to determine whether the application is good acceptable or poor acceptable.^[34] The third domain is usability, to define when the feature of digital health met the needs of consumers (diabetes patients or health care providers). The best example of usability validation in CGM is calculation of high and low glucose scores, user's experiences, and patch attachment adherence.^[35] The last domain is about the cost or amount of price that consumers should pay to get access to a digital health service or product. In some diabetes apps, it is low cost and somehow it is free of charge. In the beginning, advanced technology such as CGM devices will be quite

Table 1: Summary of the articles

Authors and Country	Title	Research Design	Results	Specific Findings and Practical Consideration
Ghosh <i>et al.</i> ^[23] (2020) India	Telemedicine for diabetes care in India during COVID-19 pandemic and national lockdown period: Guidelines for physicians.	Review	India government suggested video mode to replace face-to-face consultation at the first consultation, this approach cannot replace the nature of physical examination. The limited resources and digital skills among the patients impact the use of video consultation might be accessed only through smartphones using WhatsApp® and Facetime®.	Guideline of Digital Health Service in India General role: Video mode should be recommended for the first-time consultation; consultation fee will be charged; the narcotic drugs cannot be prescribed. Physical examination can be conducted through video such as simple neurological deficit, and by taking a photograph for issues of visible abscess and wound. Health education: mandatory hygiene to prevent COVID-19, individualized diet; follow up blood glucose, and albumin; insulin and medication adjustment, physical exercise more likely aerobic or yoga. Specific conditions for face-to-face consultation during lockdown (gestational diabetes, a part of infection COVID-19 needs IV antibiotic, diabetes with acute complication, foot infection, new T1D) may be applicable.
Peter and Garg ^[24] (2020) USA	The silver lining to COVID-19: Avoiding diabetic ketoacidosis admissions with telehealth.	Case Report	The use of CGM with “share” feature was effective to manage acute condition such as ketosis and hyperglycemia among two adult T1D patients.	Diabetes ketoacidosis could be well managed virtually using CGM shared blood glucose monitoring data monitoring. The finding presented the use of Clarity Software and the “Share” feature report the patient’s CGM data to the health care provider. Using the software, health care providers could adjust the insulin dose and prevent further DKA complication.
Filho <i>et al.</i> ^[25] (2020) Brazil	Knowledge levels among elderly people with diabetes mellitus concerning COVID-19: an educational intervention via a teleservice.	Cross-sectional design	Total of 30 elderly participants, mostly women (76.7%) and married (63.3%), with the average age was 69.96±4.46 years. Due to limited health literacy through an online system, information about COVID-19 among elderly patients with diabetes was inadequate. Most of the information was accessed through televisions, radios, and social media with the lowest grade of trustworthiness. The role of teleservice using phone calls suggested as the easiest approach to correct the misleading information from social media.	The lowest level of digital literacy among elderly is the biggest barrier in the delivery of health services. The government should officially check information related to COVID-19 before it spreads out through TV and radio. The strategy of using phone calls for elderly may be feasible, but the volume and the clarity of the voice should be adequate for elderly with hearing problems.
Vigersky <i>et al.</i> ^[26] (2020) USA	The Effectiveness of virtual training on the MiniMedTM670 g system in people with T1D during the COVID-19 pandemic	Quasi experimental design	CGM training was held virtually by zoom could improve patient satisfaction in using MiniMedTM 670G as a blood glucose monitoring device.	The virtual training reduced the use of auto mode significantly from 14±7 days to 11±5 days.
Panzirer ^[27] (2020) USA	Role of non-profit organization during COVID-19 for diabetes care: Healthcare inequities and role of virtual specialty clinic	Quasi experimental design	This study recruited 35 T1D and T2D patients who used CGM in rural areas and required basal insulin regimens. The visual specialty clinic, where the diabetes care and education specialists (DCES) guided the CGM process, interpreted and used the data for 3 months, was developed as intervention.	Non-government organization (NGO) developed literate peer support to help enhance HCPs’ role in educating patients with diabetes.

Contd...

Table 1: Contd...

Authors and Country	Title	Research Design	Results	Specific Findings and Practical Consideration
Wicaksana <i>et al.</i> ^[6] (2020) Asian, European, and American countries	Diabetes management and specific considerations for patients with diabetes during coronavirus diseases pandemic: A scoping review	Scoping Review	This evidence emphasized the used of telehealth consultation for blood sugar monitoring and telemedicine using mobile phones are useful for delivering diabetes education. This review included 7 papers with 31.625 participants.	Urgent face-to-face consultation for emergency cases such as severe hypoglycaemia, chest pain, gastroenteritis, foot lesion, loss of consciousness and infection related COVID-19 was acceptable. Diabetes in children and adolescents, pregnant women, and elderly should be addressed by visiting the health care provider for insulin regulation when the symptom of hypoglycaemia or ketoacidosis occurred.

Table 2: Framework of Digital Health Technology (NICE, 2019)

Level of Evidence	Functional consideration
Level 1	System services not involve patient outcomes
Level 2	Inform: Public resource of health information and education Simple monitoring: Allow patient to track their medical record Communicate: Allow communication patients to health care or peer
Level 3A	Preventative behavior change: Changing patient bad habit through personal encouragement Self-manage: Allow health care feedback based on clinical data which is sent by the patient
Level 3B	Treat: Allow clinical judgment based on real time data Active monitoring: Wearable device allows automatic recording Calculate: Provide early warning sign based on measurable parameters Diagnose: Provide specific diagnosis by gathering continuous and real time data

expensive. In future, this cost will be paid congruence with a better quality of care.^[36]

Besides the complexity of digital health scorecard, The New Zealand's government releases the minimum requirement of digital, data, and service.^[37] In general, digital health service should obey the Health Information Standards Organization (HISO) standards, roadmaps and architecture guidelines. About the security aspects, digital health service should follow the guidance of Health Information Security Framework and Cloud Risk Assessment framework. However, the data should be easily accessed and shared to the authorization stakeholder. The vision of enhancing digital health as a global strategy supported by WHO was explained in a draft shaping the future 2020–2025.^[38]

Implementing digital health service during endless COVID-19 pandemic is essential. Reshaping formal health services into digital is an urgent need to replace a regular clinic or hospital visit for patients with diabetes. In future, digital health services could save and adjust cost and health care resource-related diabetes consultation. In the countries with limited resources, as the majority of study findings, highlighted the use of digital health level 2. Even with a simple technology could provide a good telehealth system for diabetes. A simple teliabetology could be developed, including observation or screening, documentation and intervention.^[39] For observation or screening the scenario is to prepare the hotline services that reachable by patients with

diabetes for critical decision making or clinic appointment. Regular visit could be replaced by private consultation through video mode to increase trust between patients and health care providers. It is important that informed consent should be delivered and keep the patient's data privacy.^[6] Collecting the data using mobile apps is feasible and make the data more readable.^[40] If the apps is not available, the consent could be sent through email and refer the patient to fill form in a link. Teliabetology using phone, email or apps also beneficial for decision making, therapy adjustment, and lifestyle intervention. Individually, health care providers promote personal case management for teleconsultation. For instance, patients may share their results of blood glucose measurement to physicians as evidence to adjust the diabetic medications or insulin doses. Patients with advanced CGM can share their blood glucose charts directly from the smartphone. Intervention to enhance self-management through diabetes education could be conducted by group intervention. Familiar social media such as WhatsApp®, WeChat®, and Line® are useful. WhatsApps® group was effective as a media for intensive diabetes education by involving 203 diabetes patients in Brazil.^[41] Educational intervention through Line® was also indicated promising diabetes outcome such as body mass index, insulin demand, and HbA1c among 193 adolescents with T1D in Italy.^[42] In China, WeChat® has been widely used for chronic disease management not only diabetes but also hypertension, cancer and coronary disease.^[43]

The use of digital health among the finding articles

Regarding the research finding, there was a gap between developed and developing countries. Based on the article, the use of WhatsApp® and Face time® among diabetes patients during the pandemic was classified in level 2 of digital health technology.^[28] It allowed two ways communication between patients/families and health care providers, to inform the patients about general condition and simple monitoring through the video mode feature. That was done even though the current national guideline in India mentioned that the treatment judgment should be based on face-to-face meeting.^[23] Finding in Brazil illustrates the use of phone calls as the simplest approach of digital health suitable for a low literacy population such as elderly meanwhile it was combined with health promotion on the television, radio and social media. The approach of phone calls can help health care providers in delivering simple information about the current health issue of COVID-19. The use of phone calls is classified in Level 2.^[28]

The use of digital health technology in the USA among diabetes patients was familiar. Among T1D patients, the used of CGM to monitor real-time blood glucose and adjust the current dose of insulin was effective to prevent the acute complication such as diabetes ketoacidosis (DKA).^[44] The use of CGM with synchronized data sharing makes diabetes educators and clinicians easy to make decisions and fix the patient's problem during the pandemic. This wearable equipment classified at level 3B because it could empower patients and families. The patients and family can do active monitoring, recording the glycemic status day by day, transmit the data to the healthcare, and do early specific diagnosis by reminder feature of hypoglycemia and hyperglycemia alarm.^[45]

Limitation

This review highlighted the broader scope of digital health services among diabetes patients during the COVID-19 pandemic. Some articles explicitly did not provide information about the methodology of research. One article did not explicitly provide the study design and two articles did not inform the number of samples. One article just mentioned very limited samples ($n = 2$) in case report study. Level 2 of digital health using video mode in social media such as Face time or WhatsApp® is not a formal health system, which cannot guarantee the data security or the cloud management acquisition. The challenge in developing rigor and pragmatic digital health service is predicted to be time-consuming, involving an exhausted collaboration, and would need a sufficient amount of funding.

CONCLUSION

This review highlighted the summary of digital health services for diabetes patients during the COVID-19 pandemic. The health care providers and policy makers could use this review as a summary of recommended health delivery care to facilitate diabetic patients during the crisis period of COVID-19. Patients

and families may consider this review to advocate their needs of health care access during self-confinement.

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Authors' contribution statement

NKDP and ALW designed the study method. NKDP was responsible for articles searching, screening, selection, and process of eligibility checking. ALW contributed in assessing the eligibility of the studies. The first draft of the manuscript was written by NKDP and then ALW reviewed the manuscript. All authors agreed and were responsible for the publication.

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Conflicts of interest

There are no conflicts of interest.

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