DIABETES CANADA

Virtual Care and Diabetes

A Position Statement

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About Diabetes Canada: Diabetes Canada is a national health charity representing more than 11.9 million Canadians living with diabetes or prediabetes. Diabetes Canada leads the fight against diabetes by helping those affected by diabetes live healthy lives, preventing the onset and consequences of diabetes, and discovering a cure. It has a heritage of excellence and leadership, and its co-founder, Dr. Charles Best, along with Dr. Frederick Banting, is credited with the co-discovery of insulin. Diabetes Canada is supported in its efforts by a community-based network of volunteers, employees, health care professionals, researchers, and partners. By providing education and services, advocating on behalf of people living with diabetes, supporting research, and translating research into practical applications, Diabetes Canada is delivering on its mission. Diabetes Canada will continue to change the world for those affected by diabetes through healthier communities, exceptional care, and high-impact research.

For more information, please visit: www.diabetes.ca.

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Position Statement

Optimal care for people with diabetes is essential due to the many complications that can arise from the condition. Virtual delivery of health care, versus traditional in-person care, has the potential to reach more people, as it is less restricted by distance, geography, and time barriers. Virtual care can therefore lead to greater accessibility for rural and underserved populations (1) . There is a need for timesaving, user-friendly, cost-effective care, particularly when access to traditional, in-person care presents challenges. At the same time, we must not lose sight of the importance of cultural safety and equity of access in all care delivery modes.

The purpose of this position statement is to provide meaningful and specific recommendations to help guide the provision of virtual care for people living with diabetes in Canada.

Diabetes Canada recommends that **health-care providers**:

- Actively include patients in shared decision-making regarding virtual or in-person visits, ensuring that patient preference is the highest priority for care delivery mode.
- Continue in-person visits for patients who have limited capacity and/or desire for virtual appointments. Monitor patients who prefer virtual visits and deliver regular reminders for appointments, lab tests, and home checks (e.g., blood pressure and foot checks) to ensure they aren't lost to follow up.
- Follow the recommendations in Diabetes Canada's Clinical Practice Guidelines on frequency of tests and assessments, whether care is delivered in person or virtually.
- Utilize telehealth models to:
    - improve self-management in underserviced communities;
    - facilitate consultation with specialized teams as part of a shared-care model;
    - improve clinical outcomes, including a decrease in A1C, an increase in quality of care (i.e., guideline adherence), a decrease in health service use and cost, and an increase in patient satisfaction and knowledge;
    - improve glycemic management and cardiovascular risk factor control; and
    - facilitate a decrease in patient costs (e.g., travel, childcare, time, etc.) and wait times.
- Continue using the ABCDESSS (A1C, blood pressure, cholesterol, drugs, eating & exercise, self-management, screening, & stop smoking) framework to guide visits, whether they are virtual or in-person. Support self-assessment by encouraging patients to assess their blood pressure, weight, and feet at home, when feasible.
- Ensure in-person care happens at recommended intervals for blood pressure measurement (and home machine calibration), foot assessment, immunizations, and review of blood glucose levels.
- When possible, collect relevant information virtually (e.g., by having patients complete electronic surveys that automatically populate their electronic medical records) prior to in-person appointments.
- Support self-management by directing patients to contact the free virtual diabetes education line through Diabetes Canada's 1-800-BANTING InfoLine, or for recommendations on other diabetes education programs.
- Utilize resources such as the Clinician Change Virtual Care Toolkit to facilitate decision-making regarding virtual care.

Diabetes Canada recommends that **people affected by diabetes**:

- Remember you are the most important member of your health-care team. Your preferences for how care is delivered should be front and centre regarding in-person versus virtual care.
- If travel distance or time are barriers to your care, ask your team about telehealth (telephone, web-based, or virtual) diabetes support and visits.
- Contact the free virtual diabetes education line through Diabetes Canada's 1-800-BANTING InfoLine for self-management support.

Diabetes Canada recommends that the **federal government**:

- Adopt a leadership role in advocating for a diversity of care delivery options for people living in Canada.
- Provide a licensure framework to promote cross-jurisdictional care to allow people living in Canada to access virtual care in other jurisdictions, particularly those living in rural, remote, and northern communities that lack qualified care specialists in their home communities.
- Support and incentivize the development of proven virtual care policies and programs in the provinces and territories.
- Broaden the technological capacities of rural and remote communities (e.g., Wi-Fi, phone lines, etc.).
- Continue advancing the initiatives and recommendations outlined by the Federal Provincial-Territorial Virtual Care Summit, including the establishment of national standards to define the model of care and how virtual care will be a part of the required integrated digital infrastructure.
- Encourage and incentivize researchers to engage in cost-effectiveness studies to strengthen this area of expertise in Canada.

Diabetes Canada recommends that **provincial and territorial governments**:

- Continue the work of transforming care delivery that began during the COVID-19 pandemic, to ensure that virtual care is permanently implemented in an equitable and high-quality manner.
- Champion a "digital front door", or single point of access, to optimize seamless integration of virtual care into existing service models to allow the opportunity to move from virtual care to an in-person visit as needed in a timely and coordinated way, or to accommodate virtual participation from essential care partners or other experts if they're unable to attend in-person.
- Maintain virtual care billing codes as a key component of remuneration for health-care providers. Where there are significant barriers to in-person care, including geographic ones, there should not be a minimum in-person requirement for care to proceed.
- Lead the development of standards and minimum criteria for virtual care, and ensure they are being consistently applied.
- Modernize primary care quality and safety measurement, regulation, and processes to reflect all care modalities, including in-person and virtual.
- Integrate virtual care into broader digital health strategies and the existing health-care system to ensure continuity of care.
- Expand access to medical devices that facilitate collection and sharing of data (including but not limited to continuous glucose monitoring devices, insulin pumps, and automated blood pressure monitoring devices).

- Continue advancing the initiatives and recommendations outlined by the Federal Provincial-Territorial Virtual Care Summit, including the establishment of national standards to define the model of care and how virtual care will be a part of the required integrated digital infrastructure.

Diabetes Canada will:

- Advocate for people with diabetes to have access to the right care at the right time, be it in-person or virtual.
- Advocate that people with diabetes have fair and equitable access to medical devices that facilitate collection and sharing of important medical data (including but not limited to glucose monitoring devices, insulin pumps, automated blood pressure monitoring devices).
- Support targeted literacy campaigns and education around appropriateness of care and flexibility for shared decision-making.
- Work with all levels of government to promote research on the cost effectiveness and long-term clinical effectiveness of virtual care programs.

Why Is Virtual Care Important to Diabetes Canada?

Diabetes has an enormous impact on individuals, families, employers, communities, and the health-care system. Diabetes Canada believes that people living with diabetes should have access to the right care at the right time, and virtual care can improve patient outcomes and satisfaction with more efficient use of existing health-care dollars. In essence, virtual health-care visits can be a key means of ensuring rapid, equitable, and efficient access to health care.

An important step in ensuring that patients can access the right care at the right time is to define clear and efficient pathways to accessing care, which understand the differing needs of diverse patient populations, and which reduce, delay, and/or prevent the progression of diabetes with timely access to care. Incorporating virtual care into standard health-care practice across the country would break down the silos of a more reactive acute care model and structure a more proactive, patient-centered, chronic disease model. Virtual care, or telehealth, is a delivery mechanism that can greatly improve patient outcomes and support the provision of interdisciplinary care to more people with diabetes.

This policy position presents research results on the benefits of virtual care and makes recommendations to governments, health-care providers, people affected by diabetes, and for Diabetes Canada.

Diabetes Canada's Clinical Practice Guidelines recommend the use of telehealth (telephone, web-based, or virtual) for diabetes care and support if travel distance and/or time are barriers to care (2). Telehealth can improve self-management in underserviced communities; facilitate consultation with specialized teams as part of a shared-care model; improve clinical outcomes in type 2 diabetes; and improve glycemic and cardiovascular risk factor management in type 1 and type 2 diabetes (2).

Even before COVID-19 forced the widescale adoption of virtual care, two thirds of Canadians were interested in consulting with health-care providers through a virtual platform (3). And of those who

were accessing virtual care, there was an 81% satisfaction rate (4). The urgency of the pandemic necessitated and accelerated widespread adoption of virtual care. Virtual appointments were required during early lockdown restrictions to keep people safe, reduce virus transmission, and preserve limited resources (scarce personal protective equipment). Canadians found the use of virtual visits important for many other reasons, including saving travel time and associated costs, reducing wait times, keeping themselves and loved ones safe from exposure to infectious diseases, being more convenient and user-friendly, and providing faster access to care (5).

Early in the COVID-19 pandemic, a group of Canadian researchers and clinicians developed "virtual first" recommendations to support family physicians and other primary care professionals in managing their patients with type 2 diabetes (6). The authors suggest continuing to use the ABCDESSS (A1C, blood pressure control, cholesterol, drugs, exercise and eating, self-management, screening, and stop smoking) framework to guide visits, while acknowledging that most routine diabetes care can be delivered virtually. Diabetes Canada believes that these recommendations should continue beyond the pandemic, and they align with Diabetes Canada's Clinical Practice Guidelines chapter on the organization of diabetes care (2).

Moving beyond COVID-19, there is a need to address all aspects of virtual care within the health-care system:

> "While the rapid uptake of virtual care enabled primary care delivery during COVID-19, tools, processes and enabling policies were often implemented as temporary and stopgap solutions. Policy and system challenges remain in ensuring uptake that is equitable and patient-centred and that ensures quality as well as sustainability" (7).

Methods

A rapid evidence review approach was taken, which is a streamlined alternative to standard systematic reviews to meet the needs of fast-paced evidence-informed decision making and advocacy (8–10). A comprehensive literature review was conducted, and 15 systematic reviews (SRs) were selected as relevant for the clinical review. The review examined the following aspects of virtual care: (a) evidence of the impact of virtual care on clinical outcomes such as blood glucose management, (b) economic evidence from the perspective of the health-care system and from the perspectives of people living with diabetes, and (c) evidence of the patient experience of virtual care, particularly satisfaction. Please see the appendix for detailed methods and findings. While the rapid review identified the population of interest as children or adults living with diabetes (type 1, type 2, or gestational diabetes), only one of the systematic reviews included a pediatric population. As such the results and related recommendations are focused primarily on virtual care delivered to adults living with diabetes.

Based on the synthesized literature, the present position statement and accompanying recommendations were formulated. This position statement was reviewed by experts in the field, including people affected by diabetes, health-care providers, public policy advisors, and policymakers.

Diabetes in Canada

Diabetes is a major chronic disease in Canada. Currently, the prevalence of diagnosed diabetes (type 1 and type 2) in Canada is approximately 4 million and is projected to increase to about 5 million by 2032 (11).

Diabetes is a condition characterized by an elevation in blood glucose levels caused by a lack of insulin or a reduced effectiveness of insulin. People living with diabetes need to manage their glucose levels to achieve their target blood glucose range. Diabetes is a leading cause of blindness, end-stage renal disease, heart disease, stroke, and non-traumatic amputation in Canadian adults (3). The all-cause mortality rate among Canadians living with diabetes is twice as high as the all-cause mortality rate for those without diabetes (12–14).

There are three main types of diabetes (15). Type 1 diabetes occurs in people when an individual's beta cells, located in the pancreas, no longer function (15). Consequently, very little or no insulin is released into the blood. As a result, glucose builds up in the blood instead of entering the cells to be used as energy. Approximately 5-10% of people living with diabetes have type 1 diabetes (15). Type 1 diabetes generally develops in childhood or adolescence but can also manifest in adulthood (15). Insulin therapy is required for the treatment of type 1 diabetes and is life-sustaining (16).

Type 2 diabetes occurs when the body cannot properly use the insulin that is released or does not make enough insulin (15). Glucose builds up in the blood instead of being used as energy. Over 90% of people with diabetes have type 2 diabetes (15). Type 2 diabetes usually develops in adulthood but children are increasingly affected (15). Various treatment options exist for type 2 diabetes, including nutrition and physical activity, glucose-lowering medications, and insulin therapy (17). Treatment plans should be individualized and will depend on goals, lifestyle, age, general health, and other socio-ethnocultural factors (17).

A third type of diabetes, gestational diabetes, is a temporary condition that occurs during pregnancy (15). It affects up to 1% of all pregnancies and increases the risk of developing type 2 diabetes for both mother and child in the future (15).

If blood glucose, blood lipids, and blood pressure levels are optimally managed, people living with diabetes are able to live healthy lives and reduce the risk of diabetes-related complications (15).

Defining Virtual Care

Virtual care, also called telemedicine or telehealth, is the provision of health care remotely by means of a variety of telecommunication tools, including telephones, smartphones, and mobile wireless devices, with or without a video connection. For the purposes of this position statement, virtual care included medical appointments for the management of diabetes—including type 1 diabetes, type 2 diabetes, and gestational diabetes:

- Via telephone, video, secure messaging, and/or other platforms;
- With primary care and/or allied health provider(s) with whom there is an established relationship, e.g., physician, registered nurse (RN), nurse practitioner; and/or

- With physician specialists, e.g., endocrinologist; and/or
- With health-care provider(s) with whom there is no established relationship, e.g., RNs working in telehealth.

Provider-patient interactions may be synchronous (i.e., no time lag) or asynchronous (i.e., provider response to contact or data from a patient that occurs with a time lag of minutes to weeks). This position statement does not include technologies where there is no interaction with health-care providers, such as some smartphone apps, web-based educational programs, automated systems, and social networking services. The range of technologies allowed in the studies in the 15 SRs was extensive, including videoconferencing; mobile apps; social networking; remote monitoring; interactive web-based platforms, phone, or video; telephone calls; text/SMS; email; fax; and websites.

Results: Impacts of Virtual Care on Diabetes Management

The range of outcomes measured varied considerably. All but one of the SRs included A1C as a measure of blood glucose control and in two of these SRs, A1C was the only outcome tracked. However, a wide variety of additional measures were reported across SRs, e.g., systolic and diastolic blood pressure (SBP, DBP); body mass index (BMI); fasting and post-prandial blood glucose (FBG, PPBG); weight; lipids; mortality; episodes of hypoglycemia; quality of life (QOL); satisfaction; feasibility and usability of technology; cost and time savings; maternal and fetal outcomes for gestational diabetes (GD); access to specialist consultations; and self-efficacy/empowerment for self-management.

The results are presented in three areas: (a) evidence of the impact of virtual care on clinical outcomes such as blood glucose management, (b) economic evidence from the perspective of the health-care system and from the perspectives of individual patients, and (c) evidence of the patient experience of virtual care, particularly patient satisfaction. Half of the SRs examined impacts for adults with both type 1 and type 2 diabetes (n=8), while the other half were split between type 2 diabetes (n=3), gestational diabetes (n=2), type 1 diabetes (n=1), and pediatric diabetes—type 1 and type 2 (n=1).

Clinical Benefits of Virtual Care

Overall, virtual care positively impacted diabetes management with significant improvements in some of the tracked outcomes, particularly hemoglobin A1c (A1C). Interactive telephone, videoconferencing, mobile health interventions, and telemonitoring were cited as successful virtual care models. Health-care provider engagement was important. However, clear-cut overall conclusions were not possible due to variations among SRs and primary studies in technologies employed, the roles of providers, and the outcomes measured.

A1C is a blood test that provides information about average levels of blood glucose, also called blood sugar, over the past 3 months. Decreases in A1C lead to better outcomes and a reduction in short-term (hyperglycemia) and long-term (microvascular) complications. Of the 14 SRs reporting on improvements in A1C in virtual care study arms, 13 reported significant improvements in all or most studies reviewed when virtual care was compared to usual, in-person care.

One of the SRs' results showed that telehealth interventions had a significantly larger influence on A1C than did usual care (18). Their analysis demonstrated positive trends (but not statistical significance) with telehealth versus usual care when there were higher levels of provider engagement, particularly via telemonitoring, telephone communication, and mobile health interventions. Another SR reported significant reductions in multiple clinical outcomes (A1C, SBP, DBP, BMI, FBG, PPBG, weight, cholesterol, and mental and physical QOL) with telemonitoring, videoconferencing, and interactive phone (19). These data reinforce the importance of telephone communication as a key delivery mechanism of virtual care—a component that does not unduly restrict people from rural and remote regions (where spotty internet access may make video calls unworkable) or those of lower economic positions (where affordability impacts internet access and video calls).

Other clinical outcomes measured across the various studies included blood pressure (BP, diastolic & systolic, DBP & SBP), cholesterol (LDL), fasting blood glucose (FBG), post-prandial blood glucose (PPBC), body-mass index (BMI), and weight. Variability in achieved outcomes on these additional clinical outcomes makes it difficult to draw conclusions on the benefits of virtual care.

Economic Benefits of Virtual Care

Seven SRs were identified that examined the economic benefits of virtual care. From a health-care perspective, the results of economic analyses varied widely from very reasonable to unacceptably high. In some cases, unacceptable costs were driven by high technology acquisition costs, although these could now be considerably lower than they were in earlier references. Also, start-up technology costs would be up-front, whereas ongoing system operation could be more reasonable. In contrast, patients consistently reported savings in terms of time and travel expenses. There are few studies that examine the economic costs and savings of virtual care, so it is unclear what the extent of health-system savings will be. More research on the financial impacts of virtual care to both the health-care system and people living with diabetes is needed.

Personal Benefits of Virtual Care

Patient perspective, particularly satisfaction, was mentioned in eight SRs. Overall, satisfaction levels were high, particularly related to improved access to care (including specialist care), reduced travel time and costs, and enhanced self-empowerment. The time-saving component of virtual care is of particular importance to patients with mobility issues who rely on carers' help. One of the more recent SRs indicated that, while virtual system uptake has traditionally been low for older adults, technological literacy has improved in the past decade, particularly due to limited in-person care options during the COVID-19 pandemic (20). Patients were positive about their health conditions being constantly monitored and cared for and they particularly liked the idea that they could receive provider advice remotely.

A recent Diabetes Canada survey of people affected by diabetes found that two-fifths of the almost 700 respondents have had virtual medical visits since the pandemic started. Respondents overwhelmingly enjoyed virtual visits and experienced confidence in achieving health outcomes through these methods. They found it convenient and felt heard and able to ask questions. While

some reported missing the sense of ease that accompanies in-person visits, most would prefer more virtual visits in future, even after COVID-19 ends. There remains strong support for ongoing provincial and territorial investments in virtual care.

While there are benefits to virtual care, there can be down sides too. Many respondents to the Diabetes Canada survey lamented the lack of in-person contact for foot screening, physical examinations, and connection with health-care providers. Concerns were also raised about the system's efficiency and operations (e.g., use of video vs. telephone, difficulty with training, etc.), while many praised the opportunity and increased accessibility of care providers. Many issues around physician or diabetes educator attitudes were raised, with concerns of dismissiveness and inaccessibility.

Conclusion

Many types of virtual care delivery have been investigated for the management of diabetes, and the landscape changes as technology advances. The provision of virtual health care has accelerated as well, particularly since the health-care system has adapted to the COVID-19 pandemic, where face-to-face care often became inaccessible. This may have been a timely change for the exploration of virtual care for people living with diabetes.

This policy statement focusses on virtual care involving interactions between providers and patients, versus technology offerings such as automated advice based on patients' input data and non-interactive educational resources. Although not universal, the clinical evidence has been compelling with respect to improvements in A1C and other important clinical outcomes of optimal diabetes management. Patient satisfaction levels have been high, and patients have benefitted with respect to savings in time and travel costs as well as new opportunities to receive care remotely, including specialist care.

Clinical Benefits. In some studies, interactive telephone, videoconferencing, mobile health interventions, and telemonitoring were cited as successful virtual models, with mention made of the importance of health-care provider engagement. The variabilities in the technologies employed, the roles of providers, and the outcomes measured limited straightforward conclusions.

Economic Benefits. Information came from seven SRs although only one was an SR of economic studies. The other SRs focussed on clinical outcomes with secondary outcomes assessing the economic aspects of care. From a health system perspective, cost calculations varied widely from reasonable to unacceptable. In some cases, unacceptable costs were driven by high technology acquisition costs although these could now be considerably lower than they were in earlier references. Also, start-up technology costs would be up-front whereas ongoing system operation could be more reasonable. In contrast, the three SRs that assessed patient costs reported savings in terms of time and travel expenses.

Patient Benefits. Patient perspective, particularly satisfaction, was reported in eight SRs, although sometimes in just a few of the SRs' included studies. Overall, patient satisfaction levels were high,

particularly related to improved access to care (including specialist care), reduced travel time, and enhanced support.

Overall, SRs showed clinical benefits in all types of diabetes when virtual care was employed. Adoption of virtual care for people living with diabetes reinforces the principle of the right care at the right time and can directly address challenges experienced by certain populations where regular, on-site visits can be challenging. This could include: (a) people who live in rural areas where travel distances and logistics are difficult, (b) socially disadvantaged people who cannot easily integrate into the usual health-system structure, and (c) people who are physically or cognitively unable to visit providers regularly. In addition, people without these challenges may be looking for alternatives to face-to-face visits. This suggests that there is a need for time-saving, cost-effective, user-friendly, and practical options for the provision of optimal management of diabetes, and virtual health care could be part of the solution (21).

References

1. Vick J. A Guide for Using Telehealth Technologies in Diabetes Self-Management Education and Support and in the National Diabetes Prevention Program Lifestyle Change Program [Internet]. Centers for Disease Control and Prevention (CDC); 2019. Available from: https://www.cdc.gov/diabetes/pdfs/programs/E_Telehealth_translation_product_508.pdf

2. Clement M, Filteau P, Harvey B, Jin S, Laubscher T, Mukerji G, et al. Organization of Diabetes Care. Can J Diabetes. 2018 Apr;42:S27–35.

3. Ontario Expanding Digital and Virtual Health Care [Internet]. news.ontario.ca. [cited 2021 Jun 22]. Available from: https://news.ontario.ca/en/release/54594/ontario-expanding-digital-and-virtual-health-care

4. Annual Report 2018-2019: A new day in health care is coming [Internet]. Toronto, ON: Canada Health Infoway; 2019 [cited 2021 Jun 25]. Available from: https://www.infoway-inforoute.ca/en/component/edocman/3726-annual-report-2018-2019/view-document?Itemid=0

5. Langstaff L. Canadians' Health Care Experiences During COVID-19: Uptake of Virtual Care [Internet]. Canada Health Infoway; 2021 May p. 14. Available from: https://infoway-inforoute.ca/en/component/edocman/3828-canadians-health-care-experiences-during-covid-19/view-document?Itemid=101

6. Kiran T, Moonen G, Bhattacharyya OK, Agarwal P, Bajaj HS, Kim J, et al. Managing type 2 diabetes in primary care during COVID-19. Can Fam Physician. 2020 Oct;66(10):745–7.

7. What we Heard: Results of a Policy Lab on the Appropriate Use of Virtual Care in a Primary Care Setting [Internet]. Ottawa: Healthcare Excellence Canada; 2022 Apr p. 28. Available from: https://www.healthcareexcellence.ca/media/rr2ctlt4/20220412_virtualcarepolicylab_en.pdf

8. Featherstone RM, Dryden DM, Foisy M, Guise JM, Mitchell MD, Paynter RA, et al. Advancing knowledge of rapid reviews: an analysis of results, conclusions and recommendations from published review articles examining rapid reviews. Syst Rev. 2015 Apr 17;4:50.

9. Ganann R, Ciliska D, Thomas H. Expediting systematic reviews: methods and implications of rapid reviews. Implement Sci IS. 2010 Jul 19;5:56.

10. Thomas J, Newman M, Oliver S. Rapid Evidence Assessments of Research to Inform Social Policy: Taking Stock and Moving Forward. Evid Policy J Res Debate Pract. 2013 Jan;9(1):5–27.

11. Canadian Diabetes Cost Model. Ottawa: Diabetes Canada; 2016.

12. Diabetes in Canada: facts and figures from a public health perspective. Ottawa Ont: Public Health Agency of Canada; 2011. 112 p.

13. Diabetes in Canada: 2022 Backgrounder [Internet]. Ottawa: Diabetes Canada; 2022. Available from: https://www.diabetes.ca/advocacy---policies/advocacy-reports/national-and-provincial-backgrounders/diabetes-in-canada

14. LeBlanc AG, Gao YJ, McRae L, Pelletier C. At-a-glance - Twenty years of diabetes surveillance using the Canadian Chronic Disease Surveillance System. Health Promot Chronic Dis Prev Can Res Policy Pract. 2019 Nov;39(11):306–9.

15. Punthakee Z, Goldenberg R, Katz P. Definition, Classification and Diagnosis of Diabetes, Prediabetes and Metabolic Syndrome. Can J Diabetes. 2018 Apr;42:S10–5.

16. Diabetes Canada Clinical Practice Guidelines Expert Committee, McGibbon A, Adams L, Ingersoll K, Kader T, Tugwell B. Glycemic Management in Adults With Type 1 Diabetes. Can J Diabetes. 2018 Apr;42:S80–7.

17. Diabetes Canada Clinical Practice Guidelines Expert Committee, Lipscombe L, Booth G, Butalia S, Dasgupta K, Eurich DT, et al. Pharmacologic Glycemic Management of Type 2 Diabetes in Adults. Can J Diabetes. 2018 Apr;42:S88–103.

18. Robson N, Hosseinzadeh H. Impact of Telehealth Care among Adults Living with Type 2 Diabetes in Primary Care: A Systematic Review and Meta-Analysis of Randomised Controlled Trials. Int J Environ Res Public Health. 2021 Nov 19;18(22):12171.

19. De Groot J, Wu D, Flynn D, Robertson D, Grant G, Sun J. Efficacy of telemedicine on glycaemic control in patients with type 2 diabetes: A meta-analysis. World J Diabetes. 2021 Feb 15;12(2):170–97.

20. Sim R, Lee SWH. Patient Preference and Satisfaction with the Use of Telemedicine for Glycemic Control in Patients with Type 2 Diabetes: A Review. Patient Prefer Adherence. 2021 Feb 10;15:283–98.

21. Aberer F, Hochfellner DA, Mader JK. Application of Telemedicine in Diabetes Care: The Time is Now. Diabetes Ther. 2021 Mar;12(3):629–39.

22. De Guzman KR, Snoswell CL, Taylor ML, Senanayake B, Haydon HM, Batch JA, et al. A Systematic Review of Pediatric Telediabetes Service Models. Diabetes Technol Ther. 2020 Aug;22(8):623–38.

23. Eberle C, Stichling S. Clinical Improvements by Telemedicine Interventions Managing Type 1 and Type 2 Diabetes: Systematic Meta-review. J Med Internet Res. 2021 Feb 19;23(2):e23244.

24. Eberle C, Stichling S. Telemetric Interventions Offer New Opportunities for Managing Type 1 Diabetes Mellitus: Systematic Meta-review. JMIR Diabetes. 2021 Mar 16;6(1):e20270.

25. Faruque LI, Wiebe N, Ehteshami-Afshar A, Liu Y, Dianati-Maleki N, Hemmelgarn BR, et al. Effect of telemedicine on glycated hemoglobin in diabetes: a systematic review and meta-analysis of randomized trials. CMAJ Can Med Assoc J. 2017 Mar 6;189(9):E341–64.

26. Li SY, Ouyang YQ, Qiao J, Shen Q. Technology-supported lifestyle interventions to improve maternal-fetal outcomes in women with gestational diabetes mellitus: A meta-analysis. Midwifery. 2020 Jun;85:102689.

27. McDaniel CC, Kavookjian J, Whitley HP. Telehealth delivery of motivational interviewing for diabetes management: A systematic review of randomized controlled trials. Patient Educ Couns. 2022 Apr;105(4):805–20.

28. McLendon SF. Interactive Video Telehealth Models to Improve Access to Diabetes Specialty Care and Education in the Rural Setting: A Systematic Review. Diabetes Spectr Publ Am Diabetes Assoc. 2017 May;30(2):124–36.

29. Niu XD, Chi JT, Guo JB, Ruan HH, Zhang J, Tao HX, et al. Effects of nurse-led web-based interventions on people with type 2 diabetes mellitus: A systematic review and meta-analysis. J Telemed Telecare. 2021 Jun;27(5):269–79.

30. So CF, Chung JW. Telehealth for diabetes self-management in primary healthcare: A systematic review and meta-analysis. J Telemed Telecare. 2018 Jun;24(5):356–64.

31. Timpel P, Oswald S, Schwarz PEH, Harst L. Mapping the Evidence on the Effectiveness of Telemedicine Interventions in Diabetes, Dyslipidemia, and Hypertension: An Umbrella Review of Systematic Reviews and Meta-Analyses. J Med Internet Res. 2020 Mar 18;22(3):e16791.

32. Wu C, Wu Z, Yang L, Zhu W, Zhang M, Zhu Q, et al. Evaluation of the clinical outcomes of telehealth for managing diabetes. Medicine (Baltimore). 2018 Oct 26;97(43):e12962.

33. Xie W, Dai P, Qin Y, Wu M, Yang B, Yu X. Effectiveness of telemedicine for pregnant women with gestational diabetes mellitus: an updated meta-analysis of 32 randomized controlled trials with trial sequential analysis. BMC Pregnancy Childbirth. 2020 Apr 6;20:198.

34. Yang S, Jiang Q, Li H. The role of telenursing in the management of diabetes：A systematic review and meta-analysis. Public Health Nurs Boston Mass. 2019 Jul;36(4):575–86.

35. Lee JY, Lee SWH. Telemedicine Cost-Effectiveness for Diabetes Management: A Systematic Review. Diabetes Technol Ther. 2018 Jul;20(7):492–500.

36. Tchero H, Kangambega P, Briatte C, Brunet-Houdard S, Retali GR, Rusch E. Clinical Effectiveness of Telemedicine in Diabetes Mellitus: A Meta-Analysis of 42 Randomized Controlled Trials. Telemed J E-Health Off J Am Telemed Assoc. 2019 Jul;25(7):569–83.

37. Teljeur C, Moran PS, Walshe S, Smith SM, Cianci F, Murphy L, et al. Economic evaluation of chronic disease self-management for people with diabetes: a systematic review. Diabet Med J Br Diabet Assoc. 2017 Aug;34(8):1040–9.

38. Wong SKW, Smith HE, Chua JJS, Griva K, Cartwright EJ, Soong AJ, et al. Effectiveness of self-management interventions in young adults with type 1 and 2 diabetes: a systematic review and meta-analysis. Diabet Med. 2020;37(2):229–41.

39. Egede LE, Dismuke CE, Walker RJ, Williams JS, Eiler C. Cost-Effectiveness of Technology-Assisted Case Management in Low-Income, Rural Adults with Type 2 Diabetes. Health Equity. 2021 Jul 26;5(1):503–11.

40. Lemelin A, Paré G, Bernard S, Godbout A. Demonstrated Cost-Effectiveness of a Telehomecare Program for Gestational Diabetes Mellitus Management. Diabetes Technol Ther. 2020 Mar;22(3):195–202.

41. Fantinelli S, Marchetti D, Verrocchio MC, Franzago M, Fulcheri M, Vitacolonna E. Assessment of Psychological Dimensions in Telemedicine Care for Gestational Diabetes Mellitus: A Systematic Review of Qualitative and Quantitative Studies. Front Psychol. 2019 Feb 5;10:153.

42. Heitkemper EM, Mamykina L, Travers J, Smaldone A. Do health information technology self-management interventions improve glycemic control in medically underserved adults with diabetes? A systematic review and meta-analysis. J Am Med Inform Assoc JAMIA. 2017 Mar 31;24(5):1024–35.

43. Macdonald EM, Perrin BM, Kingsley MI. Enablers and barriers to using two-way information technology in the management of adults with diabetes: A descriptive systematic review. J Telemed Telecare. 2018 Jun;24(5):319–40.

Appendix – Detailed Methods and Findings

Evidence Synthesis

An experienced health information specialist developed and tested database search strategies through an iterative process. The MEDLINE strategy was peer reviewed by a second information specialist using the PRESS Checklist (McGowan et al 2016). The following databases were searched on November 6, 2021: Ovid MEDLINE® ALL, including Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Embase Classic+Embase, and EBM Reviews - Cochrane Database of Systematic Reviews. CINAHL (Ebsco platform) was also searched.

Strategies used a combination of controlled vocabulary (e.g., "Diabetes Mellitus", "Telemedicine", "Therapy, Computer-Assisted") and keywords (e.g., "T2DM", "virtual care", "health care app"). Filters to identify systematic reviews (SRs), health technology assessments and clinical practice guidelines were applied in MEDLINE, Embase and CINAHL. Results were limited to English and the publication years 2016 to November 6, 2021. A second search of Ovid MEDLINE® and Embase was carried out on November 29 to identify additional materials specific to economic analyses of telehealth for management of diabetes.

Citations and abstracts were reviewed by one author who identified possibly relevant sources. Full text of these articles was obtained and reviewed for fit with the pre-defined search parameters and a short list of articles was derived. One author then prepared the report.

The tables on the following pages summarize the studies by topic area.

TABLE 1, CLINICAL BENEFITS: SRs OF VIRTUAL CARE FOR MANAGEMENT OF ADULTS WITH DIABETES (presented alphabetically)

Lead author; location	Technologies in the SR's included studies	Patient population	End of search; # studies; study types	Outcome measures	Results in brief re influence of telehealth interventions	Additional notes
De Groot (19) Australia	Texts, videoconferences, mobile applications, interactive phone systems, online servers, websites, social networking	T2DM	June 2020 N=43 RCTs	A1C, SBP, DBP, BMI, PPBG, FBG, weight, cholesterol, mental QoL, physical QOL	Significant favourable reductions in all outcome measures except SBP and cholesterol	Best A1c results when interventions were offered less than weekly, duration 6 months, and led by allied health
De Guzman (22) Australia (Pediatric)	Videoconferences, remote monitoring, mobile Health, interactive web-based platforms	Age <18 T1DM & T2DM	June 2019 N=29 Various: 11 were RCTs	A1C in 17 studies Satisfaction, feasibility, psychosocial effectiveness, usability	12 of 17 studies (7 of 9 RCTs) reported improvements in A1C	Increased interactions between patients and providers, improved access to specialized care, and increased monitoring
Eberle & Stitchling (23) Germany	Videoconferences, phone calls, emails, SMS/text, internet/web-based platforms, mixed forms	T1DM & T2DM pooled	April 2020 N=31 Various: 21 SRs, 8 RCTs, 2 other	A1C, BMI, BP, FBG, weight, cost, time saving	All sources reported improvements in A1C; most were significant 4 of 5 economic analyses reported cost-effectiveness	Patients with T2DM could benefit more than patients with T1DM re A1C
Eberle & Stitchling (24) Germany	Telemetry, telemedicine, telementoring, telemonitoring	T1DM	April 2020 N=17 Various: 5 SRs, 9 RCTs, 3 other	A1C, BP, FBG, weight, cost, time saving, QOL	11 of 17 studies (65%) reported overall (mildly) positive effects related to all outcomes; 8 of 12 reported A1C improvements	--
Faruque (25) Canada	Phone, smartphone app, email, text/SMS, web portal, "smart" device or glucometer	T1DM & T2DM	November 2015 N=111 RCTs	A1C, QOL, mortality, episodes of hypoglycemia	Telemedicine achieved significant but modest reductions in A1C although had no effect on QOL, mortality, or episodes of hypoglycemia	Telemedicine improved A1C, especially where it allowed medication adjustments with or without text or Web portal

Lead author; location	Technologies in the SR's included studies	Patient population	End of search; # studies; study types	Outcome measures	Results in brief re influence of telehealth interventions	Additional notes
Li (26) China	Technology-supported lifestyle interventions	Gestational DM	September 2019 N=10 RCTs	A1C, FBG, PPBG, weight gain, multiple pregnancy outcomes such as preterm deliveries, C-sections	Significant improvement in weight gain in pregnancy and PPBG but no impact on other outcomes	--
McDaniel (27) USA	Telephone, telecommunication, video, or any other tech-based means	DM or pre-DM	March 2021 N=21 RCTs	A1C, SBP, DM self-efficacy/empowerment, physical activity, DBP, lipids, BMI, depressive symptoms, QOL	Benefit seen in A1C, SBP, DM self-efficacy/empowerment, physical activity; minor changes in the other outcomes	Focus was on the influence of motivational interviewing for DM management
McLendon (28) USA	Interactive video telehealth	T1DM & T2DM	2016 N=10 clinical + 4 cost 3 were comparative	Access to endocrinology consultations, clinical care management, and/or DSME	Telehealth can improve local access to specialty care and clinical management; lower costs of travel, accommodation, childcare, food, and parking; plus limit the inconvenience and expense of time away from work, home, and family	Provider benefits: improved quality of services, professional development, access to specialists, continuity of care, and coordination and management of patients who may need to transfer to a tertiary center
Niu (29) China	Mobile phone apps, web-based interventions, telemetry device-based interventions	T2DM	July 2020 N=11 RCTs	A1C, SBP, LDL, FBS, DBP, BMI or other lipids	Benefits seen in A1C, SBP, LDL but no significant changes in FBS, DBP, BMI or other lipids	The authors noted that telemedicine interventions are generally led by physicians so nurse-led care is an alternative (7 of the 11 studies were from the USA, UK or EU).

Lead author; location	Technologies in the SR's included studies	Patient population	End of search; # studies; study types	Outcome measures	Results in brief re influence of telehealth interventions	Additional notes
Robson (18) Australia	Telemonitoring, mHealth, phone communication, virtual consultation (web) and video education in primary care	T2DM	September 2021 N=29 (18 in an MA) RCTs	A1C	The MA demonstrated that telehealth interventions had a significant influence on A1C vs usual care	Interventions that addressed T2DM self-management behaviours and that had higher levels of provider engagement had greater effects on lowering A1C levels vs usual care
So (30) Hong Kong	Telehealth for self-management via telephone or online	T1DM &/or T2DM	October 2015 N=7 RCTs	A1C, FBG	All studies reported significant decreases in A1C but a non-significant trend towards FBS decrease	Focus was self-management in primary care
Timpel (31) Germany	Telemedicine	T1DM &/or T2DM	October 2018 N=23 covering DM SRs/MAs of RCTs	A1C	Significant and clinically relevant reduction rates were found for A1C in patients with T2DM, less so for T1DM	Umbrella review of SRs covered DM, dyslipidemia, and hypertension
Wu (32) China	Telehealth	T1DM &/or T2DM	December 2017 N=19 RCTs	A1C, SBP, DBP, BMI, total cholesterol, QOL	Significant decreases in A1C, SPB and DBP but not BMI; variable impact on cholesterol and QOL	Targeting patients with higher A1C levels and delivering more frequent intervention may achieve greater improvement
Xie (33) China	Mobile phones, Bluetooth, phones, email, websites	Gestational DM	July 2019 N=32 RCTs	A1C, FBG, PPBG were primary outcomes, plus 11 secondary outcomes related to maternal and neonatal/fetal complications	Significant decreases in A1C, FBG, and PPBG	Regarding complications: significant decreases in C-section rate, neonatal hypoglycaemia, PROM, macrosomia, pre-eclampsia, and 2 others

Lead author; location	Technologies in the SR's included studies	Patient population	End of search; # studies; study types	Outcome measures	Results in brief re influence of telehealth interventions	Additional notes
Yang (34) China	Telephone, fax, email, Internet, video-monitoring, interactive video	T1DM &/or T2DM	April 2018 N=17 RCTs	A1C, FBG, BMI, cholesterol	Significant decreases in A1C and FBG but not BMI or cholesterol	Impact on A1C levels was only significant with follow-up < 3 months

A1C = hemoglobin A1c, BMI = body mass index, BP = blood pressure, DBP = diastolic blood pressure, DM = diabetes mellitus, DSME = diabetes self-management education, FBG = fasting blood glucose, LDL = low density lipoprotein, MA = meta-analysis, PD = professional development, PPBG = post-prandial blood glucose, PROM = premature rupture of membranes, QOL = quality of life, RCT = randomized controlled trial, SBP = systolic blood pressure, SR = systematic review, T1DM = Type 1 diabetes mellitus, T2DM = Type 2 diabetes mellitus

TABLE 2: ECONOMIC SRs OF THE VIRTUAL MANAGEMENT OF DIABETES (presented alphabetically)

Lead author; location	Technologies included	End of search; # studies; study types	Results in brief	Notes
Lee (35) Malaysia	Telephone-based DM management	February 2018 N=7 SR of RCTs	Studies focussed on reduction in glycemic levels and risk factors from a health-care perspective. Studies reported moderate cost-effectiveness with ICERs ranging from $4,744 to $86,276/QALY. Telephone charges and labour costs were the main contributors to increased costs.	Excluded for our review were studies on tele-ophthalmology and telemonitoring. Also, detail about who provided the telephone support were not included in the review; at least one involved a call centre.
McDaniel (27) USA	Telehealth delivery of motivational interviewing for DM	March 2021 N=1 relevant (of 19) SR of RCTs	The single cost study of RN-delivered care (Fischer et al 2012) found that telehealth cost per patient was less expensive than usual care: $6,600 versus $9,033. The numbers of physician visits and hospital admissions were similar between groups.	Only one included study in this SR of RCTs assessed costs. The authors noted that generalizability is questionable as the study was in a safety-net health organization caring for mostly indigent and Latino populations.
McLendon (28) USA	Video conferencing (n=1) and home monitoring/care management via telehealth (n=3)	2016 N=14 of which 4 were cost studies Various designs	Three of 4 telehealth cost analyses showed benefits with regard to reducing treatment costs and complications for patients living in rural areas. The main savings were in patient travel and visit costs.	The unfavourable study in this review was Palmas et al 2010 (conducted from 2000-2006) which showed that remote monitoring technology for high-risk patients with DM was not cost-effective due to high technology costs.

Lead author; location	Technologies included	End of search; # studies; study types	Results in brief	Notes
So (30) Hong Kong	Automated telephone disease management with RN follow-up	October 2015 N=7 studies of which 2 mentioned costs RCTs	An older USA study (Piette et al 2001) reported that the implementation of telehealth interventions could save more than US$100 million per year based on projected improvements in A1C levels. Another American study (Charpentier et al 2011) stated that physicians' time spent on each patient was the same for the control and intervention groups, but the intervention group saved time and travel costs.	Only 2 of the included studies mentioned economic considerations.
Tchero (36) France	Phone-based versus paper in 2, online interactive in the third	December 2016 N=42 studies – 3 mentioned costs RCTs	Cost-effectiveness calculations were $464 and $490 per person for each unit reduction in A1C for the 2 phone-based systems, and $29,869 for a more complex web-based system. NOTE: Subgroup analyses of clinical benefit (decreased A1C) showed greater improvements for: (a) patients with T2DM versus T1DM, (b) age groups 41-50 and 50+ versus younger patients, and (c) telemedicine programs of 6+ months duration versus shorter programs.	Studies used phone-based interventions (4-10 contacts/year) or patient monitoring/data uploading, videoconferencing, and access to an educational website.
Teljeur (37) Ireland	Transmitting self-monitoring results or enabling remote interaction with clinical staff to support self-management	March 2015 N=37 economic studies of which 11 involved telehealth Costing studies plus modelling studies – RCTs and before/after designs	There was only one good quality study which reported an ICER of $82,000 – a value that is not considered cost-effective using conventional USA willingness-to-pay thresholds of $50,000 per QALY.	Telemedicine interventions require substantial capital investment in equipment; however, they have potential for cost-savings due to reduced travel, remote monitoring, and more efficient use of staff time. Also, when trials have a short follow-up period, there may be too little time to observe benefits to offset initial costs.
Wong (38) Singapore	Video consultations	February 2019 N=13 studies - 1 mentioned costs RCTs	When video consultations replaced clinic visits, participants reported saving a mean of 115 ± 86 minutes and €80 (range €10 to €400) in travel expenses.	Only one included study in this SR of 13 RCTs assessed costs.

A1C = hemoglobin A1c, FTF = face-to-face, GDM = gestational diabetes mellitus, ICER = incremental cost effectiveness ratio, QALY = quality-adjusted life year, RN = registered nurse, T2DM = type 2 diabetes mellitus

TABLE 3: ECONOMIC PRIMARY STUDIES OF THE VIRTUAL MANAGEMENT OF DIABETES (presented alphabetically)

Lead author; location	Type of study	Intervention & control	Included in costs	Results
Egede (39) USA	Economic study (randomized) N=113 low-income, rural adults with T2DM and A1C ≥8%	Technology-assisted case management with medication titration by nurses via a specific telehealth technology called FORA Usual FTF office care	The intervention including institutional overhead; RN time; FORA device, test strips, lancing device, and web system Patient lost wages	The telehealth model of 6 months of case management was more expensive than FTF care by $4,020 ($1,360 vs $5,380), but it was also more clinically effective in lowering A1C. This resulted in ICER of $6,300 per 1% decrease in A1C. Cost savings for a 1% change in A1C were $1,000 - $4,000 per person per year depending on glycemic control and comorbidities.
Lemelin (40) Canada	Comparative clinical trial with cost analysis N=161 pregnant women with GDM	The intervention group monitored capillary glucose via a meter and uploaded results to software. Nurses contacted patients based on results and gave advice and education, sometimes using automated resources Usual care	Costs of provider care (Indirect costs for patients were not included, e.g., parking, babysitting, lost wages)	There was a significant decrease in medical visits (56%) and in total health-care costs (16%) in women in the remote monitoring arm without impact on pregnancy outcomes, quality of care, safety, or patient satisfaction. Satisfaction with educational support was significantly increased in the remote monitoring group. Costs for GDM management: Per patient: $875 for remote vs $1,043 for usual care.
A1C = hemoglobin A1c, FTF = face-to-face, GDM = gestational diabetes mellitus, ICER = incremental cost effectiveness ratio, QALY = quality-adjusted life year, RN = registered nurse, T2DM = type 2 diabetes mellitus				

TABLE 4: SUMMARY OF PSYCHOSOCIAL FINDINGS FROM SRs

Lead author; location	Findings related to the patient perspective
From the SRs included in the clinical & economic sections	
McLendon (28) USA	Patient satisfaction was reported in 5 of 14 studies on interactive video telehealth. Satisfaction levels were high for reasons such as: rural access to urban specialists with multidisciplinary teams partnering with local providers, reduced travel costs, and self-empowerment in DM management.

Lead author; location	Findings related to the patient perspective
Robson (18) Australia	Of 29 included RCTs on use of various types of telehealth in primary care, only two reported levels of treatment satisfaction in the study groups. In one, the intervention group had significantly higher satisfaction levels versus the control group as well as better knowledge regarding blood glucose testing and a better understanding of diabetes; however, people in the second study reported no significant difference between groups.
So (30) Hong Kong	Of 7 included RCTs on automated telephone disease management, only two commented on patient satisfaction. In the first RCT conducted in USA Veterans Affairs patients, 81% of the intervention group participants were moderately or very satisfied – slightly higher than responses from patients in the control group. In the second, 75% reported at 6 months that they wanted to continue with the system for routine follow-up.
From other publications	
Fantinelli (41) Italy	This SR of 13 studies focussed on the psychological dimensions in telemedicine care for women with gestational DM including empowerment, self-efficacy, engagement, and satisfaction. There was scant reporting for the first three outcomes but more consistent and positive results concerning the satisfaction of patients and providers; however, in one study, providers reported disadvantages with loss of face-to-face patient contact.
Heitkemper (42) USA	An SR of 13 studies explored whether health information technology self-management interventions improved glycemic control in medically underserved adults with DM. Although the focus was on clinical outcomes, psychosocial outcomes were briefly recorded in all studies, i.e., "*Interventions improved psychosocial outcomes such as diabetes self-efficacy, satisfaction with medication information, ability to manage one's health, and self-care behaviors*."
Macdonald (43) Australia	An SR of two-way information technology to manage adults with DM included 48 studies; about 20% reported on patient satisfaction. The level of providers' engagement with technology and their relationship with participants had a significant impact, as did frequency and quality of feedback.
Sim (20)	This review focussed on patient preference and satisfaction with the use of telemedicine for glycemic control in patients with T2DM. Included were 20 articles and the following results were reported: "*Patients were generally satisfied … Users reported that telemedicine was beneficial as it provided constant monitoring, improved access to health-care providers, and reduced waiting time. When adopting a telemedicine platform, most patients expressed preference for mobile health as the telemedicine modality, especially if it has been endorsed by their physician. To improve usability and sustainability, patients suggested that modules related to diabetes education be enhanced, together with sufficient technical and physician support. Patients also expressed the importance of having a sufficiently flexible platform that could be adapted to their needs*."
Wong (38) Singapore	The SR assessed the effectiveness of self-management interventions in young adults aged 15-39 years. Of interest, one RCT reported that 97% who used video consultations in place of clinic visits were very satisfied.