



Newest Diabetes-Related Technologies for Pediatric Type 1 Diabetes and Its Impact on Routine Care: a Narrative Synthesis of the Literature

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Abstract

Purpose of Review This review aims to address the actual state of the most advanced diabetes devices, as follows: continuous subcutaneous insulin infusions (CSII), continuous glucose monitoring systems (CGM), hybrid-closed loop (HCL) systems, and “Do-it-yourself” Artificial Pancreas Systems (DIYAPS) in children, adolescents, and young adults. This review has also the objective to assess the use of telemedicine for diabetes care across three different areas: education, social media, and daily care.

Recent Findings Recent advances in diabetes technology after integration of CSII with CGM have increased the popularity of this treatment modality in pediatric age and shifted the standard diabetes management in many countries. We found an impressive transition from the use of CSII and/or CGM only to integrative devices with automated delivery systems. Although much has changed over the past 5 years, including a pandemic period that precipitated a broader use of telemedicine in diabetes care, some advances in technology may still be an additional burden of care for providers, patients, and caregivers. The extent of a higher rate of “auto-mode” use in diabetes devices while using the HCL/DIYAPS is essential to reduce the burden of diabetes treatment.

Summary More studies including higher-risk populations are needed, and efforts should be taken to ensure proper access to cost-effective advanced technology on diabetes care.

Keywords Type 1 diabetes · Insulin pump · Continuous glucose monitors · Closed-loop · Artificial pancreas · Telemedicine

Introduction

The year 2021 marks the one-hundredth anniversary of the discovery and development of insulin. A tremendous evolution has been observed across the past few years and it is well-known and established that the continuous subcutaneous insulin infusions (CSII) appear to be effective and

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safe in people with type 1 diabetes (T1D) regardless of age besides offering flexible management of diabetes [1]. With the overall uptake of the continuous glucose monitoring (CGM) systems, children with diabetes (CWD) benefited from fewer episodes of severe hypoglycemia, reduced number of painful fingersticks, and remote monitoring features of the latest system [2]. Recent advances in diabetes technology after integration of the CSII with CGMs have increased the popularity of this treatment modality and become standard diabetes management in many countries and almost ideal for pediatric age and bringing more peacefulness to the families of CWD [3]. The integration between the insulin delivery and glucose meters came with the sensor-augmented pump (SAP) systems, although potential beneficial effects were counter steered by low sensor use [4]. These pumps especially worked on the prevention of hypoglycemic events by shutting down insulin delivering and paved the way to the development of the automated insulin delivery systems, the so-called “artificial pancreas.” The first advanced product in that direction was the MiniMed 670G (Medtronic Diabetes, Northridge, CA, USA) which received the Food and Drug Administration (FDA) approval in September 2016 [5]. The hybrid closed-loop (HCL) insulin delivery when compared with SAP showed an improvement of glucose control while reducing the risk of hypoglycemia across pediatric patients with suboptimally controlled type 1 diabetes [6]. To date, there are few commercial closed-loop systems available in most high-income countries. Firstly introduced, the Medtronic 670G system showed from a clinical trial that the HCL system was safe for use in people 14 years of age and older with type 1 diabetes with no serious adverse events, such as diabetic ketoacidosis (DKA) or severe hypoglycemia (very low glucose levels) reported during the study [7]. Then, Tandem Control IQ system (Tandem Inc, USA) was also approved after the closed-loop system led to a greater percentage of time that the glucose level was in a target range, with less hyperglycemia and hypoglycemia, and better glycated hemoglobin (HbA1c) levels than a sensor-augmented pump. More recently the introduction of the advanced HCL MiniMed 780G system (Medtronic Diabetes, Northridge, Ca, USA) in adolescents allowed well-controlled patients with T1D to rapidly increase their time in range (TIR), without increasing hypoglycemia frequency [8]. However, just before HCL systems became commercially available, “Do-It-Yourself” artificial pancreas systems (DIYAPS) were developed by individuals with a personal interest in automating insulin delivery with the motto #wearenotwaiting. Although they are still unlicensed products, and users must take total responsibility for associated risks with their use, they report improvements in HbA1c and TIR, and reduced burden of diabetes [9].

The broader use of the newest diabetes technologies made intensive treatment easier to achieve as diabetes management steps forward to be more patient centered. Apart from technological advances and greater patient satisfaction, and although insulin remains the mainstay of diabetes treatment, results are only better when diabetes care becomes primarily patient-dependent or, in the case of young children, the family assumes this management supported by the multidisciplinary team. Given the fast emergence of innovations in glucose monitoring and insulin delivery, the burden of self-care has reduced in a manner that improved outcomes [10].

Lately, the beneficial impact of telemedicine and telehealth resources for continuous care in dealing with non-communicable diseases, which includes diabetes, is an undisputable benefit, especially in countries with large distances and socioeconomic inequalities [11].

This narrative synthesis review aimed to address the actual state of CSII, CGM systems, HCL systems, including DIYAPS in children, adolescents, and young adults. Also, we reviewed telemedicine and telehealth for diabetes care on main results and achievements on this ever-expanding ground of knowledge. To better describe terminologies in diabetes-related technology, we will use acronyms detailed in Table 1.

Methods

This review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) [14]. We conducted a bibliographic search in Medline (PubMed database) to identify all articles published with defined Boolean search terms (Supplementary Content) from January 2016 to March of 2021. No language restriction was set. We also hand-searched for additional references in previous reviews.

We selected randomized controlled trials and observational studies comprising real-world data that presented glycemic and/or patient-related outcomes after using CSII, CGM system, automated, and integrated insulin infusion devices with glucose monitorization (closed-loop systems). We also included studies that applied telemedicine and telehealth into diabetes clinical practice. For these, we also considered data assessed from surveys. To better systematically present data, studies on telemedicine and telehealth were divided into three groups: education, social media, and daily routine care.

Glycemic outcomes were assessed from HbA1c, severe hypoglycemic (SH) episodes, diabetic ketoacidosis (DKA) events, and the percentage of time that the glucose level was in the target (TIR), below (TBR) and above the range (TAR) of 70 to 180 mg/dL (3.9 to 10.0 mmol/L) respectively and patient-reported outcomes were assessed from

Table 1 Terminologies of the newest diabetes-related technological devices

Diabetes-related technological devices	Acronyms	Description
Continuous subcutaneous insulin infusion	CSII	Devices that continuously deliver basal insulin supply and mealtime or correction boluses whenever needed, turning it into the most physiological way to imitate insulin maintenance [3]
Real-time continuous glucose monitoring system	rt-CGM	These devices measure interstitial glucose concentrations subcutaneously at 5-to-15-min intervals utilizing enzyme-tipped electrodes or fluorescence technology [2]
Flash glucose monitoring system	FGM	Differently from rt-CGM, the FGM does not automatically display glucose readings at regular intervals, but report glucose levels only when the user scans the sensor by holding a reader, or a cell phone, close to the sensor. An advantage is that they are factory calibrated, thus eliminating the need for recalibration, increase ease of use, and economic feasibility [2]
Sensor-augmented pump	SAP	They are the combination of CSII with rt-CGM measurement and offer by different algorithms a more sophisticated and semiautomated pump therapy once related to the time a sensor is worn or not worn [3]
Hybrid closed-loop insulin delivery system	HCL	These devices integrate CGM systems with an insulin pump including an algorithm which automates insulin delivery [12]
“Do-it-yourself” artificial pancreas systems (DIYAPS)	DIYAPS	They involve the use of rt-CGM (or FGM with the addition of hardware that allows conversion to rt-CGM), an algorithm that calculates insulin doses, a communication device (like a smartphone), and an insulin pump. Together, these systems automatically adjust basal rates and bolus doses in response to CGM values. In simple terms, as blood glucose rises, the system automatically delivers more insulin, and as it drops, the system delivers less. There are currently three types of DIY closed-loop system: Open APS, Looping, and Android APS. They differ in the combination of pumps, user communication devices, hardware, and algorithms used [9, 13]

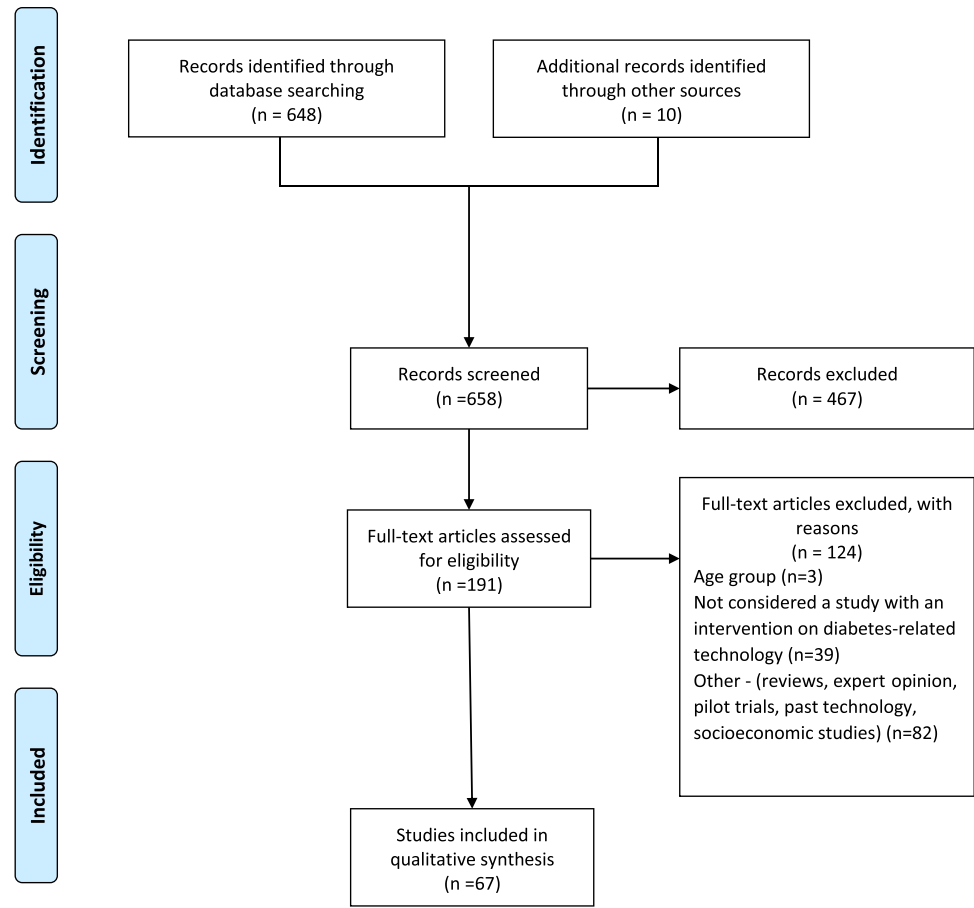
health/diabetes related quality of life (HRQoL), and patient/caregiver satisfaction. Our final selection was outlined in studies that were conducted with children, adolescents, and young adults exclusively with type 1 diabetes that reported any of the outcomes of interest: HbA1c, SH, DKA, percentage in TIR, TBR, and TAR, HRQoL or patient/caregiver satisfaction. Comparisons between studies and meta-analysis were not a goal, nor performed. We excluded studies that did not meet the age criteria, that were not considered studies with an intervention in diabetes-related technology, nor review studies or expert opinion papers, nor pilot or past technology trials, nor those that they only focused on socioeconomic analysis.

Two reviewers (TJS, CK) worked independently to check eligibility of studies (title and abstract) and extracted the appropriate information in full-text articles for the remainder reviewers (TCR, MKP, RFA). Data extracted from the studies included year of publication, country, baseline characteristics of participants, type of intervention (type of insulin pump, CGMS or closed-loop system, and strategy applied for telemedicine), glycemic and patient-reported outcomes. We analyzed the following glycemic outcomes: (i) changes in HbA1c (%/mmol/mol), (ii) changes in the number of SH episodes (below 54 mg/dL (3.0 mmol/L) or an event associated with severe cognitive impairment (including coma and convulsions) requiring external assistance), (iii) changes in

the number of people with DKA event, and (iv) changes in the mean (\pm SD) percentage of TIR (percentage of readings in the glycemic range of 70–180 mg/dl (3.9–10.0 mmol/L) per unit of time), TAR and TBR assessed with any continuous glucose monitoring systems [15–17]. We collected information on questionnaires that assessed the overall mean (\pm SD) HRQoL score for each group at the end of the study.

Results

A total of 648 articles were identified and their titles and abstracts were screened for eligibility. After removing those articles that did not match the inclusion criteria, we assessed 191 studies; of them, 124 were excluded for various reasons (see Fig. 1). A total of 67 articles were included in our narrative synthesis; of these 19 are RCTs, 44 observational studies presenting real-world data, and 15 are cross-sectional surveys or interviews. We classified the included studies in four different areas in order to better assess their results, as follows: 14 on CSII, 9 on CGM systems, 22 on HCL systems (artificial pancreas), including 4 on DIYAPS (Supplemental Table 1), and 23 on telemedicine and telehealth (Supplemental Table 2).

Fig. 1 Flow diagram across the review

Continuous Subcutaneous Insulin Infusions

Use of the newest insulin pumps was associated with lower mean HbA1c values in several studies [18–23]. Their use was also related to a higher treatment satisfaction and better health perception, as well as a significant decline of overall diabetes burden at follow-up than those on MDI [24, 25], although timing of pump initiation did not seem to be important in QoL scores [21]. Pump therapy was also associated with a lower rate of SH compared with injection therapy [20, 26], particularly in school-aged children [23], and with predictive low-glucose management (PLGM) system [27]. It is important to add that a longer duration of nocturnal pump suspension resulted in a higher percentage of mornings with elevated blood ketones in children aged under 6 years old, but not in the older age group [28].

Sensor-augmenting pump therapy use adds value to treatment satisfaction without correlation with the duration of the sensors use [25]. But, for each 100 h of CGM use per 28-day period, HbA1c was 0.39% (95% CI 0.10–0.69%) lower, and higher CGM adherence was associated with reduced time with glucose > 10 mmol/L [29]. Additionally, there were no differences regarding mean self-monitoring of blood glucose values, insulin total daily dose, body mass index, level of

insertion site pain or local reaction, technical problems, and quality of life among different brand devices [30].

From a United Kingdom National Health System perspective, although CSII had little benefit, it was more expensive than MDI with a mean total cost (£1863, 95% CI £1620 to £2137) with no additional quality-adjusted life-year (QALY) gains (–0.006 QALYs, 95% CI –0.031 to 0.018 QALYs) [31].

Continuous Glucose Monitoring Systems

Pediatric CGM use increased in national T1D registries and was associated with lower mean HbA1c, better glucose control, and fewer diabetes-related emergency visits, regardless of insulin delivery modality [32, 33]. A large cohort of people with type 1 diabetes from 1 to 18 years compared patients on injections or pump, with or without sensor for CGM, and observed lower HbA1c and fewer DKA episodes in participants using either a pump or CGM or both. Pump without sensor experienced less SH episodes and pump with sensor experienced less DKA [33]. Interestingly, glycemic outcomes seem to be improved when information from CGM system was shared with caregivers [34].

A randomized trial comparing CGM and SMBG showed small statistically significant improvement in glycemic control over 26 weeks with CGM use in adolescents and young adults [35]. Another randomized trial showed that insulin pump therapy with CGM offering LGS significantly reduced fear of hypoglycemia not related to CGM adherence in children with type 1 diabetes and their parents [36].

In a cross-sectional study to evaluate the use of flash glucose monitoring, the glycemic variability defined by the CV modifies the relationship between the TIR and HbA1c/Glucose Management Indicator and should be considered when individualizing TIR targets, regardless of age or the type of treatment used [37].

Hybrid Closed-Loop Insulin Delivery System and “Do-It-Yourself” Artificial Pancreas System

Randomized controlled trials in pediatric age with HCL systems showed greater percentage of time that the glucose level was in a target range, less hyperglycemia and hypoglycemia, and better HbA1c levels than sensor-augmented pumps [6, 38–42]. Similarly, observational studies with real-world data presented more benefits with commercialized HCL systems with improved glycemic control, glycemic variability, and patient satisfaction in children and adolescents when time in auto mode was active [43–50]. In regards to the DIYAPS, no RCT was found, and the few articles were focused on assessing patients and caregivers’ perspectives and satisfaction in using the DIYAPS [51–53]. It is noteworthy that one study assessed very young children with T1D, and it seemed to be safe as no episodes of severe hypoglycemia or DKA were reported [51]. However, users still identify the primary challenge of sourcing necessary devices and setting up the closed loop [52].

In addition, a few studies aimed to present data on logic algorithms assembling automated artificial intelligence-based decision support systems and they demonstrated to be safe during day and night [54, 55]. Interviews and surveys focused on assessing patient’s attitudes reported substantial benefits using the closed loop systems; however, they also identified ways in which the technology could be refined, and education and training tailored to optimize effective use and reduce management distress [56, 57].

Telemedicine—Education

Training using the *Zoom Cloud Meetings* platform (Zoom Video Communications, Inc, San Jose, CA, USA) seemed to be useful, especially in adult and motivated patients, whose satisfaction indices were high, and problems with platform very low [58]. Remote training for candidates for HCL pump, MiniMed 670G using digital teleconference platforms provided continuous support for technological devices and

improved the delivery of better care for T1D patients [59]. It is of note that probably some aspects of this training should be adapted for pediatric patients.

Results from a pilot study aimed to assess interventions in telehealth cognitive behavioral therapy have proven its usefulness in T1D pediatric patients younger than 7 years and their caregivers in reducing fear of hypoglycemia, emphasizing the potential cost-effective use for remote group sessions [60].

A web-based program prototype “Type 1 Teamwork,” with six main topics such as “Being a Parent,” “Parents as Partners,” “Communicate,” “Letting Go,” “Getting Emotional,” and “You Matter,” was considered very relevant for both parents and care providers. This resource is potentially useful to be offered via web based or mobile apps [61].

Telemedicine—Social Media

Adolescents with T1D expressed interest in the use of social media as a tool to support diabetes management and increase engagement with their diabetes care team [62]. Specific implementation measures around privacy and professionalism should be considered when developing a social media intervention to facilitate communication between adolescents and care teams [62]. Social media like *Facebook* (Menlo Park, CA, USA) and *Viber* (Luxembourg, LU) were found to be an additional communication tool for adolescents and young people with type 1 diabetes and significantly lowered HbA1c compared to patients without social media use, as demonstrated in a retrospective and cross-sectional study [63]. People using CSII were more likely to use both social media (*Facebook* and *Viber*) compared with those on MDI (*Facebook* only).

Web-based portal initiatives such as “*Sugarsquare*” should be tailored to fit parents’ interests, and offer multiple options, as forums, chat, and links to access professional advice in a personal fashion, to be considered useful tools for pediatric diabetes care [64].

Telemedicine—Routine Daily Care

The accumulation of evidence on the effectiveness and safety of telehealth in diabetes care should contribute to implementing this approach in practical health care [65]. Remote medical care, or telehealth, had been practiced increasingly for people with T1D with positive impact on their metabolic control [66]. Telemedicine’s usefulness, applied to diabetic retinopathy even before pandemics, has led to optimization of health care delivery in this field around the world [67]. Recently, the COVID19 pandemic made the telemedicine practice a necessary tool to ensure care worldwide [68–70]. Even during the most restricted lockdown, an Italian group of patients using rt-CGM and followed by telemedicine

did not show worsening of their glycemic controls [71]. In another group tested during pandemics, results demonstrated that remote HbA1c monitoring via dried blood spot is feasible and offers an avenue to support assessment of glycemic control for patients seen via telemedicine [72]. Assessments from survey on people with type 1 diabetes during lockdown showed that at least two-thirds underwent changes in the management of their condition [73]. Data from the International Society for Pediatric and Adolescent Diabetes (ISPAD) also reported high degrees of migration to telemedicine/e-health tools [69].

Qualitative analyses have identified a number of unique benefits of telemedical interventions, including higher frequency of contacts, greater sense of patient's safety, ability to interact with patients in their own homes, more timely and accurate medical monitoring, and improved data management after a technical training for video consultations [74]. A good strategy to engage adolescents with T1D is to offer them a message platform to support behavior changes, interconnecting through apps with social interface, rewarding (grading and earning points), and "gamification" features are interesting tools for this age group [75].

Technology also allows the integration of care that goes beyond glycemic control, as demonstrated by the AID-GM (Advanced Intelligent Distant—Glucose Monitoring) web-based program for integration of blood glucose profile and other data (sleep patterns, physical activity, food intake, and other inputs), which may announce the dawn of what is called "e-Health" in diabetes care [76]. Remote monitoring in children with DM1 resulted in significant improvements in glycemic control (HbA1c, glycemic variability, and hypoglycemic frequency) [65]. However, inequalities in access to technology and eHealth even in high-income societies, with access to good and affordable health services, may happen [77].

Discussion

In this review of the literature of the past 5 years on current diabetes devices for those in the pediatric age range, we found an impressive transition from the use of insulin pumps and/or CGMs only to integrative devices with automated delivery systems. While a lot has changed in the past 5 years, including a pandemic period that precipitated a broader use of telemedicine in diabetes care [69], for many healthcare providers, caregivers and people with diabetes, such advances in diabetes technology, may represent an additional burden of care [78–80].

One of the most assertive advances in diabetes technology was the launching of pumps with predictive low glucose suspension (PLGS) system and turned diabetes management into a suitable and safe therapeutic option, especially for

very young children with diabetes to prevent risk of severe hypoglycemia [18]. And it also seems to be effective in addressing age-specific challenges and able to improve glycemic control in children of all ages [81].

Since insulin discovery in 1921, different advances emerged to improve metabolic control, reduce diabetes chronic complications, and ameliorate QoL. Glucose monitoring was one of the most important tools that contributed to the improvement of glycemic control and its long-term consequences [82]. Drawing a timeline, we observe the spectacular transformations that have taken place over decades of diabetes management and the accelerated advances in recent years. Until the 1960s, glucose monitoring was performed through the measurement of glycosuria. In 1965, the first method of measuring capillary blood glucose, the Dextrostix, was performed, but was a semi-quantitative test, with high error rate [83]. The Dextrometer launched in 1980 was the first digital panel glucometer, followed by new generation devices, with lower costs and greater accuracy [83, 84]. Since the Diabetes Control and Complications Trial (DCCT) study [85], metabolic control was assessed by HbA1c, that reflects metabolic control of three to four months, showing a positive relationship with frequent assessment of self-monitoring of blood glucose (SMBG) [86, 87]. Nevertheless, HbA1c can be influenced by several clinical and personal conditions and does not reflect hypoglycemic events or glucose excursions.

The improvement of diabetes technologies and the need to assess and comprehend glycemic control, hypoglycemia, and glycemic variability led to the development of CGM systems, and nowadays intermittent CGMs (iCGM or FGM) and real-time CGM (rT-CGM) are available [82]. CGM systems provide a continuous measurement of interstitial glucose over time, allow to detect TIR, hypoglycemic and hyperglycemic events (time below or above range) and glucose variation (coefficient of variation—CV). Data of different observational studies and randomized control trials (RCT) reflects the spreading use of CGMs in the pediatric population and demonstrates that they can improve glycemic control by lowering mean HbA1c, regardless of insulin delivery modality, reducing DKA episodes and increasing TIR with a reduction of time spent in hypo or hyperglycemia [29, 32–37, 88–90]. Notably, studies with the largest pediatric population are observational and only a few randomized studies demonstrated the impact of the CGM contribution in children and adolescents.

Given the greater glycemic outcomes with significantly fewer events of DKA, severe hypoglycemia, and with no hospital admission when using the HCL systems in auto-mode [8, 38, 43, 45–47], and after an improved patient's uptake with these systems [56, 57, 91], it is foreseeable that diabetes care is becoming increasingly patient centered. Individualization of glucose control, aiming to minimize

high glucose peaks while preventing hypoglycemia, and almost “automate” diabetes control is expected to be the next step to provide full CLS to all people living with T1D.

While a few commercial systems have been launched lately, the movement #WeAreNotWaiting has disseminated technologies that are open source and available as do-it-yourself (DIY) CLS or DIY artificial pancreas systems (APS). Currently, there are two different algorithms: Loop, that runs on iPhone, and OpenAPS, that runs on both iPhone and Android systems. In general, it is made up of an old pump device associated with a CGM system that synchronizes with an open-source platform that connects CGM in the cloud, the *Nightscout* project [92]. This platform allows real time access to a CGM data via personal website, smart-watch viewers, or apps and widgets available for smartphones. Although it means a lot for patients and caregivers, OpenAPS are still unlicensed products. A promising launching of a commercially available project, the Tidepool (Palo Alto, Ca, USA), using the Loop algorithm, is a hope to regulate it and enable patients to program and calculate their own algorithms to work with their CGM sensors and devices.

In an era of automation and very close to the artificial pancreas, Telemedicine and Telehealth also seem to be here to stay. Even before the pandemic, some initiatives in distance diabetes education and the use of social networks and interactive behavioral support groups were already being tested, with positive results [60, 92].

The pandemic certainly accelerated its broader implementation. Almost all participants agreed with the concept of telemedicine, favoring telephone and video calls as their preferred means of communication also for future care [73, 93], the strategy has proved to be valid not only for patients, but also for caregivers and health professionals [62]. The use of platforms such as *Zoom*, *Viber* and *Facebook*, widely used for group and workgroup connections has proved to be an especially useful tool for teenagers and caregivers, both from an educational point of view and for optimizing the use of pumps and other devices, with positive results in the guidance and glycemic control of patients [58, 63, 64]. And in the context of the epidemiological emergency of the COVID19 pandemic, several groups used the strategy to ensure training and follow-up of their patients [58, 59]. And there is certainly a place for these strategies regardless of the current epidemiological context. Minimizing distances and optimizing time add value to digital tools.

For the daily care routine of patients such as T1D, telehealth initiatives were pushed forward especially after 2020 [66, 69, 73]. Telephone and video calls, electronic messages and use of telemedicine platforms were used by several groups worldwide [68, 70, 94]; however, there is a need for training in the use of digital tools [74], and an effort to reduce discrepancy in access, even in economically

developed countries [77], which includes internet speed and safety. The most important question is the impact of distance care on patients’ glycemic control and, although data are still limited, there is favorable evidence for improved glycemic control, reduction of severe hypoglycemia and in the incidence of DKA [65, 71]. Digital platforms and initiatives capable of increasing patients’ access to induce transformation on general health care strategies, such as “*Sugarsquare*,” “gamification apps,” and “Advanced Intelligent Distant — Glucose Monitoring,” appear to be promising e-health initiatives that find good acceptance in the chronic care required by T1D, especially for this new generation of pediatric and adolescents [64, 75–77, 94]. All of this must not ignore the need to design equitable eHealth solutions to address social/economic gaps in society [77]. Promising results have been demonstrated with multidisciplinary team care [94] and telemedicine as a useful tool to deliver diabetes care for the transitional age group, from pediatric age to adulthood [95].

Conclusion

Healthcare in this century has been converging with the technological advances of the last decades. Considering T1D management, the last decade brought new types of insulin and technological devices, allowing an even more intensive glycemic control, largely due to the broader use of CGM. The goals of glycemic control include stabilization of glycemic variability to achieve glycemic targets, in addition to the traditional measurement of HbA1c. In the past 5 years, insulin pumps have been approaching the long-awaited artificial pancreas, but so far, the big breakthrough is still the suspension of insulin infusion in hypoglycemia (or risk of), ensuring protection from severe episodes of hypoglycemia, reducing worries, and increasing confidence and tranquility of caregivers with these systems. The future is to be reached, as we can count on almost full closed loop systems, regrettably not to all people living with T1D.

Children, adolescents, and young adults with chronic diseases need intensive education on selfcare. Particularly for T1D, it is beneficial when it comes along with tele-education and telemonitoring. Telemedicine and telehealth, with simple tools already available, like telephone/video calls and text messages, show promising data, but specific platforms for T1D can be even more assertive. It is important that healthcare systems worldwide include these strategies more equitably for children and adolescents. Possibly, some patients may benefit even more from tele-education and telehealth in diabetes, with a focus on higher-risk groups (persistently high HbA1c and/or low socioeconomic status) to ensure that existing disparities in health outcomes and access to advanced technology do not increase.

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Author Contribution TS was responsible for the conception and design of the study. TS and CK selected the articles. All authors extracted the data and conducted the narrative synthesis. All authors drafted the whole manuscript. All authors revised this work for important intellectual content and approved the final manuscript.

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Code Availability Not applicable.

Declarations

Ethics Approval and Consent to Participate Not applicable.

Consent for Publication Not applicable.

Conflict of Interest The authors declare no competing interests.

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Papers of particular interest, published recently, have been highlighted as:

- Of importance
- Of major importance

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