

ISPAD Clinical Practice Consensus Guidelines 2022: The delivery of ambulatory diabetes care to children and adolescents with diabetes

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1 | WHAT IS NEW OR DIFFERENT

- In this update, the general guidelines regarding the gold standard of ambulatory care for children, adolescents, and young adults with type 1 diabetes (T1D) have been revised.
- Guidance on current diabetes technology has been expanded to include relevant information on telemedicine, data support, education and literacy.
- Updated guidance on type 2 diabetes (T2D) ambulatory care is provided.

2 | EXECUTIVE SUMMARY

2.1 | Introduction

- From diagnosis, the child or adolescent with diabetes and their caregivers must receive education and care from a multidisciplinary

diabetes team comprised of specialists with training and expertise in both diabetes and pediatrics, including child and adolescent development. B

- The diabetes team should implement a person-centered care model, where the persons with diabetes and their family are the central members of the care team. B
- Clear and consistent communication around education and treatment plans is essential. C
- Current technologies commensurate with available resources and the individual child's/family's needs should be integrated into the treatment plan. C
- It is important to empower children and families with the awareness that diabetes is a condition that can be managed and avoid the young person with diabetes being defined by the condition ("the diabetic child" or "the sick child"); and use language that engages and motivates children and families towards dynamic diabetes management. C

- If a multidisciplinary team is not locally available, the clinicians providing diabetes care should have ready access to advice and expertise from the multidisciplinary diabetes care team in regional centers of excellence, and this could be facilitated using telemedicine. C

2.2 | Objectives of ambulatory care

- The ultimate goal is to provide care that results in “on target” glucose profiles, good quality of life, normal growth and development, and lowest possible risk of acute and long-term diabetes complications. E

2.3 | Key points in diabetes care delivery

- Specialized hospital medical care. E
- Expert comprehensive ambulatory care for diabetes and associated conditions. E
- Support available 24 h a day for young people with diabetes and their caregivers. C
- Comprehensive education for the young person and his/her caregivers on day-to-day management of diabetes including insulin therapy, glucose monitoring, nutrition. C
- Ongoing diabetes education and self-management training on issues such as hypoglycemia, exercise, sick-day management, travel, fasting, festivals and other special occasions. E
- Integration of diabetes technology in pediatric diabetes care and appropriate education of young people with diabetes and their families about diabetes technology. C
- Consistent articulation of glycemic targets. C
- Introduction of new therapies and technologies as diabetes management evolves. E
- Screening for comorbidities and complications and related risk factors. B
- Psychosocial support for all young people with diabetes and families. B
- Advice for care at school, camps, and other venues where children with diabetes require care when away from home. E
- Guidance on other age and developmentally appropriate goals and life events (including contraception, driving safety, use of alcohol, tobacco and other substances, and other risk-taking behaviors). E
- Additional psychosocial evaluation and support for children who are at high-risk of acute and/or chronic complications due to suboptimal glycemic management, frequent utilization of emergency departments/hospital, other social considerations and/or mental health needs. B
- Recommendation on routine vaccinations to be provided for children with diabetes according to age-related and regional recommendations. Advice on annual vaccination against influenza for all individuals with diabetes above 6 months of age. Pneumococcal and meningococcal vaccines are also recommended. C

- Enable telemedicine consultation for diabetes clinic visits and psychosocial counseling. C
- Advice and support for physicians and health care professionals who provide diabetes care where immediate access to a specialized diabetes care team is not possible. B
- Provision and updating the team (including the child with diabetes and the family) with current information on research in diabetes. E

2.4 | Key points in processes of diabetes care

Following diabetes diagnosis and stabilization, the child or young person with diabetes and caregivers should be provided with: C

- Essential skills such as glucose and ketone monitoring
- Administration of insulin including the concepts of dosing for meals, management of hypoglycemia and hyperglycemia
- Access to an on-call team (24 h a day)
- Routine visits, at least every 3 months, should include:
 - Ongoing evaluation of diabetes management that includes review of insulin doses and glucose profiles, data interpretation and decision-making empowerment based on standardized glucose reports.
 - Evaluation of growth and physical development, and general health (including concomitant medical conditions and medications)
 - Physical examination with inspection of glucose monitoring sites and injection sites
 - Nutrition consultation
 - Options to communicate between visits, for example, for insulin dose adjustments, should be provided, including text messages or virtual visits via video, telephone, or live chat.
- An annual review visit that in addition to the above routine care includes:
 - Expanded physical assessments (such as pubertal staging, foot examination)
 - Additional self-management assessments, such as dietary knowledge (ability to estimate carbohydrate consumption and accurately determine insulin doses), glucose data interpretation, autonomy in diabetes management, knowledge about sick day rules
 - Psychosocial assessment
 - Screening for comorbidities, long-term complications, and related risk factors

2.5 | Other key aspects of ambulatory care

- Identification of barriers to care. B
- Considering specific needs of minority groups. C
- A planned, structured transition approach to adult diabetes care to facilitate continuity of care during this critical time. B The age of

transition to an adult clinic varies according to individual maturity and local circumstances

- Contact with other families of children with diabetes. E
- Promotion of diabetes camps. E
- Interactions with schools as part of day-to-day diabetes care. B
- Facilitating access to care by in-person and virtual diabetes visits through telemedicine or telehealth. B

2.6 | Quality of care

- Diabetes centers need methods to evaluate and enhance the quality and equity of the diabetes services they provide and the outcomes of their management. C
- Given the complexity of T1D management, this entails a multi-faceted approach that integrates psychosocial supports, recognizes social determinants of health, leverages information science, and the application of quality improvement (QI) methodology. E
- Diabetes registries can be an important tool for population management at individual centers, QI, and benchmarking across collaborating centers. B
- Benchmark reporting that evaluates effectiveness of diabetes care measured against guidelines for standard practices can promote accountability and system wide improvements in diabetes care. C
- Involvement of governments, policy makers and health insurance providers facilitate provision of adequate resources that are required for high quality diabetes care. E

2.7 | Type 2 diabetes

- The main goals of T2D management include education for diabetes self-management, normalization of glycaemia, weight loss, promotion of physical activity and management of comorbidities and complications. B
- The aims of therapy in youth-onset T2D are to improve glycaemia, prevent acute and chronic complications, prevent metabolic decompensation, improve insulin sensitivity and provide exogenous insulin when necessary. C
- Like T1D, the process of ambulatory care for children and youth with T2D includes an outpatient follow-up every 3 months and an annual review of care. C
- Initial treatment of youth with T2D should focus on lifestyle modifications to decrease weight and may include metformin and/or insulin alone or in combination. B
- Blood glucose monitoring (BGM) should be individualized, with a frequency based on specific treatment, degree of glycemic management and available resources. HbA1c concentration should be determined every 3 months. C

2.8 | Glucose monitoring technologies in the ambulatory care

- Continuous glucose monitoring (CGM) data can greatly enhance the effectiveness of the ambulatory care visit, facilitates remote communication between the family and the diabetes care team, allowing for an effective teleconsultation, and promotes “shared decision-making”. C
- Clinicians should review the ambulatory glucose profile (AGP), available for most CGM systems. C
- Clinicians should focus on patterns and trends of glucose levels and less about single days. It is recommended that clinicians review 14 days of data for adequate decision-making. C

3 | INTRODUCTION

This chapter of the ISPAD Consensus 2022 Guidelines outlines recommendations for ambulatory diabetes care, including routine clinical assessments according to best current practice. Specific recommendations for certain elements of ambulatory care, including insulin therapy, monitoring of glycemic management, nutritional management, diabetes education, screening for and management of comorbidities and vascular complications, T2D, specific age groups, diabetes in school, and use of diabetes technology are addressed in detail elsewhere in the ISPAD guidelines, which should be consulted in conjunction with this chapter.

Diabetes is primarily managed in the outpatient or ambulatory setting, where all children with diabetes should receive specialized person-centered care from a multidisciplinary team, qualified to provide up-to-date pediatric specific education and support. The period following diabetes diagnosis and stabilization is a critical opportunity to commence education and preparation for outpatient care. Thereafter, regular, ongoing ambulatory diabetes care assessment should be provided throughout childhood and adolescence and be complemented with a well-supported program to facilitate transition to adult care at the appropriate time.

The overall goal of well-structured and high-quality ambulatory diabetes care for young people with diabetes is to promote high quality of life, normal growth and development, and prevent the risk of acute and chronic complications.

An investment in excellent diabetes care, particularly during childhood and adolescence, should be advocated globally and is likely to have a significant economic benefit.

The components of clinical care include structure, processes, content and outcomes and they are extensively discussed in this chapter. Structure of care describes how delivery systems are organized and financed; processes of care describe how care is delivered; content of care describes what is being delivered, including education and treatment that affect outcomes.¹ Intermittent critical re-examination of these components provides an opportunity to continually improve the

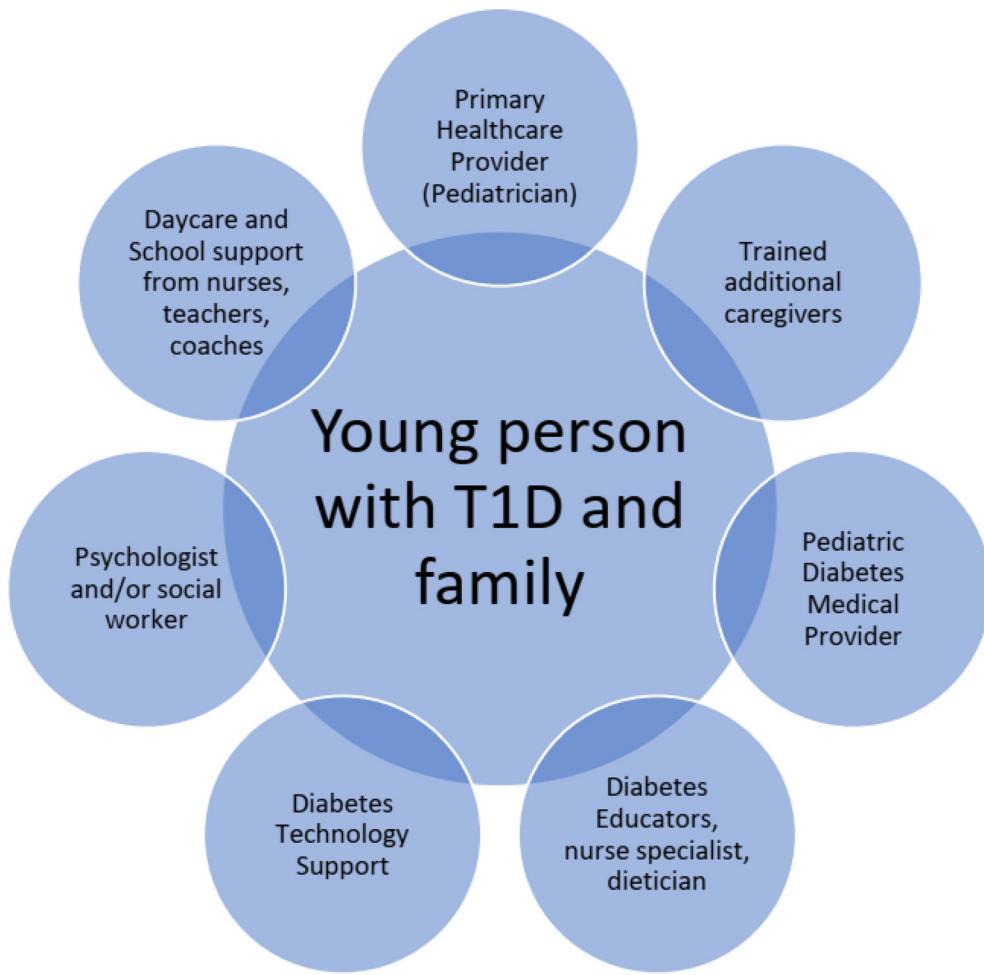


FIGURE 1 Structure of care: Person-centered pediatric diabetes care model. Diabetes care is best delivered by a multidisciplinary team with the youth with T1D and family at the center. The team should consist of a pediatrician specialized in diabetes or endocrinology (preferred), or physician/advanced nurse practitioner with a special interest (and training) in childhood and adolescent diabetes, diabetes nurse specialist or diabetes nurse educator, dietitian trained in pediatrics with knowledge of childhood diabetes and normal growth, psychologist trained in pediatrics and with knowledge of childhood diabetes and chronic illness, pediatric social worker with training in childhood diabetes and chronic illness. The team should regularly receive training and education on technology and have the resources to develop strong links, effective communication, and shared practices with primary healthcare providers, schools, and other essential caregivers.

quality of care delivered using available tools and resources. Because diabetes is a chronic condition, approaches to all aspects of clinical care will undoubtedly change over time.

This chapter aims to establish ideal guidelines for a comprehensive diabetes service. A dedicated *ISPAD 2022 Consensus Guidelines Chapter 25 on Management of Diabetes in Limited Resource Settings* is available separately to complement this guidance.

4 | STRUCTURE OF CARE

The structure of diabetes care delivery should support accomplishment of the following:

- Overall goals: To promote high quality of life, normal growth and development, a balanced approach to the psychological handling of a demanding chronic condition, early detection of co-morbidities and avoidance of severe short- and long-term complications.
- Individualized treatment plan: A glucose monitoring and insulin regimen that should, ideally, mimic physiologic insulin secretion to maintain healthy metabolism, and is in accordance with the treatment preferences of the child and family, which may change over time.

- Access to multidisciplinary diabetes expertise: Medical care providers, educators, mental and behavioral health resources that are available both during episodic visits and between encounters.

4.1 | Person-centered diabetes care

Diabetes care is complex and is best delivered by a multidisciplinary team of specialists with training and expertise in both diabetes and pediatrics, and knowledgeable about child and adolescent development. Diabetes self-management requires mastery of an extensive set of skills. Therefore, from diagnosis, it should be emphasized that the child and immediate family are the central members of the care team.² (Figure 1) The diabetes care team should have the resources to develop strong links, effective communication, and shared practices with extended family members or other care providers who play an important role in the child's diabetes care and may serve as a liaison between the child and the medical team, including school nurses, daycare staff, teachers, sports coaches, camp personnel, and others who care for children. Teams should be sensitive to language and numeracy barriers and information delivered with language appropriate

resources and pitched at relevant levels of understanding.³ It is important to review such knowledge and understanding on a regular basis at clinic visits.

Engaging directly with the young person with diabetes and their caregivers to gauge understanding and diabetes knowledge, health behaviors, goals, perceived benefits, and risks should be built into standard structures of care delivery. It is imperative to promote the understanding that the child retains his/her full prior potential to achieve goals physically and intellectually. Over time, continued engagement by the diabetes team with children as they mature, using developmentally appropriate educational tools, while recognizing that the child must be treated in the context of their existing psychosocial environment is essential. Effective and clear communication at all levels, between team and families and within the family structure are crucial predictors of early glycemic management and future psychosocial functioning.^{4,5}

It is important to empower children and families that diabetes is a condition that can be managed, rather than being defined by the condition ("the diabetic child" or "the sick child"), and to use language that engages and motivates children and families.³ This requires the multidisciplinary team to have a high level of cultural competence, avoiding shaming and blaming and stigma⁶ (#Language Matters campaign). Substitution of judgmental words (such as "uncontrolled", "non-compliant", "non-adherent") with neutral ones (like "time in range (TIR)", "higher HbA1c", "difficulties in", "troubles in") can lower anxiety, build confidence, and promote positive therapeutic relationships.^{7,8} Since people encounter various difficulties while managing their diabetes, the team should use language that supports a pathway to navigate challenges rather than underline mistakes. Labeling persons with diabetes with their condition ("the diabetic") increases stigma and may lead to unconscious discriminatory behaviors from the clinician. All these efforts are needed to increase treatment satisfaction and engagement, which are recognized factors impacting health outcomes.⁹

4.2 | Individualized diabetes care

The general aims of the diabetes care team should be to provide individualized diabetes care that best meets the needs of the child and family. This requires structured care delivery:

1. Aims of the diabetes care team:

- Ongoing diabetes education and self-management training.
- Up-to-date advice on insulin management, glucose and ketone monitoring techniques.
- Monitoring for comorbidities, complications, and risk factors for complications.
- Consistent articulation of individualized goals, such as HbA1c or CGM metrics.¹⁰
- Contact with other children and families with diabetes and support groups.

- Psychosocial screening and referrals to social worker or psychology as indicated.¹¹
- Providing families an opportunity to raise questions about information they may have obtained from the internet or other sources.¹²
- Current information on relevant research in diabetes.
- Ongoing training for the diabetes care team on technology and communication skills.
- Ongoing commitment to advancing clinical practice through the optimal application of existing and new technologies and the development and evaluation of new technologies.

4.3 | Diabetes team organization

The organization of the diabetes care team, its size, and composition will depend on local resources, geographical and demographic characteristics; indeed, there is significant variation worldwide.¹³ In general, for members of the pediatric diabetes team to obtain sufficient experience, the center should provide care to at least 150 children and youth with diabetes. The number of diabetes care providers depends on local circumstances; a suggested guide to optimal resource allocation per 100 patients is: 1.0–1.25 diabetes nurse, 0.75–1.0 pediatric diabetologist, 0.5 dietitian, 0.3 social worker/psychologist,¹⁴ which is similar to expert consensus recommendations provided by the international diabetes consortium SWEET peer recognition program. These staffing ratios should be sufficient to meet standards of care. It is recognized, however, that all clinics will not be resourced according to these recommendations. Clinics should be outfitted with digital diabetes data platforms capable of interfacing with cloud-based systems for blood glucose meters, continuous glucose monitors, insulin pumps, and insulin pens to enable glucose pattern review for decision-making at and between visits.

A multidisciplinary team is unlikely to be available in areas of low population density and where childhood diabetes rarely occurs. In these circumstances, care usually is provided by a local pediatrician or general (family) practitioner, who should have ready access, via electronic means of communication, to the diabetes care team at a regional center of excellence.^{15,16} Alternatively, teams from district or regional centers often organize outreach clinics to accommodate children and families living in remote areas. Adequate resources are needed to sustain such services.¹⁷ In some areas, two-way telecommunication utilizing video-computer technology or platforms for Voice over Internet Protocol (VoIP) and local medical staff to facilitate the telemedicine visit allows for efficient and effective distant care.^{18–21}

COVID-19 dramatically impacted care delivery; widespread use of telemedicine became more prevalent and enabled more efficient and effective distance care.^{22–24} Regarding telemedicine and data sharing from devices, awareness of current data protection rights and regulations is important. For example, the European Union's General Data Protection Regulation (<https://gdpr.eu/article-9-processing-special-categories-of-personal-data-prohibited/>) introduced in Spring 2018 may impact remote monitoring of people with diabetes devices

and telehealth; regulations vary between regions. In all cases, appropriate reimbursement must be available to support these essential non-face-to-face services in order to ensure that diabetes care team can afford to sustain provision of remote care to individuals with diabetes using these technologies.²⁵

5 | PROCESSES AND CONTENT OF CARE

It is important to maintain a framework which reassures the child and family that the child is able to live a normal and healthy life.²⁶ The importance of providing a good start with clear, positive messages, support, and advice, cannot be overemphasized. Setting appropriate expectations and empowering people with diabetes and parents with relevant and developmentally appropriate information is paramount. Generally accepted good clinical approaches for the successful management of children and adolescents with diabetes need to be practiced through the lifespan.

5.1 | Process of care following diagnosis

5.1.1 | Education and practical care guidance

- Depending on the severity of the symptoms and center organization, education should be started immediately after stabilization in either an in- or out-patient setting.
- Soon after diagnosis the child with T1D and caregivers should be provided with an age-appropriate and comprehensive diabetes education module that allows the self-management of diabetes in an outpatient setting (Box 1).
- The management of children who are metabolically stable following diagnosis and do not need admission to hospital, requires members of the diabetes care team to be experienced in outpatient initiation of insulin therapy, management, and education.

BOX 1 Modular age-appropriate education should include

- Insulin as a life-saving therapy
- In due course insulin adjustment, carbohydrate counting, and bolus advisors should be introduced
- Blood glucose monitoring and glycemic targets
- Role of technology in diabetes management
- Nutrition and healthy eating
- School and diabetes care
- Management of hypoglycemia and hyperglycemia
- Managing exercise and sports
- Sick day management
- Psychosocial support and adapting to living with diabetes

- It is important to create a partnership between the care providers and the child and family allowing for shared decision-making and a long-term relationship based on trust.

5.1.2 | Setting expectations

It is important to explain to the child and family the natural course of T1D from diagnosis. This includes the expected changes from a “catch up nutrition phase” with escalating insulin requirements and increased appetite, to the development of a “honeymoon phenomenon” when insulin requirements significantly decrease. The latter is important to highlight as it can frequently bring into question the diagnosis and need for insulin therapy. Revision of the diagnosis and differences between T1D and T2D is often helpful at this stage. It also allows for a conversation about the need for ongoing insulin therapy, regular home glucose monitoring, growth and development of the child with diabetes.

5.1.3 | Psychosocial support for the child and family

This includes identifying the members of the family who will provide care (e.g., one or both parents, a grandparent or another relative, or others) and ensure they receive the necessary education.

It is important to identify and address detrimental health beliefs (e.g., that diabetes is not contagious, and the child does not need to be segregated from other children). Written and/or pictorial age-appropriate materials should be provided in a format (e.g., paper pamphlets, booklets, electronic versions) and language the family understands. Such materials are readily available on several excellent websites of associations involved with pediatric diabetes care, including the ISPAD website (www.ispad.org), Life for a Child (<https://lifeforachild.org>), and Changing Diabetes in Children (<https://www.ispad.org/page/changing>).

5.2 | Outpatient care after diagnosis

After stabilization and provision of the education module, outpatient care should be well planned and expectations for contact and support clarified. The following approach is suggested (Box 2):

5.3 | Outpatient care follow-up

5.3.1 | The honeymoon phase

In the first months and up to 1 year after diagnosis, many children experience a partial, temporary remission (the “honeymoon” period) during which insulin requirements may decrease dramatically. Frequent contact with the diabetes care team is necessary to help

BOX 2 Outpatient care after diagnosis of T1D

Approach after diagnosis for youth and families:

- Introduce the diabetes team members and provide a clear follow-up plan
- Expectations for when and how to contact the on-call team (24 h a day)

Outpatient follow-up:

- An outpatient clinic review should occur every 3 months
- An annual review is recommended, which, in addition to routine care, should include screening for relevant comorbidities^a
- Screen for vascular complications in accordance with recommended guidelines^b

^a See ISPAD 2022 Consensus Guidelines Chapter 19 on “Other complications and associated conditions in children and adolescents with type 1 diabetes”.

^b See ISPAD 2022 Consensus Guidelines Chapter 18 on Microvascular and macrovascular complications in children and adolescents.

manage the changing insulin requirements typical of the early phases of diabetes. Contact may occur through frequent clinic visits, telemedicine, telephone, text messaging, home visits or other methods of communication. Depending on local circumstances, contact often occurs through a combination of these methods. Insulin treatment should not be discontinued even if the insulin requirement is very low and continued regular glucose monitoring should be encouraged. It should be emphasized to the family that it is a temporary phase, and not a “cure”, and that insulin requirements will gradually increase over time. A prolonged “honeymoon” period lasting more than 1 year during which insulin requirement remains ≤ 0.5 unit/kg/day should raise consideration of monogenic diabetes and genetic testing should be considered if pancreatic antibodies were negative.²⁷

5.3.2 | Mental and psychosocial health

Screening for a cognitive or mental health disorder soon after diagnosis will identify individuals (either child or caregiver) who may require greater support to adhere to treatment and self-care. A total of 5%–10% of all children suffer from a neurocognitive disorder and at least 2% from a psychiatric disorder. The combination of a cognitive or mental health disorder with diabetes or the presence of a psychiatric disorder in a parent/caregiver increases the likelihood of inadequate or incorrect self-care.²⁸ These individuals need special attention and treatment.

5.4 | The outpatient visit

It is standard practice for the diabetes care of children and adolescents to be reviewed in an outpatient clinic (face-to-face or remotely) every 3 months, and more often if difficulties in managing diabetes are recognized, or the child is very young (*Please refer ISPAD 2022 Consensus Guidelines Chapter 23 Managing diabetes in preschoolers*). Multidisciplinary team consultation should be available at each visit if required (e.g., nutrition or psychology consultation).

Outpatient and/or telehealth visits with members of the diabetes care team should include an interval history and assessment of the following:

5.4.1 | Diabetes management review

- Self-management skills
- Assess hypoglycemia history including determination of hypoglycemia awareness, method of treating hypoglycemia and access to glucagon.
- Engagement and management of glucose data: enabling the young person and their caregiver(s) to use and upload data from the available technologies including BGM and CGM to cloud systems. Promoting and enabling them to understand and synthesize the information to alter and improve their diabetes management behaviors. Required skills for this to occur include:
 - i. Understanding of relevant targets including TIR and HbA1c.
 - ii. Ability to connect and upload device data to cloud systems at home.
 - iii. Analysis of home glucose monitoring data (BGM from glucose meter readings, real time CGM (rtCGM), “intermittently scanned” CGM (isCGM), urine glucose/ketone monitoring, symptoms of nocturia and hypoglycemia).
- When using BGM and a cloud system is not available, check glucose values stored in the glucose meter memory for accuracy of information reported by parents/child.
- Have an open, non-judgmental dialogue when there are concerns about accuracy of data provided if inconsistent with overall glycemic management measured with a reference method of HbA1c. Exclude technical reasons for inconsistencies including glucometer/CGM malfunction (e.g., expired or improperly stored test strips, poor testing technique, wrong code).

5.4.2 | Intensive insulin therapy

Intensive insulin therapy consists of multiple daily injections (MDI) and insulin pump therapy (continuous subcutaneous insulin infusion – CSII). Young people with diabetes and their families need to be familiar with and able to manage their prescribed insulin therapy. Insulin types, doses, and injection/insulin delivery devices, adequacy of storage and transport of insulin, injection technique should be reviewed regularly. Insulin adjustments for glucose values, food, and exercise

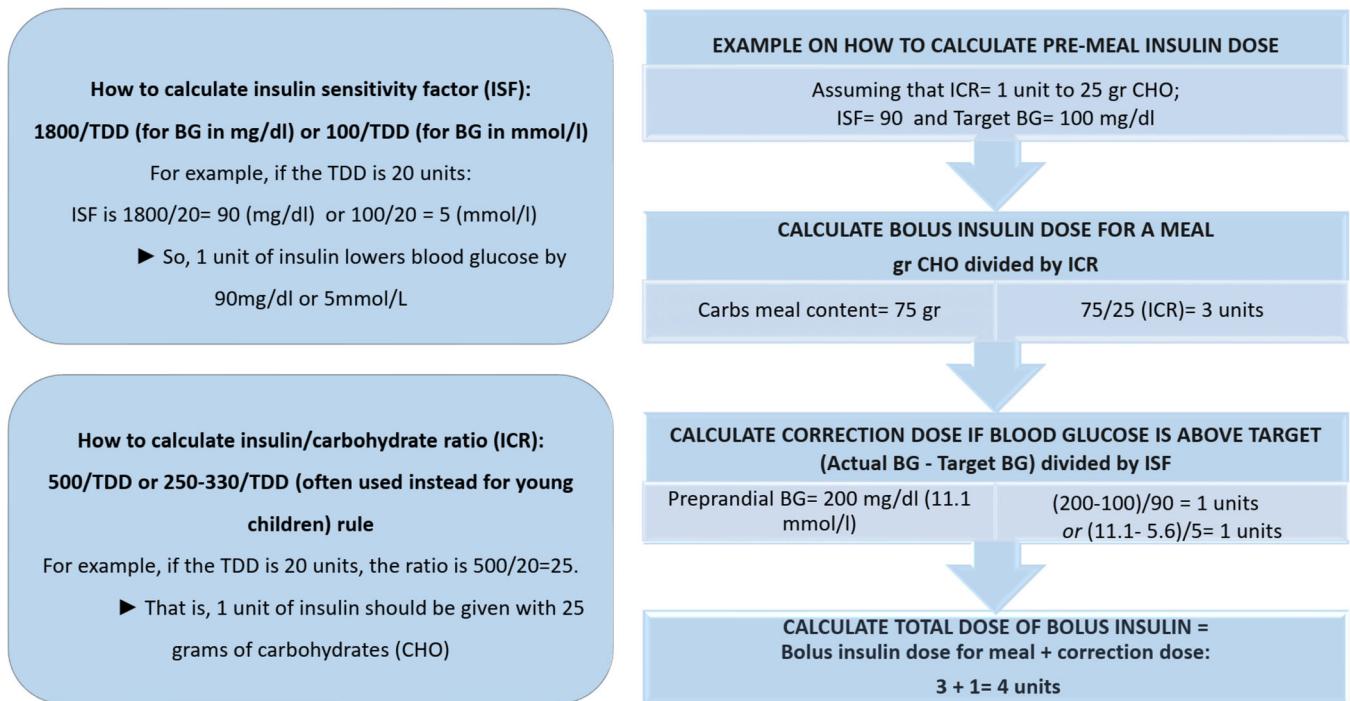


FIGURE 2 Insulin/carbohydrate ratio (ICR) and insulin sensitivity factor (ISF)

are an essential part of the discussion with families. (Figure 2) (see ISPAD 2022 Consensus Guidelines Chapter 9 “Insulin treatment in children and adolescents with diabetes”)

- MDI: familiarity with the concepts of carbohydrate counting, insulin to carbohydrate ratio and insulin sensitivity (correction) factors need to be reinforced and reviewed at every visit. More recently, the use of Application (Apps) based bolus calculators has proliferated and are widely and freely available. Adoption of a consistent system by the diabetes team helps to implement and educate about the use such systems.
- Pump therapy: CSII, sensor augmented CSII and hybrid closed loop systems. Several insulin pump (CSII) delivery system platforms are commercially available. Recently the use of hybrid closed loop systems has become more widespread (see ISPAD 2022 Consensus Guidelines Chapter 16 “Technology: Glucose monitoring”; and Chapter 17 “Technology: Insulin Delivery”). Regardless of the specific pump being used, review of “back up” basal rates should occur regularly, particularly in adolescents during rapid pubertal growth. Optimization of insulin to carbohydrate ratios, insulin sensitivity (correction) factors and glucose targets should also occur at each visit in order to optimize algorithm adjustments. Disconnection doses and management of pump failure should be reviewed at each visit to ensure safety and clear procedures are in place in the event of device failure.

5.4.3 | General health and well-being

- History of intercurrent health problems such as infections, enuresis/nocturia, diabetes-related emergency and hospital/emergency

department visits, and other pediatric and developmental problems).

- Review of all current medications and supplements including medications from alternative medicine sources, and herbal preparations.
- Systems review with particular attention to symptoms relevant to associated comorbid conditions. In the presence of symptoms or signs, given the predisposition to autoimmune conditions, additional evaluation may be indicated (coeliac disease, autoimmune thyroiditis, adrenal insufficiency).
- New health conditions, including disordered eating behaviors and/or changes in dietary preferences (e.g., adopting a vegan or very low carbohydrate, ketogenic diet).
- Changes in developmental performance, education (particularly school absences or behavioral problems), leisure and sport activities, and psychosocial status.

5.4.4 | Physical examination

- Height, weight, body mass index (BMI) and pubertal status (data recorded and tracked on appropriate growth charts, on which mid-parental height is marked). Weight status can give a general indication of glycemic management, with weight loss and/ or delayed puberty suggesting poor glycemic management.
- Blood pressure with reference to age-appropriate normal levels.
- Oral mucosa and dentition (for dental caries, gingivitis)
- Thyroid gland, cardiac, and abdominal (for hepatomegaly) examinations, feet examination (for corns, ingrown toenails and other lesions) as well as neurological function test (e.g., light touch, vibration sense).

TABLE 1 Screening and prevention guidelines for routine pediatric and adolescent diabetes visits.

| | Evaluation | Type 1 diabetes | Type 2 diabetes |
|-----------------------------|--|---|---|
| Glycemic Management | HbA1c Glucose values from meter, log, or CGM AGP report for TIR, TBR, TAR | Quarterly at each visit At each visit and in between visits as needed for insulin dose adjustments | |
| Cardiovascular risk factors | Blood pressure Smoking status Lipids | Every visit Every visit Discourage smoking in youth who do not smoke and encourage smoking cessation in those who do Begin ≥11 years; if normal results are obtained; repeat every 3 years. | Begin after glycaemia control or after 3 months of diagnosis; repeat annually |
| Microvascular complications | Kidney disease: urine albumin: creatinine ratio Retinopathy: dilated eye exam Neuropathy: comprehensive foot exam | Start at puberty or from age 11 years, whichever is earlier, after 2–5 years diabetes duration; repeat annually for kidney disease and neuropathy; every 2–3 years for retinopathy | Begin at diagnosis; repeat annually |
| Autoimmune screening | Thyroid function: TSH, total or free T4 and thyroid autoantibodies Celiac screening (TTG-IgA, if IgA normal) Addison's disease (primary adrenal insufficiency), autoimmune hepatitis, autoimmune gastritis, dermatomyositis, and myasthenia gravis | At or near diagnosis; Every 2 years: TSH (sooner if positive thyroid autoantibodies at diagnosis or with symptoms) At or near diagnosis; repeat at 2–5 years intervals (sooner if symptomatic or first degree relative with celiac disease) As clinically indicated | N/A N/A N/A |
| Psychosocial screening | Diabetes distress, depression, disordered eating | Begin shortly after diagnosis; routinely (at least annually) | |
| Anticipatory guidance | Pre-conception counseling, risk-taking behaviors, transition to adult care | Pre-conception counseling for girls of childbearing potential. Discussion about risk-taking behaviors and preparation for transition to adult care can begin in early adolescence and be revisited at least annually | |

- Skin, particularly at the insulin administration and glucose monitoring sites, catheter insertion, for evidence of lipohypertrophy, lipoatrophy, infection or skin reactions to adhesives used for sensors and patch pumps. Providers should reinforce the need for rotation of sites for injection, catheter or sensor. Also note presence of acanthosis nigricans, suggestive of insulin resistance, and in girls, of acne or hirsutism, which may be indicative of polycystic ovarian syndrome.

5.4.5 | Laboratory assessment, particularly HbA1c every 3 months

5.5 | Annual review visits

It is good practice to provide an annual review, which includes the above-described routine outpatient assessment and screening for

complications as per guidelines in *ISPAD 2022 Consensus Guidelines Chapter 18 on Microvascular and macrovascular complications in children and adolescents* and summarized in Table 1. The main components of the annual review visit are:

- Expanded physical development with particular emphasis on growth and pubertal development.
- Additional diabetes self-management assessment (e.g., exercise, nutrition and sick-day rules)
- Any new pertinent family history (e.g., new diabetes or other endocrine diagnoses, cardiovascular events/diagnosis).
- Discuss new aspects of diabetes management including diabetes technology
- Consider expanded review of the nutritional plan and dietary management by a dietitian. Parents may be encouraged to bring a food diary recording the last few days' diet to inform the consultation about individualized dietary advice.
- Consider expanded review of physical activity and insulin dose adjustments made to manage exercise.

- Psychosocial assessment that includes screening for depression and disordered eating, household structure (e.g., single vs. two-parent, joint families, sibling issues, household stability, marital stress, parental support), bullying or discrimination at the home, school or workplace.
- Assessment by a psychologist or social worker of the family's and child's adjustment to diabetes and age-appropriate transfer of responsibility for self-care to the older child/adolescent.
- Determination of barriers to successful diabetes management including needle phobia, fear of hypoglycemia (parent and child), and financial challenges (see section below)
- Education concerning the need for routine dental care. Suboptimal glycemic management in children and adolescents has been associated with higher salivary glucose levels and more dental caries.²⁹
- For adolescents, guidance around safe driving, effects of tobacco, alcohol, marijuana and other substances on glycaemia and long-term health, sex, contraception and preconception counseling. It is appropriate to request parents/caregivers to wait in another room so that these topics can be discussed privately with the adolescent, and to allow the adolescent an opportunity to practice speaking directly to their provider.
- For adolescents and young adults, preparation for transition
- Assessment of understanding of risks for complications and care plans to minimize these risks.
- Screening for co-morbidities and complications. (see Table 1). This includes screening at regular intervals for thyroid dysfunction and celiac disease in asymptomatic children. In some settings, consider obtaining a hemoglobin or hematocrit, as anemia is common and could be nutritional, pernicious anemia, associated with hypothyroidism or celiac disease, or due to menorrhagia. In the presence of additional risk factors, such as family history of dyslipidemia, additional testing and/or intervention may be indicated. (see ISPAD 2022 Consensus Guidelines Chapter 19 on "Other complications and associated conditions in children and adolescents with type 1 diabetes").

6 | OUTCOMES OF OUTPATIENT CARE

The outcome of each visit should include:

- An individualized plan of diabetes care that includes:
 - i. Updated specific insulin-to-carbohydrate ratio and insulin sensitivity (correction) factor for insulin dose calculations and BGM targets
 - ii. Particular needs of each child/ adolescent and family to optimize the child's diabetes outcomes (e.g., exercise, nutrition, sick days management)
- A written copy of the plan is provided to the family after the visit, including results of HbA1c measurement (including individual HbA1c target) and screening tests for comorbidities/complications.
- Identification of behavioral goals for the upcoming interval. Motivational discussion including the family's and child's understanding of general treatment goals and an understanding of the medical

rationale behind these, for example, good glycemic management is associated with better quality of life and lower risk of microvascular and macrovascular complications. Because children and adolescents are insufficiently cognitively mature to be concerned about health problems in the distant future, emphasis on immediate benefits of good control (feeling better, improved academic and physical performance) may more effectively drive behavioral change.

7 | TYPE 2 DIABETES

7.1 | Structure of care

Management goals include education for diabetes self-management, normalization of glycaemia while minimizing hypoglycemia, weight management, dietary changes, increase in physical activity and exercise capacity and control of comorbidities and complications, including hypertension, dyslipidemia, nephropathy, sleep disorders, and hepatic steatosis.

Education should be delivered by team members with expertise and knowledge of the unique dietary, exercise, and psychological needs of youth with T2D. The education and treatment team for T2D ideally should include a pediatric diabetologist, nutritionist, psychologist and/or social worker, and exercise physiologist. Education in T2D places greater emphasis on healthy lifestyle habits including behavioral, dietary and physical activity changes than is generally required for T1D, and should be provided in a culturally sensitive and age-appropriate manner.

Lifestyle change is the cornerstone of treatment of T2D and clinicians should initiate a lifestyle modification program for children and adolescents at the time of diagnosis of T2D.³⁰ The interventions include promoting a healthy lifestyle through behavior change, including nutrition, exercise training, weight management, and smoking cessation.

The entire family will need education to understand the principles of T2D management and the critical importance of lifestyle changes for the entire family to successfully manage a youth with T2D.

7.2 | Processes and content of care of T2D

The aims of therapy in youth onset T2D are to improve glycaemia, prevent acute and chronic complications, improve insulin sensitivity and endogenous insulin secretion, restore normal glucagon and incretin physiology, and provide exogenous insulin when necessary. The choice of therapeutic approach should also consider the effect on comorbidities and cardiovascular risk.

7.2.1 | At onset

- The importance of providing a good start with clear, positive messages, support, and advice, cannot be overemphasized. As for T1D, easy access (24 h a day) for rapid diagnosis and initiation of treatment with availability of written protocols, provision of practical

care guidance at diagnosis, and creating a partnership between the care providers and the child and family allowing for shared decision-making.

- Providing psychosocial support for the child and family, assessing resources and potential barriers to adjustment to the diabetes diagnosis are some of the measures that the diabetes team should also initiate.
- Written and/or pictorial age-appropriate materials should be provided in a format (e.g., paper pamphlets, booklets, electronic versions) and language the family understands. Unfortunately, such material is not readily available for children with T2D compared to T1D. Some of the materials are available at TODAY public website (portal.bsc.gwu.edu/web/today) and as an ADA program called Be Healthy TODAY; Be Healthy for Life (<http://www.diabetes.org/living-with-diabetes/parents-and-kids/childrenand-type-2/>)
- Initial treatment of youth with T2D should include metformin and/or insulin alone or in combination. The specifics of the initial treatment modality are determined by symptoms, severity of hyperglycemia, and presence or absence of ketosis/ketoacidosis (see ISPAD 2022 Consensus Guidelines Chapter 3 on Type 2 Diabetes).

7.2.2 | Subsequent management of T2D

- The goal of initial treatment should be to attain an HbA1c of less than 7.0% (53 mmol/mol) and in some situations <6.5% (48 mmol/mol).³¹ This can usually be accomplished with metformin and basal insulin, alone or in combination. Use of other oral or injected agents known to be effective in adults with T2D may be beneficial for youth with T2D in addition to, or instead of, metformin and insulin. Liraglutide has been shown to be effective and safe for use in adolescents with T2D aged 10–17 years and has been approved for use since June 2019.³² (Please refer ISPAD 2022 Consensus Guidelines Chapter 3 on Type 2 Diabetes)
- Blood glucose monitoring should be individualized, with a frequency based on specific treatment plan, degree of glycemic management and available resources. More frequent monitoring is required during acute illness or when symptoms of hyper- or hypoglycemia occur. HbA1c concentration should be determined every 3 months.

Literature to support the use of CGM in youth onset T2D is limited.³³ In the research setting, CGM has also been used as a tool for studying potential differences in the causes of insulin resistance in T2D youth, with CGM-detected hyperglycemia being correlated with increased insulin resistance.³⁴ Given the greater burden of disease in youth with T2D, further studies are required to identify whether intermittent use of CGM may lead to glycemic improvements and how best to use the device (who may benefit, how often to prescribe and when) to inform therapeutic recommendations in this age group.

7.2.3 | Ongoing diabetes care

- Similar to T1D, the process of ambulatory care for children and youth with T2D includes outpatient follow-up every 3 months

and an annual review of care (Table 1). C (see ISPAD 2022 Consensus Guidelines Chapter 3 on Type 2 Diabetes)

8 | GLUCOSE MONITORING TECHNOLOGIES IN THE AMBULATORY CARE

8.1 | Practical approach to CGM users and diabetes teams

CGM should be considered for all children with T1D who are on intensive insulin therapy. CGM (rtCGM and isCGM devices, e.g., Freestyle Libre) offer significant advantages over fingerstick BGM. rtCGM should be worn nearly continuously and isCGM should be scanned at least once every 8 h, and more frequently for T1D, in order to use the information well. All CGMs can provide auditory and vibratory alerts when glucose levels exceed or are predicted to exceed high or low pre-selected thresholds, or when glucose levels rapidly rise or fall. These alert settings should be discussed, as unnecessarily tight settings may lead to excessive alarms, leading to alarm fatigue and/or anxiety for children or their caregivers. CGM systems display trend arrows in addition to glucose values. Insulin dosing can be anticipatorily adjusted based on the direction and angle of the arrow, which indicate rate of change. Earlier approaches included increasing or decreasing insulin doses by 10%–20% based on how quickly glucose levels were changing.³⁵ Newer guidance suggests a specific number of units to increase or decrease based on the individual person's correction factor.³⁶ While these algorithms may be helpful for some children and families, it is unknown how much this improves glycemic management in children.

Integration of CGM into diabetes care requires an additional level of education, as well as time and effort from the child/adolescent, family, and diabetes care team. Data from CGM systems can greatly enhance the usefulness of the ambulatory care visit. Glucose monitoring device data (either from BGM meters or CGM meters) can be downloaded onto the family's home computer or uploaded to the manufacturer's web platform for family review and for transmission electronically to the diabetes care team before routine ambulatory care visits or when families require advice on management. This facilitates the contact between the family and the diabetes care team, allowing for an effective teleconsultation and promoting "shared decision-making".

Most CGM systems have similar versions of the AGP, which is a standardized glucose report that allows for visualization of daily curves of glucose, median (50%) glucose values and percentage of TIR, time below range (TBR) and time above range (TAR) for the reported period (Figure 3). Clinicians should focus on patterns of glycaemia, and less about single days. It is recommended that diabetes clinicians review 14 days of data for adequate decision-making,³⁷ which can either be done ahead of time if the person with diabetes downloads their device at home, or can be done at the time of the clinical visit.

The CGM data should be reviewed in consultation with the family to promote a shared decision-making approach and a learning opportunity for the family on how to interpret data themselves.

Example of an Ambulatory Glucose profile (AGP)

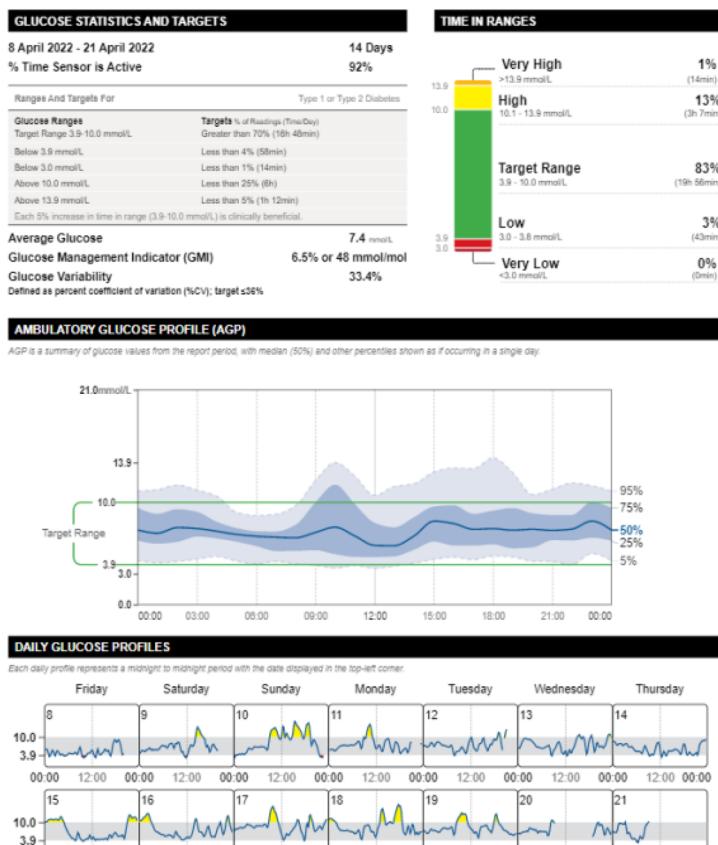


FIGURE 3 Ambulatory glucose profile (AGP)

Typically, patterns of hypoglycemia should be addressed first with insulin dosing adjustments or behavioral instruction (counting carbohydrates, timing of insulin doses). Thereafter, patterns of hyperglycemia should be evaluated, and potential causes identified and addressed. In general, clinicians should consider making 1 or 2 dosing or behavioral changes at a time, as too many changes may confuse the family or lead to new unintentional effects on glucose patterns.

(Please also refer to ISPAD 2022 Consensus Guidelines Chapter 16 “Technology: Glucose monitoring”).

9 | TELEMEDICINE AND TELEHEALTH

Telemedicine and telehealth can be described as the use of telecommunications to deliver health services, including interactive, consultative, and diagnostic services.^{38,39} The most used approaches are virtual visits via video, telephone, or live chat. Telehealth also includes chat-based interactions to transmit health data to healthcare providers to review and deliver a consultation, diagnosis, or treatment plan.³⁹ Other approaches are remote monitoring and technology-enabled modalities, for example, physician-to-physician consultation and diabetes education to the families.³⁹

AGP report is displayed for 14 days of sensor wear

Time in Range Recommendations

- > 70% of readings between 3.9-10.0 mmol/L (70-180mg/dl)
 - < 4% of readings < 3.9mmol/L (<70mg/dl)
 - < 1% of readings < 3.0mmol/L (<54mg/dl)
 - < 25% of readings > 10.0 mmol/L (>180mg/dl)
 - < 5% of readings > 13.9 mmol/L (>250 mg/dl)

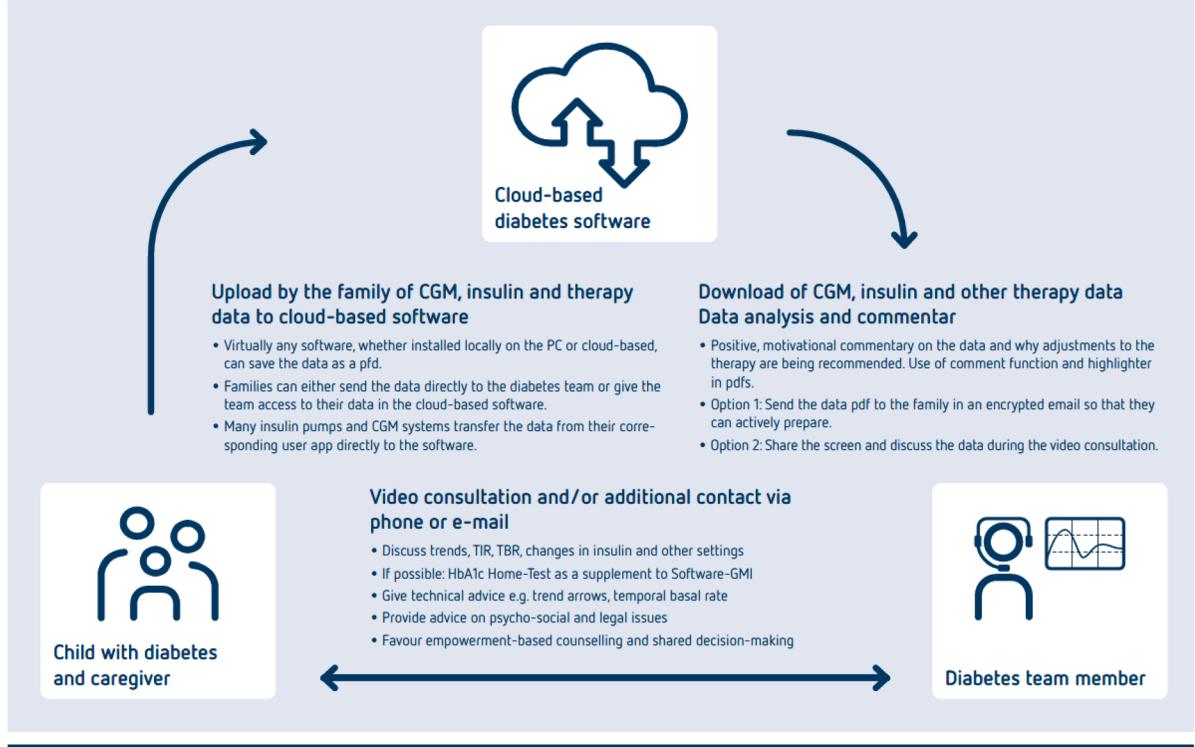
- Blue line: is the median **the median** glucose of that particular hour of the day
 - Dark blue area indicates the interquartile range or 50% of all values**(area between the 25th and 75th percentiles)**
 - Lighter blue area **(between the 10th and 90th percentile lines)** indicate that only 10% of glucose reading are above or below that values

9.1 | Evidence for feasibility and positive results

Diabetes is well-suited for telemedicine given that the individual's treatment data can be recorded and shared electronically. Recent studies have shown that video consultation is feasible for diabetes clinic visits⁴⁰⁻⁴² and psychosocial counseling in young adults with diabetes⁴³ (Figure 4A). The care concept of the diabetes clinics in the Netherlands, for example, has shown for many years how in-person care for children supplemented by multiple contacts via video, telephone, and email can improve the outcome of children with diabetes.⁴⁴ Some qualitative studies^{45,46} have reported high levels of satisfaction with telemedicine use among study participants and diabetes care team members, as telemedicine visits can help to overcome barriers related to time and travel distance and offer increased flexibility, feeling of security and more frequent appointments for families. Nevertheless, the level of telemedicine that can be achieved is highly dependent on the infrastructure available and affordability of smartphone/internet technology.

Historically, ambulatory diabetes care has taken place primarily as face-to-face consultations in a diabetes outpatient clinic. However, the organizational design of ambulatory care for children and adolescents with diabetes depends on many factors, including the ratio of diabetes providers for the number of children requiring care in a region and the size of the catchment area. Depending on

(A) Video visits for children with diabetes



(B) Step by step tutorial: incorporating video consultation into long-term outpatient care

1. Preparation

1. Ensure that families have the required equipment (smartphone, or computer with camera and microphone) and diabetes software. Instal professional video chat software for the team.
2. Discuss appropriate data protection measures
3. Test of hardware and software
4. Provide information for families on how to upload diabetes data and how to use the video chat program
5. Clarify financing of video consultations as a supplement or replacement for outpatient consultations

2. Integration

1. Define type of integration into previous outpatient care: Video consultation can be offered as an occasional replacement, as a regular replacement with higher frequency of appointments in the Virtual Clinic, or as an Add-on to supplement regular outpatient consultations
2. Define target groups e.g. younger children for Add-on or children with AID systems, children with good or suboptimal metabolic control, or children living far away from the diabetes team, for preferable treatment in a Virtual Clinic
3. Explain to families the new mix of in-person and virtual appointments and its advantages, but also the tasks for parents (uploading data, keeping appointments, switching to phone call in case of technical problems)

3. Process

1. How can patients register for video consultation?
2. Which team members will perform video consultation?
3. What will be the duration/timing of the appointments? If the objective is to make small adjustments to the therapy, then more frequent, but shorter, sessions are a good option.
4. Should families view the data pdfs before the video appointment? Preliminary work on CGM data by parents and young adults is desirable, but it takes time for healthcare professionals to pre-send the data pdf with comments

4. The video consultation

1. Prepare the data PDF (if not already done): Highlight GMI, TIR, Tab, TBR and improvements (e.g. infusion set changes, number of injections) and identify the „best days“ when metabolic control was very good
2. Check camera position (should be at eye level) and background
3. Explain curves, trends and statistical measures, mention successful days and actions and discuss issues needing attention
4. Discuss the insulin setting
5. Schedule a new appointment

Postponed and missed appointments: call the family and investigate the reasons for not responding

FIGURE 4 (A) Video visits in detail. (B) Video-consultation step by step

the clinic resources and the individual patient's circumstances, it may not always be possible for each individual to achieve the minimum of one in-person visit with the diabetes care team every 3 months.

Telemedicine may provide an opportunity to explore the promotion of equitable care; however, limited access to hardware and software required for video consultations may conversely exacerbate inequities. Taking into account available staff and time resources, it

may also be important to consider whether more frequent but shorter video consultations may allow for better use of existing resources.

9.2 | Two models of telemedicine and telehealth

A typical synchronous (live and interactive) video consultation can offer a virtual environment that is comparable to the outpatient clinic experience through image and audio transmission. The prerequisite for effective video consultation is the transmission and joint viewing of data that include BGM or CGM, as well as information about insulin administration and meals. The storage and graphical presentation of CGM, insulin pump, insulin pen and other data in cloud-based software has made virtual review of therapy data feasible before, during, and after a video consultation. In comparison, asynchronous telemedicine is time-delayed communication, often via email or an electronic medical record portal, between health care providers and persons with diabetes. People with diabetes and their families can contact their care team between clinic visits and then receive feedback in a defined time window.

9.3 | Requirements for implementation of telemedicine

Appropriate staffing models to support video consultations and processes of care to support billing and prescription issues for telemedicine visits need to be clarified and established. This could involve both information technology (IT) support as part of the team and/or team training in technology literacy. Interventions and challenges for restructuring of a diabetes outpatient clinic to successfully include telemedicine and video consultation were assessed especially during the COVID-19 pandemic.^{23,47,48} A first important step is to ensure that individuals with diabetes can actively upload their data to a diabetes software and receive technical help, if necessary. Passive data upload and sharing may be available once an app has been linked to the software account. It will be necessary to revise the outpatient care workflows, provide video contacts, and redistribute roles and responsibilities (Figure 4B). To enhance the efficiency of telemedicine, it will be important to overcome the issue of interoperability of the different software solutions, which often do not allow data from different medical devices to be merged.

An advantage of telemedicine is the use of mobile health products (e.g., apps), emails or short text messages to allow extra contacts with families. In the past few years, telemedicine has proven to be feasible for diabetic retinopathy screening using digital photographs of the fundus, which are forwarded and analyzed by a distant eye-care specialist/ophthalmologist. In a meta-analysis, the accuracy of telemedicine retinopathy screening was high.⁴⁹ In a recent study, the use of a non-mydriatic camera in the diabetes outpatient clinic has been a suitable option to implement retinopathy screening recommendations in the pediatric outpatient appointment.⁵⁰

Telemedicine services can be an excellent addition to the ongoing outpatient care of children and adolescents with diabetes, by providing an increased frequency of counseling contacts and various additional modes of contact with or access to online diabetes education or expert advice, when needed (Figure S1).

As a result, telemedicine can play an important role in improving access to health care, if a family is equipped with internet access and the requisite diabetes technology and software to record data and share data.

10 | TRANSITION TO ADULT CARE

T1D is commonly diagnosed in childhood but requires lifelong medical care involving both pediatric and adult healthcare systems.^{51,52} Planned transition between pediatric and adult health care is a purposeful process over time⁵³ distinguished from transfer of care, which is a discrete point at which the provider or care setting changes. Both transition preparation and transfer between health systems occur in parallel with the broader developmental task of moving from adolescence to adulthood. Emerging adulthood (late teens through mid-twenties) is recognized as an interval marked by increasing independence and exploration of educational, vocational, social, and financial challenges and opportunities.⁵⁴ For emerging adults with diabetes, this developmental stage is often also associated with increasing responsibility for self-management as parental involvement in diabetes care and oversight decreases.⁵⁵ Emerging adults may also have a developmentally normative sense of invulnerability, where one discounts risk to future health.⁵⁶ Therefore, even though transition is an expected process as adolescents age out of pediatric care, the challenge of integrating increased responsibility of diabetes management occurs in the broader context of competing life priorities, which may contribute to lapses in care and deterioration of glycemic management often observed in this population.^{57–60}

Reports from centers in different countries, including those with universal health insurance systems, demonstrate that between 25% and 65% of young adults experience gaps between pediatric and adult diabetes care for significant periods of time^{61–63} and express dissatisfaction with the transition experience.^{64–66} Adverse diabetes-related outcomes, including suboptimal glycemic targets, increased diabetes-related hospitalizations post-transfer, emergence of chronic diabetes complications and premature mortality have been widely reported.^{67–71}

In response, clinical guidelines and a growing body of literature recognize the significance of planned transition from pediatric settings to adult receivership models for emerging adults with diabetes to mitigate the risk of adverse outcomes.^{51,52} Anticipatory guidance and identification of modifiable factors, such as transition readiness, self-management skills and psychosocial supports, can promote higher levels of success as indicated by individual-reported satisfaction with care,^{58,72,73} effective self-management post transfer, and decreased gaps in care.^{74,75} Discussion about transition to another care team or diabetes care provider at multiple visits before transfer occurs helps

young people prepare for transition.⁷⁶ In addition, providing counseling on how care and practices may differ in adult clinics may be helpful to teens.⁵⁵ Peer mentoring can be effective to share experiences and organize ways to overcome social barriers to diabetes care that may not be addressed in a medical context.⁷⁷

A 2011 joint consensus statement,⁷⁸ along with related resources from Got Transition/Center for Health Care Transition Improvement (www.gottransition.org), set forth specific health care system recommendations and guidelines for planning the transition from pediatric to adult care that include establishing: (1) clinic transition policy; (2) mechanism for tracking persons with diabetes; (3) readiness assessment to identify individual-specific health care needs; (4) longitudinal transition planning; (5) facilitated transfer of care process; and (6) successful transfer completion confirmation. In parallel, recommendations for successful adult receivership include communication between providers, reassessment of knowledge and skills after transfer to adult care, establishing new trusting relationships, addressing psychosocial needs, and a team-based approach.^{79,80} A joint effort sponsored by several organizations including ISPAD provides a tool kit of ready to use resources for transition preparation and successful transfer of care available online: (<https://www.endocrine.org/improving-practice/transitions#t1d>).

There are methodological challenges to systematically evaluate the impact of transition interventions and compare outcomes, based on heterogeneous models of pediatric and adult care (Figure 5A). The age and process of transfer to an adult clinic varies by location and health care delivery system, and is influenced by local practices and resources, young people with diabetes and family preferences, and national policies. Descriptive reports of transition programs, systematic reviews of the literature, and clinical trials^{81–85} provide insights into existing models and evidence. There are several reported processes for transition between pediatric and adult care, outlined in Figure 5B.

- Structured transition programs that include developmentally tailored diabetes education, case management, and clinical care have demonstrated proof of concept in improving glycemic outcomes and health care utilization among young adults previously with a history of or risk for lapses in care.^{83–87}
- Programs featuring transition coordinators, or “patient navigators” decrease post-transition gaps and improve post-transition clinic attendance and have reduced DKA rates. The role of navigator may be a community health coach, social worker, or diabetes nurse, whose role is to coordinate setting up appointments, address transportation or financial barriers, and make phone calls to confirm successful transfer.^{88–91}
- There are established models that provide case management for the adolescent during a transition process that lasts at least 1 year (www.btp-ev.de).⁹²
- Physician continuity between pediatric and adult health care systems can provide a level of familiarity to ease changes in health care settings. Joint attendance of pediatric and adult diabetes care providers at the last pediatric clinic visit and first adult clinic appointment may be beneficial, although this is not always feasible.

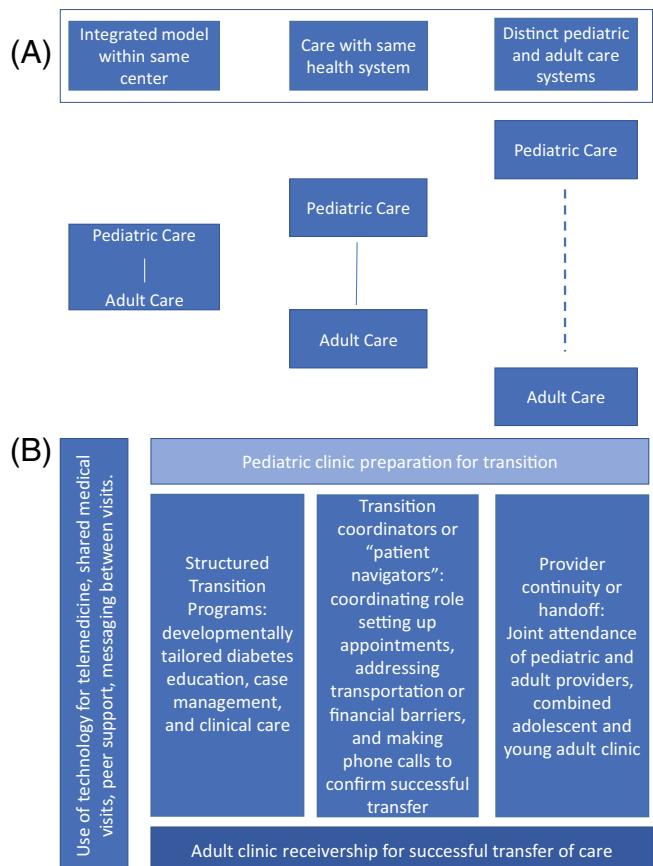


FIGURE 5 (A) Transition models to adult care: Transition models vary in physical proximity, sharing of medical records, and care providers (as indicated by distance and solid or dotted lines in model). Strategies for building connections between pediatric and adult diabetes providers needs to be tailored to local contexts.

(B) Transition process to adult care

- Alternatively, a combined adolescent/young adult clinic with both pediatric and adult diabetes specialists has been proposed as an optimal model of transition to adult care.^{93–95}
- Innovative uses of technology including telemedicine and shared medical appointments can simultaneously reduce barriers to in-person visits and provide peer support.^{96–98} Web-based and text messaging interventions have also been used to engage adolescents with chronic conditions between visits.^{99,100} As COVID-19 has catalyzed the use of telemedicine, uptake of video telehealth visits has been increasingly tested in the setting of adolescent care.
 - Adult providers play an essential role in caring for emerging adults with diabetes by receiving them from pediatric care and maintaining health throughout the lifespan. Adult receivership practices should be in place to facilitate ongoing education, clinical support, and promotion of self-management initiated in pediatric care.^{79,80}

In summary, when moving between pediatric and adult health systems, emerging adults have to balance the demands of self-management with competing life priorities, which contribute to a risk for deterioration of glycemic management with associated increased

mortality and morbidity. Based on available evidence and clinical recommendations, a planned, structured transition approach is multi-faceted with elements of longitudinal preparation in pediatric care, active engagement by persons with diabetes and their families in readiness assessments, psychosocial evaluation and interventions, peer support, health navigation guidance, communication between providers, and adult receivership clinics. There is an ongoing need for consensus on meaningful outcome measures to support further rigorous evaluation of intervention studies. In the interim, clinics are encouraged to utilize available free resources to promote an organized approach to transition within the structure of their specific local health systems.

11 | BARRIERS TO OPTIMAL CARE

There are many potential barriers to delivering optimal ambulatory diabetes care, which can be broadly categorized as those related to (Table S1):

- i. The organization and infrastructure of health care services, including the accessibility, availability, and affordability of care. Barriers related to infrastructure of care include the distance the individual with diabetes must travel to a diabetes center, inconvenient clinic appointment times, restricted reimbursement, and the shortage and time constraints of physicians trained in diabetes management.^{101,102} Potential solutions to accessibility/availability barriers are to offer local diabetes clinic options or, in cases where organizing smaller diabetes centers or regular outreach clinics is not feasible, training local primary care physicians, implementing a shared electronic medical record to track the child's care and identify "red flags" that might impact motivation and clinic visit attendance. Virtual hub-and-spoke networks can be organized in order to disseminate knowledge in underserved areas and support primary care physicians.^{103,104} The use of telemedicine provides a potential practical solution to overcome the barriers related to travel and the absence of local expertise in diabetes management.^{23,105} Where affordability of care is the main barrier, efforts should focus on advocacy for reimbursement, as well as promoting collaborations between local/national government agencies and diabetes advocacy groups.
- ii. Social determinants of health, including a) socioeconomic status and related housing and food insecurity, as well as limited access to social security, b) educational status and literacy, c) neighborhood and built environment that can provide access to healthy eating and space for exercise, and d) determinants of social context and cohesion, such as incarceration, domestic violence, substance abuse, as well as discrimination and stigma. Minority status, a crucial social determinant of health that encompasses most of these factors, is discussed separately.^{106,107} These factors have been consistently correlated with suboptimal glycemic outcomes and clinic attendance, highlighting the importance of focusing on these factors.^{108,109}

Screening for social determinants of health could help identify issues affecting diabetes management and overcome communication

gaps between diabetes care providers and young people with diabetes and their families.^{110,111} Stigma is perceived in 36–78% of people with diabetes even in socially sensitive societies.¹¹² Integration and acceptance should begin in the school setting and be supported at the community level through educational campaigns. Diabetes care teams should consult resources on social determinants of health that are currently available from various organizations¹⁰⁷ and assist families to use community services if social needs are identified.

- iii. Psychological factors/individual perceptions and needs that pertain to the acceptability of care. The perception of the child and their family regarding the burden of diabetes management in their everyday life should be acknowledged. Some families may underestimate the usefulness of structured educational programs, regular clinic attendance or even the benefits of efficient self-management and good glycemic management, and they might feel already self-confident and empowered, even if diabetes is not optimally managed.¹¹³ It is crucial that the diabetes team identify and address these issues,^{114,115} by providing problem-oriented interactive education that may include integrating technology, revisiting daily routines and treatment options, ensuring mental health support, and restoring communication and balance within the family.^{116–119} Language used by the diabetes care team is crucial for building a strong relationship. It should be kept accessible and simple, motivating, compassionate, yet realistic, not judging or shaming and adjusted to the personal preferences of the child with diabetes.¹²⁰

The presence of mental health comorbidities and family conflicts can influence diabetes management as well.^{121,122} Available tools should be used to screen for and identify mental health comorbidities and barriers to diabetes self-care.^{123–131}

Barriers to incorporate the use of technology in daily diabetes care should also be considered in young people with T1D.^{132–134} These may include concerns about (i) increased burden on diabetes management (overwhelming data, difficulties in downloading and data interpretation, alarms, faulty devices); (ii) therapeutic effectiveness of the devices (mis-trust of automated decision making technology, inaccuracy of measurements); (iii) physical interference of the devices (adhesion and insertion issues, multiple devices, body image, "public display" of diabetes, interference with daily activities and exercise).^{135–137} In some cases, even the diabetes care team can be reluctant to actively introduce technology, being themselves overwhelmed by the extra burden related to its implementation.^{138,139} The sustained benefit of the use of technology on metabolic control and quality of life of children, adolescents and young adults with T1D is by itself the most rewarding motivation.

12 | CARE FOR CHILDREN FROM MINORITY GROUPS AND CHILDREN OF RECENT IMMIGRANTS: A PRACTICAL APPROACH

Globalization and migration are great challenges to health care systems. The recent fluxes of immigrants and refugees have changed the characteristics of the populations accessing the healthcare services in

the host countries, requiring changes of the local diabetes care team to address the needs of these people. Data demonstrates that children with diabetes from migrant/minority families have less favorable glycemic outcomes, higher body mass index, less physical activity, lower utilization of technologies and higher frequency of diabetes-related hospitalization than native populations (Table S2).^{140,141}

As immigrants and refugees are usually not aware of the health insurance policies and organization of the health system of their host countries, it must be ensured that children with diabetes have unrestricted access to a safe location to store insulin, glucagon, diabetes management-related consumables, and devices and that instructions are well understood and followed. Key points related to the ambulatory diabetes care of children from minority groups and immigrant populations are:

- Define structured pathways of care for the initial visits.
- Assign a regular provider for each child
- Provide home and school visits, when possible.
- When available, dedicated staff members known as “patient navigators” may help families with T1D through the healthcare system (e.g., set up appointments for doctor visits and medical tests, assist with obtaining financial, legal, and social support if needed).^{142,143}
- Licensed interpreters must be used to support the diabetes team in understanding some of the cultural norms. If a licensed interpreter is not available, a non-family member may serve as an interpreter. The child or other family members should only be used as an interpreter if no other option is available.
- Translation of educational material, diabetes management plans, instructions for emergencies, as well as important administrative forms (i.e., informed consent for the use of personal data) in the most common preferred language. If possible, medical certificates that accompany the child should also be translated.^{144–146}
- The diabetes team should be aware and familiar with cultural differences that may have an impact on diabetes management. Where available, cultural and language specific materials should be used (i.e., Translation and Cultural Adaptation of the “Barriers to Diabetes Adherence” into Arabic Context, picture-based carbohydrate-counting resource for Somalis, etc.) as well as sensitive toolboxes such as EthnoMed (www.ethnomed.org).¹⁴⁷ Specific guidelines for the management of diabetes during Ramadan or other religious fasting are available and should be discussed with specific families (See related ISPAD 2022 Consensus Guidelines Chapter 24 on *Ramadan and other religions fasting by young people with diabetes*).

12.1 | Racial disparities

It is important to recognize the presence of racial disparities in the provision of ambulatory diabetes care. Studies have shown differences in the receipt of recommended screening for diabetes-related complications and comorbidities, based on race/ethnicity.^{148,149} Racial disparities are particularly evident in the use of diabetes technology.

These differences cannot be solely attributed to lower socio-economic status, educational level or health insurance status, but may reflect lack of a culturally sensitive approach and systemic structural racism.^{150–152} To overcome these barriers, efforts should be made to actively support the use of technology for all in a trackable and standardized way.

13 | EDUCATION AND LITERACY IN DIABETES TECHNOLOGY

Diabetes technology has evolved rapidly and the number of youths using advanced diabetes technologies has increased substantially in the past decade. Youth with diabetes are routinely using CGM, smart insulin pens, CSII using insulin pumps, and AID to support glucose monitoring and insulin delivery for their day-to-day management. Despite the rapid integration of diabetes technology into pediatric diabetes care, there continue to be multiple barriers to the uptake, use, and accessibility of diabetes technologies for youth with diabetes. Thus, robust diabetes education, device training, and follow-up of children and families are essential to minimize device discontinuation and maximize proper device use to help achieve target glycemic outcomes.

Health care teams play an important role in setting realistic expectations for the youth and family when starting on any new diabetes technology and ensuring an understanding of what devices can and cannot do to support diabetes management.¹⁵³ Technology selection must be appropriate for the youth with diabetes. While device companies offer online tutorials and training videos, as well as written materials on their use, structured education delivered by the care team can provide youth and families with practical guidance to support the successful adoption and use of technologies.

Historically, structured, person-centered, and empowerment-based education programs for diabetes technology use have been delivered mostly in-person by a certified diabetes specialist. With the expansion of telehealth services during the COVID-19 pandemic, virtual training sessions to start diabetes technology have been shown to be feasible since CGM and insulin pump data can be uploaded from home and accessed remotely by care teams.^{154–157}

Since multiple caregivers are generally involved in a child's care (e.g., babysitters, daycare providers, school nurses, teachers), education and support must extend beyond the youth and family in pediatric diabetes care. In addition, routine clinic visits should be used to re-evaluate the benefit being achieved by and the adequacy of use of the diabetes technology by the medical provider.¹⁵⁸ If there is a lack of measurable benefit, or a concern about safe use of the technology, ongoing training and education in the use of diabetes technologies for youth and their families should be provided, especially given that the technologies are constantly being improved and updated. Studies examining re-education of more experienced insulin pump users, showed reduced frequency of hypoglycemic events and slightly improved HbA1c levels.¹⁵⁹

Deficiencies in literacy and numeracy can make diabetes education and the use of diabetes technology very difficult. Pictorial

materials can be developed to assist with these situations. Innovative measures can be used, such as teaching the mother or child to draw the numbers because they cannot write them, providing pre-marked syringes (wrapped with colored tape to mark the dose), and using color coding to designate doses of insulin based on proximity of glucose reading to target range. Somewhat similar is the problem of multiple languages or dialects as educational and instructional materials may not be available in the local language. Finally, education should be provided in a developmentally appropriate format that meets the behavioral and emotional needs of a growing child and family. To support the incorporation of child-centered language, the act of play can be used to introduce information about diabetes technology in an age-appropriate manner.¹⁶⁰ Given the potential of play-based strategies providing the child with positive experiences related to their ongoing diabetes care and their interactions with the diabetes team, certified child life specialists can be incorporated as members of the multidisciplinary care team.

Health care team members training and supporting the youth and family on the use of diabetes technology must be proficient with all glucose monitoring and insulin delivery technologies available to prescribe to their persons with diabetes. Teams should develop formal standards, which set out the core competencies expected of staff delivering diabetes technology education and care.¹⁶¹ In addition, to support requisite expertise on the multidisciplinary care team, teams should consider:

- Having at least one staff member with formal training in the use of each diabetes technology device approved for use for their young children with diabetes
- Providing guidance to the entire care team on available systems and their suitability for different types of users
- Offering relevant continued professional development, if available, to the entire care team and encouraging the use of demonstration systems to support understanding of the functionality of advanced diabetes technologies

Applications (apps) for smartphones designed to support diabetes self-management offer an additional tool for supporting diabetes education and self-management. These include apps for tracking data (e.g., blood glucose values, insulin doses, and carbohydrate counting), apps for teaching and training, and food reference databases. While the growth of digital health apps has the potential to offer benefit to youth with diabetes, the available evidence on the safety and effectiveness of mobile health apps for diabetes remains limited.¹⁶² Regardless, given the growing use of diabetes apps, health team members should be knowledgeable about commonly used apps and their strengths and weaknesses. Further, care team members should be comfortable on how to support youth and their families on the use of digital health apps to augment diabetes management, as well as inform them about the privacy risks and steps that can be taken to keep data confidential and secure.

Please also refer to ISPAD 2022 Consensus Guidelines Chapter 16 “Technology: Glucose monitoring”; and Chapter 17 “Technology: Insulin Delivery”).

14 | CHILDREN WITH DIABETES AT SCHOOL: HOW TO INTEGRATE DIABETES MANAGEMENT IN A SCHOOL SETTING

Children with diabetes have the same right to participate in education as their peers without diabetes. However, data show they are at higher risk from being excluded from school.¹⁶³

Normalization of day-to-day living and functioning in the school settings for children should be a primary goal of diabetes care. Children spend 40%–50% of their waking hours in school, and much of their socialization skills is learned there.

The outpatient diabetes team should work closely with schools and empower school staff through education and provision of relevant and appropriate information, to confidently look after children with diabetes. The diabetes team should also support the school and family in developing the diabetes management plan and update it as needed.

A designed member of the diabetes team (often a diabetes educator/nurse) should be the point of contact for school staff and be available to provide regular training/support and be contacted should the staff require assistance during school hours.

For additional information see ISPAD 2022 Consensus Guidelines, Chapter 22 “Management and support of children and adolescents with T1D in school”.

15 | CHILDREN WITH DIABETES IN ORGANIZED CAMPS

Diabetes camp (or diabetes school camp) is an educational activity developed for children, adolescents and young adults with diabetes, in a setting located outside the hospital. Diabetes camps have been organized since the first half of the 20th century, soon after the introduction of insulin to treat people with diabetes.¹⁶⁴ Diabetes camps provide a typical camping experience of different durations and usually include a variety of activities.¹⁶⁵

Many local and national diabetes organizations manage residential and day camps for children and adolescents with diabetes. It is estimated that worldwide 15,000–20,000 young people attend diabetes camps annually.¹⁶⁴ Diabetes camps are usually staffed by professionals and volunteers trained in the management of children with diabetes. Please see Box 3 for details of requirements of Diabetes Camps.

Diabetes camps offer children and adolescents the opportunity to enjoy a camping experience in a safe environment and to experience a setting where caring for diabetes is a shared experience with other campers who also have diabetes. During their camp experience, many children learn more about how to care for their diabetes.

Most camps provide some education on diabetes management, either in planned formal sessions or, more commonly, by taking advantage of helping campers “learn by doing” and of “teachable moments” to discuss topics one-on-one or in a group. However, camp staff should understand that the primary goal of camp is to provide an

BOX 3 Camps specializing in children with diabetes should have

- Adequately trained staff
- Presence of a complete diabetes team, including
 - At least 1 physician serving as camp coordinator
 - At least 1 pediatrician/pediatric resident per 10 campers
 - At least 1 nurse per 5 campers
 - At least 1 dietitian and 1 psychologist
 - An adequate number of educators/entertainers for the regular operation of the camp
- Available insulin and consumables to meet children's needs
- Knowledge of insulin dose adjustments (considering an increased level of activity)
- An understanding of how to manage different glucose sensors, pumps and algorithms
- A staff trained to recognize and treat hypoglycemia and ketosis (and decide when referral to a medical facility is necessary)
- A member with knowledge of nutrition, carbohydrate content of meals, and the principles of insulin doses adjusting for variable carbohydrate content of meals
- A plan to maintain a log of each camper's glucose levels and insulin doses
- What is necessary to manage sick day, trauma or initial medical emergency

enjoyable experience for each child and to interact with other children with diabetes in a safe environment.^{164,165} Camps can also be valuable venues to test a new technology (CGM, pump, algorithm, drug) in children and adolescents with diabetes in a real-life setting.^{167–169} Furthermore, camps can be used to conduct studies in a small group of people, to evaluate different aspects of the disease (such as physical or psychological)¹⁷⁰ or to evaluate a clinical algorithm.¹⁷¹

Many national organizations have position statements or guidelines for the care of children with diabetes in a camp setting. These are valuable references and should be reviewed by camp medical directors to ensure that national standards are used.¹⁶⁵

16 | QUALITY OF CARE, STRUCTURE OF CARE, PROCESSES OF CARE AND OUTCOMES

Despite remarkable advances in pharmacology and diabetes device technology, many people with diabetes continue to experience sub-optimal health outcomes.^{172,173} Diabetes centers need methods to evaluate and enhance the quality and equity of the services they

provide and the outcomes of their management.¹⁷⁴ Given the complexity of diabetes management, a multifaceted approach that integrates psychosocial supports,¹¹ recognizes contributions of social determinants of health,¹⁷⁵ leverages information science,¹⁷⁶ and application of QI methodology¹⁷⁷ is needed to complement emerging therapeutic modalities for diabetes.

QI methods describe a systematic and continuous approach to accomplish measurable change in a process or outcome of care.^{178,179} Reliable implementation of evidence-based care processes, such as uptake of diabetes technology and rates of preventative screening laboratory tests and services, predictably precede improvements in clinical outcome measures such as HbA1c, TIR, severe hypoglycemia, quality of life, and reduced long-term complications of retinopathy or nephropathy.

The impact of features such as composition of diabetes care team, access to care and costs, frequency of visits, type of encounter via telehealth or in-person, community and peer supports on clinical outcomes remains an important topic for health services research in pediatric diabetes and is an emerging area for further QI efforts. Across categories of structure, process, and outcomes, selection of meaningful measures is essential to the practice of QI to monitor progress and direct interventions. Increasingly, there is recognition of the importance of metrics beyond HbA1c alone to describe salient elements of care delivery, diabetes management, and lived experience.^{180–182} Efforts towards inclusion of individual-reported outcomes, collaborating with people with diabetes and families in QI initiatives, addressing social determinants of health, and screening for common comorbidities associated with diabetes offer further opportunities for an even more comprehensive understanding of quality assessment of pediatric diabetes services.

Diabetes registries can be an important tool for population management at individual centers, QI, and benchmarking across collaborative centers.¹⁸³ Benchmark reporting that evaluates effectiveness of diabetes care measured against guidelines for standard practices can promote accountability and system wide improvements in diabetes care.^{176,184–189} When data transparency through benchmarking is combined with QI methods and open sharing of best practices, it is possible to accelerate and sustain process improvements and measurable changes in outcomes.¹⁹⁰ The international SWEET registry showed worldwide improvement of HbA1c and increased use of diabetes technology associated with twice yearly benchmarking.¹⁹¹ The Swedish National Pediatric Registry (SWEDIAKIDS) is an example of a national QI collaborative that observed a sustained decrease in mean HbA1c level for children 0–18 years from baseline of 62.6 mmol/mol (7.9%) in 2010 to 56.9 mmol/mol (7.4%) in 2014^{192,193} and continues to be a leader in pediatric diabetes outcomes.

Involvement of governments and policy makers facilitates provision of adequate resources that are required for high quality diabetes care. It should be a priority to collect and provide information on cost of care and long-term cost-effectiveness data of optimal care of children with diabetes to governments and health care agencies.

17 | BALANCING COSTS AND BENEFITS IN DIABETES CARE

Diabetes imposes a large economic burden on the individuals, their families, national health systems, and countries,^{194,195} which is likely underestimated in low-income and middle-income countries (LMICs), due to the scarcity of representative population-based information and premature deaths before diagnosis. In other areas of the world, these numbers are also underestimated because they do not account for loss of quality of life, loss of productivity as well as burden of care on the families.

Analysis of costs of care is important in helping to determine appropriate recommendations for care and in health policy decision-making.¹⁹⁶ The total health care expenditure for diabetes was estimated to be greater than USD\$ 760 billion dollars and equivalent to ~12% of all global health expenditure.¹⁹⁷ It is of great concern that ~80% of all expenditure is associated with treatment of complications, suggesting their prevention could significantly reduce global health costs.¹⁹⁸ There is vast disparity in health spending between regions and countries. In 2019, only 14.8% of global diabetes health expenditure was spent in LMICs, where 41.8% of people with diabetes live.¹⁹⁷ A study in LMICs reported that annual inpatient and medication costs were the most expensive aspects of diabetes care, with a high degree of cost variability. Reported annual inpatient costs ranged from less than US\$20 up to more than \$1000, and medications alone ranged from less than \$20 per year to more than \$500.¹⁹⁹ Studies by the International Insulin Foundation found suboptimal access to insulin in seven LMICs, with availability in only 20% of public sector outlets in Mali and Mozambique.²⁰⁰

Despite promising downward trends in mortality and disability-adjusted life years (DALY) rates observed over the past three decades, there remains a substantial gap in life expectancy between people with T1D and the general population, even within high-income countries (HICs).²⁰¹ In Sweden, Scotland, and Taiwan, T1D resulted in 10.2–17.7 lost life years; this life-expectancy gap is more pronounced among low-income settings with poor access to insulin.²⁰² A Swedish study showed that higher life expectancy was correlated with lower HbA1c and higher estimated glomerular filtration rate.²⁰³

The proportion of children with optimized glycemic outcomes (HbA1c <7.5%) was estimated to be 32.4% in HICs, 27.5% in upper-middle-income countries (UMICs), 21.7% in LMICs, and 12.7% in low-income countries (LICs). Notably over the past 15 years, on average about 76.4% children with T1D globally were unable to achieve optimized glycemic outcomes.²⁰⁴ Hence, an investment in gold standard care particularly during childhood and adolescence should be advocated globally and it is likely to lead to significant economic benefits. Improved glycemic outcomes through adequate education, treatment modalities and regular glucose monitoring can decrease the risk of complications. It is obvious that regular home glucose monitoring is cost effective, decreasing costs of diabetes care by reducing emergencies.

Both rapid- and long-acting analogs have been shown to reduce the frequency of mild and moderate hypoglycemia. Given the reduced

incidence of hypoglycemia, newer analogs may be even more cost-effective.²⁰⁵ However, affordability for individuals remains a challenge in many settings with cumulative markups ranging from 8.7% to 565.8%.²⁰⁶ In many LMICs, the price of insulin is paid for by the individual or, in some contexts, subsidies are in place. By contrast, in most HICs, various government-funded or health insurance schemes provide some form of financial protection, either ensuring that insulin is provided for free to the individual or, at least, that the person does not bear the full cost.²⁰⁷

The most notable change in diabetes management over the past 5–7 years has been the substantial increase in use of CGM which has led to a reduction in HbA1c.¹⁷² The increase in CGM use has been most prominent among young children, giving parents the ability to monitor glucose data remotely. The early adoption of insulin pumps and CGM are associated with less frequent hospital admissions due to diabetes ketoacidosis compared with injection users. Among individuals with diabetes using CGM, HbA1c concentrations were similar among MDI users or insulin pump users.²⁰⁸

Studies on CSII versus MDI suggest that CSII modestly lowers HbA1c compared with MDI, but there is insufficient data on other glycemic outcomes. In a study in socially disadvantaged young people living in HICs, despite an overall suboptimal HbA1c, CSII led to some improvement in glycemic outcomes.²⁰⁹ A large non-randomized prospective study supported the idea of early CSII initiation following T1D diagnosis.²¹⁰ However, Blair and colleagues, who compared clinical outcomes and costs associated with CSII versus MDI, concluded that CSII was not clinically superior to MDI when started at diagnosis and was associated with significantly higher costs.²¹¹

AID systems might offer even better futures for children and young adults living with T1D and could 1 day be available in LMICs.²¹² Both inpatient and outpatient trials have indicated that AID are more effective than conventional therapy at achieving higher percentage of time in range, and reduced time in hypoglycemia and hyperglycemia.²¹³ There are still no data comparing the costs of using different insulin delivery systems.

Although the benefit of insulin analogs, CGM and AID systems are well known, a large proportion of people with diabetes have restricted access to such high-priced treatment modalities.¹³³ It is important to continually reassess cost-effectiveness of insulin therapies and technologies as advances are made and as outcomes data are collected over longer periods of time. Advocacy for broad access and affordability of optimal therapies is needed to ensure equitable delivery of care.

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Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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REFERENCES

- Institute of Medicine (US) committee on quality of health Care in America. Crossing the quality chasm: A new health system for the 21st century. Institute of Medicine. National Academies Press; 2001.
- Brorsson AL, Leksell J, Andersson Franko M, Lindholm OA. A person-centered education for adolescents with type 1 diabetes-a randomized controlled trial. *Pediatr Diabetes*. 2019;20(7):986-996. doi:[10.1111/pedi.12888](https://doi.org/10.1111/pedi.12888)
- Dickinson JK, Guzman SJ, Maryniuk MD, et al. The use of language in diabetes care and education. *Diabetes Care*. 2017;40(12):1790-1799. doi:[10.2337/dci17-0041](https://doi.org/10.2337/dci17-0041)
- Drotar D, Ittenbach R, Rohan JM, Gupta R, Pendley JS, Delamater A. Diabetes management and glycemic control in youth with type 1 diabetes: test of a predictive model. *J Behav Med*. 2013;36(3):234-245. doi:[10.1007/s10865-012-9426-0](https://doi.org/10.1007/s10865-012-9426-0)
- Northam EA, Lin A, Finch S, Werther GA, Cameron FJ. Psychosocial well-being and functional outcomes in youth with type 1 diabetes 12 years after disease onset. *Diabetes Care*. 2010;33(7):1430-1437. doi:[10.2337/dc09-2232](https://doi.org/10.2337/dc09-2232)
- Lloyd CE, Wilson A, Holt RIG, Whicher C, Kar P. Language matters: a UK perspective. *Diabet Med*. 2018;35(12):1635-1641. doi:[10.1111/dme.13801](https://doi.org/10.1111/dme.13801)
- Cooper A, Kanumilli N, Hill J, et al. Language matters. Addressing the use of language in the care of people with diabetes: position statement of the English advisory group. *Diabet Med*. 2018;35(12):1630-1634. doi:[10.1111/dme.13705](https://doi.org/10.1111/dme.13705)
- Speight J, Skinner TC, Dunning T, et al. Our language matters: improving communication with and about people with diabetes. A position statement by Diabetes Australia. *Diabetes Res Clin Pract*. 2021;173:108655. doi:[10.1016/j.diabres.2021.108655](https://doi.org/10.1016/j.diabres.2021.108655)
- Holmes-Truscott E, Browne JL, Ventura AD, Pouwer F, Speight J. Diabetes stigma is associated with negative treatment appraisals among adults with insulin-treated type 2 diabetes: results from the second diabetes MILES - Australia (MILES-2) survey. *Diabet Med*. 2018;35(5):658-662. doi:[10.1111/dme.13598](https://doi.org/10.1111/dme.13598)
- Swift PG, Skinner TC, de Beaufort CE, et al. Target setting in intensive insulin management is associated with metabolic control: the Hvidøere childhood diabetes study group centre differences study 2005. *Pediatr Diabetes*. 2010;11(4):271-278. doi:[10.1111/j.1399-5448.2009.00596.x](https://doi.org/10.1111/j.1399-5448.2009.00596.x)
- Young-Hyman D, de Groot M, Hill-Briggs F, Gonzalez JS, Hood K, Peyrot M. Psychosocial care for people with diabetes: a position statement of the American Diabetes Association. *Diabetes Care*. 2016;39(12):2126-2140. doi:[10.2337/dc16-2053](https://doi.org/10.2337/dc16-2053)
- Macken AP, Sasaki E, Quinn A, et al. Paediatric diabetes: information-seeking behaviours of families. *Ir Med J*. 2014;107(3):87-88.
- Saiyed M, Hasnani D, Alonso GT, et al. Worldwide differences in childhood type 1 diabetes: the SWEET experience. *Pediatr Diabetes*. 2021;22(2):207-214. doi:[10.1111/pedi.13137](https://doi.org/10.1111/pedi.13137)
- de Beaufort C, Vazeou A, Sumnik Z, et al. Harmonize care to optimize outcome in children and adolescents with diabetes mellitus: treatment recommendations in Europe. *Pediatr Diabetes*. 2012;13(16):15-19. doi:[10.1111/j.1399-5448.2012.00908.x](https://doi.org/10.1111/j.1399-5448.2012.00908.x)
- Walker AF, Cuttriss N, Haller MJ, et al. Democratizing type 1 diabetes specialty care in the primary care setting to reduce health disparities: project extension for community healthcare outcomes (ECHO) T1D. *BMJ Open Diabetes Res Care*. 2021;9(1):e002262. doi:[10.1136/bmjdrc-2021-002262](https://doi.org/10.1136/bmjdrc-2021-002262)
- Cuttriss N, Bouchonville MF, Maahs DM, Walker AF. Tele-rounds and case-based training: project ECHO telementoring model applied to complex diabetes care. *Pediatr Clin North Am*. 2020;67(4):759-772. doi:[10.1016/j.pcl.2020.04.017](https://doi.org/10.1016/j.pcl.2020.04.017)
- Simm PJ, Wong N, Fraser L, et al. Geography does not limit optimal diabetes care: use of a tertiary centre model of care in an outreach service for type 1 diabetes mellitus. *J Paediatr Child Health*. 2014;50(6):471-475. doi:[10.1111/jpc.12499](https://doi.org/10.1111/jpc.12499)
- Pinsker JE, Nguyen C, Young S, Fredericks GJ, Chan D. A pilot project for improving diabetes outcomes using a website: the pediatric diabetes education portal. *J Telemed Telecare*. 2011;17(5):226-230.
- Izquierdo R, Morin PC, Bratt K, et al. School-centered telemedicine for children with type 1 diabetes mellitus. *J Pediatr*. 2009;155(3):374-379.
- Wood CL, Clements SA, McFann D, Slover R, Thomas JF, Wadwa RP. Use of telemedicine to improve adherence to American Diabetes Association standards in pediatric type 1 diabetes. *Diabetes Technol Ther*. 2016;18(1):7-14.
- Guljas R, Ahmed A, Chang K, Whitlock A. Impact of telemedicine in managing type 1 diabetes among school-age children and adolescents: an integrative review. *J of Pediatric Nursing*. 2014;29:198-204.
- Giani E, Dovc K, Dos Santos TJ, et al. Telemedicine and COVID-19 pandemic: the perfect storm to mark a change in diabetes care. Results from a world-wide cross-sectional web-based survey. *Pediatr Diabetes*. 2021;22:1115-1119. doi:[10.1111/pedi.13272](https://doi.org/10.1111/pedi.13272)
- Lee JM, Carlson E, Albanese-O'Neill A, et al. Adoption of telemedicine for type 1 diabetes care during the COVID-19 pandemic. *Diabetes Technol Ther*. 2021;23(9):642-651. doi:[10.1089/dia.2021.0080](https://doi.org/10.1089/dia.2021.0080)
- Sarteau AC, Souris KJ, Wang J, et al. Changes to care delivery at nine international pediatric diabetes clinics in response to the COVID-19 global pandemic. *Pediatr Diabetes*. 2021;22(3):463-468. doi:[10.1111/pedi.13180](https://doi.org/10.1111/pedi.13180)
- Rodbard D. Continuous glucose monitoring: a review of successes, challenges, and opportunities. *Diabetes Technol Ther*. 2016;18(2):S3-S13. doi:[10.1089/dia.2015.0417](https://doi.org/10.1089/dia.2015.0417)
- Simons R, Koopman H, Osinga M. Would you fly with a pilot on insulin. *Lancet Diabetes-Endocrinol*. 2014;2:446-447.
- Siller AF, Tosur M, Relan S, et al. Challenges in the diagnosis of diabetes type in pediatrics. *Pediatr Diabetes*. 2020;21(7):1064-1073. doi:[10.1111/pedi.13070](https://doi.org/10.1111/pedi.13070)
- Nylander C, Tindberg Y, Haas J, et al. Self- and parent-reported executive problems in adolescents with type 1 diabetes are associated with poor metabolic control and low physical activity. *Pediatr Diabetes*. 2017;19:98-105. doi:[10.1111/pedi.12520](https://doi.org/10.1111/pedi.12520)
- Lai S, Cagetti MG, Cocco F, et al. Evaluation of the difference in caries experience in diabetic and non-diabetic children-a case control study. *PLoS One*. 2017;12(11):e0188451.
- Copeland KC, Silverstein J, Moore KR, et al. Management of newly diagnosed type 2 diabetes mellitus (T2DM) in children and adolescents. *Pediatrics*. 2013;131(2):364-382. doi:[10.1542/peds.2012-3494](https://doi.org/10.1542/peds.2012-3494)
- Zeitler P, Hirst K, Copeland KC, et al. HbA1c after a short period of monotherapy with metformin identifies durable glycemic control among adolescents with type 2 diabetes. *Diabetes Care*. 2015;38(12):2285-2292. doi:[10.2337/dc15-0848](https://doi.org/10.2337/dc15-0848)
- Tamborlane WV, Barrientos-Pérez M, Fainberg U, et al. Liraglutide in children and adolescents with type 2 diabetes. *N Engl J Med*. 2019;381(7):637-646. doi:[10.1056/NEJMoa1903822](https://doi.org/10.1056/NEJMoa1903822)

33. Chan CL, Pyle L, Newnes L, Nadeau KJ, Zeitler PS, Kelsey MM. Continuous glucose monitoring and its relationship to hemoglobin A1c and oral glucose tolerance testing in obese and prediabetic youth. *J Clin Endocrinol Metab.* 2015;100(3):902-910. doi:[10.1210/jc.2014-3612](https://doi.org/10.1210/jc.2014-3612)
34. Chan CL, Pyle L, Morehead R, Baumgartner A, Cree-Green M, Nadeau KJ. The role of glycemia in insulin resistance in youth with type 1 and type 2 diabetes. *Pediatr Diabetes.* 2017;18(6):470-477. doi:[10.1111/pedi.12422](https://doi.org/10.1111/pedi.12422)
35. Buckingham B, Xing D, Weinzimer S, et al. Use of the DirecNet applied treatment algorithm (DATA) for diabetes management with a real-time continuous glucose monitor (the FreeStyle navigator). *Pediatr Diabetes.* 2008;9(2):142-147. doi:[10.1111/j.1399-5448.2007.00301.x](https://doi.org/10.1111/j.1399-5448.2007.00301.x)
36. Laffel LM, Aleppo G, Buckingham BA, et al. A practical approach to using trend arrows on the Dexcom G5 CGM system to manage children and adolescents with diabetes. *J Endocr Soc.* 2017;1(12):1461-1476. doi:[10.1210/js.2017-00389](https://doi.org/10.1210/js.2017-00389)
37. Johnson ML, Martens TW, Criego AB, Carlson AL, Simonson GD, Bergenstal RM. Utilizing the ambulatory glucose profile to standardize and implement continuous glucose monitoring in clinical practice. *Diabetes Technol Ther.* 2019;21(S2):S217-s225. doi:[10.1089/dia.2019.0034](https://doi.org/10.1089/dia.2019.0034)
38. Faruque LI, Wiebe N, Ehteshami-Afshar A, et al. Effect of telemedicine on glycated hemoglobin in diabetes: a systematic review and meta-analysis of randomized trials. *Can Med Assoc J.* 2017;189(9):E341-E364. doi:[10.1503/cmaj.150885](https://doi.org/10.1503/cmaj.150885)
39. Telehealth: Defining 21st century care. <https://www.americantelemed.org/resource/why-telemedicine/>, Accessed July 31, 2021.
40. Reid MW, Krishnan S, Berget C, et al. CoYoT1 clinic: home telemedicine increases young adult engagement in diabetes care. *Diabetes Technol Ther.* 2018;20(5):370-379. doi:[10.1089/dia.2017.0450](https://doi.org/10.1089/dia.2017.0450)
41. von Sengbusch S, Eisemann N, Mueller-Godeffroy E, et al. Outcomes of monthly video consultations as an add-on to regular care for children with type 1 diabetes: a 6-month quasi-randomized clinical trial followed by an extension phase. *Pediatr Diabetes.* 2020;21(8):1502-1515. doi:[10.1111/pedi.13133](https://doi.org/10.1111/pedi.13133)
42. Crossen SS, Marcin JP, Qi L, et al. Home visits for children and adolescents with uncontrolled type 1 diabetes. *Diabetes Technol Ther.* 2020;22(1):34-41. doi:[10.1089/dia.2019.0214](https://doi.org/10.1089/dia.2019.0214)
43. Bakhach M, Reid MW, Pyatak EA, et al. Home telemedicine (CoYoT1 clinic): a novel approach to improve psychosocial outcomes in young adults with diabetes. *Diabetes Educ.* 2019;45(4):420-430. doi:[10.1177/0145721719858080](https://doi.org/10.1177/0145721719858080)
44. <https://diabeter.nl/en/about-diabeter/who-we-are/> Accessed July 17, 2021.
45. Frieltz FS, Dördelmann J, Lemke S, et al. Assessing the benefits and challenges of video consultations for the treatment of children with type 1 diabetes - a qualitative study among diabetes professionals. *Exp Clin Endocrinol Diabetes.* 2021;129(11):831-836. doi:[10.1055/a-1149-8814](https://doi.org/10.1055/a-1149-8814)
46. von Sengbusch S, Doerdelmann J, Lemke S, et al. Parental expectations before and after 12-month experience with video consultations combined with regular outpatient care for children with type 1 diabetes: a qualitative study. *Diabet Med.* 2021;38(6):e14410. doi:[10.1111/dme.14410](https://doi.org/10.1111/dme.14410)
47. Crossen S, Raymond J, Neinstein A. Top 10 tips for successfully implementing a diabetes telehealth program. *Diabetes Technol Ther.* 2020;22(12):920-928. doi:[10.1089/dia.2020.0042](https://doi.org/10.1089/dia.2020.0042)
48. March CA, Flint A, DeArment D, et al. Paediatric diabetes care during the COVID-19 pandemic: lessons learned in scaling up telemedicine services. *Endocrinol. Diabetes Metabol.* 2021;4(1):e00202. doi:[10.1002/edm2.202](https://doi.org/10.1002/edm2.202)
49. Shi L, Wu H, Dong J, Jiang K, Lu X, Shi J. Telemedicine for detecting diabetic retinopathy: a systematic review and meta-analysis. *Br J Ophthalmol.* 2015;99(6):823-831. doi:[10.1136/bjophthalmol-2014-305631](https://doi.org/10.1136/bjophthalmol-2014-305631)
50. Strul S, Zheng Y, Gangaputra S, et al. Pediatric diabetic retinopathy telescreening. *J AAPOS.* 2020;24(1):10.e1-10.e5. doi:[10.1016/j.jaapos.2019.10.010](https://doi.org/10.1016/j.jaapos.2019.10.010)
51. Chiang JL, Kirkman MS, Laffel LM, Peters AL. Type 1 diabetes sourcebook a. type 1 diabetes through the life span: a position statement of the American Diabetes Association. *Diabetes Care.* 2014;37(7):2034-2054. doi:[10.2337/dc14-1140](https://doi.org/10.2337/dc14-1140)
52. Peters A, Laffel L, American Diabetes Association Transitions Working G. Diabetes care for emerging adults: recommendations for transition from pediatric to adult diabetes care systems: a position statement of the American Diabetes Association, with representation by the American College of Osteopathic Family Physicians, the American Academy of Pediatrics, the American Association of Clinical Endocrinologists, the American Osteopathic Association, the Centers for Disease Control and Prevention, children with diabetes, the Endocrine Society, the International Society for Pediatric and Adolescent Diabetes, Juvenile Diabetes Research Foundation International, the National Diabetes Education Program, and the pediatric Endocrine Society (formerly Lawson Wilkins pediatric Endocrine Society). *Diabetes Care.* 2011;34(11):2477-2485. doi:[10.2337/dc11-1723](https://doi.org/10.2337/dc11-1723)
53. Blum RW, Garell D, Hodgman CH, et al. Transition from child-centered to adult health-care systems for adolescents with chronic conditions. A position paper of the Society for Adolescent Medicine. *J Adolesc Health.* 1993;14(7):570-576.
54. Arnett JJ. Emerging adulthood. A theory of development from the late teens through the twenties. *Am Psychol.* 2000;55(5):469-480.
55. Weissberg-Benchell J, Wolpert H, Anderson BJ. Transitioning from pediatric to adult care: a new approach to the post-adolescent young person with type 1 diabetes. *Diabetes Care.* 2007;30(10):2441-2446. doi:[10.2337/dc07-1249](https://doi.org/10.2337/dc07-1249)
56. Wasserman R, Anderson BJ, Schwartz DD. Illness-specific risk-taking in adolescence: a missing piece of the nonadherence puzzle for youth with type 1 diabetes? *Diabetes Spectr.* 2017;30(1):3-10. doi:[10.2337/ds15-0060](https://doi.org/10.2337/ds15-0060)
57. Lyons SK, Libman IM, Sperling MA. Clinical review: diabetes in the adolescent: transitional issues. Research support, N.I.H., extramural review. *J Clin Endocrinol Metab.* 2013;98(12):4639-4645. doi:[10.1210/jc.2013-2890](https://doi.org/10.1210/jc.2013-2890)
58. Hilliard ME, Perlus JG, Clark LM, et al. Perspectives from before and after the pediatric to adult care transition: a mixed-methods study in type 1 diabetes. *Diabetes Care.* 2014;37(2):346-354. doi:[10.2337/dc13-1346](https://doi.org/10.2337/dc13-1346)
59. Miller KM, Foster NC, Beck RW, et al. Current state of type 1 diabetes treatment in the U.S.: updated data from the T1D exchange clinic registry. *Diabetes Care.* 2015;38(6):971-978. doi:[10.2337/dc15-0078](https://doi.org/10.2337/dc15-0078)
60. Helgeson VS, Reynolds KA, Snyder PR, et al. Characterizing the transition from paediatric to adult care among emerging adults with type 1 diabetes. *Diabet Med.* 2013;30(5):610-615. doi:[10.1111/dme.12067](https://doi.org/10.1111/dme.12067)
61. Sandler CN, Garvey KC. A practice in maturation: current perspectives on the transition from pediatric to adult care for young adults with diabetes. *Curr Diab Rep.* 2019;19(11):126. doi:[10.1007/s11892-019-1247-x](https://doi.org/10.1007/s11892-019-1247-x)
62. Garvey KC, Wolpert HA, Laffel LM, Rhodes ET, Wolfsdorf JI, Finkelstein JA. Health care transition in young adults with type 1 diabetes: barriers to timely establishment of adult diabetes care. *Endocr Pract.* 2013;19(6):946-952. doi:[10.4158/EP13109.OR](https://doi.org/10.4158/EP13109.OR)
63. Nakhla M, Daneman D, To T, Paradis G, Guttmann A. Transition to adult care for youths with diabetes mellitus: findings from a universal health care system. *Pediatrics.* 2009;124(6):e1134-e1141. doi:[10.1542/peds.2009-0041](https://doi.org/10.1542/peds.2009-0041)

64. Dovey-Pearce G, Hurrell R, May C, Walker C, Doherty Y. Young adults' (16-25 years) suggestions for providing developmentally appropriate diabetes services: a qualitative study. *Health Soc Care Commun.* 2005;13(5):409-419. doi:[10.1111/j.1365-2524.2005.00577.x](https://doi.org/10.1111/j.1365-2524.2005.00577.x)
65. Garvey KC, Wolpert HA, Rhodes ET, et al. Health care transition in patients with type 1 diabetes: young adult experiences and relationship to glycemic control. *Diabetes Care.* 2012;35(8):1716-1722. doi:[10.2337/dc11-2434](https://doi.org/10.2337/dc11-2434)
66. Busse FP, Hiermann P, Galler A, et al. Evaluation of patients' opinion and metabolic control after transfer of young adults with type 1 diabetes from a pediatric diabetes clinic to adult care. *Horm Res.* 2007; 67(3):132-138. doi:[10.1159/000096583](https://doi.org/10.1159/000096583)
67. Lotstein DS, Seid M, Klingensmith G, et al. Transition from pediatric to adult care for youth diagnosed with type 1 diabetes in adolescence. *Pediatrics.* 2013;131(4):e1062-e1070. doi:[10.1542/peds.2012-1450](https://doi.org/10.1542/peds.2012-1450)
68. Bryden KS, Dunger DB, Mayou RA, Peveler RC, Neil HAW. Poor prognosis of young adults with type 1 diabetes: a longitudinal study. *Diabetes Care.* 2003;26(4):1052-1057. doi:[10.2337/diacare.26.4.1052](https://doi.org/10.2337/diacare.26.4.1052)
69. Laing SP, Jones ME, Swerdlow AJ, Burden AC, Gatling W. Psychosocial and socioeconomic risk factors for premature death in young people with type 1 diabetes. *Diabetes Care.* 2005;28(7):1618-1623. doi:[10.2337/diacare.28.7.1618](https://doi.org/10.2337/diacare.28.7.1618)
70. Kapellen TM, Muther S, Schwandt A, et al. Transition to adult diabetes care in Germany-high risk for acute complications and declining metabolic control during the transition phase. *Pediatr Diabetes.* 2018;19:1094-1099. doi:[10.1111/pedi.12687](https://doi.org/10.1111/pedi.12687)
71. Allassaf A, Gharaibeh L, Grant C, Punthakee Z. Predictors of type 1 diabetes mellitus outcomes in young adults after transition from pediatric care. *J Diabetes.* 2017;9(12):1058-1064. doi:[10.1111/1753-0407.12536](https://doi.org/10.1111/1753-0407.12536)
72. Corathers SD, Kichler JC, Fino NF, et al. High health satisfaction among emerging adults with diabetes: factors predicting resilience. *Health Psychol.* 2017;36(3):206-214. doi:[10.1037/he0000419](https://doi.org/10.1037/he0000419)
73. Markowitz JT, Laffel LM. Transitions in care: support group for young adults with type 1 diabetes. *Diabet Med.* 2012;29(4):522-525. doi:[10.1111/j.1464-5491.2011.03537.x](https://doi.org/10.1111/j.1464-5491.2011.03537.x)
74. Schwartz LA, Tuchman LK, Hobbie WL, Ginsberg JP. A social-ecological model of readiness for transition to adult-oriented care for adolescents and young adults with chronic health conditions. *Child Care Hlth Dev.* 2011;37(6):883-895. doi:[10.1111/j.1365-2214.2011.01282.x](https://doi.org/10.1111/j.1365-2214.2011.01282.x)
75. Modi AC, Pai AL, Hommel KA, et al. Pediatric self-management: a framework for research, practice, and policy. *Pediatrics.* 2012;129(2): e473-e485. doi:[10.1542/peds.2011-1635](https://doi.org/10.1542/peds.2011-1635)
76. Garvey KC, Foster NC, Agarwal S, et al. Health care transition preparation and experiences in a U.S. National Sample of Young adults with type 1 diabetes. *Diabetes Care.* 2017;40(3):317-324. doi:[10.2337/dc16-1729](https://doi.org/10.2337/dc16-1729)
77. Lu Y, Pyatak EA, Peters AL, et al. Patient perspectives on peer mentoring: type 1 diabetes management in adolescents and young adults. *Diabetes Educ.* 2015;41(1):59-68. doi:[10.1177/0145721714559133](https://doi.org/10.1177/0145721714559133)
78. American Academy of P, American Academy of Family P, American College of P, Transitions Clinical Report Authoring G, Cooley WC, Sagerman PJ. Supporting the health care transition from adolescence to adulthood in the medical home. *Pediatrics.* 2011;128(1): 182-200. doi:[10.1542/peds.2011-0969](https://doi.org/10.1542/peds.2011-0969)
79. Iyengar J, Thomas IH, Soleimanpour SA. Transition from pediatric to adult care in emerging adults with type 1 diabetes: a blueprint for effective receivership. *Clin Diabetes Endocrinol.* 2019;5:3. doi:[10.1186/s40842-019-0078-7](https://doi.org/10.1186/s40842-019-0078-7)
80. Agarwal S, Raymond JK, Schutta MH, Cardillo S, Miller VA, Long JA. An adult health care-based pediatric to adult transition program for emerging adults with type 1 diabetes. *Diabetes Educ.* 2017;43(1):87-96. doi:[10.1177/0145721716677098](https://doi.org/10.1177/0145721716677098)
81. Findley MK, Cha E, Wong E, Faulkner MS. A systematic review of transitional care for emerging adults with diabetes. *J Pediatr Nurs.* 2015;30(5):e47-e62. doi:[10.1016/j.pedn.2015.05.019](https://doi.org/10.1016/j.pedn.2015.05.019)
82. Chu PY, Maslow GR, von Isenburg M, Chung RJ. Systematic review of the impact of transition interventions for adolescents with chronic illness on transfer from pediatric to adult healthcare. *J Pediatr Nurs.* 2015;30(5):e19-e27. doi:[10.1016/j.pedn.2015.05.022](https://doi.org/10.1016/j.pedn.2015.05.022)
83. Little JM, Odiaga JA, Minutti CZ. Implementation of a diabetes transition of care program. *J Pediatr Health Care.* 2017;31(2):215-221. doi:[10.1016/j.pedhc.2016.08.009](https://doi.org/10.1016/j.pedhc.2016.08.009)
84. Spaic T, Robinson T, Goldbloom E, et al. Closing the gap: results of the multicenter Canadian randomized controlled trial of structured transition in young adults with type 1 diabetes. *Diabetes Care.* 2019; 42(6):1018-1026. doi:[10.2337/dc18-2187](https://doi.org/10.2337/dc18-2187)
85. Sequeira PA, Pyatak EA, Weigensberg MJ, et al. Let's empower and prepare (LEAP): evaluation of a structured transition program for young adults with type 1 diabetes. *Diabetes Care.* 2015;38(8):1412-1419. doi:[10.2337/dc14-2577](https://doi.org/10.2337/dc14-2577)
86. Pyatak EA, Sequeira PA, Vigen CL, et al. Clinical and psychosocial outcomes of a structured transition program among young adults with type 1 diabetes. *J Adolesc Health.* 2017;60(2):212-218. doi:[10.1016/j.jadohealth.2016.09.004](https://doi.org/10.1016/j.jadohealth.2016.09.004)
87. Pasquini S, Rinaldi E, Da Prato G, et al. Growing up with type 1 diabetes mellitus: data from the verona diabetes transition project. *Diabet Med.* 2021;39:e14719. doi:[10.1111/dme.14719](https://doi.org/10.1111/dme.14719)
88. Steinbeck KS, Shrewsbury VA, Harvey V, et al. A pilot randomized controlled trial of a post-discharge program to support emerging adults with type 1 diabetes mellitus transition from pediatric to adult care. *Pediatr Diabetes.* 2015;16(8):634-639. doi:[10.1111/pedi.12229](https://doi.org/10.1111/pedi.12229)
89. Butalia S, Crawford SG, McGuire KA, Dyjur DK, Mercer JR, Pacaud D. Improved transition to adult care in youth with type 1 diabetes: a pragmatic clinical trial. *Diabetologia.* 2021;64(4):758-766. doi:[10.1007/s00125-020-05368-1](https://doi.org/10.1007/s00125-020-05368-1)
90. Van Walleghem N, Macdonald CA, Dean HJ. Evaluation of a systems navigator model for transition from pediatric to adult care for young adults with type 1 diabetes. *Diabetes Care.* 2008;31(8):1529-1530. doi:[10.2337/dc07-2247](https://doi.org/10.2337/dc07-2247)
91. Holmes-Walker DJ, Llewellyn AC, Farrell K. A transition care programme which improves diabetes control and reduces hospital admission rates in young adults with type 1 diabetes aged 15-25 years. *Diabet Med.* 2007;24(7):764-769. doi:[10.1111/j.1464-5491.2007.02152.x](https://doi.org/10.1111/j.1464-5491.2007.02152.x)
92. Findorff J MS, von Moers A, Nolting HD, Burger W. Das Berliner TransitionsProgramm. Sektorübergreifendes Strukturprogramm zur Transition in die Erwachsenenmedizin. De Gruyter; 2016.
93. Williams S, Newhook LAA, Power H, Shulman R, Smith S, Chafe R. Improving the transitioning of pediatric patients with type 1 diabetes into adult care by initiating a dedicated single session transfer clinic. *Clin Diabetes Endocrinol.* 2020;6:11. doi:[10.1186/s40842-020-00099-z](https://doi.org/10.1186/s40842-020-00099-z)
94. Cadario F, Prodam F, Bellone S, et al. Transition process of patients with type 1 diabetes (T1DM) from paediatric to the adult health care service: a hospital-based approach. *Clin Endocrinol.* 2009;71(3):346-350. doi:[10.1111/j.1365-2265.2008.03467.x](https://doi.org/10.1111/j.1365-2265.2008.03467.x)
95. Vanelli M, Caronna S, Adinolfi B, Chiari G, Gugliotta M, Arsenio L. Effectiveness of an uninterrupted procedure to transfer adolescents with type 1 diabetes from the paediatric to the adult clinic held in the same hospital: eight-year experience with the Parma protocol. *Diabetes Nutr Metab.* 2004;17(5):304-308.

96. Fogel JL, Raymond JK. Implementing telehealth in pediatric type 1 diabetes mellitus. *Pediatr Clin North Am.* 2020;67(4):661-664. doi:10.1016/j.pcl.2020.04.009
97. Los E, Ulrich J, Guttmann-Bauman I. Technology use in transition-age patients with type 1 diabetes: reality and promises. *J Diabetes Sci Technol.* 2016;10(3):662-668. doi:10.1177/1932296816632543
98. Raymond JK. Models of care for adolescents and young adults with type 1 diabetes in transition: shared medical appointments and telemedicine. *Pediatr Ann.* 2017;46(5):e193-e197. doi:10.3928/19382359-20170425-01
99. Raymond JK, Reid MW, Fox S, et al. Adapting home telehealth group appointment model (CoYoT1 clinic) for a low SES, publicly insured, minority young adult population with type 1 diabetes. *Contemp Clin Trials.* 2020;88:105896. doi:10.1016/j.cct.2019.105896
100. Huang JS, Terrones L, Tompane T, et al. Preparing adolescents with chronic disease for transition to adult care: a technology program. *Pediatrics.* 2014;133(6):e1639-e1646. doi:10.1542/peds.2013-2830
101. Hynes L, Byrne M, Dinneen SF, McGuire BE, O'Donnell M, Mc SJ. Barriers and facilitators associated with attendance at hospital diabetes clinics among young adults (15-30 years) with type 1 diabetes mellitus: a systematic review. *Pediatr Diabetes.* 2016;17(7):509-518. doi:10.1111/pedi.12198
102. Ladha S, Fox D, Bone JN, Amed S. An analysis of self-reported barriers to type 1 diabetes care in a pediatric population in British Columbia. *Canada Can J Diabetes.* 2021;45(5):383-389. doi:10.1016/j.jcjd.2020.10.015
103. Laloo C, Diskin C, Ho M, et al. Pediatric project ECHO: implementation of a virtual medical education program to support Community Management of Children with Medical Complexity. *Hosp Pediatr.* 2020;10(12):1044-1052. doi:10.1542/hpeds.2020-0067
104. Locke SR, Dix G, Te Hiwi B, et al. Improving diabetes care in the British Columbia Southern Interior: developing community-university initiatives to address service gaps. *Can J Diabetes.* 2021;45(1):5-14.e2. doi:10.1016/j.jcjd.2020.04.003
105. Elbarbary NS, dos Santos TJ, de Beaufort C, Agwu JC, Calliari LE, Scaramuzza AE. COVID-19 outbreak and pediatric diabetes: perceptions of health care professionals worldwide. *Pediatr Diabetes.* 2020;21(7):1083-1092. doi:10.1111/pedi.13084
106. Fortin K, Kwon S, Pierce MC. Characteristics of children reported to child protective services for medical neglect. *Hosp Pediatr.* 2016;6(4):204-210. doi:10.1542/hpeds.2015-0151
107. Hill-Briggs F, Adler NE, Berkowitz SA, et al. Social determinants of health and diabetes: a scientific review. *Diabetes Care.* 2020;44(1):258-279. doi:10.2337/dc20-0053
108. Barry SA, Teplitsky L, Wagner DV, Shah A, Rogers BT, Harris MA. Partnering with insurers in caring for the most vulnerable youth with diabetes: NICH as an integrator. *Curr Diab Rep.* 2017;17:26. doi:10.1007/s11892-017-0849-4
109. Kordonouri O, Lange K, Biester T, et al. Determinants of glycaemic outcome in the current practice of care for young people up to 21 years old with type 1 diabetes under real-life conditions. *Diabet Med.* 2020;37(5):797-804. doi:10.1111/dme.14130
110. Sokol R, Austin A, Chandler C, et al. Screening children for social determinants of health: a systematic review. *Pediatrics.* 2019;144(4). doi:10.1542/peds.2019-1622
111. Hershey JA, Morone J, Lipman TH, Hawkes CP. Social determinants of health, goals and outcomes in high-risk children with type 1 diabetes. *Can J Diabetes.* 2021;45(5):444-450.e1. doi:10.1016/j.jcjd.2021.02.005
112. Hansen UM, Olesen K, Willaing I. Diabetes stigma and its association with diabetes outcomes: a cross-sectional study of adults with type 1 diabetes. *Scand J Public Health.* 2020;48(8):855-861. doi:10.1177/1403494819862941
113. Coates VE, Horigan G, Davies M, Davies MT. Exploring why young people with type 1 diabetes decline structured education with a view to overcoming barriers. *Diabet Med.* 2017;34(8):1092-1099. doi:10.1111/dme.13368
114. Kellett J, Sampson M, Swords F, et al. Young people's experiences of managing type 1 diabetes at university: a national study of UK university students. *Diabet Med.* 2018;35(8):1063-1071. doi:10.1111/dme.13656
115. Fried L, Chetty T, Cross D, et al. The challenges of being physically active: a qualitative study of Young people with type 1 diabetes and their parents. *Can J Diabetes.* 2021;45(5):421-427. doi:10.1016/j.jcjd.2020.09.010
116. McIntosh B, Khatchadourian K, Amed S. British Columbian healthcare providers' perspectives on facilitators and barriers to adhering to pediatric diabetes treatment guidelines. *Can J Diabetes.* 2017;41(2):224-240. doi:10.1016/j.jcjd.2016.10.002
117. Fiallo-Scharer R, Palta M, Chewning BA, et al. Impact of family-centered tailoring of pediatric diabetes self-management resources. *Pediatr Diabetes.* 2019;20(7):1016-1024. doi:10.1111/pedi.12899
118. Heller SR, Gianfrancesco C, Taylor C, Elliott J. What are the characteristics of the best type 1 diabetes patient education programmes (from diagnosis to long-term care), do they improve outcomes and what is required to make them more effective? *Diabet Med.* 2020;37(4):545-554. doi:10.1111/dme.14268
119. Skedgell KK, Cao VT, Gallagher KA, Anderson BJ, Hilliard ME. Defining features of diabetes resilience in emerging adults with type 1 diabetes. *Pediatr Diabetes.* 2021;22(2):345-353. doi:10.1111/pedi.13136
120. Banasiak K, Cleary D, Bajuryn V, et al. Language matters - a diabetes Canada consensus statement. *Can J Diabetes.* 2020;44(5):370-373. doi:10.1016/j.jcjd.2020.05.008
121. Redondo MJ, Callender CS, Gonynor C, et al. Diabetes care provider perceptions on family challenges of pediatric type 1 diabetes. *Diabetes Res Clin Pract.* 2017;129:203-205. doi:10.1016/j.diabres.2017.05.006
122. Rankin D, Harden J, Barnard K, et al. Barriers and facilitators to taking on diabetes self-management tasks in pre-adolescent children with type 1 diabetes: a qualitative study. *BMC Endocr Disord.* 2018;18(1):71. doi:10.1186/s12902-018-0302-y
123. Welch GW, Jacobson AM, Polonsky WH. The problem areas in diabetes scale. An evaluation of its clinical utility. *Diabetes Care.* 1997;20(5):760-766. doi:10.2337/diacare.20.5.760
124. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. *J Gen Intern Med.* 2001;16(9):606-613. doi:10.1046/j.1525-1497.2001.016009606.x
125. Varni JW, Burwinkle TM, Jacobs JR, Gottschalk M, Kaufman F, Jones KL. The PedsQL in type 1 and type 2 diabetes: reliability and validity of the pediatric quality of life inventory generic core scales and type 1 diabetes module. *Diabetes Care.* 2003;26(3):631-637. doi:10.2337/diacare.26.3.631
126. Polonsky WH, Fisher L, Earles J, et al. Assessing psychosocial distress in diabetes: development of the diabetes distress scale. *Diabetes Care.* 2005;28(3):626-631. doi:10.2337/diacare.28.3.626
127. Markowitz JT, Butler DA, Volkening LK, Antisdel JE, Anderson BJ, Laffel LM. Brief screening tool for disordered eating in diabetes: internal consistency and external validity in a contemporary sample of pediatric patients with type 1 diabetes. *Diabetes Care.* 2010;33(3):495-500. doi:10.2337/dc09-1890
128. de Wit M, Winterdijk P, Aanstoot HJ, et al. Assessing diabetes-related quality of life of youth with type 1 diabetes in routine clinical care: the MIND youth questionnaire (MY-Q). *Pediatr Diabetes.* 2012;13(8):638-646. doi:10.1111/j.1399-5448.2012.00872.x
129. Cox ED, Fritz KA, Hansen KW, et al. Development and validation of PRISM: a survey tool to identify diabetes self-management barriers. *Diabetes Res Clin Pract.* 2014;104(1):126-135. doi:10.1016/j.diabres.2014.01.015

130. Browne JL, Ventura AD, Mosely K, Speight J. Measuring type 1 diabetes stigma: development and validation of the type 1 diabetes stigma assessment scale (DSAS-1). *Diabet Med.* 2017;34(12):1773-1782. doi:[10.1111/dme.13507](https://doi.org/10.1111/dme.13507)
131. Iturralde E, Hood KK, Weissberg-Benchell J, Anderson BJ, Hilliard ME. Assessing strengths of children with type 1 diabetes: validation of the diabetes strengths and resilience (DSTAR) measure for ages 9 to 13. *Pediatr Diabetes.* 2019;20(7):1007-1015. doi:[10.1111/pedi.12898](https://doi.org/10.1111/pedi.12898)
132. O'Connor MR, Carlin K, Coker T, Zierler B, Pihoker C. Disparities in insulin pump therapy persist in youth with type 1 diabetes despite rising overall pump use rates. *J Pediatr Nurs.* 2019;44:16-21. doi:[10.1016/j.pedn.2018.10.005](https://doi.org/10.1016/j.pedn.2018.10.005)
133. Sumnik Z, Szypowska A, Iotova V, et al. Persistent heterogeneity in diabetes technology reimbursement for children with type 1 diabetes: the SWEET perspective. *Pediatr Diabetes.* 2019;20(4):434-443. doi:[10.1111/pedi.12833](https://doi.org/10.1111/pedi.12833)
134. Addala A, Auzanneau M, Miller K, et al. A decade of disparities in diabetes technology use and HbA1c in pediatric type 1 diabetes: a transatlantic comparison. *Diabetes Care.* 2021;44(1):133-140. doi:[10.2337/dc20-0257](https://doi.org/10.2337/dc20-0257)
135. Patton SR, Clements MA. Psychological reactions associated with continuous glucose monitoring in youth. *J Diabetes Sci Technol.* 2016;10(3):656-661. doi:[10.1177/1932296816638109](https://doi.org/10.1177/1932296816638109)
136. Naranjo D, Suttiprata SC, Iturralde E, et al. What end users and stakeholders want from automated insulin delivery systems. *Diabetes Care.* 2017;40(11):1453-1461. doi:[10.2337/dc17-0400](https://doi.org/10.2337/dc17-0400)
137. Laffel LM, Kanapka LG, Beck RW, et al. Effect of continuous glucose monitoring on glycemic control in adolescents and Young adults with type 1 diabetes: a randomized clinical trial. *JAMA.* 2020;323(23):2388-2396. doi:[10.1001/jama.2020.6940](https://doi.org/10.1001/jama.2020.6940)
138. James S, Perry L, Gallagher R, Lowe J. Diabetes educators: perceived experiences, supports and barriers to use of common diabetes-related technologies. *J Diabetes Sci Technol.* 2016;10(5):1115-1121. doi:[10.1177/1932296816660326](https://doi.org/10.1177/1932296816660326)
139. Tanenbaum ML, Adams RN, Lanning MS, et al. Using cluster analysis to understand clinician readiness to promote continuous glucose monitoring adoption. *J Diabetes Sci Technol.* 2018;12(6):1108-1115. doi:[10.1177/1932296818786486](https://doi.org/10.1177/1932296818786486)
140. Scheuing N, Wiegand S, Bächle C, et al. Impact of maternal country of birth on type-1-diabetes therapy and outcome in 27,643 children and adolescents from the DPV registry. *PLoS One.* 2015;10(8):e0135178. doi:[10.1371/journal.pone.0135178](https://doi.org/10.1371/journal.pone.0135178)
141. Predieri B, Bruzzi P, Bigi E, et al. Health-related quality of life and metabolic control in immigrant and Italian children and adolescents with type 1 diabetes and in their parents. *Pediatr Diabetes.* 2020;21(6):1031-1042. doi:[10.1111/pedi.13042](https://doi.org/10.1111/pedi.13042)
142. Natale-Pereira A, Enard KR, Nevarez L, Jones LA. The role of patient navigators in eliminating health disparities. *Cancer.* 2011;117(15):3543-3552. doi:[10.1002/cncr.26264](https://doi.org/10.1002/cncr.26264)
143. Malik FS, Yi-Frazier JP, Taplin CE, et al. Improving the care of youth with type 1 diabetes with a novel medical-legal community intervention: the diabetes community care ambassador program. *Diabetes Educ.* 2018;44(2):168-177. doi:[10.1177/0145721717750346](https://doi.org/10.1177/0145721717750346)
144. Okrainec K, Booth GL, Hollands S, Bell CM. Impact of language barriers on complications and mortality among immigrants with diabetes: a population-based cohort study. *Diabetes Care.* 2015;38(2):189-196. doi:[10.2337/dc14-0801](https://doi.org/10.2337/dc14-0801)
145. Iovane B, Cangelosi AM, Bonaccini I, et al. Effectiveness of a tailored medical support to overcome the barriers to education, treatment and good metabolic control in children with type-1 diabetes from ethnic minorities. *Acta Biomed.* 2018;88(4):477-482. doi:[10.23750/abm.v88i4.6779](https://doi.org/10.23750/abm.v88i4.6779)
146. Majidi S, Ebekozien O, Noor N, et al. Inequities in health outcomes in children and adults with type 1 diabetes: data from the T1D exchange quality improvement collaborative. *Clin Diabetes.* 2021;39(3):278-283. doi:[10.2337/cd21-0028](https://doi.org/10.2337/cd21-0028)
147. Ibrahim SA, ElHajj M, Zidan A, Owusu Y, Awaisu A. Barriers to diabetes adherence: translation and cultural adaptation of the instrument into Arabic context. *Value Health Reg Issues.* 2020;22:49-53. doi:[10.1016/j.vhri.2020.03.005](https://doi.org/10.1016/j.vhri.2020.03.005)
148. Snyder LL, Stafford JM, Dabelea D, et al. Socio-economic, demographic, and clinical correlates of poor glycaemic control within insulin regimens among children with type 1 diabetes: the SEARCH for diabetes in youth study. *Diabet Med.* 2019;36(8):1028-1036. doi:[10.1111/dme.13983](https://doi.org/10.1111/dme.13983)
149. Malik FS, Stafford JM, Reboussin BA, et al. Receipt of recommended complications and comorbidities screening in youth and young adults with type 1 diabetes: associations with metabolic status and satisfaction with care. *Pediatr Diabetes.* 2020;21(2):349-357. doi:[10.1111/pedi.12948](https://doi.org/10.1111/pedi.12948)
150. Commissariat PV, Boyle CT, Miller KM, et al. Insulin pump use in young children with type 1 diabetes: sociodemographic factors and parent-reported barriers. *Diabetes Technol Ther.* 2017;19(6):363-369. doi:[10.1089/dia.2016.0375](https://doi.org/10.1089/dia.2016.0375)
151. Almutlaq N, Neyman A, LA DM. Are diabetes microvascular complications risk factors for fragility fracture? *Curr Opin Endocrinol Diabetes Obes.* 2021;28(4):354-359. doi:[10.1097/med.0000000000000642](https://doi.org/10.1097/med.0000000000000642)
152. Lai CW, Lipman TH, Willi SM, Hawkes CP. Racial and ethnic disparities in rates of continuous glucose monitor initiation and continued use in children with type 1 diabetes. *Diabetes Care.* 2021;44(1):255-257. doi:[10.2337/dc20-1663](https://doi.org/10.2337/dc20-1663)
153. Desrochers HR, Schultz AT, Laffel LM. Use of diabetes technology in children: role of structured education for young people with diabetes and families. *Endocrinol Metab Clin North Am.* 2020;49(1):19-35. doi:[10.1016/j.ecl.2019.11.001](https://doi.org/10.1016/j.ecl.2019.11.001)
154. Pinsker JE, Singh H, McElwee Malloy M, et al. A virtual training program for the tandem t:slim X2 insulin pump: implementation and outcomes. *Diabetes Technol Ther.* 2021;23(6):467-470. doi:[10.1089/dia.2020.0602](https://doi.org/10.1089/dia.2020.0602)
155. Vigersky RA, Velado K, Zhong A, Agrawal P, Cordero TL. The effectiveness of virtual training on the MiniMed TM 670G system in people with type 1 diabetes during the COVID-19 pandemic. *Diabetes Technol Ther.* 2021;23(2):104-109. doi:[10.1089/dia.2020.0234](https://doi.org/10.1089/dia.2020.0234)
156. Messer LH, Berget C, Ernst A, Towers L, Slover RH, Forlenza GP. Initiating hybrid closed loop: a program evaluation of an educator-led control-IQ follow-up at a large pediatric clinic. *Pediatr Diabetes.* 2021;22(4):586-593. doi:[10.1111/pedi.13183](https://doi.org/10.1111/pedi.13183)
157. Gomez AM, Henao D, Parra D, et al. Virtual training on the hybrid close loop system in people with type 1 diabetes (T1D) during the COVID-19 pandemic. *Diabetes & Metabolic Syndrome.* 2021;15(1):243-247. doi:[10.1016/j.dsx.2020.12.041](https://doi.org/10.1016/j.dsx.2020.12.041)
158. Choudhary P, Campbell F, Joule N, Kar P. A type 1 diabetes technology pathway: consensus statement for the use of technology in type 1 diabetes. *Diabet Med.* 2019;36(5):531-538. doi:[10.1111/dme.13933](https://doi.org/10.1111/dme.13933)
159. Rytter K, Schmidt S, Rasmussen LN, Pedersen-Bjergaard U, Norgaard K. Education programmes for persons with type 1 diabetes using an insulin pump: a systematic review. *Diabetes Metab Res Rev.* 2020;37:e3412. doi:[10.1002/dmrr.3412](https://doi.org/10.1002/dmrr.3412)
160. Ortiz La Banca R, Butler DA, Volkening LK, Laffel LM. Play-based interventions delivered by child life specialists: teachable moments for youth with type 1 diabetes. *J Pediatr Health Care.* 2020;34(4):356-365. doi:[10.1016/j.pedhc.2020.02.002](https://doi.org/10.1016/j.pedhc.2020.02.002)
161. Kimbell B, Rankin D, Ashcroft NL, et al. What training, support, and resourcing do health professionals need to support people using a closed-loop system? A qualitative interview study with health professionals involved in the closed loop from onset in type 1 diabetes

- (CLOuD) trial. *Diabetes Technol Ther.* 2020;22(6):468-475. doi:[10.1089/dia.2019.0466](https://doi.org/10.1089/dia.2019.0466)
162. Fleming GA, Petrie JR, Bergenstal RM, Holl RW, Peters AL, Heinemann L. Diabetes digital app technology: benefits, challenges, and recommendations. A consensus report by the European Association for the Study of diabetes (EASD) and the American Diabetes Association (ADA) diabetes technology working group. *Diabetes Care.* 2020;43(1):250-260. doi:[10.2337/dc19-0062](https://doi.org/10.2337/dc19-0062)
163. Fleming M, Fitton CA, Steiner MFC, et al. Educational and health outcomes of children treated for type 1 diabetes: Scotland-wide record linkage study of 766,047 children. *Diabetes Care.* 2019;42(9):1700-1707. doi:[10.2337/dc18-2423](https://doi.org/10.2337/dc18-2423)
164. Maslow GR, Lobato D. Diabetes summer camps: history, safety, and outcomes. *Pediatr Diabetes.* 2009;10(4):278-288. doi:[10.1111/j.1399-5448.2008.00467.x](https://doi.org/10.1111/j.1399-5448.2008.00467.x)
165. American Diabetes Association. Diabetes management at camps for children with diabetes. *Diabetes Care.* 2012;35(1):S72-S75. doi:[10.2337/dc12-s072](https://doi.org/10.2337/dc12-s072)
166. La Banca RO, Brandão MCM, Sparapani VC, et al. A fun way to learn about diabetes: using therapeutic play in a Brazilian camp. *J Pediatr Nurs.* 2020;53:e35-e40. doi:[10.1016/j.pedn.2020.02.002](https://doi.org/10.1016/j.pedn.2020.02.002)
167. Phillip M, Battelino T, Atlas E, et al. Nocturnal glucose control with an artificial pancreas at a diabetes camp. *N Engl J Med.* 2013;368(9):824-833. doi:[10.1056/NEJMoa1206881](https://doi.org/10.1056/NEJMoa1206881)
168. Ekhlaspour L, Forlenza GP, Chernavsky D, et al. Closed loop control in adolescents and children during winter sports: use of the tandem control-IQ AP system. *Pediatr Diabetes.* 2019;20(6):759-768. doi:[10.1111/pedi.12867](https://doi.org/10.1111/pedi.12867)
169. Del Favero S, Boscarini F, Messori M, et al. Randomized summer camp crossover trial in 5- to 9-year-old children: outpatient wearable artificial pancreas is feasible and safe. *Diabetes Care.* 2016;39(7):1180-1185. doi:[10.2337/dc15-2815](https://doi.org/10.2337/dc15-2815)
170. Gawrecki A, Michalak A, Gałczyński S, Dachowska I, Zozulińska-Ziółkiewicz D, Szadkowska A. Physical workload and glycemia changes during football matches in adolescents with type 1 diabetes can be comparable. *Acta Diabetol.* 2019;56(11):1191-1198. doi:[10.1007/s00592-019-01371-0](https://doi.org/10.1007/s00592-019-01371-0)
171. McTavish L, Wiltshire E. Effective treatment of hypoglycemia in children with type 1 diabetes: a randomized controlled clinical trial. *Pediatr Diabetes.* 2011;12(4):381-387. doi:[10.1111/j.1399-5448.2010.00725.x](https://doi.org/10.1111/j.1399-5448.2010.00725.x)
172. Foster NC, Beck RW, Miller KM, et al. State of type 1 diabetes management and outcomes from the T1D exchange in 2016-2018. *Diabetes Technol Ther.* 2019;21(2):66-72. doi:[10.1089/dia.2018.0384](https://doi.org/10.1089/dia.2018.0384)
173. Prigge R, McKnight JA, Wild SH, et al. International comparison of glycaemic control in people with type 1 diabetes: an update and extension. *Diabet Med.* 2022;39(5):e14766. doi:[10.1111/dme.14766](https://doi.org/10.1111/dme.14766)
174. Lu JB, Danko KJ, Elfassy MD, Welch V, Grimshaw JM, Ivers NM. Do quality improvement initiatives for diabetes care address social inequities? Secondary analysis of a systematic review. *BMJ Open.* 2018;8(2):e018826. doi:[10.1136/bmjopen-2017-018826](https://doi.org/10.1136/bmjopen-2017-018826)
175. Ebekozien O, Mungmode A, Odugbesan O, et al. Addressing type 1 diabetes health inequities in the United States: approaches from the T1D exchange QI collaborative. *J Diabetes.* 2022;14(1):79-82. doi:[10.1111/1753-0407.13235](https://doi.org/10.1111/1753-0407.13235)
176. Witsch M, Kosteria I, Kordonouri O, et al. Possibilities and challenges of a large international benchmarking in pediatric diabetology-the SWEET experience. *Pediatr Diabetes.* 2016;17(23):7-15. doi:[10.1111/pedi.12432](https://doi.org/10.1111/pedi.12432)
177. Wells S, Tamir O, Gray J, Naidoo D, Bekhit M, Goldmann D. Are quality improvement collaboratives effective? A systematic review. *BMJ Qual Safety.* 2018;27(3):226-240. doi:[10.1136/bmjqqs-2017-006926](https://doi.org/10.1136/bmjqqs-2017-006926)
178. Gilmour JA, Mukerji G, Segal P, et al. Implementing change ideas, interpreting data and sustaining change in a quality improvement project. *Can J Diabetes.* 2019;43(4):249-255. doi:[10.1016/j.jcjd.2019.02.007](https://doi.org/10.1016/j.jcjd.2019.02.007)
179. Ginnard OZB, Alonso GT, Corathers SD, et al. Quality improvement in diabetes care: a review of initiatives and outcomes in the T1D exchange quality improvement collaborative. *Clinical Diabetes.* 2021;39(3):256-263. doi:[10.2337/cd21-0029](https://doi.org/10.2337/cd21-0029)
180. Bellido V, Aguilera E, Cardona-Hernandez R, et al. Expert recommendations for using time-in-range and other continuous glucose monitoring metrics to achieve patient-centered glycemic control in people with diabetes. *J Diabetes Sci Technol.* 2022;19322968221088601. Epub ahead of print. doi:[10.1177/19322968221088601](https://doi.org/10.1177/19322968221088601)
181. Agostratidou G, Anhalt H, Ball D, et al. Standardizing clinically meaningful outcome measures beyond HbA1c for type 1 diabetes: a consensus report of the American Association of Clinical Endocrinologists, the American Association of Diabetes Educators, the American Diabetes Association, the Endocrine Society, JDRF International, the Leona M. and Harry B. Helmsley Charitable Trust, the Pediatric Endocrine Society, and the T1D exchange. *Diabetes Care.* 2017;40(12):1622-1630. doi:[10.2337/dc17-1624](https://doi.org/10.2337/dc17-1624)
182. Indyk JA, Buckingham D, Obryna KS, et al. The type 1 diabetes composite score: an innovative metric for measuring patient care outcomes beyond hemoglobin a1c. *Pediatr Qual Saf.* 2020;5(5):e354-e354. doi:[10.1097/pq9.0000000000000354](https://doi.org/10.1097/pq9.0000000000000354)
183. Burry E, Ivers N, Mahmud FH, Shulman R. Interventions using pediatric diabetes registry data for quality improvement: a systematic review. *Pediatr Diabetes.* 2018;19(7):1249-1256. doi:[10.1111/pedi.12699](https://doi.org/10.1111/pedi.12699)
184. Cardona-Hernandez R, Schwandt A, Alkandari H, et al. Glycemic outcome associated with insulin pump and glucose sensor use in children and adolescents with type 1 diabetes. Data from the international pediatric registry SWEET. *Diabetes Care.* 2021;44(5):1176-1184. doi:[10.2337/dc20-1674](https://doi.org/10.2337/dc20-1674)
185. Alonso GT, Corathers S, Shah A, et al. Establishment of the T1D exchange quality improvement collaborative (T1DX-QI). *Clin Diabetes.* 2020;38(2):141-151. doi:[10.2337/cd19-0032](https://doi.org/10.2337/cd19-0032)
186. Bohn B, Karges B, Vogel C, et al. 20 years of pediatric benchmarking in Germany and Austria: age-dependent analysis of longitudinal follow-up in 63,967 children and adolescents with type 1 diabetes. *PLOS One.* 2016;11(8):e0160971. doi:[10.1371/journal.pone.0160971](https://doi.org/10.1371/journal.pone.0160971)
187. Margeirsdottir HD, Larsen JR, Kummernes SJ, Brunborg C, Dahl-Jørgensen K. The establishment of a new national network leads to quality improvement in childhood diabetes: implementation of the ISPAD guidelines. *Pediatr Diabetes.* 2010;11(2):88-95. doi:[10.1111/j.1399-5448.2009.00542.x](https://doi.org/10.1111/j.1399-5448.2009.00542.x)
188. UK and Wales National Paediatric Diabetes Audit 2020-2021. <https://www.rcpch.ac.uk/resources/nspa-annual-reports>. Accessed May 2, 2022.
189. Craig ME, Prinz N, Boyle CT, et al. Prevalence of celiac disease in 52,721 youth with type 1 diabetes: international comparison across three continents. *Diabetes Care.* 2017;40(8):1034-1040. doi:[10.2337/dc16-2508](https://doi.org/10.2337/dc16-2508)
190. Corathers SD, Schoettker PJ, Clements MA, et al. Health-system-based interventions to improve care in pediatric and adolescent type 1 diabetes. *Curr Diab Rep.* 2015;15(11):91. doi:[10.1007/s11892-015-0664-8](https://doi.org/10.1007/s11892-015-0664-8)
191. Gerhardsson P, Schwandt A, Witsch M, et al. The SWEET project 10-year benchmarking in 19 countries worldwide is associated with improved HbA1c and increased use of diabetes technology in youth with type 1 diabetes. *Diabetes Technol Ther.* 2021;23(7):491-499. doi:[10.1089/dia.2020.0618](https://doi.org/10.1089/dia.2020.0618)

192. Peterson A, Hanberger L, Åkesson K, Bojestig M, Andersson Gäre B, Samuelsson U. Improved results in paediatric diabetes care using a quality registry in an improvement collaborative: a case study in Sweden. *PLOS One*. 2014;9(5):e97875. doi:[10.1371/journal.pone.0097875](https://doi.org/10.1371/journal.pone.0097875)
193. Samuelsson U, Åkesson K, Peterson A, Hanas R, Hanberger L. Continued improvement of metabolic control in Swedish pediatric diabetes care. *Pediatr Diabetes*. 2018;19(1):150-157. doi:[10.1111/pedi.12467](https://doi.org/10.1111/pedi.12467)
194. Patterson CC, Karuranga S, Salpea P, et al. Worldwide estimates of incidence, prevalence and mortality of type 1 diabetes in children and adolescents: results from the International Diabetes Federation Diabetes Atlas, 9th edition. *Diabetes Res Clin Pract*. 2019;157:107842. doi:[10.1016/j.diabres.2019.107842](https://doi.org/10.1016/j.diabres.2019.107842)
195. Arredondo A, Azar A, Recamán AL. Diabetes, a global public health challenge with a high epidemiological and economic burden on health systems in Latin America. *Glob Public Health*. 2018;13(7):780-787. doi:[10.1080/17441692.2017.1316414](https://doi.org/10.1080/17441692.2017.1316414)
196. Yeaw J, Halinan S, Hines D, et al. Direct medical costs for complications among children and adults with diabetes in the US commercial payer setting. *Appl Health Econ Health Policy*. 2014;12(2):219-230. doi:[10.1007/s40258-014-0086-9](https://doi.org/10.1007/s40258-014-0086-9)
197. Williams R, Karuranga S, Malanda B, et al. Global and regional estimates and projections of diabetes-related health expenditure: results from the international diabetes federation diabetes Atlas, 9th edition. *Diabetes Res Clin Pract*. 2020;162:108072. doi:[10.1016/j.diabres.2020.108072](https://doi.org/10.1016/j.diabres.2020.108072)
198. Baxter M, Hudson R, Mahon J, et al. Estimating the impact of better management of glycaemic control in adults with type 1 and type 2 diabetes on the number of clinical complications and the associated financial benefit. *Diabet Med*. 2016;33(11):1575-1581. doi:[10.1111/dme.13062](https://doi.org/10.1111/dme.13062)
199. Moucheraud C, Lenz C, Latkovic M, Wirtz VJ. The costs of diabetes treatment in low- and middle-income countries: a systematic review. *BMJ Glob Health*. 2019;4(1):e001258. doi:[10.1136/bmjgh-2018-001258](https://doi.org/10.1136/bmjgh-2018-001258)
200. Ewen M, Joosse H-J, Beran D, Laing R. Insulin prices, availability and affordability in 13 low-income and middle-income countries. *BMJ Glob Health*. 2019;4(3):e001410. doi:[10.1136/bmjgh-2019-001410](https://doi.org/10.1136/bmjgh-2019-001410)
201. Henderson M, Friedrich M, Van Hulst A, et al. CARDEA study protocol: investigating early markers of cardiovascular disease and their association with lifestyle habits, inflammation and oxidative stress in adolescence using a cross-sectional comparison of adolescents with type 1 diabetes and healthy controls. *BMJ Open*. 2021;11(9):e046585. doi:[10.1136/bmjjopen-2020-046585](https://doi.org/10.1136/bmjjopen-2020-046585)
202. Lin X, Xu Y, Pan X, et al. Global, regional, and national burden and trend of diabetes in 195 countries and territories: an analysis from 1990 to 2025. *Sci Rep*. 2020;10(1):14790. doi:[10.1038/s41598-020-71908-9](https://doi.org/10.1038/s41598-020-71908-9)
203. Tran-Duy A, Knight J, Clarke PM, Svensson AM, Eliasson B, Palmer AJ. Development of a life expectancy table for individuals with type 1 diabetes. *Diabetologia*. 2021;64(10):2228-2236. doi:[10.1007/s00125-021-05503-6](https://doi.org/10.1007/s00125-021-05503-6)
204. Chen X, Pei Z, Zhang M, et al. Glycated hemoglobin (HbA1c) concentrations among children and adolescents with diabetes in middle- and low-income countries, 2010-2019: a retrospective chart review and systematic review of literature. *Front Endocrinol (Lausanne)*. 2021;12:651589. doi:[10.3389/fendo.2021.651589](https://doi.org/10.3389/fendo.2021.651589)
205. Pollock RF, Tikkainen CK. A short-term cost-utility analysis of insulin degludec versus insulin glargine U100 in patients with type 1 or type 2 diabetes in Denmark. *J Med Econ*. 2017;20(3):213-220. doi:[10.1080/13696998.2016.1245663](https://doi.org/10.1080/13696998.2016.1245663)
206. Ball D, Ewen M, Laing R, Beran D. Insulin price components: case studies in six low/middle-income countries. *BMJ Glob Health*. 2019;4(5):e001705. doi:[10.1136/bmjh-2019-001705](https://doi.org/10.1136/bmjh-2019-001705)
207. Babar Z-U-D, Ramzan S, El-Dahiyat F, Tachmazidis I, Adebisi A, Hasan SS. The availability, pricing, and affordability of essential diabetes medicines in 17 low-, middle-, and high-income countries. *Front Pharmacol*. 2019;10:1375. doi:[10.3389/fphar.2019.01375](https://doi.org/10.3389/fphar.2019.01375)
208. Gilbert TR, Noar A, Blalock O, Polonsky WH. Change in hemoglobin A1c and quality of life with real-time continuous glucose monitoring use by people with insulin-treated diabetes in the landmark study. *Diabetes Technol Ther*. 2021;23(S1):S35-s39. doi:[10.1089/dia.2020.0666](https://doi.org/10.1089/dia.2020.0666)
209. Dos Santos TJ, Donado Campos JM, Argente J, Rodríguez-Artalejo F. Effectiveness and equity of continuous subcutaneous insulin infusions in pediatric type 1 diabetes: a systematic review and meta-analysis of the literature. *Diabetes Res Clin Pract*. 2021;172:108643. doi:[10.1016/j.diabres.2020.108643](https://doi.org/10.1016/j.diabres.2020.108643)
210. Kamrath C, Tittel SR, Kapellen TM, et al. Early versus delayed insulin pump therapy in children with newly diagnosed type 1 diabetes: results from the multicentre, prospective diabetes follow-up DPV registry. *Lancet Child Adolesc Health*. 2021;5(1):17-25. doi:[10.1016/s2352-4642\(20\)30339-4](https://doi.org/10.1016/s2352-4642(20)30339-4)
211. Blair JC, McKay A, Ridyard C, et al. Continuous subcutaneous insulin infusion versus multiple daily injection regimens in children and young people at diagnosis of type 1 diabetes: pragmatic randomised controlled trial and economic evaluation. *BMJ*. 2019;365:l1226. doi:[10.1136/bmj.l1226](https://doi.org/10.1136/bmj.l1226)
212. Ramli R, Reddy M, Oliver N. Artificial pancreas: current Progress and future outlook in the treatment of type 1 diabetes. *Drugs*. 2019;79(10):1089-1101. doi:[10.1007/s40265-019-01149-2](https://doi.org/10.1007/s40265-019-01149-2)
213. Bekiari E, Kitsios K, Thabit H, et al. Artificial pancreas treatment for outpatients with type 1 diabetes: systematic review and meta-analysis. *BMJ*. 2018;361:k1310. doi:[10.1136/bmj.k1310](https://doi.org/10.1136/bmj.k1310)

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