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Quality of Life and Technology: Impact on Children and Families with Diabetes

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Abstract

Ensuring quality of life (QOL) while maintaining glycemic control within targets is an important challenge in type 1 and type 2 diabetes treatment. For children with diabetes, QOL includes enjoying meals, feeling safe in school, and perceiving positive, supportive relationships with parents, siblings, and friends. Yet many treatment-related and psychosocial barriers can interfere with a child's QOL and their ability to manage diabetes effectively. Diabetes management also imposes considerable lifestyle demands that are difficult and often frustrating for children to negotiate at a young age.

Recent advances in diabetes medications and technologies have improved glycemic control in children with diabetes. Two widely used technologies are the insulin pump and continuous glucose monitoring (CGM) system. These technologies provide patients with more flexibility in their daily life and information about glucose fluctuations. Several studies report improvements in glycemic control in children with type 1 diabetes using the insulin pump or sensor-augmented pump therapy. Importantly, these technologies may impact QOL for children and families with diabetes, although they are rarely used or studied in the treatment of children with type 2 diabetes. Further, emerging closed loop and web- and phone-based technologies have great potential for supporting diabetes self-management and perhaps QOL. A deeper understanding and appreciation of the impact of diabetes technology on children's and parents' QOL is critical for both the medical and psychological care of diabetes. Thus, the purpose of this review is to discuss the impact of new diabetes technologies on QOL in children, adolescents and families with type 1 diabetes.

Keywords

Adolescents; Children; Quality of life; Type 1 diabetes; Continuous glucose; monitoring; Continuous subcutaneous insulin infusion; Insulin pump; Technology

Introduction

Ensuring quality of life (QOL) for children and their families while maintaining glycemic control within targets is an important challenge in diabetes treatment. For children with diabetes, this well-recognized outcome[1, 2] includes enjoying meals, feeling safe in school,

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and perceiving positive, supportive relationships with parents, siblings, and friends. Diabetes management imposes considerable demands (diabetes nutrition guidelines, insulin regimens, glucose fluctuations, and blood glucose monitoring) that are difficult for children to negotiate at a young age. Family support is an essential factor for successful treatment, yet parents may worry about both acute and long-term side effects and complications[3].

The literature has no generally accepted definition of QOL and the value of generic versus health-related QOL is under debate[4, 5].Here we adopt Wallander et al.[5]'s broad definition: the combination of objective and subjective measures of well-being in multiple domains of life important to one's culture and time[12]. Relevant QOL domains for children and families with type 1 diabetes include treatment satisfaction, family relationships, self-efficacy, lifestyle flexibility, anxiety, fears of glucose fluctuations, fear of diabetes complications, and treatment expectations. Because QOL and glycemic control are two important and related outcomes in diabetes management, understanding relationships among these domains and outcomes has important implications for the effective adoption and use of diabetes technology in children and families with type 1 diabetes. Figure 1 shows the possible relationships among these domains and diabetes outcomes: glycemic control (A1C) and QOL.

Recent advances in insulin delivery systems and other technologies have helped improve glycemic control in those with type 1 diabetes. Specifically, insulin therapy has improved with the development of new diabetes technologies, such as subcutaneous continuous insulin infusion (the insulin pump) and continuous glucose monitoring (CGM). Several meta-analyses suggest that insulin pump therapy and CGM improve glycemic control[6-10]. Two older reviews [4, 10] suggest that more rigorous methodology in clinical trials that include quality of life is important to further evaluate the impact of new therapies on QOL. Here we build on and update those reviews.

New diabetes technologies are rarely used or studied in the treatment of children with type 2 diabetes, thus their effectiveness is not known. While children with type 2 diabetes are generally asymptomatic, both children and their families encounter additional lifestyle challenges (e.g., weight reduction, increased physical activity) and numerous barriers to diabetes management that impact quality of life[11]. The DAWN Youth Survey found that 35% of young adults with type 2 diabetes and 48% of their parents reported poor well-being[12]. Two studies conducted in adults with type 2 diabetes using insulin pump therapy found that participants reported higher treatment satisfaction, less management burden and fewer social limitations[13, 14]. Research on the potential benefits, including QOL, of insulin pump therapy, CGM, and other technologies for children and adolescents with type 2 diabetes is needed. Further, uniform measurement of QOL is necessary to reduce variation in observed outcomes and allow for direct comparisons across research studies[15].

In this review, we discuss the impact of new technologies on quality of life in children and families with type 1 diabetes. In the first section, we describe QOL of children with type 1 diabetes and their parents, specifically the relationship among QOL, glycemic control, and parental support in type 1 diabetes self-care. Next, we discuss the impact of insulin pump therapy and then that of continuous glucose monitoring on QOL and related domains in children and their parents. Finally, we briefly introduce other new technologies and their potential for influencing QOL.

Quality of Life for Children with Type 1 Diabetes and Parents

Intensive insulin treatment and improved glycemic control are associated with long-term reduction in diabetes complications in type 1 diabetes[16]. Intensive insulin regimens are demanding and include multiple daily injections (MDI), frequent blood glucose monitoring,

appropriate food consumption, and adequate exercise. Importantly, the Diabetes Control and Complications Trial demonstrated that intensive insulin treatment with its more rigorous self-care improved glycemic control while maintaining QOL[17]. Further, good glycemic control itself is associated with better QOL in adolescents with type 1 diabetes[18, 19]. Many clinicians, however, worry that the demands of managing diabetes, e.g., timing of meals and insulin, prevention of complications and glucose fluctuations, and the glucose fluctuations themselves, have a negative impact on the child's and family's QOL.

Successful diabetes treatment depends heavily on appropriate self-management and children and adolescents need family support and assistance to be effective in their self-care. Importantly, parental support is associated with good glycemic control in children[20, 21], is subsequently associated with better life satisfaction in parents[3]. However, parents of children with type 1 diabetes may worry about emotional and behavioral problems[22] and they report children's overall health to be poorer than that of the general population, especially in psychosocial and parent/family domains[23]. Further, parents of adolescents with type 1 diabetes experienced less life satisfaction than other parents of school-aged children[3].

Importantly, parental involvement is associated with adolescents' more frequent blood glucose monitoring[24], while less parental support is associated with poorer diabetes outcomes[25]. Parental over-involvement can detrimental, however, and result in "miscarried helping," in which parents, although well-intentioned, blame and shame the child rather than assisting in diabetes management. [26, 27]. Further, parental over-involvement may create diabetes-related family conflicts[28]. High family conflict and low family support are both associated with poor glycemic control[29] and poor QOL[30]. Children's perceived conflict is greater than that of parents[24]; the main sources of conflict for adolescents are parental worry, intrusive and/or blaming behaviors, and parents' lack of understanding about diabetes [26]. Conversely, warm and caring family behaviors positively impact self-care participation by children and adolescents with type 1 diabetes. Such agency over their self-care contributes to fewer worries, a lower impact of diabetes, and greater life satisfaction[31].

In summary, good glycemic control with intensive insulin regimen, sufficient children's self-management, and adequate family support are important factors for improving and/or maintaining QOL for both children with type 1 diabetes and their parents.

Impact of Diabetes Technology on Quality of Life

Insulin Pump Therapy

Impact of Insulin Pump Therapy on Quality of Life of Children and Their Parents—The development of the insulin pump has improved intensive insulin therapy[10]. With the pump, patients have the benefit of 1) flexibility to make precise adjustments to insulin doses; 2) multiple bolus insulin infusion patterns such as normal, square, and dual-wave boluses and 3) adjustment of hourly basal insulin doses[32]. With other tools such as the insulin pen, injections can only be adjusted by 0.5 units compared to 0.1 unit adjustments in bolus insulin and 0.025-0.05 unit/h adjustments in basal doses with the pump. For children with type 1 diabetes, this increased flexibility in daily life is one of the main benefits of insulin pump therapy[33].

Whether increased flexibility in insulin dose adjustments translate to improved QOL survey scores is not yet established. In several short-term randomized trials, QOL did not differ between children using insulin pump therapy versus MDI treatment[34-36]. However, most of these studies were limited by small sample sizes (e.g., n=16-72). An open, parallel

randomized trial reported clinical improvements in Pediatric Quality of Life Inventory (PedsQL)[37] scores following insulin pump treatment versus MDI[34]. A multi-center prospective pre-post study found that children using insulin pump therapy showed improvements in diabetes-specific QOL with moderate to large effect sizes (Cohen's effect sizes d = 0.6-1.3)[38]. Another study found flexibility in dosage and timing of meals is an important benefit of insulin pump therapy[39] and that parents of young children on the insulin pump reported fewer mealtime behavior problems[40].

Diabetes self-efficacy, a person's confidence in his/her ability to perform diabetes self-care tasks, is another factor that may influence QOL. Diabetes self-efficacy is related to better glycemic control in adolescents[41, 42]. Studies show that patients on the insulin pump improve diabetes self-efficacy more than patients on MDI treatment[43, 44]. A qualitative study found that adolescents using the insulin pump reported greater independence and more responsibility for their diabetes regimen[39]. One explanation for improved diabetes self-efficacy is that insulin pump therapy requires frequent blood glucose checks and insulin adjustment for food intake, which may increase a patient's sense of self-management responsibility and involvement in care.

For parents of children with type 1 diabetes, a major concern is the development of complications[3]. Parents often expect the pump to reduce the chances of complications through better glycemic control[39]. However, when children transition to insulin pump therapy during the first few weeks, parents may worry about the catheter, pump malfunction, whether their child receives too much insulin, and whether other children at school might press pump buttons. Parents must learn new treatment skills, such as how to operate the insulin pump, how to adjust insulin doses, and how to insert infusion sets. Although these techniques can be challenging for many parents, most report feeling confident with the insulin pump 6 weeks to 9 months after initializing therapy[45].

In terms of parental QOL, some randomized controlled studies show that diabetes-specific QOL scores do not differ between insulin pump groups and MDI groups[34, 46-48], with similar results on parenting stress[49]. However, these studies are limited by small samples sizes (e.g., n=16-38). A randomized controlled study found that fathers in the insulin pump group improved QOL scores at 6-month follow-up[46]. Other studies found that parents report increased flexibility of meal schedules, insulin infusion timing, dose adjustment, and sleep schedules as benefits of insulin pump therapy[33, 39]. Sleep schedule flexibility may be a result of reduced anxiety due to decreases in nocturnal hypoglycemia with insulin pump therapy. Some parents described this flexibility as the release from the "slavery of diabetes management" that affects parents, children, siblings, and overall family life. In addition, parents reported that their newly found freedom (i.e., flexibility) allowed them to pay more attention to their children without diabetes[45].

Treatment satisfaction, a component of QOL, is an essential factor for both children and parents. Two randomized controlled studies showed insulin pump use improved children's treatment satisfaction [35, 50]. A cross-sectional study and a qualitative study found that both parents and children had high satisfaction with insulin pump therapy[33, 39]. Another study showed that parents reported reduced frequency and intensity of parenting stress and fear associated with hypoglycemia[38].

Children and their parents may have excessively high expectations of improvements in glycemic control with insulin pump treatment, especially if the child is in poor control. In an adult qualitative study on insulin pump therapy, patients with poor glycemic control described expectations reminiscent of a "magical" or "miracle" view of the insulin pump. In contrast, patients in good glycemic control recognized that the insulin pump was "a

convenient tool" to help them reach treatment goals[51]. Most of the technology that patients use today requires patient involvement; the main operator in diabetes treatment remains the patient, not the instrument. Thus, clinicians and diabetes educators should prepare children and their patients with realistic expectations for the use of this technology.

In summary, the flexibility of insulin pump treatment has several benefits for both children and their parents, including improvement of children's self-management and diabetes self-efficacy. Our review supports those presented by Phillip and colleagues[52], stating that QOL with insulin pump therapy is similar to or higher than that of children and adolescents with MDI. These findings are promising; however, more well-designed studies are needed to confirm the impact of insulin pump therapy on quality of life in these children and their parents. As noted by Barnard and colleagues[4], poor methodological designs (e.g., no control group), low participant numbers and inconsistent assessments of QOL limit the ability to assert a strong association between QOL benefits and insulin pump therapy.

Barriers of Insulin Pump Therapy—Insulin pump therapy has several adverse effects, which may impact quality of life, including severe hypoglycemia, diabetic ketoacidosis (DKA), and infection, pain and/or skin problems at the infusion site. Because patients use only a quick-acting insulin analog in their insulin pump, disruptions in insulin flow can rapidly induce DKA. Technology limitations in earlier versions of the insulin pump (e.g., loose tubing causing insulin leaks, bent or kinked tubing preventing insulin delivery) increased the risk for DKA; however, with improved insulin pump technology the risk for DKA has decreased greatly. However, most randomized controlled studies with the insulin pump and MDI treatment in children and adolescents showed no differences in the frequency of DKA[10, 34-36, 46-48, 53]. Further, a multicenter pair-matched cohort study showed that insulin pump therapy decreased the frequency of DKA; this finding was maintained at the three year follow-up period [54]. DKA remains a serious side-effect of insulin pump therapy, but as patients, families, and clinicians become more familiar with the technology, the frequency of DKA should decrease[55, 56].

Hypoglycemia poses a significant challenge of parents and children with type 1 diabetes [57]. Most randomized controlled studies do not show differences in the frequency of severe hypoglycemia in insulin pump use versus insulin injections[34-36, 46-48, 50, 53], most likely because these studies were short-term with small samples (e.g., n=16-72). Importantly, in longitudinal studies with three[54, 58] to four year[59] follow-up, the frequency of severe hypoglycemia decreased with insulin pump therapy.Further, parental fear of hypoglycemia for children on MDI treatment can be higher than that of children on insulin pump therapy[60].

Some clinicians worry that body image concerns may be a barrier to insulin pump treatment because children may feel self-conscious or embarrassed about wearing devices that could call attention to their diabetes. Further, these devices may be viewed as an invasion of privacy[61]. However, in a qualitative study of parents' experiences managing their child's type 1 diabetes using an insulin pump, the insulin pump was described as a "mini life-support system"[45]. Another qualitative study found insulin pumps had little impact on how children felt about their bodies or their appearance, and only described tape residue and old sites as minor issues related to appearance[39]. Thus, wearing the insulin pump may not be a problem for most children. One explanation for this finding is that the pumps may be less intrusive or embarrassing for children than using alternatives such as insulin pens or syringes.

Insulin pump therapy requires more skills than other treatments. One study found that children acquire mastery for insulin pump-related skills at an older age compared to MDI

skills, most likely due to the increased number and complexity of skills associated with insulin pumps[62]. However, this does not mean younger children cannot independently master pump procedures for bolus infusions. Research shows that parents can help younger children learn about pump mechanics and share insulin pump tasks with their children more easily than with MDI treatment[63].

Finally, minimal research has explored the distribution of insulin regimens across racial/ethnic backgrounds and socioeconomic status. A recent study by Paris and colleagues shows insulin pump use is more common in non-Hispanic white families and families with higher household incomes, higher parental education and private insurance[64]. This finding is particularly important given that adolescents from ethnic minorities are more likely to have higher HbA_{1c} levels[65-68]. More equitable distribution of resources is needed to help all children and adolescents with type 1 diabetes improve glycemic control and QOL. Additional research is needed to understand the impact of race/ethnicity, education and socioeconomic status on diabetes treatment preferences.

School Life with Insulin Pump Therapy—Appropriate diabetes care in school is necessary for children's safety, long-term well-being, and optimal academic performance[69]. Children and adolescents on intensive insulin treatment regimens report higher health-related quality of life (HRQOL) on Friends and School subscales[70]. The positive impact of insulin pump therapy on friendships may be due to children with diabetes being perceived as the same as others, rather than being identified as 'different.' Further, the flexibility in food choices and meal times allows children to participate more fully in social activities with their friends[63].

Keeping children with diabetes safe in school is extremely important, as they spend half of their day in school. School nurses play an important role in children's diabetes care, especially for younger patients who are not able to take care of their diabetes themselves. Lack of understanding about type 1 diabetes and related technologies is common among teachers and school nurses[71]. School nurses may lack education and experience with new diabetes technologies[72] because schools are often under-resourced and under-funded. Training, including hands-on experience with the insulin pump, can help school nurses to correctly understand and operate the device[72]. In pre-school age type 1 diabetes children, research indicates that there is no difference in glycemic control between patients whose mothers take care of their insulin pump treatment versus other caregivers[73].Thus, pre-school and school nurses who understand the treatment can effectively manage insulin pump therapy and interact more appropriately with children with type 1 diabetes. Including school nurses as a member of the child's diabetes care team is important for consistent care[61].

Continuous Glucose Monitoring Treatment—HbA_{1c} reflects average blood glucose levels over several months. Recent research argues that glycemic instability, not just high HbA_{1c} levels, may contribute to the development of diabetes complications[74-76], suggesting that preventing blood glucose fluctuations as well as high HbA_{1c} levels is important for well-controlled diabetes. Thus, understanding and preventing glycemic fluctuations is becoming more important in the treatment of diabetes.

Continuous glucose monitoring (CGM) is a novel monitoring system that measures glucose levels at five-minute intervals. Originally, CGM devices had wires attaching the subcutaneous sensor to the device; data were then downloaded to a computer. Now wireless devices that have the advantage of providing glucose readings in real-time are also available. One important benefit of CGM is the ability to identify glucose trends between meals and during the night. CGM also allows patients to preset alerts to warn of hypoglycemia or hyperglycemia.

Parents have high expectations of CGM. Only a small percentage of parents believe that using a CGM will increase their diabetes-related stress, though many have anxiety about using a new treatment[77]. Children and their parents reported the following benefits of real-time CGM: hypoglycemia prevention (88%), elimination of hypoglycemia-related anxiety(83%), ease of pattern management, improvement in diabetes control (80%), improvement in quality of life (78%), and ease of diabetes care (78%)[78].

Impact of Continuous Glucose Monitoring on Quality of Life—With the advent of new complex technologies, clinicians often worry that quality of life for children and families would be negatively affected. However, Chase et al. reported no difference in diabetes quality of life (DQOL) scores between the CGM group and conventional treatment group in a randomized study with a small sample size[79]. Several large randomized controlled studies have examined QOL in real-time CGM versus conventional treatment[80-83]. In a multicenter randomized controlled trial, the Diabetes Research in Children Network (DirecNet) group found high parental satisfaction with CGM treatment but no meaningful changes in QOL, parental fear of hypoglycemia, and diabetes-related distress[80]. The Juvenile Diabetes Research Foundation (JDRF) study, a large multicenter randomized controlled study comparing real-time CGM versus conventional treatment group, also found no differences in generic and diabetes-specific QOL scores [81]. Further, this study reported no differences in parental fear of hypoglycemia between CGM and conventional treatment groups. Both the DirecNet study[80] and JDRF study[81] observed no differences between CGM and conventional treatment groups in parental QOL and parent diabetes-related distress scores. Interestingly, a small follow-up study to the JDRF trial found that children (8-17 years old) randomized to CGM reported greater anxiety and negative affect around blood glucose monitoring compared to children randomized to standard blood glucose monitoring[84] Others found that pain, discomfort, problematic equipment, intrusiveness and other hassles as barriers[85]. These findings support the need to examine relationships between multiple psychosocial correlates and CGM in order to improve CGM utilization, glycemic control and QOL.

Frequency of CGM use may be associated with QOL and glycemic control. JDRF and Sensor-Augmented Pump Therapy for A1C Reduction (STAR 3) studies showed improvement in HbA1c levels in the insulin pump and CGM treatment group[82, 83]. Both the child and adult groups improved HbA1c levels in the STAR 3 study; however, in the JDRF study the 8-14 year old age group and 15-24 year old age group did not improve HbA1c levels. In the JDRF study, 83% of patients aged 25 years or older used CGM 6 or more days per week, while usage decreased in both the 15 to 24 year old and 8 to 14 year old groups (30% and 50% of patients respectively)[83]. In the DirecNet study, only 41% children used CGM at least 6 or more days per week at the end of study (26 weeks) [80]. The STAR 3 study also found an association between an increase in the frequency of sensor use and a greater reduction in HbA1c[82]. In terms of QOL and treatment satisfaction, the DirecNet study found that higher parents' scores on a self-management survey[86] and PedsQL were associated with more frequent CGM use[87]. In the JDRF study, CGM satisfaction was higher for patients who used CGM 6 or more days per week compared to those who used it less than 6 days per week[81, 88]. This finding suggests that patients who use CGM less frequently may feel annoyed with multiple CGM sensor insertions and the alarms. In contrast, patients who use CGM 6-7 days per week may perceive more benefits than disadvantages from using CGM because the CGM has become part of their daily routine. In summary, improvement in QOL with CGM may depend on how frequently patients use the device, patients' attitude towards CGM, and perceptions of its value.

Barriers to CGM Use—CGM requires more tasks than finger stick glucose monitoring. The main areas of dissatisfaction involve mechanical problems such as sensor alarms,

interference in daily routine by alarms, and the sensor feeling too bulky[78]. Children and parents reported more problems with the technical aspects (e.g., false alarms, inaccuracy) and less dissatisfaction with the psychological ramifications of CGM use (e.g., anxiety, intrusiveness, family conflict)[89]. Further, body image concerns may be a barrier with CGM. Patients who treat their diabetes with the insulin pump and CGM wear two devices at two insertion sites. Skin reactions may also become a barrier. One study showed that skin reactions were cited as a main reason for reduced frequency of CGM use in children less than 4 years of age[90]. However, in the JDRF study, children reported fewer concerns about pain at insertion sites and body image issues compared to their parents and more annoyances with alarms[88]. Finally, the high cost of new diabetes technology can be a barrier for diabetes treatment as CGM is more expensive than fingerstick monitoring, and some insurance companies do not cover these costs[91].

Other Diabetes Technologies

Impact of Other Technologies on Quality of Life—Several other technologies may be useful for diabetes education and self-care support. For example, web-based programs targeting adolescents may support self-care[92-95] and mobile phones are easy and convenient tools for both data management and medical support[96-99]. Importantly, usage of new technologies may wane over time[96]. Some children with type 1 diabetes may require complex insulin adjustment, and the new smart phones may help with applications such as a food intake calculator, an insulin dose calculator, and a blood glucose reference tool. In a meta-analysis of mobile phone interventions, patients with type 1 diabetes reduced HbA1c values by a mean change of 0.3%[100]. Importantly, 24-hour mobile phone support was associated with reduced DKA in young adults with type 1 diabetes (mean age is 19.9-22.0 years old)[101]. An intervention study using the insulin pump and mobile phone support showed an improvement in DQOL global scores and DQOL satisfaction scores[102]. Another study using a daily scheduled text-messaging support system found improvements in diabetes self-efficacy and self-care adherence in children with type 1 diabetes aged 8 to 18 years[103]. Finally, a study of phone-based glucose monitoring found no effect on QOL.[104] Although more studies are needed, smart phone technologies have potential for improving both self-care and QOL.

Other new technologies have been developed specifically for insulin treatment. The intraperitoneal insulin infusion pump has shown improvements in QOL compared to standard insulin pump treatment[105, 106], although the comparative impact on HbA1c remains unclear[106, 107]. Inhaled insulin has also shown improvements in glycemic control and treatment satisfaction in a randomized controlled trial with adult type 1 diabetes patients[108, 109].

The ideal insulin treatment device of the future may be the closed-loop system. A few closed-loop systems have been developed and tested in randomized controlled trials[110-112], however, these systems are not yet ready for commercial use. If and when closed-loop systems are approved for use, their impact on patients' and families' QOL will be of great interest.

Conclusions

New technologies for diabetes treatment have several benefits. In this review, we reported that increased flexibility of daily life is one of the most important benefits for improving QOL for children with type 1 diabetes and their parents. Insulin pump therapy improves meal-times, bolus infusion patterns and hourly basal insulin does, which in turn, increases flexibility in children's and families daily lives. Further, insulin pump therapy can improve diabetes self-efficacy and engagement in children, thereby improving diabetes self-

management. CGM treatment is helpful in identifying glucose trends between meals and during the night, which can decrease fear of hypoglycemia and improve QOL for children and their families. Finally, combined treatment, or CGM sensor-augmented insulin pump therapy, may be the most successful treatment for children with type 1 diabetes until closed-loop systems are approved for use.

While several observational and qualitative studies report improvements in QOL, diabetes self-efficacy and treatment satisfaction with insulin pump therapy and CGM treatment, only a few randomized controlled studies demonstrate improvements in QOL. Thus, future randomized controlled studies need to include QOL as an outcome to ensure that developing technologies have a positive impact on children and families with diabetes. Further, the examination of QOL as an important health outcome is particularly relevant given that the US FDA now recommends patient-reported outcome results in clinical trials[1, 2, 113]. Finally, minimal research has examined the impact of new technology in children with type 2 diabetes. Clinical trials that assess the effectiveness of these new treatment tools for technology in children and families with type 2 diabetes are needed.

In conclusion, both children and their families face numerous challenges to diabetes management that impact QOL. Clinicians are well-positioned to recognize the cues of children and parents struggling to manage diabetes amidst self-care difficulties and daily life stressors. Integrating diabetes technology, such as insulin pump therapy and CGM, into a child's treatment plan may help children improve their QOL and glycemic control while preventing severe hypoglycemia and DKA. Thus, a more comprehensive understanding and appreciation of children's and parents' QOL and the provision of support and self-management skills training are critical for both the medical and psychological care of type 1 diabetes.

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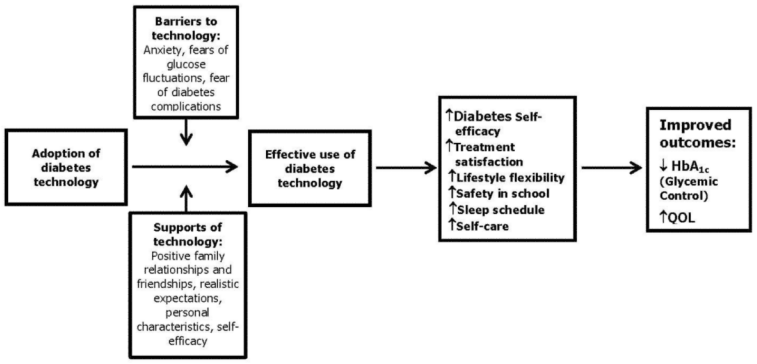

Figure 1.
Conceptual Model of the Possible Relationships among Factors Influencing the Adoption of Diabetes Technology.