Diabetes Technology and the Human Factor

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Introduction

THE ROLE OF TECHNOLOGIES in the management of diabetes (both type 1 and type 2) has become increasingly significant in recent years. Continuous glucose monitors (CGMs) and insulin pumps (continuous subcutaneous insulin infusion [CSII]) as well as artificial pancreas systems (AP) are undergoing rapid technological development and many diabetic patients choose to start using them over traditional diabetes management. Utilization of these devices is correlated with improved glycemic control and significant reduction of hypoglycemia events. However, there is still a significant gap between the benefits of using such diabetes technologies and the relatively low percentage of patients who start using them. In addition, patients are faced with challenges in successful onboarding and continued use in terms of being able to manage their own expectations and the expectations of their health-care teams, burnout with frequent alarms and connectivity issues, and lack of sufficient understanding as to how to make sense of the large amounts of associated data, leading to suboptimal use or discontinuation of these devices. The documentation of barriers to device use can help in the design of interventions to increase uptake. A significant part of the factors affecting diabetes technologies utilization are addressed at the person or family level. In particular, the “human factors”—or patient perceptions, beliefs, attitudes, expectations, and preferences—regarding technology use are included among the most important goals for research as well as for clinical intervention. In this article, we review studies from the past year dealing with the interface between the latest technologies in diabetes and the human factor. The studies focused on a variety of psychosocial areas such as patient satisfaction and quality of life from devices and their impact on adherence to treatment; attitudes of professionals treating diabetes toward the technologies; and their impact on mediating the use of the device for patients. In addition, studies concerned with fear and hypoglycemia in the specific context of diabetes technologies were explored, as this remains a widespread anxiety for many. As technologies continue to improve and offer opportunities for both optimal glycemic management and reduced burden associated with living with diabetes, the way that psychosocial factors are considered and addressed in development, onboarding, and ongoing support will continue to grow in importance in achieving desired outcomes.

Key Articles Reviewed for the Article

Closing the loop in adults, children and adolescents with suboptimally controlled type 1 diabetes under free living conditions: a psychosocial substudy

Barnard KD, Wysocki T, Ullly V, Mader JK, Pieber TR, Thabit H, Tauschmann M, Leelarathna L, Hartnell S, Acerini CL, Wilinska ME, Dellweg S, Benesch C, Arnolds S, Holzer M, Kojzar H, Campbell F, Yong J, Pichierri J, Hindmarsh P, Heinemann L, Evans ML, Hovorka R

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Continuous glucose monitoring (CGM) adherence in youth with type 1 diabetes: associations with biomedical and psychosocial variables

Giani E, Snelgrove R, Volkening LK, Laffel LM

Diabetes Sci Technol 2017; **11**: 476–483

Diabetes device use in adults with type 1 diabetes: barriers to uptake and potential intervention targets

Tanenbaum ML, Hanes SJ, Miller KM, Naranjo D, Bensen R, Hood KK

Diabetes Care 2017; **40**: 181–187

Evaluating the experience of children with type 1 diabetes and their parents taking part in an artificial pancreas clinical trial over multiple days in a diabetes camp setting

Troncone A, Bonfanti R, Iafusco D, Rabbone I, Sabbion A, Schiaffini R, Galderisi A, Marigliano M, Rapini N, Rigamonti A, Tinti D, Vallone V, Zanfardino A, Boscarei F, Del Favero S, Galasso S, Lanzola G, Messori M, Di Palma F, Visentin R, Calore R, Leal Y, Magni L, Losiouk E, Chernavsky D, Quaglini S, Cobelli C, Bruttomesso D

Diabetes Care 2016; **39**: 2158–2164

Glycemia, treatment satisfaction, cognition, and sleep quality in adults and adolescents with type 1 diabetes when using a closed-loop system overnight versus sensor-augmented pump with low-glucose suspend function: a randomized crossover study

Sharifi A, De Bock MI, Jayawardene D, Loh MM, Horsburgh JC, Berthold CL, Paramalingam N, Bach LA, Colman PG, Davis EA, Grosman B, Hendrieckx C, Jenkins AJ, Kumareswaran K, Kurtz N, Kyoong A, MacIsaac RJ, Speight J, Trawley S, Ward GM, Roy A, Jones TW, O'Neal DN

Diabetes Technol Ther 2016; **18**: 772–783

Influence of health locus of control and fear of hypoglycaemia on glycaemic control and treatment satisfaction in people with type 1 diabetes on insulin pump therapy

Indelicato L, Mariano V, Galasso S, Boscarei F, Cipponeri E, Negri C, Frigo A, Avogaro A, Bonora E, Trombetta M, Bruttomesso D

Diabet Med 2017; **34**: 691–697

Initiation of insulin pump therapy in children at diagnosis of type 1 diabetes resulted in improved long-term glycemic control

Lang EG, King BR, Miller MN, Dunn SV, Price DA, Foskett DC

Pediatr Diabetes 2017; **18**: 26–32

Optimal use of diabetes devices: clinician perspectives on barriers and adherence to device use

Tanenbaum ML, Adams RN, Hanes SJ, Barley RC, Miller KM, Mulvaney SA, Hood KK

J Diabetes Sci Technol 2017; **11**: 484–492

Psychological outcomes of evening and night closed-loop insulin delivery under free living conditions in people with type 1 diabetes: a 2-month randomized crossover trial

Kropff J, DeJong J, Del Favero S, Place J, Messori M, Coestier B, Farret A, Boscarei F, Galasso S, Avogaro A, Bruttomesso D, Cobelli C, Renard E, Magni L, DeVries JH; for the AP@home consortium

Diabet Med 2017; **34**: 262–271

Reexamining the hypoglycemia fear survey for parents of young children in a sample of children using insulin pumps

Patton SR, Noser AE, Clements MA, Dolan LM, Powers SW

Diabetes Technol Ther 2017; **19**: 103–108

White coat adherence in pediatric patients with type 1 diabetes who use insulin pumps

Driscoll KA, Wang Y, Bennett Johnson S, Lynch R, Stephens H, Willbur K, Gill E, Wright N, Deeb LC

J Diabetes Sci Technol 2016; **10**: 724–729

Closing the loop in adults, children and adolescents with suboptimally controlled type 1 diabetes under free living conditions: a psychosocial substudy

Barnard KD¹, Wysocki T², Ullly V³, Mader JK³, Pieber TR³, Thabit H^{4,5}, Tauschmann M^{4,6}, Leelarathna L^{4,5}, Hartnell S⁵, Acerini CL⁶, Wilinska ME⁴, Dellweg S⁷, Benesch C⁷, Arnolds S⁷, Holzer M³, Kojzar H³, Campbell F⁸, Yong J⁸, Pichierri J⁹, Hindmarsh P⁹, Heinemann L⁷, Evans ML^{4,5}, Hovorka R⁴

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Objective

The aim of this study was to examine psychosocial experiences of closed-loop technology for people with type 1 diabetes (adults, children, and adolescents) and their parents who took part in two multicenter, free-living, randomized crossover home studies.

Methods

Subjects who were using insulin pump therapy were divided into two randomized groups: one using 12 weeks of automated closed-loop glucose control and then 12 weeks of sensor augmented insulin pump therapy (open loop), and doing the reverse. Adults used the closed-loop system for 24 hours; children and adolescents used it only overnight. Participants filled in the Diabetes Technology Questionnaire (DTQ) occasionally and shared their views in semistructured interviews. This analysis is to identify the participant experiences with the closed-loop technology, and how this technology affects everyday living and factors important to quality of life in ways that are important to participants.

Results

Thirty-two adults (55% male, age 38.6 ± 9.6 years) and 26 children (54% male, mean age 12 years [range 6–18 years]) participated in this study. DTQ results indicated moderately

better impact and satisfaction with both open and closed-loop interventions, and with little evidence of a comparative advantage of either. Improved blood glucose control; improved general well-being, particularly on waking; improved sleep; reduced burden of diabetes; and visibility of data were identified as positive key elements. Having to carry the equipment and insertion of the pumps and a second cannula were considered as negative elements.

Conclusions

In general, participants reported a positive experience with the closed-loop technology. Results are compared with previous studies showing that size of equipment is still a problem. Progress is being made in the usability of the closed-loop system.

Comments

Research in the field of artificial pancreas has undergone several stages of development in recent years. While most early studies of the AP have been performed in controlled situations, more current AP research has been taken out of the laboratory and into more normal “free living” situations (1). In the current study, participants have moved from being able to eat their meals in an observed outpatient setting or able to perform short periods of unannounced exercise for example, to engaging in lifestyle behaviors much more reflective of real-life experience. There is no doubt that the transition to research in a natural environment is significant and important. However, understanding the subjective experience of patients is another essential step in adapting the technologies to the psychological needs of patients. The experience of patients with diabetes must be taken into account—their coping with CGM and CSII and the difficulty of some patients (especially adolescents) in wearing the devices on their bodies may be a critical component of their long-term adherence to AP treatment.

Continuous glucose monitoring (CGM) adherence in youth with type 1 diabetes: associations with biomedical and psychosocial variables

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Background

Although the overall performance of CGMs have improved over the past few years, its use is still not common by many patients, especially in the pediatric age group. This study is aimed at exploring the reasons for the low use of CGM.

Method

Youth with type 1 diabetes (T1D) and their caregivers were recruited and followed for a 6-month observation period to assess CGM use. Electronic medical records and joint parent–youth interviews provided demographic and clinical data. CGM use was verified by downloads indicating the 4-week periods preceding 3- and 6-month study visits. Subjects and their parents filled in validated psychosocial surveys at baseline and 6 months.

Results

A total of 61 youth aged 12.7 ± 2.9 years old, with T1D (52% male, 93% Caucasian, 80% pump treated), duration of T1D of 6.3 ± 3.8 years, and mean glycohemoglobin (HbA1c) $7.9 \pm 0.9\%$ participated in the study. Mean CGM use at 3 months was 4.1 ± 2.1 days/week (median=4.8) and at 6 months was 3.4 ± 2.3 days/week (median=3.9). At 3 and 6 months, participants discontinued using CGM at a rate of 15% and 20%, respectively. At 6 months, participants using CGM 6–7 days/week had more frequent blood glucose (BG) monitoring ($P=0.05$), less insulin omission ($P=0.02$), and greater probability of HbA1c $<7.5\%$ ($P=0.01$) than those using CGM less often. Youths who consistently used CGM 6–7 days/week during the 6-month study period demonstrated lower HbA1c at 3 months compared with baseline ($P=0.03$) and maintained the improvement at 6 months ($P=0.5$, 3 vs. 6 months); those using CGM less often exhibited no significant change in HbA1c. Baseline BG monitoring ≥ 8 times/day or HbA1c within target ($<7.5\%$) predicted greater CGM use (6–7 days/week) at 6 months (OR=4.6, $P=0.02$). CGM use did not worsen the psychosocial functioning of the participants.

Conclusions

Coherent and durable CGM use in youth with T1D is correlated with treatment adherence and better glycemic control without increasing psychosocial distress.

Comments

Over the past decade, significant progress has been made in the usability and accuracy of CGM; however, the use of CGM remains challenging for many patients, especially for children and adolescents (2,3). Barriers for CGM use may be physical (e.g., pain, skin irritations); clinical (e.g., alerts and alarms may cause discontinuation); social (e.g., visibility of disease state); and financial. There are further subjective psychosocial factors that affect adherence to CGM use, such as stress caused by diabetes regimen, quality of life, and family conflicts. Onboarding to CGM should include support to address these factors alongside clinical factors. The assessment of adherence to CGM among children and adolescents should include the integration of both biomedical (e.g., HbA1c and blood glucose monitoring) and psychosocial factors.

Diabetes device use in adults with type 1 diabetes: barriers to uptake and potential intervention targets

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Objective

It is well known that the use of technologies for the treatment of diabetes, such as insulin pumps and CGMs, improves glycemic control. However, we find that the utilization of these devices is low. Some obstacles to device use may be improved by psychosocial intervention, but not much is known regarding how to tackle them.

Research Design and Methods

The authors reviewed 1503 adults who participated in the T1D Exchange (mean age 35.3 [SD 14.8] years; mean diagnosis duration 20.4 [12.5] years) in an effort to understand what are the barriers that keep patients away from use of technology, identify the profiles of device users versus nonusers, and see if there are any differences by age and sex. The authors used the following measures: diabetes distress scale, technology use attitudes (general and diabetes specific), barriers to device use, and reasons for discontinuing devices.

Results

Most of the reported difficulties were associated with the challenges of wearing devices (47%) and aversion to having them on the body (35%). Participants who used CGM (37%) were older than nonusers (mean 38.3 vs. 33.5 years) and had diabetes for longer time (22.9 vs. 18.8 years). CGM users also had more positive attitudes toward technology (22.6–26.0 vs. 21.4–24.8) than did nonusers (3.3 vs. 4.3). The youngest group (18–25 years) had the lowest CGM (26% vs. 40%–48%) and insulin pump uptake (64% vs. 69%–77%), as well as the highest diabetes distress (2.2 vs. 1.8–2.1) and HbA1c levels (8.3% [67 mmol/mol] vs. 7.2%–7.4% [55–57 mmol/mol]).

Conclusions

Efforts to increase device use need to be directed at improving the physical features relating to the wearing of the devices and should be focused on treating young adults, since this group had the lowest device uptake rates, highest distress, and highest HbA1c compared with older age groups.

Comments

According to the data taken from the T1DX CGM, uptake rates among type 1 diabetes patients remains relatively low despite the reported benefits of CGM on glycemic control as well as health-related quality of life and treatment satisfaction (4). Moreover, considering

the central role these devices as integral components of artificial pancreas systems, low usage of CGMs may decrease the acceptance and use of such systems in the future.

This study offers an interesting perspective about discontinuation of CGM. Given that CGM users reported more positive attitudes about technology and diabetes-specific technology than nonusers, it could be expected that there would be more young users than adults. Surprisingly, the opposite was found; there are more older users than young people. A possible explanation for this interesting finding may be related to the fact that younger people are deterred by other aspects of CGM, such as disliking the visibility of diabetes devices (5), being worried about the opinion of their peers, the scrutiny of (otherwise unseen) data by parents and HCPs, or receiving negative attention about their diabetes device. These findings underscore the necessity to take into consideration unique barriers to diabetes device use among young adults and address these on an individual basis.

Evaluating the experience of children with type 1 diabetes and their parents taking part in an artificial pancreas clinical trial over multiple days in a diabetes camp setting

Troncone A¹, Bonfanti R², Iafusco D³, Rabbone I⁴, Sabbion A⁵, Schiaffini R⁶, Galderisi A⁷, Marigliano M⁵, Rapini N⁸, Rigamonti A², Tinti D⁴, Vallone V⁹, Zanfardino A³, Boscarì F⁹, Del Favero S¹⁰, Galasso S⁹, Lanzola G¹¹, Messori M¹², Di Palma F¹², Visentin R¹⁰, Calore R¹⁰, Leal Y¹⁰, Magni L¹², Losiouk E¹¹, Chernavvsky D¹³, Quaglini S¹¹, Cobelli C¹⁰, Bruttomesso D⁹

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Objective

The aim of this study was to investigate the experiences of children with type 1 diabetes and their caregivers who participated in an artificial pancreas clinical trial during a 7-day summer camp.

Methods

The authors used a semistructured interview consisting of 14 questions based on the Technology Acceptance Model and carried out at the end of the clinical trial. Subjects also answered the Diabetes Treatment Satisfaction Questionnaire (DTSQ, parent version) and the AP Acceptance Questionnaire.

Results

The study was completed by 30 children (5–9 years old) and their parents. A content analysis of the interviews showed that while parents had more interest in understanding the mechanisms, risks, and benefits of the new device, the children were more interested in the novelty of the new system. The parents' main concerns about adopting the new system seemed connected to the quality of glucose control. The mean scores of DTSQ subscales indicated that parents were generally satisfied (44.24 ± 5.99 , range 32–53) with the system and had trust in its ability to control diabetes (7.8 ± 2.2 , range 3–12). Responses to the AP Acceptance Questionnaire showed that 70.5% of the parents considered the AP easy to use, 94.0% anticipated that they will use it for a long time, and 67.0% felt that it was capable of improving glucose control.

Conclusions

Results of this study suggest a positive approach of the participants toward the AP. Additional studies are needed to explore participants' perceptions early in the AP development so that the new treatment can be individualized as much as possible and tailored in a way that will accommodate their needs.

Comments

In recent years research on artificial pancreas has progressed significantly. It is especially important to understand the psychosocial implications of this technology in order to improve user engagement. Additionally, it is equally important to evaluate the level of confidence a person with diabetes has in the accuracy of the system, as well as their perceived burden in using the technology—specifically, how much effort will be required of him or her in order to manage it (6). In the current research, one of the most significant factors that could affect parents' willingness to start using AP was the fear of novelty, their inexperience with such a new system, and an anxiety around changing from their familiar diabetes regimen. In addition, they were concerned about the challenges of using a new therapy with associated loss or passage of diabetes control from the parent to a technological device. Parents' concerns regarding the utilization of AP for their children must be taken into consideration to achieve improved acceptance of these new devices and to prevent potential psychological barriers to AP technology adoption and continued use.

Glycemia, treatment satisfaction, cognition, and sleep quality in adults and adolescents with type 1 diabetes when using a closed-loop system overnight versus sensor-augmented pump with low-glucose suspend function: a randomized crossover study

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Background

The aim of this study was to compare glycemia, treatment satisfaction, sleep quality, and cognition in patients with T1D using a nighttime Android-based hybrid closed-loop system (Android-HCLS) versus sensor-augmented pump with low-glucose suspend function (SAP-LGS).

Material and Methods

The study was conducted as an open-label, prospective, randomized crossover including 12 adolescents (mean [SD] age 15.2 [1.6] years) and 16 adults (42.1 [9.6] years). All subjects used Android-HCLS (proportional integral derivative with insulin feedback algorithm; Medtronic) and SAP-LGS at home for four consecutive nights. The primary outcome was the percent time of CGM (00:00–08:00 h) within target range (72–144 mg/dL), and secondary endpoints were the percent time of CGM time above target (>144 mg/dL) and below target (<72 mg/dL), glycemic variability (SD), symptomatic hypoglycemia, adult treatment satisfaction, sleep quality, and cognitive function.

Results

The main result for all participants was not statistically different between Android-HCLS and SAP-LGS (mean [SD] 59.4 [17.9]% vs. 53.1 [18]%; $P=0.14$). Adults had greater percent time within target range (57.7 [18.6]% vs. 44.5 [14.5]%; $P<0.006$); less time above target (42.0 [18.7]% vs. 52.6 [16.5]%; $P=0.034$); and lower glycemic variability (35

[10.7] mg/dL vs. 46 [10.7] mg/dL; $P=0.003$). Median time below target with Android-HCLS vs. SAP-LGS was lower for both adults (0.0 [IQR 0.0–0.4]% vs. 0.80 [0.0–3.9]%; $P=0.025$) and adolescents (0.0 [0.0–0.0]% vs. 1.8 [0.1–7.9]%; $P=0.011$). The decrease in nocturnal symptomatic hypoglycemia was significant in adolescents (1 vs. 10; $P=0.007$), but not in adults (5 vs. 13; $P=0.059$). Treatment satisfaction increased by 10 points in adults ($P<0.02$). There was no difference for sleep quality and cognition measures.

Conclusions

Android-HCLS lowered nocturnal hypoglycemia in adults as well as in adolescents. In adults, it improved overnight time in optimal range and treatment satisfaction compared with SAP-LGS.

Comments

In the current study neither subjective nor objective measures of cognitive functioning differed between Android-HCLS and SAP-LGS. The authors suggest that “the current study used only exploratory endpoints” and that “studies with larger numbers and of longer duration may be needed to estimate an effect.” Previous studies have shown that cognitive domains commonly reported to be affected in people with type 1 diabetes include general intellectual ability (both verbal and performance) and executive functioning parameters such as continuous performance, auditory attention, and concept formation (7,8). These important domains together create the ability to fully achieve cognitive potential. In light of these data, it makes sense that prolonged use of technologies that enable continuous monitoring and/or automatic insulin delivery will help prevent cognitive decline among people with diabetes.

Influence of health locus of control and fear of hypoglycaemia on glycaemic control and treatment satisfaction in people with Type 1 diabetes on insulin pump therapy

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This manuscript is also discussed in the article on Insulin Pumps, page S-30.

Aim

The psychological profile of people eligible for CSII therapy is an important factor for the management of

diabetes. The aim of this study is to explore the impact of psychological factors on glycemic control and treatment satisfaction in adults using insulin pumps.

Methods

Two hundred and fourteen subjects (mean $\pm$ SD age 43.4 ± 12.1 years) with type 1 diabetes participated in a multicenter, cross-sectional study. They were consecutively enrolled and were divided into two groups: an "acceptable glucose control" group ($HbA1c \leq 58$ mmol/mol [7.5%]) and a "suboptimum glucose control" group ($HbA1c > 58$ mmol/mol [7.5%]). All received questionnaires to assess health locus of control (Multidimensional Health Locus of Control [MHLC] scale, with internal and external subscales), fear of hypoglycemia (Hypoglycemia Fear Survey II [HFS-II]), and treatment satisfaction (Diabetes Treatment Satisfaction Questionnaire [DTSQ]).

Results

The suboptimum glucose control group ($n=127$) had lower mean $\pm$ SD internal MHLC and DTSQ scores than the acceptable glucose control group (19.6 ± 5.2 vs. 21.0 ± 5.0 , $P=0.04$, and 28.8 ± 4.8 vs. 30.9 ± 4.5 , $P<0.001$). HFS-II scores were identical between the two groups. Internal MHLC score was negatively associated with $HbA1c$ ($r=-0.15$, $P<0.05$) and positively correlated with DTSQ score ($r=0.17$, $P<0.05$) as well as the number of hypoglycemic episodes both mild and severe ($r=0.16$, $P<0.05$, and $r=0.18$, $P<0.001$, respectively). HFS-II score was positively associated with number of severe hypoglycemic episodes ($r=0.16$, $P<0.05$) and negatively associated with DTSQ score ($r=-0.18$, $P<0.05$).

Conclusions

Internal locus of control plays a significant role in achieving tight glucose control in adults with type 1 diabetes using CSII therapy.

Comments

In accordance with a recent consensus statement, characteristic traits of patients with diabetes may be used to predict a successful utilization of insulin infusion (9). For example, a preferred candidate for CSII would be a patient with high engagement with their diabetes regimen, that is, one who is highly motivated to achieve optimal blood glucose control yet unable to do so on current therapy and has both the willingness and ability to carry out the tasks required for optimal benefit of this complex and time-consuming therapy. On the other hand, individuals who are less motivated by technology, who have a history of nonadherence to insulin injection protocols, who report substantial reservations about pump usage interfering with lifestyle, or who have unrealistic expectations of pump therapy (e.g., belief that it reduces the requirements of intensive insulin management) will not be good candidates for CSII use. However, there is no reference to the psychological factors that increase or decrease such engagement or to the extent that patient or health-care professional expectations can be managed in terms of the requirements of pump

treatment. In the current study, the theory of locus of control is applied for this purpose. This theory is often used in health psychology to assess self-management behavior in chronic illness. When applied to diabetes management, people with an internal control orientation (success or failure are attributable to one's own efforts) are expected to engage more effectively with pump use because they believe that they can influence the disease.

Initiation of insulin pump therapy in children at diagnosis of type 1 diabetes resulted in improved long-term glycemic control

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Background

The use of continuous subcutaneous insulin infusion (CSII) by children and young people with type 1 diabetes is becoming more and more popular. There is uncertainty as to when is the right time for children to start using insulin pumps.

Objective

The aim of this study was to assess whether early initiation of CSII in children with type 1 diabetes leads to better glycemic control and quality of life (QOL) in comparison with later introduction of CSII.

Participants

Thirty-eight participants were assigned to the early pump group (EPG) (age 12.6 ± 4.9 years; 23 male) and thirty-seven to the later pump group (LPG) (age 13.1 ± 4.1 years; 19 male).

Methods

Demographic and clinical data ($HbA1c$ levels, rates of severe hypoglycemia, and diabetic ketoacidosis [DKA], as well as other diabetes-related parameters) were collected retrospectively from the medical records of the participants for up to 48 months prior to the beginning of the study. Subjects and/or their parents completed both a Pediatric and Pediatric Diabetes-Specific Quality of Life Inventory.

Results

Across the 48 months of the study, $HbA1c$ measurements were lower in the EPG (6.8%; 51 mmol/mol) compared with the LPG (7.9%; 63 mmol/mol) ($P<0.0001$). There was no

significant difference between the two groups in the rate (per patient years) of severe hypoglycemia (0.02 and 0.07 for EPG and LPG respectively; $P=0.075$). There were no episodes of DKA in either group. Satisfaction rates were high, with no significant difference in QOL between the groups.

Conclusions

Beginning CSII in children with type 1 diabetes at diagnosis resulted in consistently lower HbA1c with apparently no change in hypoglycemia, DKA, or QOL.

Comments

In recent years, a growing body of evidence has developed, examining the effect of early insulin pump initiation on glycemic control and the quality of diabetes management. So far there has been no consensus among researchers about the effectiveness of early initiation. Several studies found no added benefit in glycemic control over time in commencement of early CSII vs. initiation of CSII later, while others showed that early CSII initiation resulted in lower and more sustained HbA1c levels than a later initiation (10–12). It is possible that the correlation between an early initiation of insulin pump therapy and better glycemic control is not a direct one, but rather, indirect and mediated by various factors. For example, as the authors of the current study suggest, it is important that the family receive general diabetes education as well as education in the use of CSII when commencing CSII. This education should include dietetic advice and the involvement of a mental health professional to optimize psychosocial outcomes alongside biomedical outcomes.

Optimal use of diabetes devices: clinician perspectives on barriers and adherence to device use

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Background

It has already been shown that using devices (insulin pumps and continuous glucose monitors) contributes to improvement of glycemic control for patients with type 1 diabetes (T1D). However, despite these reported benefits, the rate of utilization of these devices continue to be low. It is therefore important to find ways in which diabetes caregivers can encourage the use of devices.

Methods

The authors reviewed the work of 209 clinicians who treat people with type 1 diabetes to define barriers to the use of devices, attitudes toward diabetes technology, and what clinicians need in order to improve acceptance of the devices.

The authors then compared their findings with their previous survey of adults with T1D.

Results

It was shown that younger clinicians were more apt to treat their patients with insulin pumps ($r=-0.26$, $P<0.001$) and CGM ($r=-0.14$, $P=0.02$), and that they had more positive attitudes toward diabetes technology ($r=-0.23$, $P=0.001$). The most commonly identified barriers from the patients' point of view were unpleasantness with having the device on their body (73% pump; 63% CGM), dislike of the alarms (61% CGM), and a lack of understanding of the device information or features (40% pump; 46% CGM). Clinicians expressed interest in better insurance coverage and lower cost for their patients and also emphasized the importance of counseling and education to help address barriers and improve uptake and continued use of devices.

Conclusions

It seems that psychoeducation and practical support (such as remote monitoring and check-ins between medical visits) as well as emotional support may encourage the use of and adherence to diabetes devices.

Comments

The role that the diabetes team plays in improving successful diabetes device utilization is central and important. Clinicians can offer and encourage appropriate device initiation, which is especially important when one takes into consideration the potential benefits of CGM but the relatively low percentage of users. Diabetes teams contribute greatly to education for effective use of technology, promoting optimal utilization of the device and supporting effective problem solving. This helps patients to improve glycemic control, reduce diabetes distress, optimize quality of life, and prevent/reduce device discontinuation (13–16). Given the above, it is a subject of great importance to understand clinicians' perceptions about barriers and their attitudes concerning diabetes technologies. It is also important to develop a structured protocol for presenting devices to the patient in a way that will encourage more people with diabetes to switch to diabetes technologies to optimize their diabetes self-management and outcomes.

Psychological outcomes of evening and night closed-loop insulin delivery under free living conditions in people with type 1 diabetes: a 2-month randomized crossover trial

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Aim

The aim of this study was to determine the impact of the current artificial pancreas (AP) prototype compared with sensor-augmented pump therapy on treatment satisfaction and fear of hypoglycemia as well as on acceptance of the AP technology.

Methods

Thirty-two patients participated in this randomized crossover trial in which patient-related results with an evening-and-night AP and with sensor-augmented pump therapy were compared. The artificial pancreas acceptance questionnaire, Hypoglycemia Fear Survey II, and Diabetes Treatment Satisfaction Questionnaire were used. Semistructured interviews were conducted in a subset of six participants after completion of the study. Quantitative outcomes were compared using a repeated-measures anova model or paired *t* test when appropriate.

Results

At the end of the AP period, the total artificial pancreas acceptance questionnaire score was 69.1 (SD 14.7; 95% CI 63.5–74.7), which indicates a positive attitude toward this system. No significant differences were found among the scores at baseline, end of sensor-augmented pump therapy period, or end of the AP period with regard to fear of hypoglycemia [28.2 (SD 17.5), 23.5 (SD 16.6), and 23.5 (SD 16.7), respectively; *P*=0.099] or diabetes treatment satisfaction [29.0 (SD 3.9), 28.2 (SD 5.2), and 28.0 (SD 7.1), respectively; *P*=0.43]. Themes mentioned in the interviews were of mixed nature—some favored the use of AP systems, noting “positive effects at work,” “improved blood glucose,” “fewer worries about blood glucose,” while others disliked “frequent alarms,” “technological issues,” and “demand for an all-in-one device.”

Conclusions

The psychological results were similar for AP and sensor-augmented pump therapy. Current AP technology is promising, but further development of this system should take into consideration the concerns of the users.

Comments

This study examined the treatment satisfaction and acceptance of an artificial pancreas system using validated questionnaires and semistructured interviews in a long-term, randomized crossover trial in people with type 1 diabetes. The theoretical framework for the semistructured interviews was based on the Technology Acceptance Model (TAM). The TAM was based on two concepts: perceived usefulness and perceived ease of use. Perceived usefulness was defined as the degree to which a person believes that using the new system would

enhance job performance. Perceived ease of use was defined as to what degree a person believes that using a particular system would be free of effort (17). The importance of this study is that it enables an examination of the correlation between acceptance of technology and fear of hypoglycemia using structured theoretical models that enable clear conceptualization.

Reexamining the hypoglycemia fear survey for parents of young children in a sample of children using insulin pumps

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Background

The authors updated the psychometric properties of the 26-item questionnaire Hypoglycemia Fear Survey–Parents of Young Children (HFS-PYC), which measures parents' hypoglycemia fear for young children using an insulin pump.

Methods

The authors integrated three similar datasets for the analyses, which included parents' responses to the HFS-PYC and demographic data. Self-monitoring of blood glucose data was also analyzed for a subset of children (*n*=91). Confirmatory factor analysis (CFA) was used to verify the measure's original factor structure. The reliability and validity of a revised HFS-PYC for parents of young children using insulin pumps were examined in further analysis.

Results

Data from 116 parents (93% mothers) was analyzed. Mean child age was 5.2±1.3 years, and HbA1c was 8.2 ±1.1%. A 22-item two-factor solution was identified by CFA (χ^2 [208, *n*=116]=368.688, *P*<0.001, root mean square error of approximation=0.08, comparative fit index=0.94, and Tucker-Lewis index=0.93) with factors corresponding to the original subscales: worry and behavior. Adequate internal consistency was demonstrated by the revised subscales (Cronbach's alpha >0.65). Significant negative associations were revealed via correlations between current HFS-PYC worry scores and children's mean daily blood glucose and rate of very high glucose levels per day, which suggests that there is less fear among parents of young children with elevated glycemic levels. Additionally, a positive association existed with the proportion of glucose levels in target range,

suggesting greater hypoglycemia fear among parents of children who have better glycemic control.

Conclusions

The results of this study provide preliminary data for the reliability and validity of a reduced 22-item HFS-PYC for parents of children using insulin pumps.

Comments

The use of an insulin pump in young children has increased significantly in recent years. Data from the T1D Exchange suggest that approximately 70% of young children use an insulin pump for daily diabetes management (18). The current study is interesting because it demonstrates that the psychological response of parents of young children with diabetes changes with the transition to an insulin pump. Perhaps surprisingly, it appears that some of the advantages of the pump may cause more psychological distress and worries among parents. For example, the authors suggest that because the pump may reduce glycemic variability compared with children who are conventionally managed, the parents of children on pumps may have less experience and lower confidence in managing hypoglycemia successfully and so report higher fear. On the other hand, the increased flexibility of pump therapy, which enables parents to make insulin adjustments more easily and to be less dependent on behaviors that may overcompensate for hypoglycemia, may lead to reduced anxiety and avoidance behaviors among parents.

White coat adherence in pediatric patients with type 1 diabetes who use insulin pumps

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Background

White coat adherence is described as the adherence behaviors of patients prior to the diabetes clinic visits. The aim of this study was to evaluate the incidence of white coat adherence in children and adolescents with type 1 diabetes (T1D) who use insulin pumps.

Methods

During two consecutive routine clinic visits, data, including blood glucose monitoring (BGM), carbohydrate inputs, and insulin boluses delivered were downloaded from the insulin pumps of children and adolescents with T1D, aged 7–19 years. Patterns of BGM, carbohydrate inputs, and insulin

boluses delivered were analyzed using linear mixed models in patients whose insulin pumps had ≥ 28 days of stored data.

Results

Overall, younger children were involved in more frequent BGM, carbohydrate inputs, and insulin boluses delivered than were older children and adolescents. Analysis of the pump data showed that in younger children only, white coat adherence occurred with frequency of BGM, carbohydrate inputs, and insulin boluses delivered.

Conclusions

Diabetes care teams need to be aware that white coat adherence may happen, especially in young children. It is customary for clinicians to download meter and insulin pump data for the 1- to 2-week period before the clinic visit. Data for patients demonstrating white coat adherence will not provide accurate information, as it will be an overestimation of the patient's actual adherence behavior.

Comments

Diabetes technologies such as CSII as well as CGM are equipped with the ability to download data for review of glucose patterns. The historical data helps to inform users and their health-care team of trends over multiple days and weeks. While a conventional blood glucose log or glucometer download provides snapshots of glycemic control, CSII and CGM device download shows a more complete picture, particularly providing postprandial glucose levels and overnight glucose values that are often missed with conventional finger-stick testing. This enables the clinician to make important changes with patients to their insulin regimens in an effort to improve glycemic control. The current study used accurate glucose data from CSII, thus facilitating a more detailed assessment of glucose exposure and glycemic variability and a much more profound insight about the concept of adherence. This study adds to a growing body of literature using objectively downloaded data from insulin pumps versus self-report data (19).

Author Disclosure Statement

No competing financial interests exist for K.B. or A.L.

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