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REVIEW

Safety, Metabolic and Psychological Outcomes of Medtronic MiniMed 780G™ in Children, Adolescents and Young Adults: A Systematic Review

Stefano Passanisi · Fortunato Lombardo · Chiara Mameli · Bruno Bombaci · Maddalena Macedoni · Gianvincenzo Zuccotti · Klemen Dovc · Tadej Battelino · Giuseppina Salzano · Maurizio Delvecchio

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ABSTRACT

The MiniMed™ 780G is a second-generation automated insulin delivery system that implements a modified proportional–integral–derivative algorithm with some features of an MD-Logic artificial pancreas algorithm. The system may deliver automatic correction boluses up to every 5 min, and it allows the user to choose between three glucose target setpoints (100, 110 and 120 mg/dL). We aimed to review the current evidence on this device in children, adolescents, and young adults living with type 1 diabetes. We screened 783 papers, but only 31 manuscripts were included in this review. Data on metabolic outcomes show that this system is safe as regards severe hypoglycaemia and diabetic ketoacidosis. The glycated haemoglobin may drop to levels about 7%, with CGM reports showing a time in range of 75–80%. The time above range and the time below range are within the recommended target in most of the subjects. Few studies evaluated the psychological outcomes. This system seems to be more effective than the first-generation automated insulin delivery systems. The MiniMed™ 780G has been associated with an improvement in sleep quality in subjects living with diabetes and their caregivers, along with an improvement in treatment satisfaction. Psychological distress is

Stefano Passanisi, Fortunato Lombardo, Giuseppina Salzano, and Maurizio Delvecchio equally contributed to the paper.

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S. Passanisi · F. Lombardo · B. Bombaci · G. Salzano
Department of Human Pathology in Adult and Developmental Age "Gaetano Barresi", University of Messina, Messina, Italy

C. Mameli · M. Macedoni · G. Zuccotti
Department of Pediatrics, Buzzi Children's Hospital, University of Milan, Milan, Italy

C. Mameli · G. Zuccotti
Department of Biomedical and Clinical Science, University of Milan, Milan, Italy

K. Dovc · T. Battelino
University Medical Center Ljubljana, University of Ljubljana, Ljubljana, Slovenia

M. Delvecchio
Department of Biotechnological and Applied Clinical Sciences, University of L'Aquila, L'Aquila, Italy

M. Delvecchio (✉)
Metabolic Disorders and Clinical Genetics, "Giovanni XXIII" Children's Hospital, AOU Policlinico-Giovanni XXIII, Via Giovanni Amendola 207, 70126 Bari, BA, Italy
e-mail: mdelvecchio75@gmail.com

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as reduced as the glucose control is improved. We also discuss some case reports describing particular situations in clinical practice. Finally, we think that data show that this system is a further step towards the improvement of the treatment of diabetes as concerns both metabolic and psychological outcomes.

Keywords: MiniMed 780G; Medtronic 780G; Automated insulin delivery; Type 1 diabetes; Advanced hybrid closed loop; CGM metrics; Quality of life

Key Summary Points
The first generation of automated insulin delivery (AID) systems improved blood glucose control, but frequent alarms and exits from the automatic function were a burden for people living with diabetes, leading to a decrease in automatic mode use over time.
The MiniMed™ 780G system is a second-generation AID system for the treatment of diabetes mellitus that is more tailored to individual users' needs, thus leading to an increase in the overall time spent in automatic mode.
The MiniMed™ 780G system is safe and effective. It improves blood glucose control, with time in range and glycated haemoglobin at target occurring more frequently than in the past.
The MiniMed™ 780G system has beneficial effects on psychological issues.
This second-generation AID system properly addresses the burden of frequent user input and auto-exits.

INTRODUCTION

Type 1 diabetes is characterized by impaired glucose regulation and manifests as hyperglycaemia due to autoimmune destruction of insulin-secreting pancreatic β-cells. Consequently, individuals with T1D currently have a lifelong need for insulin replacement therapy [1]. The primary goal in the management of T1D is to maintain blood glucose levels as close to normal as possible, since prolonged exposure to hyperglycaemia may result in micro- and macrovascular complications [2]. The achievement of tight glycaemic targets has been shown to considerably lower the risk of complications [3] and premature death [4], making intensive insulin treatment essential for precise diabetes management.

Recent advances in diabetes technologies have fundamentally changed the landscape of diabetes care and represent an important aid for preventing the consequences of impaired glucose control. Continuous glucose monitoring (CGM) systems are increasingly reliable and currently represent the standard of monitoring for people living with T1D [5]. Insulin pumps were shown to have better glycaemic outcomes compared to insulin injection therapy due to the ability to simulate physiological insulin secretion through individually tailored basal and bolus insulin delivery [6]. The introduction of sensor-augmented pumps, resulting from the connection of insulin pumps to CGM systems with the aim of suspending insulin delivery in the case of incipient or predicted low glucose levels, has resulted in a further improvement in the safety and quality of life of people with T1D [7–10]. More recently, some automated insulin delivery (AID) systems have been approved for clinical practice. The MiniMed™ 670G was the first commercialized automated insulin delivery (AID) system. It implements a modified proportional–integral–derivative (PID) algorithm that automatically adjusts the basal insulin delivery rate to achieve a predetermined sensor glucose target of 120 mg/dL. Data from clinical trials and observational studies have shown an overall beneficial effect on glycaemic outcomes among paediatric and adult participants [11].

However, the need for more aggressive and efficient AID systems has arisen from the difficulty of maintaining sustained optimal glycaemic outcomes for many users [12]. A high rate of therapy discontinuation, mainly due to technical issues, was reported [13], and there is a substantial burden due to the excessive amount of time spent engaging with the device [14].

Second-generation AID systems, also labelled advanced hybrid closed-loop (AHCL) systems, were developed and are increasingly available on the market [15]. The MiniMed™ 780G received Conformite Europeenne approval for clinical use in 2020. To create this second-generation system, the first-generation PID controller was upgraded by embedding some features of an MD-Logic artificial pancreas algorithm. The new algorithm is also able to detect meals through a specific module and, if needed, to deliver more responsive automatic correction boluses up to every 5 min, allowing the user to choose between three different glucose target setpoints of 100, 110 and 120 mg/dL. In addition, integral action, the insulin feedback module, and the adaptation method have been modified to make insulin delivery patterns even more tailored to the individual users' needs, with the aim being to increase the overall time spent with the automatic mode activated by changing the conditions for AID mode exits [16]. However, similar to other current AID systems, the MiniMed™ 780G is not yet fully automated, and meal announcements with carbohydrate estimation from users are still needed.

In this systematic review, we aim to summarize current evidence on glycaemic and psychological outcomes of the MiniMed™ 780G system use in children, adolescents, and young adults living with T1D.

METHODS

This review was run in keeping with the PRISMA statement for systematic reviews [17]. The literature search was launched on 30 March 2023 in the PubMed and Embase databases. The keywords used were "Medtronic 780G", "MiniMed 780G", "advanced hybrid closed loop", and "advanced hybrid closed loop system". Non-English language papers were excluded. We included randomized trials, retrospective studies, observational studies and case reports regarding children, adolescents and non-pregnant young adults up to 25 years of age with T1D who were treated with the Medtronic MiniMed™ 780G in auto mode. Reviews, letters, commentaries, editorials and guidelines were excluded. The studies were taken into consideration irrespective of study setting (real-life conditions, an experimental setting, diabetes camps), duration of intervention, and baseline treatment. We decided to comment on case report papers as well because they investigate uncommon situations such as prolonged starvation or surgical procedure. These case reports may support clinicians in clinical practice.

Data Extraction

Four authors (BB, SP, MM, CM) worked independently on the two different online databases. The search retrieved 783 papers. They screened all records and excluded 136 duplicates. The remaining 647 records were screened by title and abstract and 565 of them were excluded. Eighty-two full texts of potentially eligible studies were retrieved for evaluation. Disagreements between authors were resolved by discussion and consensus with the supervision of the senior authors. At the end of the selection process, 31 manuscripts were selected for this review (Fig. 1). Six of the 31 investigated psychological issues and 23 investigated metabolic outcomes. Twelve papers investigated safety issues and five papers were case reports.

This article is based on previously conducted studies and does not contain any new studies with human participants or animals performed by any of the authors.

Outcomes

We retrieved data about blood glucose control, defined as glycated haemoglobin (HbA1c), and about the CGM metrics, in keeping with the International Consensus Statement [18]. In

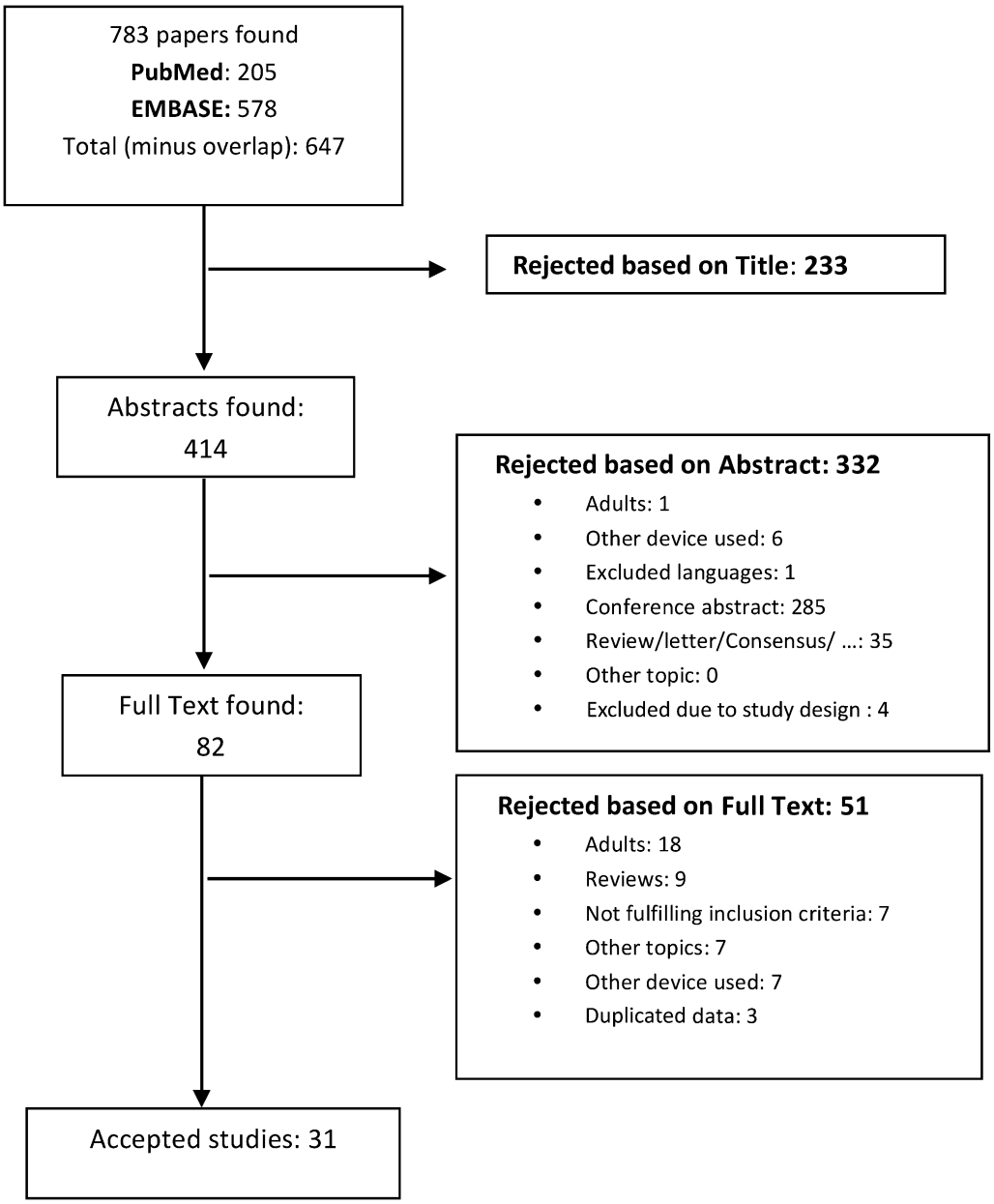

Fig. 1 PRISMA flowchart

particular, we evaluated the time in range (TIR), time in tight range (TITR), time below range (TBR), time above range (TAR), mean sensor glucose (SG) level, glucose management indicator (GMI), glycaemia risk index (GRI), coefficient of variation (CV) and standard deviation of blood glucose (SD). In addition, when available, we evaluated the percentages of time spent with glucose levels between 54 and 69 mg/dL (3.0–3.9 mmol/L, level 1 hypoglycaemia) (TBR1) and below 54 mg/dL (< 3.0 mmol/L, level 2 hypoglycaemia) (TBR2) and the percentages of time spent with glucose levels between 181 and 250 mg/dL (10.1–13.9 mmol/L, level 1 hyperglycaemia) (TAR1) and above 250 mg/dL (> 13.9 mmol/L, level 2

hyperglycaemia) (TAR2). When available, CGM metrics were extracted both for 24-h and overnight periods. Fear of hypoglycaemia and sleep quality were considered as the main psychological outcomes.

Information was extracted from each manuscript and summarized as (1) the participants' features (age, sex, diabetes duration, HbA1c before AHCL initiation); (2) inclusion and exclusion criteria in the case of clinical trials; (3) the study design, outpatient setting and follow-up duration; (4) metabolic outcomes; and (5) psychological outcomes (fear of hypoglycaemia and sleep quality).

Safety outcomes, such as diabetic ketoacidosis (DKA) and severe hypoglycaemia (SH), were considered.

Data Analysis

Extracted data were evaluated and synthesized using a narrative analysis. Evidence from qualitative studies was summarized thematically. If data were collected in cohorts with different age ranges, we only considered data about children, adolescents and young adults aged < 25 years, if clearly stated.

Studies on MiniMed™ 780G Effectiveness

Clinical Trials

The effectiveness of the MiniMed™ 780G was first demonstrated by a randomized crossover clinical trial comparing an AHCL system to a sensor-augmented pump + predictive low glucose management (SAP + PLGM). Thirty-three out of 59 individuals involved in the study were children and adolescents. The authors reported that AHCL use in youth was associated with better CGM metrics. In particular, mean SG levels, overall TIR, daytime TIR, nighttime TIR, and TAR were significantly improved ($p < 0.001$) in the AHCL group. No between-group differences in TBR1 and TBR2 were found [19].

Nimri et al. tested the home-based feasibility of the MiniMed™ 780G in their prospective, single-arm study of 12 adolescents and young adults with T1D, which included the following phases: a first stage consisting of a 6-day open-loop run-in period with the predictive low-glucose suspend feature on; a second stage characterized by 6 days/5 nights in a supervised hotel setting while using the AHCL system; and finally, 3 weeks with unrestricted home use. HbA1c decreased from 7.1% (6.7; 7.9) to 6.8% (6.6; 7.4) ($p = 0.027$) and TIR increased from 68.4 ± 10.6% to 74 ± 6.1% ($p = 0.06$). Significant improvements occurred in nighttime TIR (64.6 ± 17.4% vs 80.7 ± 7.8%; $p = 0.007$) and TAR (30.7 ± 20.7% vs 16.8 ± 7.6%; $p = 0.035$). No significant changes in mean SG, SD and TBR were reported [20].

In a multicenter single-arm clinical trial of a large cohort of 39 adolescents, 90-day AHCL use was compared to a baseline run-in period in which SAP ± PLGM was enabled for 14 days. The study revealed that HbA1c ($p < 0.001$), TBR ($p = 0.021$), TIR ($p < 0.001$), TAR ($p < 0.001$) and TAR2 ($p < 0.001$) significantly improved in the adolescents. Changes in daytime and nighttime CGM metrics were similar [21].

A multinational, seven-centre, randomized crossover trial known as the FLAIR study showed that the AHCL system was also able to improve HbA1c levels ($p = 0.03$), TIR ($p < 0.001$) and TAR ($p < 0.001$) without increasing TBR ($p = 0.42$) in 113 adolescents and young adults with T1D when compared to the hybrid closed-loop (HCL) system. Both daytime and nighttime TIR were significantly higher ($p < 0.001$) in the AHCL arm. Additionally, the 24-h glucose profile showed that AHCL led to a consistently lower mean SG [16]. Further analyses from the FLAIR study showed that there were no differences in TIR, TITR, TAR, TBR, CV or mean SG between AHCL and HCL systems in postprandial glucose control [22] or in the impact of temporary glucose targets (i.e. 150 mg/dL) [23].

A prospective, single-arm study showed that 12 weeks of AHCL use allowed significant improvements in HbA1c, TIR, TAR, mean SG values ($p < 0.001$ for all) and TBR2 ($p = 0.008$) in adolescents who previously underwent multiple daily injection (MDI) therapy [24]. Similar findings were reported by another recent prospective, single-arm, dual-centre study on 20 youths who were previously treated with MDI

but did not meet their glucose targets. All participants greatly improved their glycaemic control, as indicated by HbA1c, TIR and TAR ($p < 0.001$). The mean SG and CV were also lower after 3 months of AHCL therapy [25].

A recent open-label prospective Finnish study reported that the AHCL device was also effective in children with T1D who were younger than 6 years of age. Across a 12-week intervention, use of the MiniMed™ 780G system was associated with improvements in glycaemic control, as indicated by HbA1c ($p = 0.01$), TIR ($p < 0.001$), TAR ($p < 0.001$) and TAR2 ($p = 0.001$), and no negative effects on TBR or CV [26].

A prospective, open-label, two-arm study on 34 adolescents using the MiniMed™ 780G system revealed that precise and accurate carbohydrate counting resulted in a higher TIR and lower TAR2 ($p = 0.043$ and $p = 0.012$, respectively) compared with the use of three personalized fixed amounts of carbohydrate [27].

Finally, a randomized controlled trial evaluated the impact of a more aggressive system setting (glucose target 100 mg/dL and AIT 2 h) versus a less aggressive setting (glucose target 120 mg/dL and AIT 3 h) on glucose control during Ramadan fasting in adolescents and young adults with T1D. The authors demonstrated that there were no significant differences in TIR (81.0 ± 9.9% vs 82.0 ± 10.2%) and TBR (2.8 ± 0.8% vs 3.0 ± 0.3%) between the two different settings [28].

Observational Studies

Most observational studies included in this review reported the changes from a baseline run-in period of 2 or 4 weeks during which individuals used a device endowed with a PLGM function in manual mode.

An analysis of 661 MiniMed™ 780G system users younger than 15 years of age who had at least 10 days of sensor glucose data pre- and post-AHCL initiation revealed that TIR increased by 11.7% while TAR and TBR decreased by 11.6% and 0.1%, respectively. The mean SG was 16.7 mg/dL lower than baseline, and GMI also decreased by 0.4% [15].

Schiaffini et al. reported that TIR increased from 65.7 ± 16.6% to 70.5 ± 17.3% ($p = 0.002$) and TAR decreased from 27.2 ± 13.2% to 23.5 ± 13.9% ($p = 0.05$) after 4 weeks of MiniMed™ 780G system use without any changes in TBR [29].

A multicentre observational real-world study on 111 children and adolescents showed that TIR, TAR1, TAR2, GRI, mean SG, and GMI significantly improved at both 3 and 6 months of AHCL use compared with baseline ($p < 0.001$ for all). No differences were reported in TBR, TBR1, TBR2 or CV [30]. These findings are in line with those reported by Piccini et al. in their single-centre study, which demonstrated a significant improvement in all glycaemic outcomes except for CV and TBR, as indicated by the mean change between manual and auto modes at each follow-up time point (i.e. 14 days, 3 months and 6 months) [31]. An analysis investigating the real-world performance of the MiniMed™ 780G system in 332 users from Latin America who were younger than 15 years of age revealed the following CGM outcomes: TIR 74.2 ± 8.9%, TAR 23 ± 9.0%, TAR2 5.2 ± 4.4%, TBR 2.9 ± 2.0%, TBR2 0.6 ± 0.7%, CV 35.9 ± 5.0%, mean SG 146.5 ± 14.1 mg/dL, SD 52.9 ± 10.7 mg/dL, and GMI 6.8 ± 0.3% [32]. Another retrospective study evaluating the raw data for 4193 patient-days of 34 children using the AHCL system reported the following results for glucose control indicators: HbA1c 7.1 ± 0.9%, TIR 80.5 ± 7.8%, TAR1 14.5 ± 6.2%, TAR2 2.5 ± 2.2%, TBR1 2 ± 1.5%, TBR2 0.5 ± 0.8%, CV 33.1%, mean SG 136.7 ± 11.6 mg/dL, SD of mean glucose 45.5 mg/dL, and GMI 6.6%. No differences in the main CGM metrics were found between children older and younger than 9 years of age [33].

The successful use of the MiniMed™ 780G system has also been demonstrated when compared with conventional insulin pump therapy. Gianini et al. conducted a study on 24 children and adolescents who were using an AHCL system and had switched from a previous continuous subcutaneous insulin infusion (CSII) therapy, including insulin pumps with intermittently scanned CGM, PLGM systems and HCL devices. The authors reported significant

improvements in TIR ($p < 0.001$), TAR ($p = 0.001$), TAR2 ($p = 0.006$), mean SG ($p = 0.002$) and SD ($p = 0.011$) 3 months after starting the new treatment. No changes in TBR and CV were described [34]. In a retrospective study, the AHCL system was compared to the first-generation AID system in a real-world setting. Despite lower baseline HbA1c levels in the MiniMed™ 780G system group [7.1% (6.8; 7.6) vs 7.7% (7.3; 8.3), $p = 0.02$], no significant between-group differences in CGM metrics were detected after 6 months of use [35].

A 1-year follow-up prospective study including 43 young adults aged < 25 years who were previously on conventional CSII or MDI therapy showed significant changes in TIR, TAR, TAR2, GMI, mean SG and SD after switching to the MiniMed™ 780G. TBR, TBR2 and CV did not change [36]. A retrospective study including 38 users ≤ 18 years showed that TIR increased by 22.3% and TAR1 and TBR1 decreased by 6.5% and 0.3%, respectively, after 1 year of MiniMed™ 780G system use [37].

Finally, Seget et al. reported the benefits of the AHCL system in 50 Polish children with well-controlled T1D and adolescents previously treated with low-glucose suspend (LGS)/predictive LGS (PLGS) systems. Four weeks after switching the therapy systems, TITR increased from 53.8 ± 12.4% to 61.7 ± 8.9% ($p < 0.001$) and TIR increased from 76.2 ± 10.3% to 81.3 ± 7.7% ($p < 0.001$), while TAR1 decreased from 15.6 ± 7.1% to 11.9 ± 5.5% ($p < 0.001$) and TAR2 decreased from 3.4 ± 3.7% to 1.9 ± 2.1% ($p < 0.001$). The mean SG and GMI also significantly decreased ($p < 0.001$ for both). More evident improvements were reported for the parameters monitored at night than for those monitored during the day [38]. Data from this study population were further analysed after 1 year. Compared with the first 2 weeks of MiniMed™ 780G system use, significant reductions in TBR1 (4.2 ± 2.7% vs 3 ± 1.8%, $p < 0.05$) and TBR2 (1.1 ± 1.1% vs 0.8 ± 0.8%, $p < 0.05$) were found. No significant differences in other glycaemic control indicators and in body mass index (BMI) *z*-score were observed [39].

Psychological Outcomes

Only a few studies have explored psychological outcomes in AHCL users in the paediatric and young-adult populations.

The first AHCL-associated improvement in subjective sleep quality compared with SAP + PLGM was demonstrated by Wheeler et al. [40] in subjects above 16 years of age in a randomized, two-sequence crossover study (4 weeks for each arm). The authors also reported a higher Diabetes Treatment Satisfaction Questionnaire Change (DTSQc) score in adolescents aged 13–17 years (14.8 ± 0.7 vs 12.1 ± 0.8, $p = 0.024$).

Higher diabetes treatment satisfaction was also found in children and adolescents aged 7–17 years upon comparing the first 12 weeks of AHCL use with previous MDI therapy [24]. Importantly, 53% of the enrolled subjects were in MDI therapy and self-monitoring blood glucose before the beginning of the study and had no previous experience with AID. The DTSQ with 12 and 14 items rated from 0 (very unsatisfied) to 6 (very satisfied) was administered to children/adolescents and their parents respectively. Average score increased from 3.6 ± 0.6 to 4.6 ± 0.8 ($p = 0.001$) in youths and similar results were found for their parents, with an average DTSQ score of 3.5 ± 0.6 at baseline and 4.8 ± 0.9 at the end of the study ($p = 0.001$). In a longer study, Gianini et al. [34] showed that the AHCL system decreased the fear of hypoglycaemia (from 60.5 ± 17.0 to 49.4 ± 3.5, $p < 0.001$) and the diabetes-related emotional distress (from 19.3 ± 12.3 to 8.6 ± 8.3, $p = 0.001$), thereby increasing the well-being perception (from 68.2 ± 16.8 to 80.5 ± 14.2, $p = 0.03$), in 24 users aged 10–18 years after 4 months of use. These findings were obtained regardless of HbA1c value (< 7% or ≥ 7%) at the beginning of the study: both subgroups showed a statistically significant improvement in the quantitative scores. Only the well-being score showed a nonsignificant improvement in the HbA1c ≥ 7% subgroup. A negative correlation between diabetes-related emotional distress and well-being was found in subjects with HbA1c ≥ 7%; instead, diabetes-related emotional distress was correlated with fear of hypoglycaemia

in the HbA1c < 7% subgroup. In addition to the quantitative results, qualitative assessment, achieved through interviews, also demonstrated an increased quality of life with AHCL usage, as it reduced the exhaustion related to disease management and stress due to dysglycaemia while increasing sleep quality, with both children/adolescents with T1D and their parents expressing their satisfaction.

AHCL was also associated with a reduction in parental diabetes distress in very young children's parents [26], as evaluated by the Problem Areas in Diabetes Scale-Parents Revised (PAID-PR) score, which decreased from 37.5 (18.2) to 27.5 (14.8) ($p = 0.006$) after 12 weeks of use. Interestingly, the score did not correlate with markers of glycaemic control, total daily dose (TDD) of insulin, age or diabetes duration ($p = 0.22$–0.91) at the beginning of the study, and no significant correlations were found between the PAID-PR score and glycaemic markers or TDD ($p = 0.15$–0.80) at 12 weeks either.

A randomized, two-period (12 weeks in each arm), crossover trial comparing AHCL versus HCL use revealed significant improvements in glucose monitoring satisfaction subscale scores for emotional and behavioural burdens ($p < 0.01$) with the use of AHCL in a cohort of 113 adolescents and young adults [41]. A further correlation analysis of glycaemic outcomes (TAR, TBR2 and percentage of time spent in auto mode) with satisfaction measures demonstrated that satisfaction increased as less time was spent in hyper- or hypoglycaemia. More time in the auto mode [86%, interquartile range (IQR) 77–91 vs. 75%, IQR 64–83%, in Medtronic 780G vs 670G, respectively] was associated with greater glucose satisfaction [16].

SAFETY: DKA AND SEVERE HYPOGLYCAEMIC EVENTS

Nimri et al. [20] demonstrated in their feasibility study that AHCL was safe, as demonstrated by the absence of DKA or SH events. During meal challenges such as a missed dinner bolus and a late meal bolus performed in the hotel setting, TBR2 was 0.5 and 1.3 for the respective challenges ($p = 0.63$) and 1.2 in the home setting ($p = 0.48$ vs missed bolus). No SH events occurred during physical activity or 2 h after physical exercise in the hotel setting.

In the first randomized control trial (RCT) investigating the MiniMed™ 780G system in free-living conditions in children, adolescents and young adults with T1D [19], only one episode of DKA occurred during the study in the SAP + PLGM treatment arm, likely due to infusion set failure. No cases of SH were reported in that trial. Those results were reached using the lower target setting of 100 mg/dL.

The FLAIR study [16] reported one SH event during AHCL use, which was considered unrelated to the study treatment. TBR1 was 0.46% at baseline, 0.50% during use of the 670G system, and 0.46% during AHCL ($p < 0.001$ for noninferiority), and no episodes of DKA were reported.

Carlson et al. [21] also evaluated the safety of the AHCL system, used for 90 days, compared with the MiniMed™ 670G system (not necessarily in auto mode) in adolescents and young adults in a multicentre single-arm study. No episode of SH was reported; also, in this case, no DKA events occurred in 14- to 21-year-old people with diabetes.

Petrovski et al. [24] demonstrated that children and adolescents with T1D without prior pump experience improved their glycaemic control in a safe manner after switching to AHCL following a 10-day well-structured educational protocol. No episodes of DKA or SH occurred in 12 weeks of the prospective clinical investigation study despite the use of more aggressive pump settings (target 100–110 mg/dL and IOB 2–3 h). These results are consistent with those obtained by Beato-Vibora et al. [36] in their 1-year follow-up study: subjects who began MDI therapy using an AHCL system obtained the same outcomes as subjects with previous pump experience. No cases of SH were reported. Interestingly, after stratification into high (TBR ≥ 4% or TBR2 ≥ 1%) or low (TBR < 4% or TBR2 < 1%) risk of hypoglycaemia at baseline, subjects with a high hypoglycaemia risk reduced their TBR, which remained within the International Consensus Guideline targets [42]. Conversely, people with an initial low

hypoglycaemia risk increased the time spent with glucose levels below 70 mg/dL but still remained below the recommended targets.

No SH episodes occurred after 3 months of AHCL use among adolescents and young adults with high-risk glycaemic control who previously underwent MDI therapy [25]. Two episodes of mild-to-moderate DKA occurred, both due to infusion set failure/occlusion and poor experience with CSII therapy.

This system was also considered safe when adolescents used fixed carbohydrate (CHO) doses [27] instead of precise CHO counting before meals as well as during Ramadan [28]. In the latter study comparing two different previously described settings, no episodes of SH or DKA nor any increase in the hypoglycaemia rate occurred with the more aggressive setting despite long fasting periods [28].

Recently, the MiniMed™ 780G system was reported to be safe for use in 2- to 6-year-old children during a 12-week follow-up period. A target of 120 mg/dL and an AIT of 3.5 h were set. No events of SH or DKA were observed during the study [26].

Gianini et al. [34] and Piccini et al. [31] confirmed that the system was safe, with no increase in episodes of SH after 4 and 6 months of use, in their respective studies.

SUMMARY OF CASE REPORTS

The usability of MiniMed™ 780G system in the presence of unusual conditions or other concomitant diseases has been demonstrated by some case reports.

Petrovski et al. reported the case of a 16-year-old male with T1D and a short stature treated with growth hormone (GH) who experienced a positive effect of AHCL use. GH has a well-known counterregulatory function, and thus GH treatment in people with T1D is often challenging for both youths and health care providers. The device was set to an AIT of 2 h and a glucose target of 100 mg/dL. HbA1c decreased from 8.6% before to 6.7% 3 months after initiating the use of the MiniMed™ 780G system. TIR improved to above 70% in the first month, reaching 73% in the third month of auto mode functionality without any SH or DKA episodes [43]. Another intriguing use of AHCL therapy was described in a young female with a long history of brittle T1D and a severe presentation of diabetic gastroparesis. This clinical condition adversely affects diabetes management as it results in an increased risk of postprandial hypoglycaemia due to a mismatch between prandial insulin absorption and the postprandial rise in blood glucose, which is delayed in individuals with gastroparesis. MiniMed™ 780G initiation led to a prompt improvement in glycaemic control, as demonstrated by the glucose metrics achieved after 3 weeks of use (TIR 75%, TAR 21%, TBR 4% and CV 28.9%). It is likely that stable glucose levels associated with dietary modifications and prokinetic drugs facilitated the regression of gastrointestinal symptoms [44]. The effectiveness of the MiniMed™ 780G system during minor surgical procedures has also been investigated. Seget et al. reported two children with T1D who underwent diagnostic endoscopy of the gastrointestinal tract with the use of sedoanalgesia and an elective umbilical hernia surgery. In both cases, a temporary target of 150 mg/dL was activated overnight before the surgical procedures and was set for 7 h after activation. Afterwards, the target was reverted to standard values. During the periprocedural periods, glucose levels remained within the target range. AHCL reports on the day of the surgical procedure were very similar to those 2 weeks prior to hospital admissions and revealed CGM metrics within the recommended clinical targets [45]. A case study of an 11-year-old subject with T1D from Saudi Arabia reported that AHCL provided satisfactory glucose control during fasting for more than 14 h per day, which is typical during the month of Ramadan. A comparison between the use of a PLGS system during Ramadan in 2021 and the use of the MiniMed™ 780G system during the following Ramadan season in 2022 showed that the AHCL system was associated with better glycaemic outcomes and a reduced time spent in hypoglycaemia. Due to the high percentages of fat in some traditional Ramadan-specific foods, supplementation with an extra bolus (15% of the previously announced carbohydrates) 90 min

after the evening meal was recommended to counteract late postprandial hyperglycaemia [46]. No DKA or SH was detected during and before Ramadan with AHCL, but significantly better results in terms of hypoglycaemia were also obtained with the MiniMed™ 780G system, with TBRs of 0% vs 2% ($p < 0.01$).

Finally, Tekielak et al. reported the use of the AHCL system in a child with T1D and very low insulin requirements. The authors described a 3-month follow-up of a 9-year-old boy whose total daily dose of insulin decreased in the first 6 weeks after switching from PLGS therapy to the MiniMed™ 780G system, reflecting the remission phase, which occurred because of tight glycaemic control with a healthy lifestyle. Despite a daily insulin dose of lower than 8 IU for nearly 38% of the days, the AHCL system was effective, resulting in a TIR percentage above 90% [47].

DISCUSSION

We focused this literature review on the MiniMed™ 780G system. The effects of this AID system have been evaluated by different authors, who aimed to evaluate the safety and effectiveness of this device [15, 16, 19–39] (Table 1) and the psychological issues [24, 26, 34, 40, 41] (Table 2) related to it.

As expected, the first studies were RCTs that aimed to compare the effectiveness of this system with the previous generation of AID systems. The MiniMed™ 780G system has been demonstrated to be better than SAP + PLGM [19] and HCL [16]; it led to significant improvements in HbA1c levels and CGM metrics after 8–12 weeks of use, without any increase in time spent in hypoglycaemia. Interestingly, the time in range does not change significantly when the temporary target is enabled [23], suggesting that it can be safely used when indicated. On the other hand, during prolonged fasting such as that occurring during Ramadan, a more aggressive setting with an active insulin time of 2 h and a glucose target of 100 mg/dL is as safe as a setting with an active insulin time of 3 h and a pre-fixed glucose target of 120 mg/dL [28]. There is no increase in time spent in hypoglycaemia and thus a more aggressive setting to obtain more physiological glucose control is advisable.

Accurate education on technology and proper counting of carbohydrates play a key role in improving glucose control. Although postprandial glucose levels are automatically improved by the PID + MD-Logic algorithm, better results can be obtained through precise counting of the carbohydrate intake, which optimizes the premeal insulin doses [27].

The benefits of the MiniMed™ 780G system have been confirmed by several observational studies. This AID system improves TIR compared to baseline by at least 10% after 4 weeks without any increase in TBR [15, 29, 38], and this finding has also been reported by other studies with longer follow-up periods of up to 1 year [30, 31, 34, 36, 39], which demonstrated a more remarkable improvement in TIR of up to 22% [35, 37] without any significant change in BMI *z*-score [39]. Basically, the MiniMed™ 780G system allows a TIR of 75–80% to be reached [32, 33]. It is worth noting that in all these studies, people with diabetes used rapid-acting insulin. Both time to reach peak insulin activity and duration of insulin action are two key factors in blood glucose management, and thus it could be speculated that new insulins with different times of action could lead to even larger improvements in CGM metrics.

Uncontrolled trials confirmed these data. TBR was shown to always remain at target, with a TIR improvement of approximately 10% in people living with diabetes who were on the PLGM system before using AHCL [20, 21, 26], and an even larger improvement of approximately 35–40% in those using MDI therapy before AHCL [24, 25].

In all the studies, the time below range was within the clinically recommended targets [42] and not significantly different compared to baseline (at which time it was already at target), suggesting that, even if the system is more aggressive than the first-generation AID systems in its glucose control, there is no increase in the risk of hypoglycaemia.

Glucose target and active insulin time have been identified as device settings that play a substantial role in the achievement of better

Table 1 Summaries of randomized clinical trials and observational studies on Minimed^{TM} 780G effectiveness included in the systematic review

Ref.	Type of study, study design, settings, and follow-up	Objective(s)	Population characteristics	Main findings
Clinical trials				
[16]	RCT, crossover study, home setting Two 12-week crossover periods	AHCL vs HCL	112 participants aged 14–29 yrs	A1c: 7.4 ± 0.8% vs 7.6 ± 0.6%, $p = 0.030$ TIR: 67 ± 8% vs 63 ± 8%, $p < 0.001$ TAR: 31 ± 8% vs 34 ± 8%, $p < 0.001$
[19]	RCT, open-label, two-sequence crossover study, home setting Two 4-week crossover periods separated by a 2-week washout	AHCL vs SAP + PLGM	59 subjects, including 33 children and adolescents aged 7–21 yrs	7–13 yrs age group: + 11.8 ± 7.4% TIR changes, $p < 0.001$ −11.2 ± 8.0% TAR changes, $p < 0.001$ 13–21 yrs age group: + 14.4 ± 8.4% TIR changes, $p < 0.001$ −14.0 ± 8.5% TAR changes, $p < 0.001$
[23]	RCT, crossover study, home setting Two 12-week crossover periods	Use of TT AHCL vs HCL	60 participants aged 14–29 yrs	TIR, TAR: $p > 0.05$
[28]	RCT, two-arm study, home setting Intervention group (AIT 3 h, target 120 mg/dL) Control group (AIT 2 h, target 100 mg/dL) 4-week follow-up during Ramadan	Intervention group vs control group	42 adolescents aged 12–25 yrs	TIR, TAR, TBR, and CV: $p > 0.05$
[27]	RCT, prospective, open-label, two-arm study 3-day baseline run-in period PLGM → 12 weeks of AHCL use in a home setting with two groups (CHO fixed counting vs CHO flex counting)	CHO fixed counting vs CHO flex counting	34 adolescents aged 13–18 yrs	TIR: 73.5 ± 6.7% vs 80.3 ± 7.4%, $p = 0.043$ TAR2: 5.7 ± 3.6% vs 3.0 ± 2.4%, $p = 0.012$

Table 1 continued

Ref.	Type of study, study design, settings, and follow-up	Objective(s)	Population characteristics	Main findings
[22]	RCT, crossover trial, home setting Two 12-week crossover periods	Postprandial glucose control AHCL vs HCL	112 participants aged 14–29 yrs	TIR, TAR, TBR and CV: $p > 0.05$
[25]	UT, single0arm study MDI → 3 months of AHCL use	AHCL vs MDI	20 participants aged 13–25 yrs; A1c ≥ 8.5%	A1C: 7.6 ± 1.1% vs 10.5 ± 2.1%, $p < 0.001$ TIR: 66.5 ± 9.8% vs 27.6 ± 13.2%, $p < 0.001$ TAR: 32.6% vs 69.9 ± 14.7%, $p < 0.001$
[21]	UT, single-arm study 14-day baseline run-in period with SAP ± PLGM → 90 days of AHCL use in a home setting	AHCL vs baseline	157 individuals, including 39 adolescents aged 14–21 yrs	A1C: 7.1 ± 0.6% vs 7.6 ± 0.8%, $p < 0.001$ TIR: 72.7 ± 5.6% vs 62.4 ± 9.9%, $p < 0.001$ TAR: 24.9 ± 5.7% vs 34.3 ± 10.7%, $p < 0.001$ TBR: 2.4 ± 1.8% vs 3.3 ± 2.7%, $p = 0.021$
[20]	UT, prospective, single-arm study 6-day baseline run-in period PLGM → 6 days of AHCL use in a hotel setting → 3 weeks of AHCL use in a home setting	AHCL vs baseline	12 adolescents and young adults aged 15–25 yrs	A1C: 6.8% (6.6; 7.4) vs 7.1% (6.7; 7.9), $p = 0.027$ TIR: 74 ± 6.1% vs 68.4 ± 10.6%, $p = 0.060$ TBR: 2.6 ± 1.9% vs 4 ± 3.5%, $p = 0.270$ TIR (nighttime): 80.7 ± 7.8% vs 64.6 ± 17.4%, $p = 0.007$ TAR (nighttime): 16.8 ± 7.6% vs 30.7 ± 20.7%, $p = 0.035$

Table 1 continued

Ref.	Type of study, study design, settings, and follow-up	Objective(s)	Population characteristics	Main findings
[24]	UT, prospective, single-arm study MDI → 12 weeks of AHCL use in a home setting	AHCL vs MDI	34 adolescents aged 13–18 yrs	A1c: 6.5 ± 0.7% vs 8.6 ± 1.7%, $p < 0.001$ TIR: 78.8 ± 6.1% vs 42.1 ± 18.7%, $p < 0.001$ TAR1: 13.4 ± 5.1% vs 28.1 ± 9.7%, $p < 0.001$ TAR2: 5.0 ± 2.2% vs 26.6 ± 16.2%, $p < 0.001$ TBR2: 0.5 ± 0.4% vs 0.8 ± 0.7%, $p = 0.008$
[26]	UT, nonrandomized single-arm clinical trial 14-day baseline run-in period PLGM → 12 weeks of AHCL use in a home setting	AHCL vs baseline	35 children aged 2–6 yrs	TIR: 66.6 ± 9.6% vs 58.3 ± 13.0%, $p < 0.001$ TAR: 29.8 ± 13.0% vs 38.4 ± 9.5%, $p < 0.001$
Observational studies				
[15]	Retrospective study 6 months of AHCL use in a real-world setting	CGM metrics over a 6-month follow-up	12,870 individuals, including 3211 users ≤ 15 yrs	TIR 73.9 ± 8.7%, TAR 22.9%, TBR 3.2%, CV 36.7 ± 4.9%
[37]	Retrospective study 14-day baseline run-in period PLGM → 1 year of AHCL use in a real-world setting	CGM metrics over a 1-year follow-up	42 individuals, including 38 users ≤ 18 yrs	TIR 73.1 ± 9.4%, TAR 18.4 ± 6.6%, TBR 2.1 ± 1.8%
[36]	Prospective study IP or MDI → 1 year of AHCL use in a real-world setting	AHCL vs IP or MDI	135 individuals, including 43 young adults aged ≤ 25 yrs	TIR: 76.4 ± 9.1% vs 65.7 ± 12.0%, $p < 0.050$ TAR: 21.5 ± 9.3% vs 31 ± 12.6%, $p < 0.050$ TBR: 2.3 ± 1.9% vs 3.4 ± 2.6%, $p < 0.050$
[34]	Prospective, single-arm study, home setting IP + CGM or PLGM or HCL → AHCL use for at least 3 months	AHCL vs other IPs	24 children and adolescents aged 10–18 yrs	TIR: 78.3 ± 6.3% vs 68.2 ± 13.9%, $p < 0.001$ TAR: 18.7 ± 5.4% vs 28 ± 14.7%, $p = 0.001$

Table 1 continued

Ref.	Type of study, study design, settings, and follow-up	Objective(s)	Population characteristics	Main findings
[32]	Retrospective study 136-day follow-up in a real-world setting	CGM metrics over the follow-up period	1025 individuals, including 332 users ≤ 15 yrs	TIR 74.2 ± 8.9%, TAR 23 ± 9.0%, TBR 2.9 ± 2.0%, CV 35.9 ± 5.0%
[33]	Retrospective study, real-world setting 4193-day follow-up	CGM metrics over the follow-up period	34 children < 18 yrs	A1c 7.1 ± 0.9%, TIR 80.5 ± 7.8%, TAR1 14.5 ± 6.2%, TAR2 2.5 ± 2.2%, TBR1 2 ± 1.5%, TBR2 0.5 ± 0.8%, CV 33.1%
[30]	Prospective study 14-day baseline run-in period PLGM → 6 months of AHCL use in a real-world setting	AHCL vs baseline	111 children and adolescents aged 7–18 yrs	TIR: 74.8 ± 9% vs 63.5 ± 13.1%, $p < 0.001$ TAR: 14.1 ± 9.6% vs 34.1 ± 14.1%, $p < 0.001$
[31]	Retrospective study 14-day baseline run-in period PLGM → 6 months of AHCL use in a real-world setting	AHCL vs baseline	44 children and adolescents (mean age 14.2 ± 4.0 yrs)	A1C: 6.6 ± 0.5% vs 7.2 ± 0.7%, $p < 0.001$ TIR: 76.3 ± 9.6% vs 69.3 ± 12.6%, $p < 0.001$ TAR1: 17% vs 22.6%, $p < 0.001$ TAR2: 3.2% vs 5.5%, $p < 0.001$
[29]	Prospective study 4-week baseline PLGM → 4 weeks of AHCL use in a real-world setting	AHCL vs baseline	14 children and adolescents aged 7–18 yrs	TIR: 70.5 ± 17.3% vs 65.7 ± 16.6%, $p = 0.002$ TAR: 23.5 ± 13.9% vs 27.2 ± 13.2%, $p = 0.050$
[38]	Prospective open-label, single-arm study SAP-LGM/PLGM → 4 weeks of AHCL use in a home setting	AHCL vs SAP-LGM/PLGM	50 children and adolescents aged 5–19 yrs	TItR: 61.7 ± 8.9% vs 53.8 ± 12.4%, $p < 0.001$ TIR: 81.3 ± 7.7% vs 76.2 ± 10.3%, $p < 0.001$ TAR1: 11.9 ± 5.5% vs 15.6 ± 7.1%, $p < 0.001$ TAR2: 1.9 ± 2.1% vs 3.4 ± 3.7%, $p < 0.001$
[39]	Prospective study 1 year of AHCL use in a real-world setting	First 2 weeks vs 12 months of AHCL use	50 children and adolescents aged 5–19 yrs	TBR1: 3 ± 1.8% vs 4.2 ± 2.7%, $p < 0.050$ TBR2: 0.8 ± 0.8% vs 1.1 ± 1.1%, $p < 0.050$

Table 1 continued

Ref.	Type of study, study design, settings, and follow-up	Objective(s)	Population characteristics	Main findings
[35]	Retrospective case/control study 2-week baseline PLGM → 6 months of AHCL use vs 6 months of HCL use in a real-world setting	AHCL vs HCL	44 individuals aged 2–21 yrs (n = 20 with HCL and n = 24 with AHCL)	A1C: 7.1% (6.8; 7.6) vs 7.7% (7.3; 8.3), p = 0.020

The main findings concern only data closely related to children, adolescents and young adults recruited in the studies

glycaemic outcomes. Better CGM metrics were reported in all the users, but a larger improvement without any increase in the time below range was achieved with a set point of 100 mg/dL rather than at a higher set point [19, 21]. Similarly, a shorter AIT is described as a predictor of optimal glucose control assessed by the concomitant achievement of recommended CGM metrics [30]. Real-world data from youth and adult individuals confirmed that an AIT of 2 h and a glucose target of 100 mg/dL were associated with the largest time-in-range value and that these settings do not increase the time spent in the hypoglycaemic range [48]. On the other hand, very recent data showed that more advanced pubertal stages, a longer disease duration, and less compliance were associated with less glucose control improvement [49]. Interestingly, the CGM metrics appeared to be stable over the 6-month study period. The safety and effectiveness of treatment are summarized by the novel GRI [50]. The MiniMed™ 780G system was found to improve this parameter [30], in keeping with other studies [51].

While technology can improve blood glucose management, the psychological and emotional burden experienced by people living with T1D is still a challenge. The previous generation of AID systems provided some benefits for users, but the frequent auto mode exits and user-input requirements presented a significant burden. The result was that the previous AID system was not effective regarding the improvement of psychosocial outcomes [11]. However, treatment satisfaction was significantly improved compared with that achieved with SAP + PLGM use [40] and MDI therapy [24]. The MiniMed™ 780G system was also more effective at improving sleep quality compared with SAP + PLGM [40]. The psychological burden for people with T1D was significantly reduced, and satisfaction measures increased [34, 41] in parallel with improvements in CGM metrics [16]. This AHCL system seemed to reduce not only the users' emotional burden but also parental distress. The parents felt more confident with this device, irrespective of metabolic and clinical parameters [26]. All the results suggest that the MiniMed™ 780G system positively affects the emotional distress of users and their caregivers, with treatment satisfaction increasing as much as glycaemic control improves.

Similar to the MiniMed™ 670G system, the 780G system proved to be safe in regard to the prevention of severe hypoglycaemia. No episodes were reported under any study condition, including an experimental setting with a late meal bolus [20] or flex vs fixed carbohydrate counting [27], a randomized clinical trial in a free-living setting [19], a single-arm study with a home setting [21, 24, 25, 31, 34, 36], prolonged fasting due to Ramadan [28], and even when tested in preschool children [26]. The study by Tornese et al. [52], which included 12 preschool children and was published after the literature search for this review, confirmed that the MiniMed 780G™ system may be safe and effective even in children < 7 years of age and with a total daily dose < 8 IU. A very recent paper by Dovc et al. [53], published in July 2023, concludes that this AHCL is safe during exercise, a condition not explored by previous papers. In this condition, the TIR is high while

Table 2 Summaries of studies on quality of life (QoL) associated with Minimed^{TM} 780G use in the systematic review

Ref	Type of study, study design, settings, and follow-up	Objective(s)	Population characteristics	Main findings
[34]	Cohort longitudinal crossover study, home setting Insulin pump (IP) + CGM or PLGM or HCL → AHCL use for 4 months	The following were administered before and at the end of the study period: *Quantitative questionnaires*: Hypoglycaemia Fear Survey for Children (C-HFS) [11-item behavior subscale and 15-item worry subscale; items were rated on a 5-point Likert scale (1 = "never" to 5 = "almost always"; higher scores indicated higher fear)] Problem Areas in Diabetes Scale (PAID) and Problem Areas in Diabetes Scale Five (PAID-5) (20 items rated on a 5-point Likert scale from 0 = not a problem to 4 = serious problem; total score range 0–100; higher scores indicate more diabetes distress) Five Item Measure of Wellbeing (World Health Organization 5; WHO-5) [6-point Likert scale rated from 0 = not present to 5 = constantly present; total raw score ranged from 0 (worst thinkable well-being) to 100 (best thinkable well-being); score < 50 suggests poor emotional well-being, while a score ≤ 28 is indicative of depression] *Qualitative interview (4 groups)*: QoL Parent involvement School environment Quality of sleep	24 participants aged 10–18 yrs $n = 17$ (10–14 yrs) $n = 7$ (15–18 yrs)	Lower fear of hypoglycaemia (C-HFS total: from 60.5 ± 17.0 to 49.4 ± 3.5; $p < 0.001$) with AHCL Lower diabetes-related emotional distress (PAID: from 19.3 ± 12.3 to 8.6 ± 8.3; $p > 0.001$) with AHCL Higher well-being (WHO-5 from 68.2 ± 16.8 to 80.5 ± 14.0; $p = 0.03$) with AHCL QoL has increased using AHCL It emphasized exhaustion with disease management, quality of sleep (also in parents), and school-related stress with dysglycaemia

Table 2 continued

Ref	Type of study, study design, settings, and follow-up	Objective(s)	Population characteristics	Main findings
[41]	Randomized, open-label, two-period crossover trial after 2–4 week run-in period 12 weeks of AHCL → 12 weeks of HCL use or vice versa in a home setting	Impact of AHCL vs HCL using the following scales completed at baseline (before randomization) and at the end of each interventional period: Diabetes Distress Scale (DDS) (17 items: higher scores indicate greater diabetes distress) Hypoglycaemia Confidence Scale (HCS) (higher scores indicate greater confidence) The Glucose Monitoring Satisfaction Survey (15 items: higher scores indicate greater satisfaction) Diabetes Technology Attitudes Survey (5 items: higher scores indicate more positive attitudes about devices and technology)	113 participants aged 14–29 yrs n = 73 (14–20 yrs) n = 40 (21–29 yrs)	Diabetes distress did not change using AHCL Behavioural burden and emotional burden subscales in the satisfaction area changed
[24]	Prospective, single-arm intervention study MDI → 12 weeks of AHCL use in a home setting	Treatment satisfaction evaluation at the beginning and at the end of the study using: Diabetes Treatment Satisfaction Questionnaire Status (DTSQs) for parents (14 items: higher scores indicate greater satisfaction) Diabetes Treatment Satisfaction Questionnaire Status (DTSQs) for teens (12 items; rated from 0 = very unsatisfied to 6 = very satisfied)	34 participants aged 7–17 yrs	DTSQs score increased from 3.6 ± 0.6 at baseline to 4.6 ± 0.8 at the end of the study (p = 0.001) for teens and from 3.5 ± 0.6 to 4.8 ± 0.9 (p = 0.001) for parents
[26]	Nonrandomized single-arm clinical trial 14-day baseline run-in period PLGM → 12 weeks of AHCL use in a home setting	Parental diabetes distress evaluation at the beginning and at the end of the study using: The Problem Areas In Diabetes—Parent, Revised (PAID-PR) survey with 18 questions (total score range 0–100; higher scores indicate more diabetes distress)	35 participants aged 2–6 yrs	PAID-PR score: 37.5 ± 18.2 in run-in period PLGM vs 27.5 ± 14.8 at the end of the study with AHCL; p = 0.006

Table 2 continued

Ref	Type of study, study design, settings, and follow-up	Objective(s)	Population characteristics	Main findings
[40]	Randomized, two-sequence crossover study after 2- to 4-week run-in period 4 weeks of AHCL → 4 week s of SAP + PLGM use or vice versa in users naïve to automated insulin delivery in free-living conditions	Impact of AHCL vs SAP + PLGS on QoL, sleep and treatment satisfaction using questionnaires administered at baseline and after each intervention phase regarding: Diabetes Treatment Satisfaction Status (QTSQs)* (6–10 items depending on the age of the responder: higher scores indicate greater satisfaction) Diabetes Treatment Satisfaction Change (QTSQc) Diabetes Technology (QTQ)** (30 items: each item has a 5-point scale from 1 = very much a problem to 5 = not at all a problem for the current subscale and from 1 = much worse to 5 = much better for the change subscale; higher QTQ scores indicate a more positive attitude or change) Pittsburgh Sleep Quality Index (PSQI)*** (a global score > 5 suggests a "poor sleeper") World Health Organization 5 Well-Being Index (WHO-5) (5 items with a 6-point Likert scale: total score range 0–100; higher scores indicate greater well-being) Hypoglycaemia Confidence Scale (HCS)*** Hypoglycemic Fear Survey (HFS-II)**** (higher scores indicate a greater fear of hypoglycaemia)	59 participants aged 7–65 yrs n = 16 (7–12 yrs) n = 14 (13–17 yrs) n = 29 (16–65 yrs)	Adolescents: DTSQc score of 14.8 ± 0.7 with AHCL vs 12.1 ± 0.8 with SAP + PLGS; p = 0.024 DTQ "change" score of 3.5 ± 0.0 with AHCL vs 3.3 ± 0.0 with SAP + PLGS; $p < 0.001$ PSQI score of 4.8 ± 0.3 with AHCL vs 5.7 ± 0.3 with SAP + PLGS; p = 0.048) Adults (> 18 yrs): DTSQs score of 30.9 ± 0.7 with AHCL vs 27.9 ± 0.7 with SAP + PLGS; p = 0.004) DTSQc score of 11.7 ± 0.9 with AHCL vs 9.2 ± 0.8 with SAP + PLGS; p = 0.032) No changes in the Well-Being Index nor in hypoglycaemia fear/confidence were found

The main findings concern only data closely related to children, adolescents and young adults recruited in the studies

*The age bands used were ≥ 18 years for the adult version, 13–17 years for the teen version, and a parent version for children aged 7–12 years

**Parents answered for the children aged 7–13 years

***It was only completed by subjects aged over 16 years (9 items)

****There was a version for 7- to 17-year-old children/teens (25 items) in addition to a version for their parents (26 items). Subjects aged 18 years or older completed the adult version (11 items)

the TAR and TBR are low. Interestingly, that paper also assessed the effectiveness of faster-acting insulin aspart when used with the MiniMed 780G^{TM} system; it was not found to be superior to standard aspart.

Only one episode of severe hypoglycaemia, considered unrelated to the study, was reported by Bergenstal et al. [16] in an international crossover study with a home setting. No DKA events in people using the MiniMed^{TM} 780G system have been reported except in the paper by Boucsein et al. [25], who described two cases of set failure with nonsevere DKA. Actually, we would like to highlight that in all the papers reporting data about safety, the enrolled subjects used the 3-day set and not the 7-day set. We may conclude that the MiniMed^{TM} 780G system seems to be effective in preventing DKA and severe hypoglycaemia, even when the system settings are more aggressive (i.e. with a shorter active insulin time and a lower glycaemic target) [24], without incurring any increase in the TBR.

In our review, we also included case reports investigating individuals using the MiniMed^{TM} 780G system. We think that these reports can be useful for clinicians when managing uncommon situations. In particular, the 780G system was shown to be effective in optimizing glucose control in a subject treated with other medications that have hyperglycaemic effects, such as recombinant human GH [43], and also in the case of surgery [45]. Even though it is very rare in youth, gastroparesis is a challenging condition in terms of blood glucose control due to the mismatch between the postmeal glucose increase and insulin action. The bolus wizard algorithm allowed the CGM metrics to be kept within the recommended targets [44]. This system seems to work better than the MiniMed^{TM} 670G system during Ramadan as well [46]. Finally, in the case of reducing insulin below 10 units/day for certain hours of the day, the system works properly [47, 52].

CONCLUSION

In conclusion, the MiniMed^{TM} 780G system is safe and effective in improving glucose control. This second-generation AID system seems to properly address the burden of frequent user input and auto-exits, which had resulted in people with diabetes dropping out of studies while using the previous version of this technology. This system enables the achievement of all the recommended clinical targets for people with diabetes without an excessive additional burden. More aggressive system settings, as indicated by a lower glycaemic target and a shorter active insulin time, have been demonstrated to be associated with better glucose control without an increase in the risk of hypoglycaemia. This system is safe and effective in uncommon situations, such as prolonged fasting. Data about psychological outcomes suggest that the measures of better metabolic control achieved with this second-generation AID system are strongly related to a reduced burden and improved psychosocial outcomes for people with diabetes and their caregivers.

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Declarations

Conflict of Interest. Tadej Battelino has served on advisory panels of Novo Nordisk, Sanofi, Eli Lilly, Boehringer, Medtronic, and Indigo Diabetes. He has received honoraria for participating in the speaker's bureaux of Eli Lilly, Novo Nordisk, Medtronic, Abbott, Sanofi, Aventis, Astra Zeneca, and Roche. Tadej Battelino's institution has received research grant support from Abbott, Medtronic, Novo Nordisk, Sanofi, Novartis, Sandoz, and Zealand Pharma, the Slovenian Research Agency, the National Institutes of Health, and the European Union. The other authors (Stefano Passanisi, Fortunato Lombardo, Chiara Mameli, Bruno Bombaci, Maddalena Macedoni, Gianvincenzo Zuccotti, Klemen Dovc, Giuseppina Salzano and Maurizio Delvecchio) do not declare any competing interest. Since the paper was submitted, Maurizio Delvecchio's affiliation has changed from Metabolic Disorders and Clinical Genetics, "Giovanni XXIII" Children's Hospital, AOU Policlinico-Giovanni XXIII, Bari, Italy, to Department of Biotechnological and Applied Clinical Sciences, University of L'Aquila, L'Aquila, Italy (his current affiliation).

Ethical Approval. This article is based on previously conducted studies and does not contain any new studies with human participants or animals performed by any of the authors.

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