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ORIGINAL ARTICLE

MiniMed 780G Six-Month Use in Children and Adolescents with Type 1 Diabetes: Clinical Targets and Predictors of Optimal Glucose Control

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Abstract

Background: The aim of this multicenter observational real-world study was to investigate glycemic outcomes in children and adolescents with type 1 diabetes over the first 6-month use of MiniMed™ 780G. The secondary objective was to evaluate demographic and clinical factors that may be significantly associated with the achievement of therapeutic goals.

Methods: Demographic, anamnestic, and clinical data of study participants were collected at the time of enrollment. Data on ambulatory glucose profile were acquired at 3 and 6 months after activating automatic mode. Aggregated glucose metrics and device settings of the entire study period were analyzed to identify predictors of optimal glycemic control, assessed by the concomitant achievement of time in range (TIR) >70%, coefficient of variation (CV) <36%, glucose management indicator (GMI) <7%, and time below range (TBR) <4%.

Results: Our study cohort consisted of 111 children and adolescents (54.1% female) aged 7–18 years. All the most relevant clinical targets were achieved according to recommendations from the International Consensus both at 3 and 6 months. When considering aggregated data, primary goals in terms of TIR, CV, GMI, and TBR were achieved, respectively, by 72.1%, 74.8%, 68.5%, and 74.8% of participants. In addition, 44 individuals (39.6%) concomitantly addressed all the above clinical targets. Regression analysis revealed that older age, briefer duration of disease, and shorter active insulin time were significant predictors of optimal glucose control. Comparing two groups of individuals stratified according to the glycated hemoglobin (HbA1c) mean value in

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the year preceding MiniMed 780G use, achieving glycemic targets was observed in the subgroup with lower HbA1c.

Conclusions: Our study highlights the effectiveness and safety of MiniMed 780G in the pediatric population. More extensive and personalized training on advanced hybrid closed-loop use should be considered for younger people and those with long disease duration.

Keywords: Advanced hybrid closed loop, Coefficient of variation, Education, Glycated hemoglobin, Pediatrics, Technology, Time in range.

Background

Prevention of micro- and macrovascular complications of type 1 diabetes (T1D) strictly depends on maintaining optimal blood glucose levels over time and reducing intraday glycemic excursions.[1,2] Both a long time spent in target glucose values and low glycemic variability are now recognized as the most important goals in the management of people with diabetes.[3] Advances in technology play a crucial role in the attempt to achieve these therapeutic outcomes.[4] The most innovative technological devices introduced in clinical practice are advanced hybrid closed-loop (AHCL) systems that automatically adjust insulin doses based on sensor glucose values.[5] The supremacy of these automated insulin delivery (AID) systems compared with other insulin pumps has been widely demonstrated in real-world studies with children and adolescents.[6–8]

Currently, the following commercial AHCL systems are available in Europe: the Medtronic MiniMed™ 780G (Medtronic, Northridge, California), the Tandem™ Control IQ (Tandem, Inc., San Diego, CA, USA), the CamAPS™ FX (CamDiab Ltd., Cambridge, United Kingdom), and the Diabeloop™ (Diabeloop, Grenoble, France). In addition to the above products, people with T1D also use self-built ''D.I.Y.'' artificial pancreas systems. These products are unlicensed and users take responsibility for any risks associated with use. The MiniMed 780G system was approved in Europe in June 2020 for people aged >7 years and is currently available in more than 40 countries around the world. It represents a second-generation AID system characterized by the capability to integrate automatic correction boluses and to set up an adjustable target glucose value between 100 and 120 mg/dL. This insulin pump works with the Guardian™ Sensor 3 continuous glucose monitoring (CGM) system.

More recently, the latest Guardian 4 sensor has been tested with great benefits in terms of achieving more time in automatic mode and favorable glycemic targets.[9] The control algorithm in the MiniMed 780G is based on the proportional integral derivative approach with insulin feedback with adaptive insulin limits and model-based auto-corrections.[6,10,11] The safety and effectiveness of the MiniMed AHCL system have been reported in both adults and youths with T1D.[10,12] However, there are still few data on the performance of this device in the T1D pediatric population in real-world settings.

This study aimed to investigate glycemic outcomes in children and adolescents with T1D over the first 6-month use of MiniMed 780G. The secondary objective was to identify demographic or clinical factors that may be significantly associated with the achievement of therapeutic goals in our study cohort.

Materials and Methods

In this multicenter, prospective, observational real-world study, we recruited children and adolescents with T1D followed up in five Italian pediatric diabetes centers who started using MiniMed 780G from October 2020 to March 2022. The study protocol was approved by the local Ethics Committee of the University of Messina. Written informed consent from at least one parent of each study participant involved in the research study was obtained before the start of study procedures. The inclusion criteria for recruitment were as follows: diagnosis of T1D based on the latest International Society for Pediatric and Adolescent Diabetes Clinical Practice Consensus Guidelines,[12] age 7–18 years, and informed consent from children and their parents to access CGM data remotely.

The exclusion criteria were partial clinical remission according to the Hvidovre Study Group definition,[13] the occurrence of skin reactions caused by glycemic sensors and/or insulin infusion sets, concomitant treatment with steroids or other drugs known to interfere with blood glucose levels, and the presence of psychological disorders. Before starting the automatic mode, all children and their caregivers received extensive training, which is standard clinical practice for the participating diabetes centers. This training consists of at least two visits lasting 90–120 min each, provided by medical and technical staff on carbohydrate (CHO) counting, bolus wizard function use, interpretation, and sharing of CGM data. Demographic, anamnestic, and clinical data of study participants (i.e., age, gender, duration of diabetes, mean value of glycated hemoglobin (HbA1c) in the previous year, anthropometric parameters, previous insulin regimen) were collected by reviewing medical records.

Glucose metrics at baseline, 3, and 6 months after activating the automatic mode were collected. Baseline was considered a 14-day run-in period during which children and their caregivers used the device in manual mode.[14] Data were extracted from specific web-cloud platforms (https://carelink.minimed.eu/app/login).

The following glucose control indicators were gathered: mean and standard deviation score (SDS) of sensor glucose levels, time expressed in percentage in target range of glucose between 70 and 180 mg/dL (% time in range [TIR]), time expressed in percentage above 180 mg/dL (% time above range [TAR] >180 mg/dL), time expressed in percentage between 180 and 250 mg/dL (%TAR 180–250), time expressed in percentage above 250 mg/dL (%TAR >250 mg/dL), time expressed in percentage below 70 mg/dL (% time below range [TBR] <70 mg/dL), time expressed in percentage between 54 and 70 mg/dL (%TBR 54–70 mg/dL), time expressed in percentage below 54 mg/dL (%TBR <54 mg/dL), glucose management

indicator (GMI), and coefficient of variation (CV) expressed in percentage.

Data were also recorded on weekly automatic mode use and sensor wear expressed in percentage CHO, total insulin daily dose per day and its distribution between basal and bolus amount, entered per day, and active insulin time (AIT). The Glycemia Risk Index (GRI) was calculated at baseline, after 3 and 6 months of AHCL use to assess the overall quality of glycemia.[15] The relative changes of TIR, TAR, TBR, mean glucose, CV, and HbA1c were calculated to estimate the percentage of variation of these glucose control indicators from baseline to the end of the study. To examine all three principal percentages of glucose values (i.e., TIR, TAR, and TBR) simultaneously, a triangular graph was created.[16]

Data acquired every 3 months were aggregated to assess the glucose control indicators and device settings for the entire study period. The concomitant achievement of TIR >70%, CV <36%, GMI <7%, and TBR <4% was considered the identifying outcome of subjects with optimal glycemic control. Finally, to evaluate the potential relationship between HbA1c before starting the AHCL system and the achievement of clinical targets, we divided study participants into two groups: those who presented HbA1c mean value in the previous year ≤7% or 53 mmol/mol and those with HbA1c mean value in the previous year >7% or 53 mmol/mol.[17]

Statistical analyses

Numerical data were expressed as mean and standard deviation, and categorical variables as absolute frequencies and percentages. These descriptive statistics were calculated for each 3-month observational period and, also, for aggregated data. The parametric approach was used since the numerical variables were normally distributed, as verified by the Kolmogorov–Smirnov test. A comparison of the main glucose control indicators among three time points by using analysis of variance (ANOVA) for repeated measures was made. Post hoc two-by-two comparisons between groups were performed using the dependent Student's *t*-test. For these multiple comparisons, Bonferroni's correction was applied, for which the significance alpha level 0.050 was divided by the number of possible comparisons (equal to 3); thus, the ''adjusted'' significance level for this analysis is equal to 0.050/3 = 0.017.

Univariate and multivariate logistic regression models were estimated to identify significant predictors of the concomitant achievement of the most relevant clinical targets (i.e., TIR, CV, GMI, and TBR). The following covariates were tested: age, gender, diabetes duration, mean value of HbA1c in the year preceding start of use of an AHCL system, type of previous therapy (insulin pump or multiple daily injections), total daily insulin dose, percentage of basal delivery, percentage of time spent in automatic mode, percentage of sensor usage time, daily CHO intake, and AIT. The results were expressed as odds ratio, 95% confidence interval, and *P*-value.

Significant differences between subjects on the basis of HbA1c mean value in the previous year were evaluated by Student's *t*-test in the case of numerical variables, and by chi-square test (or exact Fisher test or likelihood ratio test, as appropriate) in cases of categorical variables. Statistical analyses were performed using IBM SPSS for Windows, Version 22 (IBM Corp., Armonk, NY, USA). The significance threshold was set to 0.05.

Results

Study population

Of the 129 study participants initially enrolled according to the inclusion and exclusion criteria, 18 dropped out during the 6-month study period (6 individuals had weekly sensor use <70%, 9 participants discontinued CSII therapy during the summer months, and glucose metrics from 3 subjects were unavailable due to the inability to share data). A summary of study participants' selection and exclusions is shown in Supplementary Figure S1.

Our study cohort consisted of 111 children and adolescents with a mild prevalence of female subjects (54.1%). The mean age of study participants was 13.1 ± 3.1 years, and the duration of diabetes was 5.4 ± 3.6 years. The mean HbA1c value in the year previous to MiniMed 780G use was 7.2% ± 0.8% (55 ± 9 mmol/mol), varying from 5.5% (36 mmol/mol) to 10.3% (89 mmol/mol). More than half of the participants (66.7%) were already on continuous subcutaneous insulin infusion therapy before starting the MiniMed 780G, while 33.3% were switched from multiple daily injections to the AHCL system. Regardless of the previous insulin regimen, 82.9% of subjects already used CGM before the study enrollment.

During the first 2 weeks of using the manual mode, TIR was 63.6%, TAR was 33.9% (time spent with glucose sensor values >250 mg/dL was 8.1%), and TBR was 2.5% (time spent with glucose sensor values <54 mg/dL was 0.5%) (Fig. 1). GRI was 39.9. Mean glucose levels were 163.4 ± 21 mg/dL. The mean baseline HbA1c was 7.2% ± 0.6% (55 ± 6 mmol/mol).

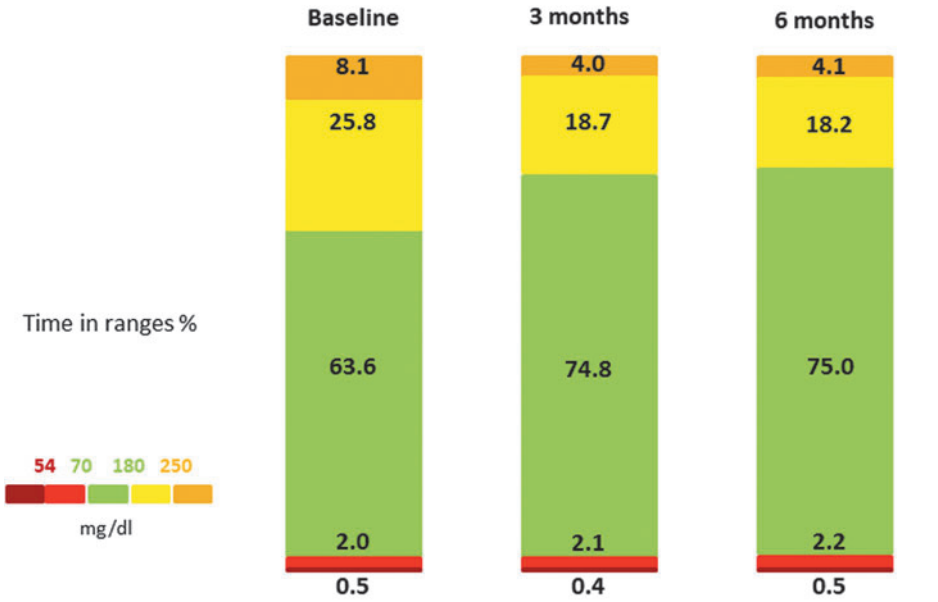
0–3-Month period

During the first 3-month use of the MiniMed 780G in automatic mode, time spent in target glucose ranges was 74.8% ± 8.3% corresponding to a relative improvement of 21.7% from baseline, time spent in hyperglycemia was 22.7% ± 9.3% with a relative reduction of 26.6% from baseline, and time spent in hypoglycemia was 2.5% ± 2.2%. GMI was 6.8% ± 0.43%, mean glucose sensor value was 146.9 ± 14.1 mg/dL, and CV was 34.1% ± 4.1%. Mean glucose sensor value decreased by 8.7% than baseline. Mean HbA1c value was 7.0% ± 0.5% (53 ± 7 mmol/mol) with a relative reduction of 3.2%.

As shown in Table 1, all CGM metrics except for TBR and CV were significantly improved from baseline. After 3 months of AHCL use, GRI was 31.2. Total daily insulin dose was 0.85 ± 0.3 IU/kg with a prevalence of bolus distribution including automated correction boluses (58.1%) compared with the basal infusion (41.9%). Automatic mode was used 92.8% ± 9.7% of the time. Glucose target was set at 100 mg/dL in most users (87.7%), only 11 subjects (9.9%) used a target of 110 mg/dL, and the remaining 2 children (1.8%) set the target at 120 mg/dL.

3–6-Month period

In the second quarter of MiniMed 780G use, data on ambulatory glucose profile were very similar to the previous



AutoMode %	/	92.7 ± 9.6	93.1 ± 10.3
CV %	34.0 ± 4.4	34.1 ± 4.1	34.4 ± 3.6
Mean glucose	163.4 ± 21.0	146.9 ± 14.1	146.4 ± 14.8
GMI (%)	7.3 ± 0.7	6.8 ± 0.3	6.8 ± 0.4
TDD (IU/kg/day)	0.82 ± 0.38	0.85 ± 0.30	0.84 ± 0.22
Basal %	51.3 ± 7.1	41.9 ± 6.6	41.8 ± 6.9
Boluses%	48.7 ± 6.8	58.1 ± 6.6	57.6 ± 8.1

FIG. 1. Data on the main glucose metrics and insulin therapy at baseline, 3, and 6 months of MiniMed™ 780G use.

period, as shown in Figure 1, and no significant changes were observed between the 3- and 6-month AHCL use (Table 1). Box plots illustrating the distribution of CGM metrics in three time points (baseline, 3 months, 6 months) are available as Supplementary Figures S2 and S3. Compared with the 14-day run-in period, TIR increased by 22.3%, while TAR and mean glucose sensor value decreased by 27.9% and 9.3%, respectively. Mean HbA1c was 6.9% ± 0.7% (52 ± 7 mmol/mol) corresponding to a relative reduction of 4.2% from baseline. As demonstrated by the triangular graph, the three principal CGM targets fell inside the euglycemic area after starting automatic mode (Fig. 2). Percentage of children and adolescents achieving the main clinical CGM targets, except for TBR, increased progressively over the 6-month study duration (Fig. 3).

Table 1. Comparison Analysis of Main Glucose Metrics at Baseline, After 3 and 6 Months

	Baseline	P[a]	*3 Months*	P[b]	*6 Months*	P[c]
TIR (%)	63.5 ± 13.1	<0.001*	74.7 ± 8.5	0.484	74.8 ± 9.0	<0.001*
TAR >180 mg/dL (%)	34.1 ± 14.1	<0.001*	22.8 ± 8.9	0.236	22.5 ± 9.6	<0.001*
TAR 180–250 mg/dL (%)	25.9 ± 9.4	<0.001*	18.8 ± 6.7	0.070	18.3 ± 6.9	<0.001*
TAR >250 mg/dL (%)	8.2 ± 6.5	<0.001*	4.0 ± 2.8	0.514	4.2 ± 3.3	<0.001*
TBR <70 mg/dL (%)	2.4 ± 2.8	0.350	2.4 ± 2.0	0.020	2.7 ± 2.2	0.095
TBR 54–70 mg/dL (%)	2.0 ± 1.9	0.370	2.0 ± 1.5	0.023	2.2 ± 1.6	0.073
TBR <54 mg/dL (%)	0.5 ± 1.0	0.426	0.4 ± 0.7	0.131	0.5 ± 0.7	0.893
GRI	39.9 ± 14.9	<0.001*	31.2 ± 9.4	< 0.001*	27.9 ± 9.5	<0.001*
Mean sensor glucose level (mg/dL)	163.5 ± 21.0	<0.001*	147.6 ± 15.4	0.414	146.8 ± 15.2	<0.001*
CV (%)	34.0 ± 4.4	0.575	34.0 ± 3.9	0.483	34.4 ± 3.7	0.460
GMI (%)	7.3 ± 0.7	<0.001*	6.8 ± 0.4	0.865	6.8 ± 0.4	<0.001*

Data are expressed as mean ± SD.
[a]Comparison between baseline and 3 months.
[b]Comparison between 3 and 6 months.
[c]Comparison between baseline and 6 months.
*Significant *P*-value.
CV, coefficient of variation; GMI, glucose management indicator; GRI, Glycemia Risk Index; SD, standard deviation; TAR, time above range; TBR, time below range; TIR, time in range.

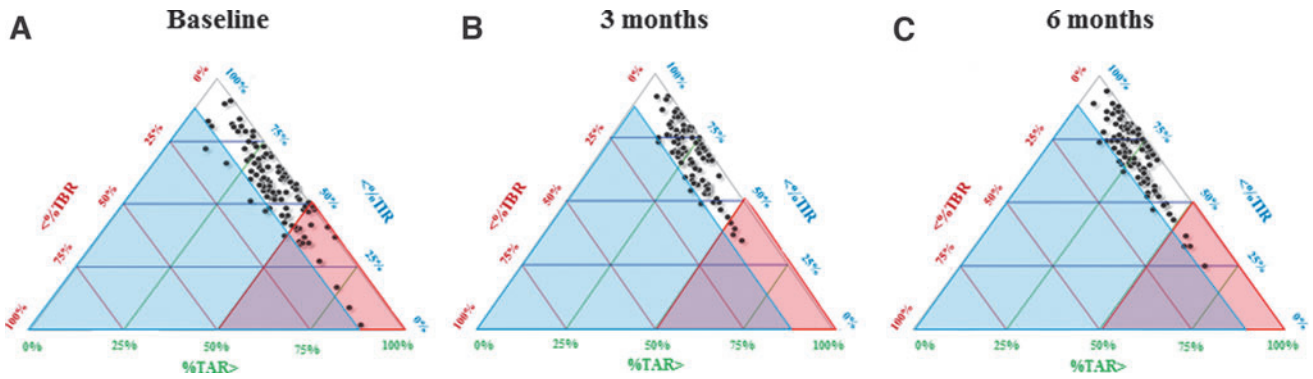


FIG. 2. Triangular plot showing CGM glucose values falling within the hypoglycemic range (<70 mg/dL), the target glucose range (70–180 mg/dL), and the hyperglycemic range (>180 mg/dL) at baseline **(A)**, after 3 months **(B)**, and at the end of the study **(C)**. Color overlays show the regions with %hypoglycemia >10% (blue), %hyperglycemia >50% (red), or problems with both hypo- and hyperglycemia (purple). CGM, continuous glucose monitoring.

No substantial changes were revealed in the total daily insulin dose, which was 0.84 ± 0.22 IU/kg, and in its distribution between basal and boluses (41.8% and 57.7%, respectively). Time spent in automatic mode increased to 93.1% ± 10.3%. Body mass index increased slightly but without significant changes, as well as daily CHO intake remained unchanged. GRI value dropped to 27.9 (Fig. 4). The assessment of auxological parameters, glucose metrics, device settings, and CHO intake during the entire study period is described in Supplementary Table S1.

Association between CGM targets and clinical variables

When considering aggregated data, the primary goals in terms of TIR, CV, GMI, and TBR were achieved, respectively, by 72.1%, 74.8%, 68.5%, and 74.8% of the study cohort. In addition, 44 individuals (39.6%) concomitantly addressed all the above clinical targets, thus obtaining glycemic targets. Regression analysis revealed that older age, briefer duration of disease, and shorter AIT were significantly associated with the achievement of all these outcomes (Table 2). No other demographic variables or factors dependent on users' behavior were found to be associated with the achievement of clinical targets.

The achievement of glycemic targets was obtained by those subjects with lower HbA1c levels before starting automatic mode. Specifically, time spent in hyperglycemia, mean glucose sensor levels, and GMI were significantly lower in individuals with a mean value of HbA1c in the previous year ≤7% or 53 mmol/mol ($P < 0.001$ for all variables) (Supplementary Table S2). Accordingly, time spent in target glucose levels was higher ($P < 0.001$). Significant differences were also found in weekly sensor wearing ($P = 0.048$) and percentage of basal delivery ($P = 0.019$). Finally, clinical targets in terms of TIR and GMI were achieved by a significantly greater percentage of children and adolescents with previous lower HbA1c levels ($P < 0.001$ and $P = 0.006$, respectively),

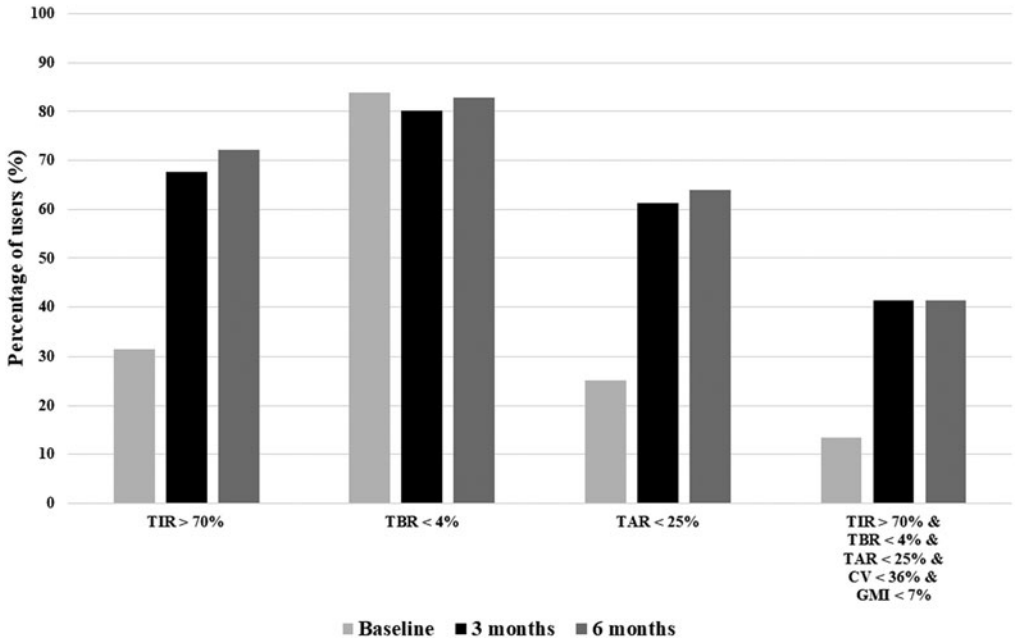


FIG. 3. Percentage of users achieving main clinical targets at baseline, 3, and 6 months of MiniMed™ 780G use.

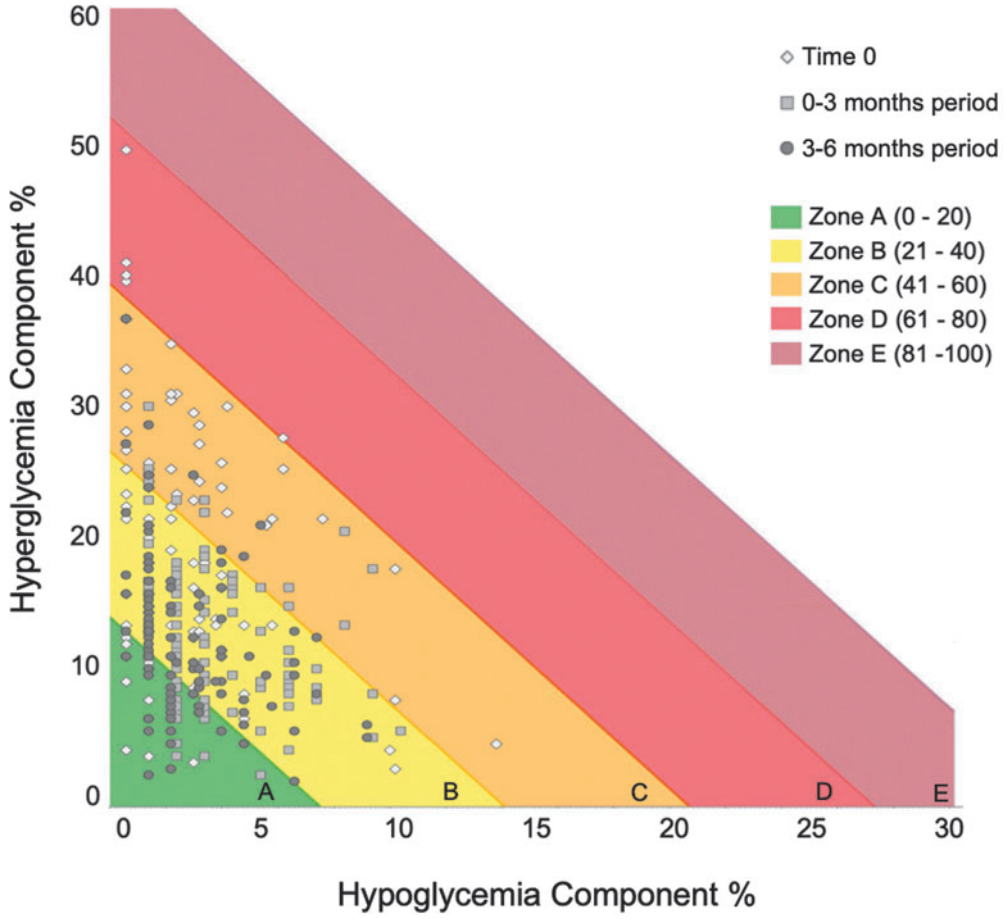


FIG. 4. A Glycemic Risk Index grid showing the hyperglycemia component versus the hypoglycemia component according to different observation periods. Hyperglycemia component is calculated as %TIR >250 mg/dL + (0.5 × %TIR 180–250 mg/dL). Hypoglycemia component is measured as %TBR <54 mg/dL + (0.8 × %TBR 54–70 mg/dL). The results of each of the three periods are shown with different symbols. TBR, time below range; TIR, time in range.

Table 2. Results of Multivariate Logistic Regression Models for the Concomitant Achievement of TIR >70%, CV <36%, GMI <7%, and TBR <4%

Variables	*OR*	*95% CI*	P
Age	1.228	1.066–1.414	0.004*
Gender (male)	2.240	0.717–7.004	0.165
Duration disease	0.856	0.735–0.998	0.047*
Mean HbA1c value of the last year	0.992	0.930–1.057	0.796
Previous insulin regimen (CSII therapy)	1.001	0.285–3.522	0.998
Active insulin time	0.382	0.199–0.733	0.004*
Daily insulin dose/body weight	0.337	0.033–3.434	0.358
% Basal distribution	0.962	0.878–1.054	0.408
% SmartGuard use	1.037	0.924–1.165	0.535
% Sensor use	0.991	0.879–1.117	0.882
Daily CHO intake/body weight	0.867	0.568–1.324	0.509

*Significant *P*-value.

CHO, carbohydrates; CSII, continuous subcutaneous insulin infusion; HbA1c, glycated hemoglobin; OR, odds ratio.

while no differences were found regarding CV, TBR, and the concomitant achievement of the above clinical targets (Fig. 5).

Discussion

Our findings showed that children and adolescents significantly improved their glycemic goals since the first months of AHCL use. Our study participants spent most of their time in target glucose values along with low glycemic variability after activating the automatic mode. All the most relevant CGM clinical targets were achieved according to international recommendations.[3] Above all, %TAR and %TIR, which provide sensitive indicators of AID effectiveness,[18] resulted within normal limits. The progressive improvement of the GRI during the entire study period further confirmed the beneficial effects of MiniMed 780G. Successful use of the other AHCL systems approved in Italy for the pediatric age has already been demonstrated in a prospective study evaluating the 6-month impact of the advanced automated functions of the Tandem™ Control-IQ on TIR of children and adolescents with T1D.[19] The first report from 1278 Italian people using MiniMed 780G in real-world settings showed higher percentages of TIR (76.7% vs. 74.7%).

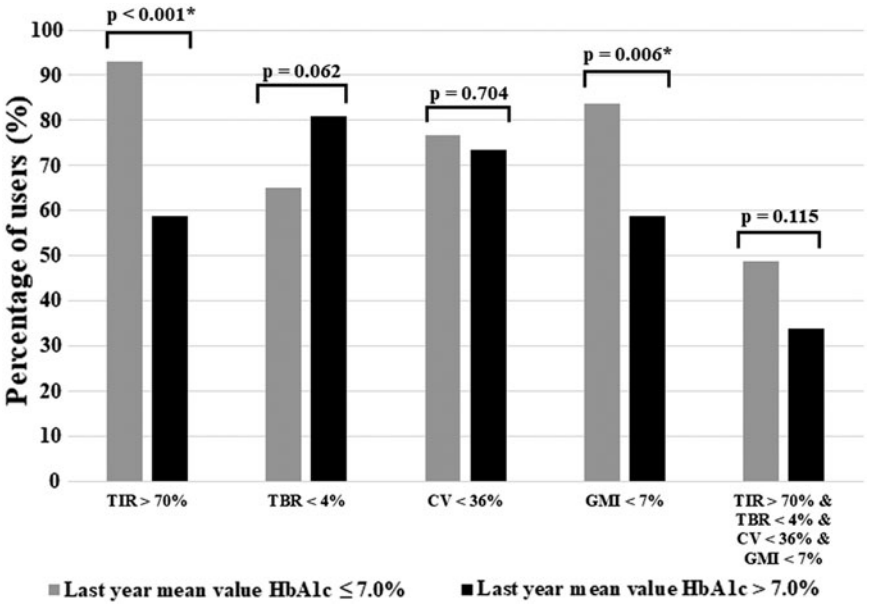


FIG. 5. Percentage of users achieving treatment goals with the MiniMed™ 780G system and HbA1c levels before starting AHCL therapy. AHCL, advanced hybrid closed loop; HbA1c, glycated hemoglobin.

However, this study included predominantly adult subjects and was limited to a short follow-up period of observation (54 ± 32 days).[20] In a prospective single-center study on 34 children with T1D switched from MDI therapy to MiniMed 780G, TIR was also higher than that reported in our study (78.8% ± 6.1% vs. 74.7% ± 8.2%) across the 12-week study phase.[21] Conversely, CGM measurements achieved by our study participants were quite similar to those reported by Arrieta et al. who described MiniMed 780G system performance in users <15 years.[22] They collected data from 790 children and adolescents across 6 months after AHCL initiation and reported an averaged TIR of 73.9% or higher over the 6 months and GMI of 6.8%.

In our study, we observed a lower average time spent in hypoglycemia (2.6% vs. 3.2%) and lower CV (34.3% vs. 36.7%) than in the Arrieta study. These findings are encouraging as they confirm the ability of AHCL systems to prevent hypoglycemic events and reduce short-term glucose variability. The close relationship between fear of hypoglycemia and glycemic outcomes is well known. Hypoglycemia in children harms the well-being of parents, and fear of hypoglycemia constitutes a barrier to the achievement of glycemic goals.[23,24] The use of AHCL systems has been recently demonstrated to improve the quality of life also in terms of decreased fear of hypoglycemia and this could lead to overcoming one of the main obstacles in the management of children with T1D.[25] The ability to decrease glycemic variability is another crucial aspect considering the impact of glycemic fluctuations on the risk of early appearance of microvascular and macrovascular complications.[26]

Our study participants obtained CV values below 36%, universally considered the threshold to define glycemic stability.

In the report by Arrieta et al., 47% of users <15 years achieved treatment goals defined as TIR >70%, TBR <4%, and GMI <7%.[22] In our experience, only 39.6% of subjects obtained all the clinical targets. However, considering that we added CV <36% among the criteria to identify optimal glucose control, our data do not differ much from those obtained by those researchers.

The only device setting detected in our study as a predictor of optimal glucose control was AIT, which is a parameter that indicates the amount of insulin still present in the body from prior boluses. AIT can be set up in a range varying from 2 to 8 h. In our study, shorter AIT appeared to facilitate the achievement of glycemic targets. This finding is consistent with another recent study that reported AIT as one of the system settings that predicted the highest mean TIR. In particular, those authors recommended setting AIT at 2 h, highlighting that shorter AIT was not associated with a higher risk of hypoglycemic events.[27]

Among demographic characteristics, the older age was the only predictor of favorable glycemic outcomes. Considering our pediatric study population, this finding is very interesting. Other studies on adults have already demonstrated that older age groups benefit greatly from the use of technology in the management of T1D.[28,29] Castañeda et al. recently reported that an increase in age was associated with a 2.5 percentage-point increase in TIR for users aged >55 years compared with those aged ≤15 years.[27] Regarding the pediatric age, this finding shed light on two relevant aspects. Children usually have a more unstructured lifestyle than older subjects with unexpected physical activities and hidden or unannounced extra meals. Therefore, parents and caregivers of younger children should be trained more carefully in receiving system-specific education tips focusing primarily on children's more unpredictable behavior patterns.[30]

In addition, the choice of children suitable to use AHCL should be likely targeted also on the basis of the possibility of close parental control of one's child. On the contrary, the evidence that the older age group was more likely to achieve glycemic targets is surprising. It is well known that teenagers often present suboptimal engagement and, consequently, suboptimal clinical outcomes due to the challenge of managing a chronic disease during a tricky transition phase such as adolescence.[31,32] Previous studies have demonstrated that HbA1c values can arise up to 1.5% from baseline, indicating

a significant deterioration in glucose levels, during this phase of life.[33,34] Therefore, our findings suggest that AHCL systems allow reaching good clinical targets also in those individuals, who usually pay less attention to diabetes management, due to the ability of the automated system to compensate for potential behavioral mistakes such as unhealthier eating, inadequate CHO counting, or bolus omission.

Another predictor of optimal glucose control revealed by our study was the duration of the disease. Specifically, a briefer duration was associated with achieving glycemic targets. It may be that children and their caregivers who received a recent education on diabetes management at the onset of the disease are more careful and motivated to respect diabetes care recommendations and this facilitates the role of automated systems to achieve clinical targets. This finding supports the theory that newly diagnosed people with diabetes could benefit from the early adoption of AID systems.[35]

Although studies evaluating the safety and efficacy of early AHCL use in adults and children at the onset of diabetes are still ongoing, it is proposed that early initiation could be related to good long-term glucose control, long-term device acceptance, and durable use.[36] On the contrary, our results suggest that it is critical that for people with a long disease history who use technology, health care professionals should periodically reinforce users' core diabetes knowledge to enable the achievement of glycemic targets related to the use of AHCL systems.[37]

Comparing the two groups of study participants stratified according to the HbA1c mean value in the year preceding AHCL initiation, it is interesting to note that subjects with higher HbA1c levels achieved all the clinical targets in terms of TIR, TAR, TBR, and CV. This finding is consistent with other recent studies that showed that AHCL users improve glycemic levels regardless of baseline HbA1c.[4,38,39] Ekhlaspour et al. observed that subjects with HbA1c ≥8.5% improved mainly by reducing daytime and nocturnal hyperglycemia.[38] In another report on T1D youth who started AHCL use for routine care, the most substantial improvement in glucose levels was also experienced by individuals with higher baseline HbA1c.[39] Conversely, our study found that the subgroup with lower HbA1c before starting MiniMed 780G achieved glycemic targets more easily. We can suppose that subjects with already glycemic stability are more likely to adhere to diabetes care recommendations, including healthy eating and physical activity.

This theory may be supported by the evidence that total daily insulin dose tended to be significantly lower in children and adolescents with previous HbA1c ≤7%. The higher percentage of weekly sensor use also highlights more careful daily disease self-management in this group of individuals.

Limitations of our study include the lack of some aspects of AHCL sustainability such as Smart Guard exits and errors, and device settings (e.g., auto correction amount per day, set and reservoir change, glucose targets). Specifically, set change time was not considered in the analysis as the extended infusion sets were introduced during the study period. These sets, which last twice as long as standard 3-day sets, were used by a number of study participants.

Unlike other studies, we did not consider glucose targets among potential predictors of glucose control as most users set a target of 100 mg/dL according to the most recent scientific evidence.[27] Other missing data are related to the percentage of automated correction boluses and the number of daily meals declared. Finally, the multicentric design of the study may be related to slight differences in training modality on AHCL use by medical and technical staff, although we believe they do not represent a significant bias.

Conclusions

Our study highlights the effectiveness and safety of MiniMed 780G in children and adolescents with T1D. The achievement of more ambitious glycemic targets depends on both certain device settings and individual characteristics. More extensive and personalized training on AHCL use should be considered for younger individuals, and those with long disease duration and with higher previous HbA1c levels. Finally, continuous education remains essential to support even the most advanced technology.

Authors' Contributions

F.L.: writing—review and editing; S.P.: writing—original draft preparation; B.B., R.B., M.D., F.D.C., E.M., E.P., C.A.P., A.R., and F.S.: data curation; A.A.: formal analysis; C.M. and G.S.: conceptualization. The article has been read and approved by all the authors and each author considers that the article represents his or her honest work.

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Supplementary Material

Supplementary Figure S1
Supplementary Figure S2
Supplementary Figure S3
Supplementary Table S1
Supplementary Table S2

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