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BRIEF REPORT

12-Month Time in Tight Range Improvement with Advanced Hybrid-Closed Loop System in Adults with Type 1 Diabetes

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ABSTRACT

***Introduction*:** Time in tight range (TITR) is an emerging and valuable metric for assessing normoglycemia. The latest advancement in automated insulin delivery (AID) systems, the advanced hybrid closed-loop (AHCL) systems, are particularly noteworthy for managing type 1 diabetes (T1D) and enhancing glycemic control.
***Methods*:** In a real-world clinical setting, we carried out a retrospective evaluation of TITR in 42 adult subjects with T1D using the AHCL Minimed™ 780G system over a 12-month period.
***Results*:** Within just 14 days of activating the automatic mode, the AHCL Minimed™ 780G system showed rapid improvement in TITR, and in the other continuous glucose monitoring (CGM) metrics. This improvement persisted over 12 months, achieving the proposed 45–50% range for effective glycemic control.
***Conclusion*:** The AHCL Minimed™ 780G system significantly enhances TITR, demonstrating continuous improvement throughout a 12-month follow-up period.

Keywords: Time in tight range; Continuous glucose monitoring metrics; Technology; Advanced hybrid closed-loop systems; Type 1 diabetes

Prior Presentation: This brief report is based on our previous work "12-Month Efficacy of Advanced Hybrid Closed-Loop System in Adult Type 1 Diabetes Patients" (Diabetes Technol Ther 26(2):130–135, 2024. https://doi.org/10.1089/dia.2023.0319).

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Key Summary Points
Why carry out this study?
To date, there have been very few studies investigating the new glycemic parameter time in tight range (TITR) among users of advanced hybrid closed-loop (AHCL) systems, particularly in adults.
The study aimed to evaluate TITR in adults with type 1 diabetes (T1D) using the AHCL Minimed™ 780G system in a real-world clinical setting over a long follow-up.
What was learned from this study?
The study demonstrates the enhancement of TITR among adults with T1D utilizing the AHCL Minimed™ 780G system.
The study results indicate that a TITR target of over 55% can realistically be achieved by users of the Minimed™ 780G AHCL system when using optimal settings.
Further studies are needed to explore the short- and long-term implications of using TITR as a continuous glucose monitoring (CGM) metric.

INTRODUCTION

Continuous glucose monitoring (CGM) systems have become essential in managing type 1 diabetes (T1D), enhancing insulin therapy and enabling better glycemic control [1, 2]. The consensus-based glycemic targets established for standardized CGM measures in clinical care, agreed upon by a global panel of technology experts during the Advanced Technologies & Treatments for Diabetes (ATTD) Congress in 2019 [3], include glucose management indicator (GMI), targeted to be ≤ 7%; time in range (TIR), set between 70 and 180 mg/dl and aimed to be > 70%; time below range (TBR), aiming for < 70 mg/dl, targeted to be < 4% overall and < 1% for values < 54 mg/dl; time above range (TAR), exceeding 180 mg/dl, which should be < 25% overall and < 5% for values > 250 mg/dl; glycemic variability (CV), targeted to be ≤ 36%, in both young and adult patients with T1D. Notably, with the established relationship between TIR and glycated hemoglobin (HbA1c) [4, 5], TIR has emerged as a new standard for evaluating glycemic control [3, 6]. However, the TIR metric of 70–180 mg/dl inadequately reflects physiological euglycemia [7]. It has been suggested that the time spent in the 70–140 mg/dl range, known as time in tight range (TITR), which was introduced by the International Consensus statement [3], may more accurately represent euglycemia in CGM metrics [7]. TITR is emerging as a valuable metric for assessing normoglycemia [8, 9] and there is ongoing debate within the scientific community regarding its utility and whether it is a viable recommendation for achieving and maintaining glycemic control. Although a specific treatment goal for TITR in individuals with T1D has not yet been firmly established [10] some researchers have proposed aiming for TITR targets between 45% and 50% as potential treatment goals [11–13].

The integration of CGM systems with insulin pumps has led to the development of advanced hybrid closed-loop (AHCL) systems, marking the most recent technological advancement in T1D treatment since the introduction of the automated insulin delivery (AID) systems [14, 15]. The AHCL systems, automatically adjusting basal insulin infusion based on CGM and administering corrective boluses as needed [16], are increasingly emerging as the new standard of care in T1D management [17, 18]. Over the past decade, clinical trials have shown that AHCL systems outperform multiple daily injections (MDI) whether used with or without CGM, as well as sensor-augmented insulin pump (SAP) therapy [19, 20]. The Minimed™ 780G system (Medtronic, Northridge, Los Angeles, USA) employs an algorithm to automate basal insulin delivery with customizable sensor glucose targets set at 100, 110, and 120 mg/dl (temporarily adjustable to 150 mg/dl for specific situations such as physical activity), and provides correction boluses every 5 min as needed. Moreover, a variable active insulin time ranging from 2 to 8 h can be set by the users, allowing for flexible adjustment of the algorithm's response speed.

The Minimed™ 780G can also be utilized as a predictive low glucose suspend (PLGS) system, often referred to as "manual mode", delivering user-programmed basal insulin with temporary automated interruption when the system predicts imminent hypoglycemia. The manual mode is the default setting upon system initiation and can be used for a customizable period before switching to "automated mode" (more properly named "SmartGuard function"). Data from the system can be uploaded to the CareLink platform and be available for consultation [21]. The safety and the efficacy of the Minimed™ 780G have been demonstrated in numerous clinical trials and real-world studies involving patients with T1D previously utilizing CGM systems and insulin pumps with varying levels of automation [22–25]. Furthermore, in these studies, although very few with an observation period of 12 months [26–31], patients using the Minimed™ 780G achieved consensus-based glycemic targets mentioned above [26, 27, 29].

To date, there have been very few studies examining TITR among users of AHCL systems, particularly in adults [13, 25, 31–37], with a variable follow-up. Bahillo-Curieses et al. conducted a prospective observational study on pediatric and adult patients with T1D who were treated with AHCL systems for at least 3 months. The study aimed to analyze TITR and its relationship with other glucose metrics. A total of 117 patients showed improvements in all CGM metrics, with 76.3% achieving TITR > 50%. Correlation analysis revealed a strong positive correlation between TITR and TIR, as well as with GMI [34]. Schiaffini et al. demonstrated in a real-world single-center cross-sectional study improvements in TIR and in TITR, as well as a reduction in CV, among children and adolescents using AHCL systems compared to those using SAP systems, MDI with real-time CGM, and MDI with intermittent scanning glucose monitoring [35]. Castañeda et al. conducted a retrospective observational analysis using real-world anonymized data from users of the MiniMed™ 780G AHCL system in individuals with T1D. They demonstrated an increase in TITR and reported that TITR treatment targets of 45%, 50%, and 55% correlated with GMI estimates of < 7.0%, < 6.8%, and < 6.5%, respectively [11]. Recently Passanisi et al. and Piona et al. reported a TITR of 51.1% in a multicenter, longitudinal, 1-year real-world study involving children and adolescents with T1D treated with the MiniMed™ 780G system, and a TITR of 47.8% in a cross-sectional multicentric real-world study that collected data from a large cohort of children and adolescents with T1D treated with AHCL systems, respectively [31, 32].

In our previous study, we demonstrated the safety and effectiveness of the MiniMed™ 780G system in managing T1D in adults over a 12-month follow-up period [38]. The aim of the present study was to evaluate the new glycemic parameter TITR in adult patients with T1D using the AHCL Minimed™ 780G system in a real-world clinical setting over a long follow-up period of 12 months. Additionally, we aimed to explore clinical parameters that may correlate with TITR and overall glycemic outcomes.

METHODS

We conducted an observational, retrospective, real-world study involving adult patients with T1D who were introduced to the AHCL Minimed™ 780G system for insulin therapy, all from the Diabetes and Metabolic Diseases Unit at the University of Siena. All participants in the study provided written consent for their data to be collected and used for research purposes. The study received approval from the local research ethics committee (Protocol number 24849. Comitato Etico Regionale per la Sperimentazione Clinica della Regione Toscana, Sezione: AREA VASTA SUD EST) and adhered to the standards set by the Declaration of Helsinki, as updated in 2013. In this study, we enrolled 42 patients with T1D (18 male patients and 24 female patients), all aged 18 or older. We collected and analyzed clinical data and CareLink reports from the first 12 months after the introduction of the Minimed™ 780G system. At baseline (T0), just before starting with the AHCL system, we evaluated several parameters: age, diabetes duration, HbA1c, previous insulin therapy, total daily insulin dose (TDI), and body mass index (BMI). After initiation of the AHCL system, specific

CGM metrics were assessed, including TITR, TIR, TAR (subdivided into TAR > 180 mg/dl and TAR > 250 mg/dl, labeled as TAR250), and TBR (further categorized into TBR < 70 mg/dl and TBR < 54 mg/dl, denoted as TBR54), CV, GMI, and mean glucose. Additionally, TDI, HbA1c, and BMI were also evaluated. We examined the aforementioned parameters at multiple time periods: 14 days after initiating manual mode (referred to as M, indicating the Minimed™ 780G use as a PLGS system), 14 days after switching to the automatic mode (referred to as auto-mode or A), and 14 days after 3 months (A3mo), 6 months (A6mo), and 12 months (A12mo) of using auto-mode. The data collected at auto-mode intervals (A, A3mo, A6mo, A12mo) were compared to those obtained during manual mode (M) as well as between the various time points in auto-mode. In addition, we looked for any statistically significant correlations between the CGM metrics mentioned above at the A and at the A12mo time periods and the T0 parameters (e.g., diabetes duration, age, BMI, HbA1c, and TDI). We also classified the study participants by several characteristics to identify distinct patterns across different groups. These subclassifications included sex (comparing male and female participants), glycemic control at T0 (HbA1c > 7.5% versus HbA1c ≤ 7.5%, 23 and 19 patients respectively), and diabetes duration (≥ 25 years versus < 25 years, 21 patients in each of the two groups respectively). The methodologies outlined above are similar to those employed in our previous study investigating the efficacy of the MiniMed™ 780G system in adults with T1D [38]. We also checked for any episodes of ketoacidosis or severe hypoglycemia occurring during the 12-month observational period. The continuous variables were expressed as mean and standard deviation. All statistical analyses were performed using GraphPad software, version 8.2.1 (441). Depending on the results of normality and lognormality tests, we applied either the paired *t* test or the Wilcoxon signed-rank test for data analysis. To compare differences between different groups, we used the non-parametric Mann–Whitney *U* test. For establishing correlations between continuous variables, we employed the non-parametric Spearman test. A p value < 0.05 was considered statistically significant.

RESULTS

At baseline (T0), the patients included in the study showed the following mean characteristics: age 43.61 ± 13.28 years, diabetes duration 25.19 ± 14.08 years, HbA1c 7.83 ± 1.39% (with 10 patients having HbA1c ≤ 7%), BMI 24.86 ± 3.99 kg/m^2, and TDI 36.78 ± 17.01 units. Before the introduction of the Minimed™ 780G system 14 patients were on MDI insulin therapy, 11 patients were using a non-automated insulin pump system (nAID) combining an insulin pump with either a CGM or a flash glucose monitoring (FGM) glucose sensor, and the other study participants were on a PLGS system or a hybrid closed-loop (HCL) system not providing automatic boluses (7 and 10 patients respectively). During the 12-month period of using the AHCL system no episodes of ketoacidosis or severe hypoglycemia were documented. At 12 months (A12mo), 15 patients had a GT set at 120 mg/dl, 12 patients at 110 mg/dl, and 12 patients at 100 mg/dl. Ten patients had a TIA set at 3 h, 2 patients at 2 h 45 min, 8 patients at 2 h 30 min, 2 patients at 2 h 15 min, and 17 patients at 2 h. All study participants consistently maintained a high usage percentage (%) of the SmartGuard function, which remained stable over the 12-month period in auto-mode (SmartGuard A: 95.02 ± 10.65%; SmartGuard A3mo: 95.47 ± 8.96%; SmartGuard A6mo: 96.02 ± 7.99%; SmartGuard A12mo: 92.94 ± 11.83%). Additionally, all participants consistently maintained over 70% use of CGM throughout the study. Remarkably, just 14 days after switching from manual mode (M) to auto-mode (A), significant improvements in CGM metrics were observed. Notably, there was a significant increase in TITR% (p < 0.0001) and TIR% (p < 0.00001). Moreover, there were significant reductions in TAR% (p < 0.0001), TBR% (p = 0.0034), CV% (p < 0.0001), mean glucose (mg/dl; p < 0.0001), and GMI% (p = 0.0004) (Figs. 1, 2). These improvements in TITR%, TIR%, TAR%, CV%, GMI%, and mean glucose were sustained and even enhanced at

	M	A	A3mo	A6mo	A12mo
TIR (%)	63.37±12.48	72.80±10.86	75.10±10.73	75.94±11.51	77.27±9.5
TITR (%)	38.05±11.67	44.83±11.83	47.89±11.75	49.35±13.27	49.52±11.75
TBR (%)	2.75±2.54	1.4±1.56	2±2	1.97±2.11	1.61±1.96
TAR (%)	34.4±12.88	24.83±11.19	22.89±11.1	21.82±11.5	21.25±10.03
CV (%)	33.89±5.39	30.74±4.36	31.08±4.79	31.53±5.16	30.06±4.5
GMI (%)	7.19±0.48	6.97±0.38	6.87±0.38	6.87±0.41	6.8±0.39
Mean Glucose (mg/dl)	162.67±19.22	153.35±15.8	149.10±15.33	147.61±16.94	146.75±15.83

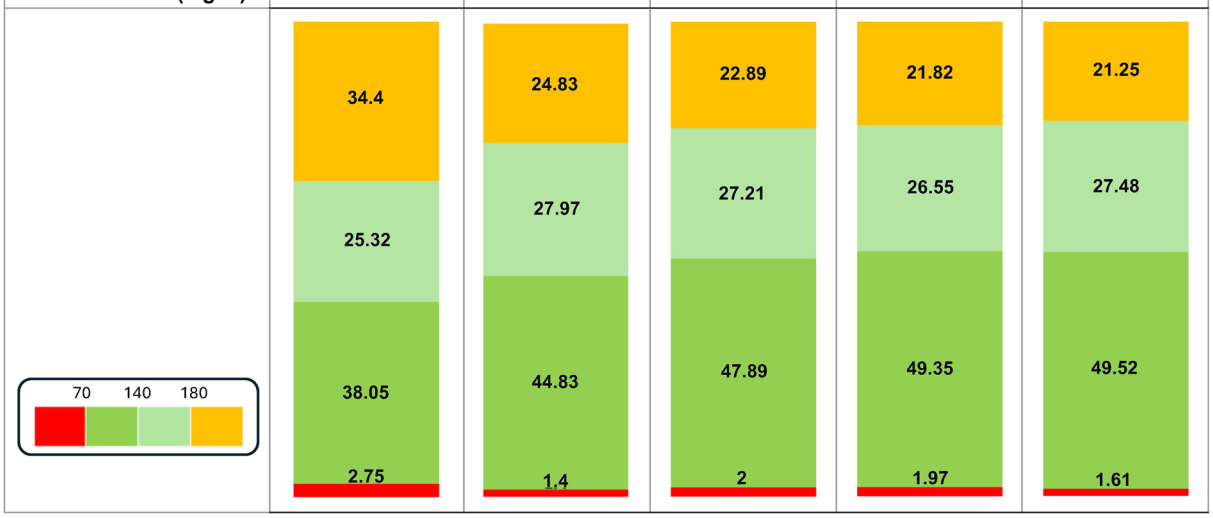
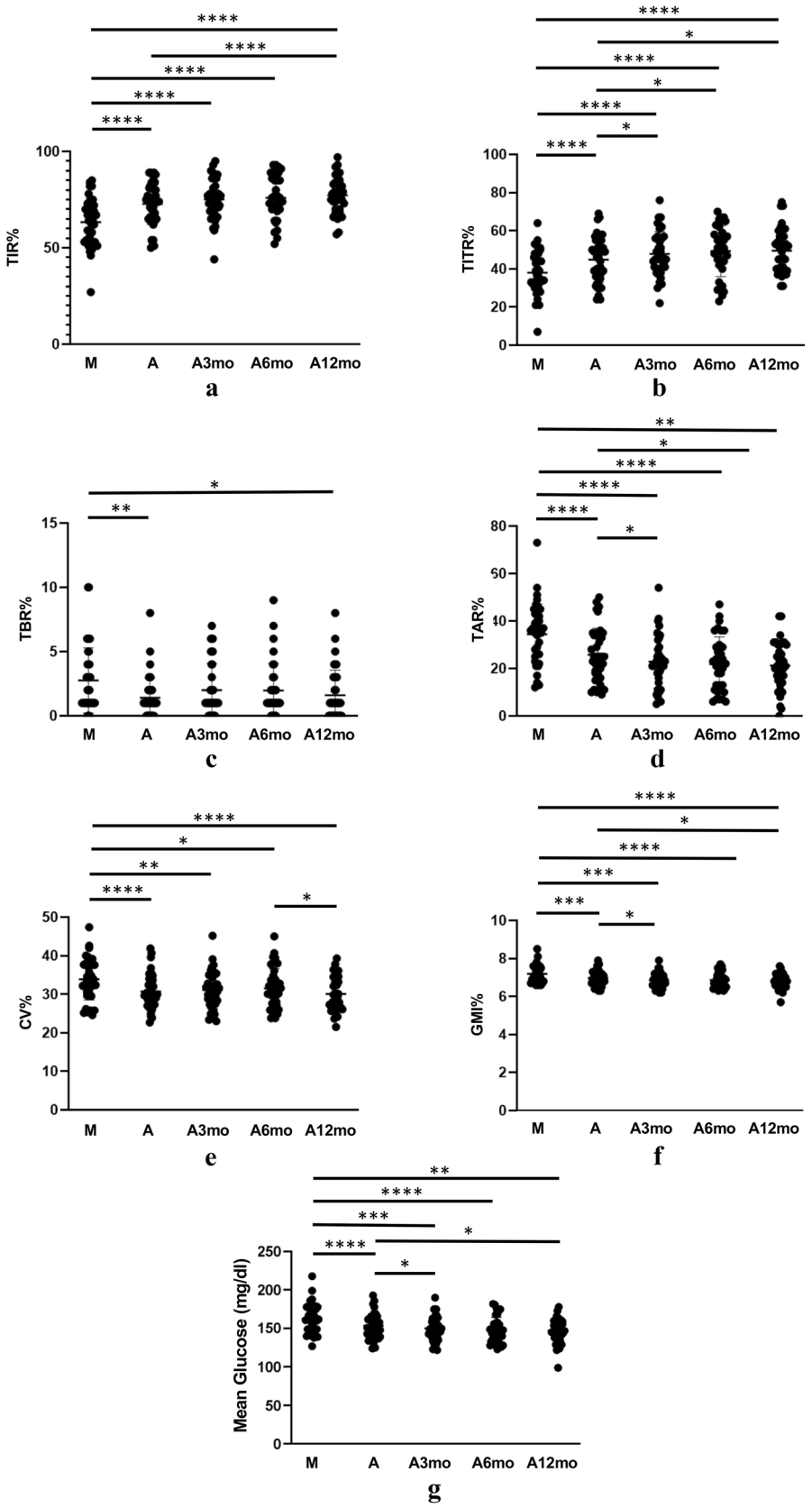


Fig. 1 Raw data results at different time points. *M* manual mode, *A* first 14 days auto-mode, *A3mo* first 14 days after 3 months auto-mode, *A6mo* first 14 days after 6 months auto-mode, *A12mo* first 14 days after 12 months auto-mode. *TIR* time in range, *TITR* time in tight range, *TBR* time below range, *TAR* time above range, *CV* glycemic variability, *GMI* glucose management indicator

subsequent time points, namely A3mo, A6mo, and A12mo, compared to the initial manual mode (M) (Figs. 1, 2), without an increase in TBR% (even decreased at A12mo compared to M; $p=0.0383$). Even at A12mo, there was a significant increase in TITR% ($p=0.0271$), TIR% ($p<0.0001$), GMI% ($p=0.0295$), and mean glucose (mg/dl; $p=0.0192$), along with a significant reduction in TAR% ($p<0.0001$) compared to A (Figs. 1, 2). Additionally, at A12mo, a significant reduction in HbA1c% was observed compared to T0 (HbA1c 7.02 ± 0.73% at A12mo versus 7.83 ± 1.39% at T0, $p=0.0094$) and A3mo (HbA1c 7.02 ± 0.73% at A12mo versus 7.22 ± 0.75% at A3mo, $p=0.0249$) (Fig. 3). Moreover, 20 patients achieved a target HbA1c of ≤ 7% at A12mo. Just 14 days into auto-mode (A), patients had already met target metrics based on standardized CGM criteria for clinical care. Specifically, the metrics were TIR 72.80 ± 10.86%, with 27 (64.28%) patients achieving a TIR of ≥ 70%; TAR 25.83 ± 11.19%, with 24 (57.14%) patients achieving a TAR of ≤ 25%; TBR 1.40 ± 1.56%, with 40 (95.23%) patients achieving a TBR of ≤ 4%; GMI 6.97 ± 0.38%, with 22 (52.38%) patients achieving a GMI of ≤ 7%; and CV 30.74 ± 4.36%, with 38 (90.47%) patients achieving a CV of ≤ 36%. These commendable metrics-related results were sustained throughout the 12-month follow-up. Fourteen days after switching to auto-mode, the TITR was 44.83 ± 11.83%, and at A12mo, it increased to 49.52 ± 11.75%, aligning with recommendations from several authors [11–13] (with an approximate increase of 12% compared to M). By the end of the observational period (A12mo), the other recorded CGM values were TIR 77.27 ± 9.50% (with an approximate increase of 15% from M), TAR 21.25 ± 10.08% (with an approximate decrease of 14% from M), TBR 1.61 ± 1.96% (with an


TIR%
M
A
A3mo
A6mo
A12mo
a
TITR%
b
TBR%
c
TAR%
d
CV%
e
GMI%
f
Mean Glucose (mg/dl)
g

◂**Fig. 2** Results at different time points (M, A, A3mo, A6mo, A12mo): **a** TIR%, **b** TITR%, **c** TBR%, **d** TAR%, **e** CV%, **f** GMI%, **g** mean glucose (mg/dl). *M* manual mode, *A* first 14 days auto-mode, *A3mo* first 14 days after 3 months auto-mode, *A6mo* first 14 days after 6 months auto-mode, *A12mo* first 14 days after 12 months auto-mode. *TIR* time in range, *TITR* time in tight range, *TBR* time below range, *TAR* time above range, *CV* glycemic variability, *GMI* glucose management indicator

approximate decrease of 1.20% from M), GMI 6.80 ± 0.39% (with an approximate decrease of 0.41% from M), and CV 30.06 ± 4.50% (with an approximate decrease of 4% from M). Interestingly, if we excluded patients with TIA of 3 h plus TG of 120 mg/dl ($n = 7$ patients), the TITR rose to 51.92 ± 11.37% (associated with a TIR of 78.60 ± 9.16%, a TBR of 1.75 ± 2.04%, a TAR of 19.82 ± 9.89%, a CV of 30.35 ± 4.43%, and a GMI of 6.74 ± 0.39%) meeting the desired threshold proposed by Castañeda et al. [11]. Moreover, if we considered only patients with TIA set at 2 h plus GT set at 100 mg/dl ($n = 7$ patients), the TITR was 55.85 ± 14.78% (associated with a TIR of 82 ± 10%, a TBR of 2.28 ± 3.30%, a TAR of 15.71 ± 11.60%, a CV of 29.24 ± 5.27%, and a GMI of 6.57 ± 0.49%). There was no notable difference in TDI at the end of the follow-up period (A12mo) compared to both the initial T0 and the manual mode (M). Additionally, the average BMI remained consistent over the 12-month period compared to the baseline (T0).

When we investigated potential correlations between TITR at A and A12mo and other glycemic outcomes at A and A12mo, as well as between TITR at A and A12mo and baseline (T0) parameters such as age, HbA1c, TDI, BMI, and duration of diabetes, several associations emerged. At A, TITR% showed a negative correlation with baseline HbA1c% ($p = 0.0029$), A TAR% ($p < 0.0001$), A GMI% ($p < 0.0001$), and A mean glucose mg/dl ($p < 0.0001$). Conversely, it had a positive correlation with A TIR% ($p < 0.0001$). There was a positive correlation also with A TBR% ($p = 0.0097$); however, A TBR, as previously described, was less than 2%, and TBR54 was less than 0.5%. At A12mo, TITR% exhibited a negative correlation with both baseline HbA1c% ($p = 0.0034$) and A12mo HbA1c% ($p = 0.0002$), A12mo TAR% ($p < 0.0001$), A12mo

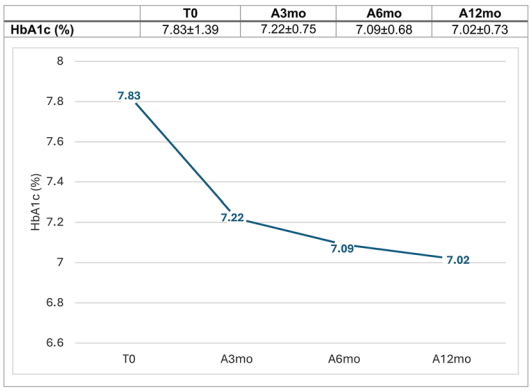


Fig. 3 Comparisons of glycated hemoglobin (HbA1c)% at baseline (T0) and at different time points post-advanced hybrid closed loop (AHCL) initiation (A3mo, A6mo, A12mo). *A3mo* first 14 days after 3 months auto-mode, *A6mo* first 14 days after 6 months auto-mode, *A12mo* first 14 days after 12 months auto-mode

GMI% ($p < 0.0001$), and A12mo mean glucose mg/dl ($p < 0.0001$). A12mo TITR% showed a positive correlation with A12mo TIR% ($p < 0.0001$). We also observed a positive correlation with A12mo TBR% ($p = 0.0012$); however, A12mo TBR was less than 2%, and A12mo TBR54 was less than 0.5%. No correlations were found between A TITR% (as well as A12mo TITR%) and age, TDI, BMI, and duration of diabetes (T0). When the study population was subdivided by sex, duration of diabetes (≥ 25 years versus < 25 years) and baseline glycemic control (HbA1c > 7.5% versus ≤ 7.5%), there was a significant improvement in TITR%, as well as in the other CGM parameters, in all subgroups at A12mo compared to M. The notable distinction was in TBR, which showed a statistically significant decrease only among subjects with HbA1c > 7.5% ($p = 0.0112$); conversely, there was no significant change in TBR% at A12mo compared to M among subjects with HbA1c ≤ 7.5%.

DISCUSSION

This observational real-world study demonstrated the improvement in TITR among adults with T1D using the AHCL Minimed™ 780G system over a 12-month follow-up period. TITR is

a glycemic parameter that seems to more accurately reflect euglycemia compared to the widely recognized TIR [7, 8]; its usefulness and applicability as a new CGM parameter remain the subject of debate. In this study, by the end of the follow-up period, there was a significant and statistically notable increase in TITR compared to both the manual mode and the initial 14 days in automatic mode. The most favorable outcomes were observed after excluding patients with TIA settings of 3 h and GT settings of 120 mg/dl and the best result, with a TITR of approximately 56%, was achieved in patients with TIA set at 2 h and GT set at 100 mg/dl. Although the TITR target is not yet established, it is widely accepted that a high TITR is desirable. Several authors consider a TITR over 45–50% as a reasonable and safe treatment target for patients with T1D [11, 12]. This because a TITR over 45% could have the greatest potential to accurately determine if patients achieve an HbA1c below 7%, as suggested by Castañeda et al. [11]. In particular, a TITR over 50% could be optimal for classifying a GMI below 6.8%, and a TITR over 55% for a GMI below 6.5% [11]. These findings have been confirmed in the present study. At the 12-month follow-up, a TITR of approximately 49% corresponded to a GMI of 6.7%, while a TITR of approximately 56% corresponded to a GMI of 6.5%. Our data confirmed the findings of Castañeda et al. showing that a TITR exceeding 55% could be reasonably achieved in Minimed™ 780G AHCL system users with T1D if optimal system settings are applied (target 100 mg/dl, insulin duration 2 h) [11]. As described in previous studies [8, 34], we observed a strong correlation between TITR and TIR. It remains to be determined whether one metric provides a more accurate assessment of glycemic control levels and predicts complications more effectively than the other.

In this study, we also confirmed the effectiveness of the Minimed™ 780G system in rapidly achieving and sustaining the recommended glycemic targets throughout the 12-month period. Approximately half of the participants achieved a HbA1c% ≤ 7%, and the majority of them aligned with consensus-based glycemic targets related to standardized CGM metrics such as TIR%, TAR%, TBR%, CV%, and GMI%. Importantly, these improvements in glycemic control were evident as early as 14 days after initiating auto-mode and continued consistently, or even improved, throughout the 12-month follow-up period. Furthermore, these findings observed at both the initiation of auto-mode and at the 12-month mark appeared unaffected by factors such as sex, age, duration of diabetes, BMI, and TDI at baseline. Moreover, many participants were previous users of either PLGS or HCL systems and already had good glycemic control. A limitation of the present study is the small population size; however, it emphasizes the robustness and consistency of the results obtained with AHCL systems in much larger cohorts and it is one of the few studies in the literature that has investigated the TITR, particularly in an adult population with a long follow-up period. Another potential limitation of our work is its retrospective design, which may introduce potential bias; however, the study population is well characterized and the data were collected and analyzed meticulously. Regarding safety, we obtained further confirmation. Importantly, transitioning to automatic mode did not increase the incidence of hypoglycemic episodes; instead, it reduced them (particularly in patients with HbA1c > 7.5% at baseline) and maintained this improvement throughout the 12-month period. Notably, at A12mo the 95% of patients showed a TBR < 4%.

The literature underscores the critical importance of optimizing glycemic control to reduce the risk of microvascular complications and the incidence of cardiovascular diseases [39, 40]; this study highlights how technological advancements now enable achieving glucose levels close to euglycemia without the risk of hypoglycemia. However, to determine whether this promising new CGM glycemic metric could become a key measure for assessing glycemic outcomes and the risk of diabetes complications, further research is needed to support a comprehensive discussion and establish a consensus target within the International Consensus group. Prospective interventional clinical trials, where patients are instructed to aim for a target of spending time with glycemic values between 70 and 140 mg/dL, conducted across different settings and diverse populations (including those at higher

risk of hypoglycemia) and using various treatment approaches, could be particularly helpful [9]. Beyond glycemic outcomes, it is important to consider whether striving for glucose levels close to euglycemia may introduce anxiety and consequently lead to a poorer quality of life due to the constant monitoring required to maintain tight glycemic control [10].

CONCLUSION

This observational, retrospective, real-world study demonstrates the improvement in TITR among adults with T1D using the AHCL Minimed™ 780G system and underscores the effectiveness of this novel glucose metric in accurately assessing glycemic control, with a TITR of 55% corresponding to an HbA1c level of 6.5%. Our findings are consistent with the limited existing literature on the desirable TITR [11, 35] and support the notion that a TITR target of over 55% can realistically be achieved by users of the Minimed™ 780G AHCL system when using optimal settings (100 mg/dl as glycemic target and 2 h as active insulin time). Further studies are needed to explore the short- and long-term implications of using TITR as a CGM metric and to establish its practical usefulness in clinical settings. Finally, our study not only reaffirms previous findings about the effectiveness of AHCL systems in achieving optimal glycemic control but also demonstrates their ability to maintain or improve control over time.

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Data Availability. The datasets generated and analyzed during the current study were available on CareLink™ System (https://carelinkhp.minimed.eu).

Declarations

Conflict of Interest. The authors Laura Nigi, Maria De Los Angeles Simon Batzibal, Dorica Cataldo and Francesco Dotta have no conflicts of interest to disclose.

Ethical Approval. All participants in the study provided written consent for their data to be collected and used for research purposes. The study received approval from the local research ethics committee (Protocol number 24849. Comitato Etico Regionale per la Sperimentazione Clinica della Regione Toscana Sezione: AREA VASTA SUD EST) and adhered to the standards set by the Declaration of Helsinki, as updated in 2013.

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