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Original Article

Impact of sensor-augmented pump therapy with predictive low-glucose management on hypoglycemia and glycemic control in patients with type 1 diabetes mellitus: 1-year follow-up

Ana M. Gómez [a, b, *], Diana C. Henao [a, b], Lucía B. Taboada [a, b], Guillermo Leguizamón [b], Martín A. Rondón [c], Oscar M. Muñoz [d], Maira A. García-Jaramillo [e], Fabián M. León Vargas [f]

[a] Pontificia Universidad Javeriana, Bogotá, Colombia
[b] Hospital Universitario San Ignacio, Division of Endocrinology, Bogotá, Colombia
[c] Department of Clinical Epidemiology and Biostatistics, Pontificia Universidad Javeriana, Bogotá, Colombia
[d] Hospital Universitario San Ignacio, Department of Internal Medicine, Bogotá, Colombia
[e] Faculty of Engineering, Universidad EAN, Bogotá, Colombia
[f] Faculty of Mechanical, Electronic and Biomedical Engineering, Universidad Antonio Nariño, Bogotá, Colombia

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ABSTRACT

Aims: To describe real-life experience with sensor-augmented pump therapy with predictive low-glucose management (SAPT-PLGM), in terms of hypoglycemia and glycemic control after one year of follow-up in T1D patients with hypoglycemia as the main indication of therapy.
Methods: Retrospective cohort study under real life conditions. Baseline and one-year follow-up variables of glycemic control, hypoglycemia and glycemic variability were compared.
Results: Fifty patients were included, 31 on prior treatment with SAPT with low-glucose suspend (LGS) feature and 19 on multiple dose insulin injections (MDI). Mean HbA1c decreased in the MDI group (8.24% −7.08%; p = 0.0001). HbA1c change was not significant in the SAPT-LGS group. Area under the curve (AUC) below 70 mg/dl improved in both SAPT-LGS and MDI groups while AUC, %time and events below 54 mg/dl decreased in SAPT-LGS group. Glycemic variability improved in the MDI group. Less patients presented severe hypoglycemia with SAPT-PLGM in both groups, however the change was non-significant.
Conclusions: Under real life conditions, SAPT-PLGM reduced metrics of hypoglycemia in patients previously treaded with MDI and SAPT-LGS without deteriorating glycemic control in SAPT-LGS patients, while improving it in patients treated with MDI.

1. Introduction

Intensive diabetes treatment is associated with a lower risk of microvascular complications among patients with type 1 diabetes (T1D) [1]. However, hypoglycemia events are a major obstacle for achieving optimal glycemic control [2,3]. Additionally, as severe hypoglycemia is associated with an increased risk of mortality and cardiovascular events [4,5], reduction of hypoglycemia events is a relevant treatment goal.

Insulin pump therapy in patients with diabetes has shown to improve glycemic control, especially among patients with T1D [6]. More recently, a reduction in the frequency of hypoglycemia events have been demonstrated with the use of pump devices integrated with continuous glucose monitoring systems (sensor-augmented pump therapy, SAPT) and low-glucose suspend (LGS) features, that enable the suspension of insulin when a glucose threshold is reached [7–9]. However, some patients persist with severe hypoglycemia events despite the low-glucose suspension feature. In a previous study, we described that 2.7% and 10.8% of patients while on treatment with SAPT-LGS persisted with severe and asymptomatic hypoglycemia respectively [8]. Because of this, new sensor-augmented pump devices with a different algorithm for insulin suspension have been developed.

* Corresponding author. Endocrinology Unit, Hospital Universitario San Ignacio, Calle 41 #13-06 Piso 3°, Bogotá, Colombia.
E-mail addresses: amgomezm5@gmail.com, anagomez@javeriana.edu.co (A.M. Gómez).

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The Minimed® 640G with SmartGuard®, enables the suspension of insulin infusion when it is predicted that the glucose level will decrease below a threshold of 20 mg/dl above the preset limit during the subsequent 30 min, making the insulin infusion to stop even before reaching the threshold of hypoglycemia. This technology is technically known as a SAPT with predictive low-glucose management (PLGM).

Multiple studies have evaluated the safety and efficacy of the use of SAPT-PLGM. Most of them have demonstrated a reduction in hypoglycemic events without deterioration of the HbA1c in comparison with multiple dose insulin injections (MDI) and conventional SAPT-LGS [10–20]. However, few studies have evaluated outcomes in the long-term. Among these, a randomized trial with 6-month follow-up comparing SAPT-PLGM vs. SAPT and a 24 months real life study with SAPT-PLGM, showed a reduction of hypoglycemia while maintaining glycemic control [19,20].

The objective of this study is to describe the real-life experience with SAPT-PLGM, in terms of glycemic control, hypoglycemic events and glycemic variability after 1 year of follow-up, in patients with T1D previously treated with MDI or SAPT-LGS with hypoglycemia as the main indication of therapy.

2. Materials and methods

A one-year retrospective cohort study was conducted. Adult patients with T1D, on treatment either with MDI or with SAPT-LGS using Paradigm® Veo™ and continuous glucose monitoring (CGM) system (Enlite™ Sensor, Medtronic, Northridge, CA), were selected to switch to SAPT − PLGM therapy with Minimed® 640G and CGM system Enlite™ Sensor (Medtronic, Northridge, CA). All patients had hypoglycemia as the main indication for the therapy. Patients were included in the analysis if they completed at least one year of follow-up, if CGM data from the 14 days prior to the one-year follow-up visit were complete, and if the sensor was used for more than 90% of the time with three or more self-monitoring blood glucose per day. Pregnant patients were excluded. The study was performed between April 2016 and July 2018 in the Hospital Universitario San Ignacio (Bogotá, Colombia). The Institutional Ethics Committee approved the study.

The demographic information and baseline characteristics of the population were extracted from systematically collected medical records. For patients on treatment with SAPT-LGS the information of the interstitial monitoring data of the 2 weeks previous to the start of SAPT-PLGM was downloaded using CareLink Personal software version 3.0 (Medtronic, Minneapolis, MN), and imported into MATLAB® calculation software for analysis [21]. For patients on MDI, data from PDF reports of 6-days ambulatory glucose profiles obtained with iPro 2 equipment (Medtronic, Minneapolis, MN, USA) and Enlite® sensor (Medtronic) were recorded. For these patients, available data included mean glucose, standard deviation (SD) and area under the curve (AUC) < 70 mg/dl.

In all patients, the MiniMed 640G® insulin pump with PLGM function, associated to enhanced Enlite® sensor and Guardian 2 Link transmitter (Medtronic, Northridge, CA) was started after completing a training program directed by the diabetes physician, education, and nutrition team. Patients and their families learned about the insulin pump device, the CGM and the carbohydrate count through personal and group sessions. The low limit was configured between 60 and 70 mg/dl depending on the patient characteristics, and PLGM function was activated in all patients. Each patient's insurance company delivered all components and accessories necessary for the insulin pump. Adjustments were made at 1, 3, 7, 15 days and then patients were requested to assist monthly. For analysis, CGM data of the last two weeks before the one-year follow up appointment were downloaded.

CGM data was pre-processed to discard monitoring days with consecutive losses greater than 50 samples, lower losses were linearly interpolated. The data of each patient was organized by calendar days (00:00–23:59 h). Based on these data, metrics of hypoglycemia, hyperglycemia and glycemic variability, were calculated [21]. Metrics calculated included: mean glucose, AUC and percentage of time (%time) below 54 and 70 mg/dl, hypoglycemia events (defined as glucose levels below 54 and 70 mg/dl for at least 20 consecutives minutes); hyperglycemia events (defined as glucose levels above 180 and 250 mg/dl for at least 20 consecutives minutes), AUC and %time above 180 and 250 mg/dl, time in range 70–180 mg/dl, SD and coefficient of variation (CV).

For patients who were under treatment with SAPT-LGS at baseline, clinical and CGM variables were compared with the data at the end of the study. For patients on MDI, because of limited basal CGM data available from the printed reports, only mean glucose, SD, CV% and AUC below 70 mg/dl, along with clinical variables were compared. Serious adverse events registered included severe hypoglycemia (defined as the need for third party help), diabetic ketoacidosis (DKA) and diabetes related hospitalization.

For the statistical analysis, sub groups were made according to the therapy used before starting SAPT-PLGM. Comparisons between baseline and one-year follow-up variables were done using Student's paired *t*-test for quantitative variables and Stuart Maxwell test for qualitative variables, with a level of significance of 0.05. The analysis was performed with STATA 15®.

3. Results

Fifty patients were included. Among these, 31 patients were on previous therapy with SAPT-LGS and 19 patients with MDI before starting SAPT-PLGM. Clinical and demographic characteristics are described in Table 1. Baseline HbA1c was 8.2 ± 1.4% for patients on MDI and 7.2% ± 1.0% for patients on SAPT-LGS. During the year before SAPT-PLMG, 31.6% percent of patients with MDI and 19.4% of patients of SAPT-LGS presented an event of severe hypoglycemia.

3.1. Outcomes of SAPT-PLGM in patients with previous treatment with MDI

After one year of switch to SAPT-PGLM mean HbA1c was significantly reduced from 8.24% to 7.08% (mean difference 1.16%, p = 0.0001). This reduction was obtained during the first six months of the therapy and was maintained during the follow-up (Fig. 1). A total of 57.9% of the patients achieved HbA1c values below 7.0%. Other outcomes such as mean interstitial glucose and metrics of glucose variability significantly improved. At the end of the follow-up the mean of time in range was 78.1% ± 16.8 (Table 2).

Even though the rate of hypoglycemia decreased from 0.53 ± 1.07 to 0.06 ± 0.24 events-per-patient and the number of patients with events of severe hypoglycemia decreased from 6 (31.6%) to 2 (10.5%), the changes were statistically non-significant. However, AUC below 70 mg/dl significantly decreased from 1.63 ± 1.5 to 0.19 ± 0.2 (p < 0.01) (Table 2).

3.2. Outcomes of SAPT-PLGM in patients with previous treatment with SAPT-LGS

After one year of switch to SAPT-PLGM, there was no significant change in values of HbA1c. However, all hypoglycemia variables from interstitial CGM data significantly decreased (Table 3). Rate of events of clinically significant hypoglycemia below 54 mg/dl decreased from 4.0 ± 4.9 to 1.7 ± 2.5 events per patient (p = 0.016), as for events below 70 mg/dl from 17.3 ± 14.2 to 10.7 ± 8.1 events per patient (p = 0.0215); %time and AUC below 54 and 70 mg/dl

Table 1
Baseline characteristics of patients.

	Total (n = 50)	MDI to SAPT-PLGM (n = 19)	SAPT-LGS to SAPT-PLGM (n = 31)
Age in years, mean (SD)	43.0 (14.1)	41.8 (13.4)	43.8 (14.6)
Male, n (%)	27 (54.0)	10 (52.6)	17 (54.8)
Age of T1D diagnosis in years, median (IQR)	15.5 (20.0)	19.0 (19.0)	15.0 (18.0)
Duration of T1D in years, mean (SD)	22.6 (11.3)	24.2 (12.0)	20.0 (9.7)
HbA1c, mean (SD)	7.6 (1.3)	8.2 (1.4)	7.2 (1.0)
Microvascular complications, n (%)			
Retinopathy	21 (42.0)	5 (26.3)	16 (51.6)
Nephropathy	20 (40.0)	6 (31.6)	14 (45.2)
Neuropathy	13 (26.0)	2 (10.5)	11 (35.5)
Gastroparesis	4 (8.0)	0 (0.0)	4 (12.9)
Macrovascular complications, n (%)			
Coronary heart disease	2 (4.0)	1 (5.3)	1 (3.2)
Stroke	0 (0.0)	0 (0.0)	0 (0.0)
Peripheral arterial disease	0 (0.0)	0 (0.0)	0 (0.0)
Diabetic foot	3 (6.0)	0 (0.0)	3 (9.7)
Patients with hospitalization for diabetes in the last year, n (%)	5 (10.0)	1 (5.3)	4 (12.9)
Patients with SH in the last year, n (%)	12 (24.0)	6 (31.6)	6 (19.4)
Patients with DKA in the last year, n (%)	2 (4.0)	0 (0.0)	2 (6.5)

SD: standard deviation; IQR: interquartile range; SH: severe hypoglycemia; DKA: diabetic ketoacidosis.

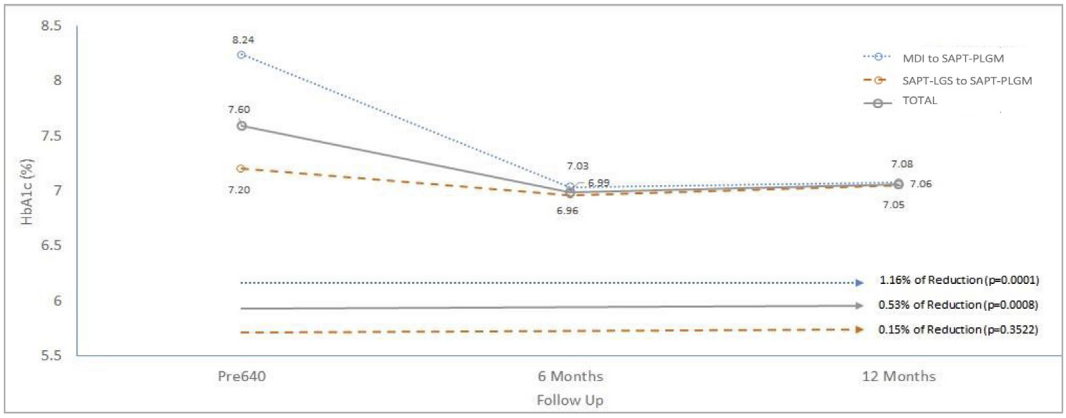

Fig. 1. Change of HbA1c according to previous treatment and in the entire population.

Table 2
Outcomes after one-year follow-up with SAPT-PLGM in patients with previous treatment with MDI.

	Baseline - MDI	One-year follow-up with SAPT-PLGM	p-value
A1c (%), mean (SD)	8.24 (1.4)	7.08 (0.9)	0.0001
A1c <7%, n (%)	3 (15.8)	11 (57.9)	0.0071
Interstitial glucose (mg/dl), mean (SD)	159.5 (28.0)	138.3 (16.9)	0.0183
SD of glucose (mg/dl), mean (SD)	64.3 (20.6)	44.3 (12.4)	0.0007
CV, mean (SD)	40.5 (11.5)	31.7 (6.9)	0.0061
Time in range 70–180 mg/dl (%), mean (SD)	–	78.1 (16.8)	–
Rate of events <70 mg/dl (events/patient) (SD)	–	9.6 (7.9)	–
Percentage of time <70 mg/dl, (%), mean (SD)	–	2.4 (2.2)	–
AUC < 70 mg/h/dL, mean (SD).	1.63 (1.5)	0.19 (0.2)	0.0016
Rate of events < 54 mg/dl (events/patient) (SD)	–	1.6 (2.0)	–
Percentage of time <54 mg/dl, (%), mean (SD)	–	0.25 (0.3)	–
AUC < 54 mg/h/dL, mean (SD)	–	0.01 (0.02)	–
Rate of events > 180 mg/dl (events/patient) (SD)	–	39.8 (23.4)	–
Percentage of time > 180 mg/dl (%), mean (SD)	–	19.5 (17.2)	–
AUC >180 mg/h/dL, mean (SD)	–	9.1 (11.8)	–
Rate of events > 250 mg/dl (events/patient) (SD)	–	10.6 (12.5)	–
Percentage of time > 250 mg/dl (%), mean (SD)	–	4.8 (7.0)	–
AUC >250 mg/h/dL, mean (SD)	–	1.9 (4.0)	–
SH (events/patient/year)	0.5 (1.0)	0.06 (0.2)	0.1037
Patients with SH in the last year, n (%)	6 (31.6)	2 (10.5)	0.1025
Patients with hospitalization for diabetes in the last year, n (%)	1 (5.3)	1 (5.3)	1.00
Patients with DKA in the last year, n (%)	0 (0.0)	1 (5.3)	0.3173

SD: standard deviation; CV: coefficient of variation; SH: severe hypoglycemia; DKA: diabetic ketoacidosis.

Table 3
Outcomes after one-year follow-up with SAPT-PLGM in patients with previous treatment with SAPT-LGS.

	Baseline - SAPT-LGS	One-year follow-up with SAPT-PLGM	p-value
A1c (%), mean (SD)	7.20 (1.0)	7.05 (0.9)	0.3522
A1c <7%, n (%)	10 (32.3)	15 (48.4)	0.1955
Interstitial glucose (mg/dl), mean (SD)	142.8 (25.5)	146.8 (19.1)	0.4238
SD of glucose (mg/dl), mean (SD)	52.2 (15.9)	50.3 (12.5)	0.3479
CV %, mean (SD)	35.9 (7.0)	34.1 (7.0)	0.0699
Time in range 70–180 mg/dl (%), mean (SD)	73.0 (14.9)	73.6 (12.7)	0.8075
Rate of events <70 mg/dl (events/patient) (SD)	17.3 (14.2)	10.7 (8.1)	0.0215
Percentage of time <70 mg/dl, (%), mean (SD)	4.7 (3.9)	2.9 (2.0)	0.0278
AUC < 70 mg/h/dL, mean (SD).	0.5 (0.5)	0.3 (0.2)	0.0057
Rate of events < 54 mg/dl (events/patient) (SD)	4.0 (4.9)	1.7 (2.5)	0.0160
Percentage of time <54 mg/dl, (%), mean (SD)	1.2 (1.5)	0.4 (0.5)	0.0043
AUC < 54 mg/h/dL, mean (SD)	0.09 (0.1)	0.02 (0.0)	0.0056
Rate of events > 180 mg/dl (events/patient) (SD)	49.1 (29.8)	47.8 (21.9)	0.8170
Percentage of time > 180 mg/dl (%), mean (SD)	22.2 (15.8)	23.5 (18.4)	0.6722
AUC >180 mg/h/dL, mean (SD)	11.7 (10.4)	10.6 (8.0)	0.5570
Rate of events > 250 mg/dl (events/patient) (SD)	15.4 (15.3)	11.8 (10.4)	0.2098
Percentage of time > 250 mg/dl (%), mean (SD)	5.8 (6.12)	4.9 (4.5)	0.4442
AUC >250 mg/h/dL, mean (SD)	2.8 (3.12)	1.99 (2.2)	0.1659
SH (events/patient/year) (SD)	2.2 (10.2)	0.2 (0.8)	0.2665
Patients with SH in the last year, n (%)	6 (19.4)	4 (12.9)	0.4142
Patients with hospitalization for diabetes in the last year, n (%)	4 (12.9)	2 (6.4)	0.3173
Patients with DKA in the last year, n (%)	2 (6.4)	0 (0.0)	0.1573

SD: standard deviation; CV: coefficient of variation; SH: severe hypoglycemia; DKA: diabetic ketoacidosis.

also significantly decreased (Fig. 2). Metrics of glycemic variability and hyperglycemia showed no change. Even though the rate and number of patients with severe hypoglycemia decreased, the changes were non-significant (Table 3).

3.3. Composite outcome

At the end of the study 23 of 50 patients achieved a HbA1c $\leq$ 7.0% without severe hypoglycemia and 12 of 50 patients achieved this HbA1c goal without episodes of clinically significant hypoglycemia (<54 mg/dl).

3.4. Other adverse events

There were no significant differences in events of DKA or diabetes related hospitalizations during the year before and during the

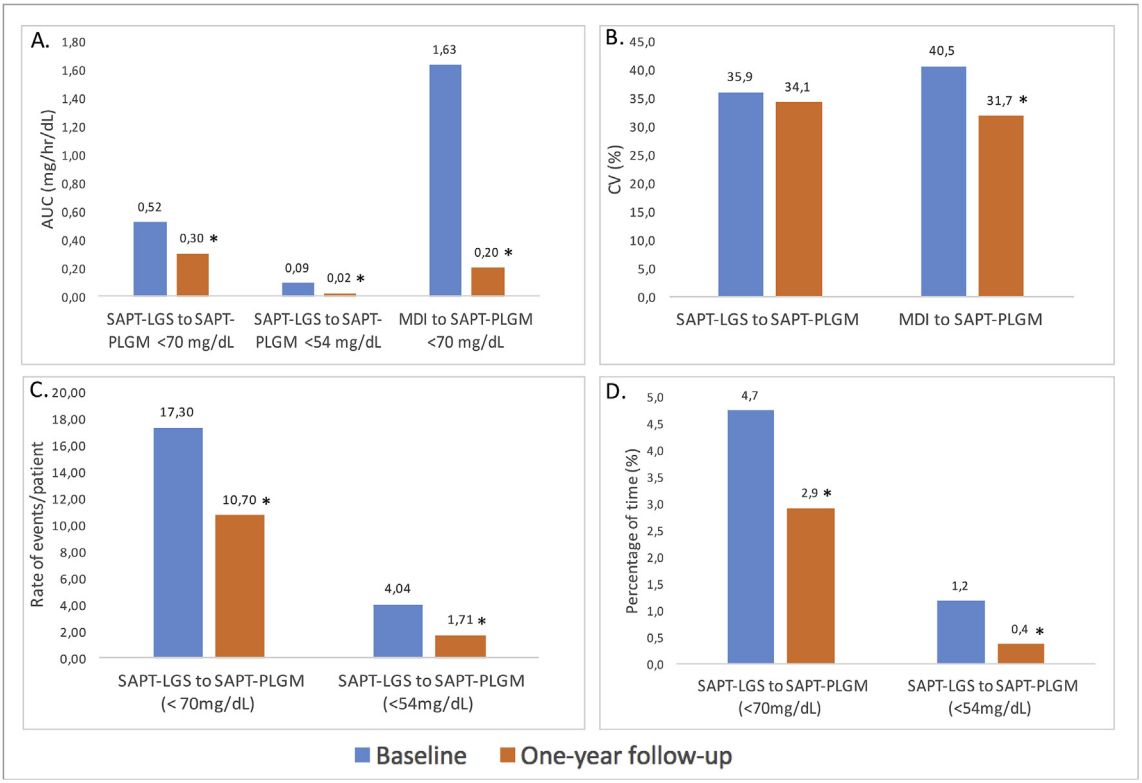

Fig. 2. Change in hypoglycemia, and glycemic variability according to previous treatment from baseline to one-year follow-up with SAPT-PLGM. (a). Change in AUC below 70 and 54 mg/dl; (b) Change in coefficient of variation; (c) Change in rate of events below 70 and 54 mg/dl per patient; (d) Change in percentage of time below 70 and 54 mg/dl. CV: Coefficient of Variation. *: Significant change, p < 0,05.

first year of SAPT-PLGM, however the frequency of this event was already low before starting SAPT-PLGM (Tables 2 and 3).

4. Discussion

Currently, diabetes treatment recommendations include in addition to a goal of HbA1c levels, the avoidance of hypoglycemia events and minimization of glycemic variability [22]. However, the intensification of insulin therapy increases the risk of hypoglycemia, which is associated with adverse events, worsening of quality of life and limits the achievement of an optimal HbA1c [3]. The use of SAPT-LGS have demonstrated to reduce the frequency hypoglycemia in different studies [7–9]. However, severe and asymptomatic hypoglycemia events persist in some patients despite SAPT-LGS therapy [8].

Previously, we published a 3 month follow-up study evaluating the safety and efficacy of SAPT-PLGM in patients treated with SAPT-LGS as baseline therapy, in which the use of PLGM system reduced the frequency of severe hypoglycemia [17]. Based on these results, we suggested that the use of PLGM function could be considered in T1D patients on treatment with SAPT-LGS who persisted with severe hypoglycemia. This technology is available in Colombia and its covered by the health care system.

In the present study we evaluated the safety and efficacy of SAPT-PLGM in a real-world setting. In terms of glycemic control, in the group of patients with MDI as baseline therapy, HbA1c significantly improved early during the treatment with SAPT-PLGM and persisted during the follow-up. Also, the percentage of patients who achieved a HbA1c level below 7.0% at the end of the follow-up significantly improved. This group had a poor baseline control (mean baseline HbA1c: 8.24%), so the goal of the therapy with SAPT-PLGM was both the reduction of hypoglycemia and improvement of glycemic control. In a similar real-world study, in which children and adults with MDI or SAPT-LGS as baseline therapy were included, the greatest benefit in terms of reduction of HbA1c after starting SAPT-PLGM was found in patients treated with MDI and SMBG; in this group HbA1c significantly improved from 7.5 to 6.8% ($p < 0.001$) after one-year follow-up [19]. Even though, most of the evidence evaluating SAPT-PLGM is centered on reduction of hypoglycemia, the efficacy of sensor augmented pump therapies in terms of improvement of glycemic control in patients with baseline uncontrolled diabetes have been proved in randomized trials that have compared this technology with MDI (STAR 3 Study) [6].

On the other hand, in the group patients on SAPT-LGS who were switched to SAPT-PLGM we didn't find a significant change in HbA1c levels. However, baseline HbA1c in this group was already very close to 7.0% (mean baseline HbA1c: 7.2%), so the primary goal of the SAPT-PLGM was reduction of hypoglycemia. This finding differs from the results previously published by our group, in which a significant reduction of 0.34% of HbA1c was documented 3 months after switching SAPT-LGS to SAPT-PLGM; nonetheless, the population in that study included both adults and children with a worst baseline glycemic control [17]. Beato-Víbora et al., in an observational study including patients who were switched from SAPT-LGS to SAPT-PLGM with an acceptable baseline HbA1c, didn't find a clinically significant HbA1c reduction, despite reductions in hypoglycemia events [19].

In terms of hypoglycemia reduction, we found an improvement in all available metrics of hypoglycemia. In patients with previous MDI therapy, AUC below 70 mg/dl significantly improved after one-year follow-up (other variables could not be compared). Similarly, in patients previously treated with SAPT-LGS, all metrics of hypoglycemia including AUC, %time and rate of events below 70 and 54 mg/dl significantly improved after one year of therapy. To highlight, the population included was a high-risk population in terms of hypoglycemia. For severe hypoglycemia events, even though, the number of events decreased in both groups, we were not able to document a significant change, this could be related to a lack of power as the sample size of the included patients may not be enough to demonstrate a significant change.

Previous studies have shown the efficacy of SAPT-PLGM in terms of reduction of hypoglycemia, both in patients treated with MDI and SAPT-LGS. In the study by Beato-Víbora et al., which included patients with baseline therapy with MDI or SAPT-LGS, there was a reduction in the %time below 70 mg/dl from $4.5 \pm 3.6\%$ to $3.1 \pm 2.3\%$ ($p = 0.001$), also a decrease in the %time below 54 mg/dl was documented but it didn't reach statistically significance; however, the authors didn't differentiate outcomes of hypoglycemia metrics between subgroups. As a highlight, HbA1c values didn't deteriorate in the group with previous SAPT-LGS, and as previously described, improved in the MDI group [19]. In the study previously published by our group, after switching patients from SAPT-LGS to SAPT-PLGM, a significant improvement in rate of events, AUC and % time below 70 mg/dl was documented, also without deterioration of HbA1c levels [17].

Is important to note, that similarly to what literature has shown, in our study there was no deterioration of HbA1c or hyperglycemia metrics (AUC, %time and rate of events above 180 and 250 mg/dl) despite improvement of hypoglycemia metrics and regardless pump suspensions before to the low limit which may be a concern with the use of PLMG technology. Prospective studies evaluating SAPT-PLGM vs. SAPT therapy without suspension algorithms, have proven that this predictive suspension does not increase HbA1c. Abraham et al. published a 6-month follow-up randomized trial, comparing SAPT-PLGM and SAPT technologies in adolescents with T1D. They found at the end of the follow-up period fewer hypoglycemic events in the SAPT-PLGM group in comparison with the SAPT group (227 vs. 139 events/patient-year, $p < 0.001$), along with a reduction in time spent in hypoglycemia (<63 mg/dl) in both groups, which was greater in SAPT-PLGM group. Patients in this study had a baseline HbA1c close to the goal, and despite improvement in hypoglycemia metrics there was no deterioration in HbA1c levels during the follow-up period in either group [20]. Special efforts should be made to properly educate patients to let the suspensions work and avoid the consumption of extra carbohydrate with manual resumption of the pump, which can lead to rebound hyperglycemia [12].

Time in range has been recently proposed as new variable to describe glycemic control, [23]. In our study, the change in this variable was not evaluated in the MDI group because the baseline data was not available for all patients. In the group of patients on previous therapy with SAPT-LGS, similar to what was found for HbA1c levels, there was no significant change in the time in range (70–180 mg/dl). However, at the end of the follow-up both groups reached a mean time in range above 70%, which can be considered an optimum time in range.

In terms of glucose variability, we found no difference in the CV after switching from SAPT-LGS to SAPT-PLGM, but there was a clinically and statistically significant reduction in the %CV in the MDI to SAPT-PLGM group, from $40.5 \pm 11.5\%$ to $31.7 \pm 6.96\%$, $p = 0.0061$. In a posterior publication using data from the STAR 3 study, it was shown that patients on SAPT therapy had lower SD and CV that those in the group of patients with MDI, at comparable values of HbA1c below 8%, concluding that the use of SAPT may improve glycemic excursions [24]. Beato-Vibora et al., reported small but statistically reduction in the CV from $36 \pm 6\%$ to $34 \pm 5\%$, $p = 0.005$) using SAPT-PLGM, however the authors do not differentiate the results according previous therapy (MDI or SAPT-LGS) [19]. Reduction of glycemic variability is important as a high

glycemic variability it is associated to a higher risk of hypoglycemia [25–27].

Considering, that few studies have evaluated long-term efficacy and safety of SAPT – PLGM, we consider as the main strength of our study the length of follow-up period. Also, this is the first "real life" study with long term follow up published with Latin American patients. However, some limitations must be considered, one of them is the lack of complete CGM data for all patients in the MDI group limiting the possibility to compare some variables in this group. Also, as this is a real-world study with a before and after comparison, we lack a control group, which raises the possibility of bias secondary to different variables other that the use of the SAPT-PLGM factors that could be associated with an improvement in glucose control such as the intense educational program of our center after initiating the therapy. Finally, we could have a lack of power to demonstrate a significant reduction in the number of severe hypoglycemia events.

In conclusion, the use of SAPT-PLGM in a real-world setting reduced hypoglycemic metrics such as time in hypoglycemia, AUC and rate of events, without deterioration of HbA1c levels in patients on previous SAPT-LGS and a baseline acceptable glucose control, while in patients with MDI as baseline therapy and uncontrolled diabetes, both HbA1c and AUC below 70 mg/dl were improved. This suggests that SAPT-PLGM may be useful in adults with T1D with history of hypoglycemia.

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Abbreviations

AUC	area under the curve
CGM	continuous glucose monitoring
CV	coefficient of variation
DKA	diabetic ketoacidosis
HbA1c	glycated hemoglobin
IQR	interquartile range
LGS	low-glucose suspend
MDI	multiple dose insulin injections
SAPT	sensor-augmented pump therapy
SD	standard deviation
PLGM	predictive low-glucose management
SH	severe hypoglycemia
T1D	type 1 diabetes
%time	percentage of time.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dsx.2019.07.024.

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