# Diabeloop DBLG1 Closed-Loop System Enables Patients With Type 1 Diabetes to Significantly Improve Their Glycemic Control in Real-Life Situations Without Serious Adverse Events: 6-Month Follow-up

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## OBJECTIVE

**To analyze safety and efficacy of the Diabeloop Generation 1 (DBLG1) hybrid closed-loop artificial pancreas system in patients with type 1 diabetes in real-world conditions.**

## RESEARCH DESIGN AND METHODS

**After a 1-week run-in period with their usual pump, 25 patients were provided the commercial DBLG1 system. The results are presented on time in range (TIR) and $HbA_{1c}$ over 6 months.**

## RESULTS

**The mean (SD; range) age of patients was 43 (13.8; 25–72) years. At baseline, the mean $HbA_{1c}$ and TIR 70–180 mg/dL were, respectively, 7.9% (0.93; 5.6–8.5%) [63 mmol/mol (10; 38–69 mmol/mol)] and 53% (16.4; 21–85%). One patient stopped using the system after 2 months. At 6 months, the mean $HbA_{1c}$ decreased to 7.1% [54 mmol/mol] ($P < 0.001$) and TIR 70–180 mg/dL increased to 69.7% ($P < 0.0001$). TIR <70 mg/dL decreased from 2.4 to 1.3% ($P = 0.03$), and TIR <54 mg/dL decreased from 0.32 to 0.24% ($P = 0.42$). No serious adverse event was reported during the study.**

## CONCLUSIONS

**The ability of the DBLG1 system to significantly improve glycemic control in real-world conditions, without serious adverse events, was confirmed in this follow-up study.**

Closed-loop systems (CLS) have raised hopes to address the challenge of achieving glycemic targets in patients with type 1 diabetes. The Diabeloop Generation 1 (DBLG1) system has enabled significant improvements in glucose time in range 70–180 mg/dL (TIR) and time below range (TBR; ie, <70 mg/dL) with absence of severe adverse events due to algorithmic recommendations in two previous randomized controlled trials (1,2). We aimed to assess safety and efficacy with this system in real-world conditions.

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## RESEARCH DESIGN AND METHODS

### Patient Selection

An initial list was compiled of 100 patients with type 1 diabetes treated with a pump and continuous glucose monitoring for >1 year and who were interested in the project. Then we excluded patients on the basis of criteria related to the Conformitè Européenne (CE) marking for the Kaleido pump and/or DBLG1 (i.e., age <22 years, daily insulin dose <8 UI or >90 UI, pregnancy) or who were already using a predictive low-glucose suspend technology or were struggling with the daily management of their diabetes as defined by a history of a severe metabolic event requiring a hospitalization in the last 12 months. So each member of our medical teams could become familiar with this new system, each diabetologist selected one to two patients to participate. Finally, 25 patients were offered the opportunity to participate in this prelaunch at two hospital centers in France.

### System Initiation

The DBLG1 system has been extensively described (3). System initiation was preceded by an "open-loop" training period with the Dexcom G6, provided on an outpatient basis. This run-in period was used to compare open-loop and CLS results.

### Outcomes and Statistical Analysis

The primary outcome was TIR. The secondary outcomes were TBR and $HbA_{1c}$, before and 6 months after system initiation. Data on changes in weight, BMI, and daily doses of insulin were also collected. Patients' characteristics are described as mean (SD; range) and percentage, respectively, for quantitative and qualitative variables. Primary and secondary outcomes were analyzed with a nonparametric Wilcoxon paired test, with a type I error rate set to 0.05 (two sided). Analysis was performed with R, version 3.5.0 (4). All patients gave their consent to collect data.

### Data Availability

The data supporting the findings of this study are available from the Yourloops cloud platform. Restrictions apply to the availability of these data, which are not publicly available.

## RESULTS

The mean (SD; range) age of patients was 43 (13.8; 25–72) years, mean diabetes duration was 19 (11.8; 2–43) years, and 76% of patients were women. Mean BMI was 24.1 (3.2; 18.4–33) kg/$m^2$. The run-in period lasted 8 (3.5; 4–15) days. Mean TIR and $HbA_{1c}$ before DBLG1 system initiation were 53% (16.4; 21–85%) and 7.9% (0.93; 5.6–8.5% [63 mmol/mol (10; 38–69 mmol/mol)]), respectively. Individual trajectories of TIR and $HbA_{1c}$ are illustrated in Fig. 1.

At 6 months, data were analyzed for 24 of the 25 patients (one dropped out of the study). The mean TIR increased by 33% (+17.2 points; 52.5–69.7%; $P < 0.0001$). The percentage of patients with TIR >70% increased from 8 to 58%. The mean TBR decreased from 2.4 to 1.3% ($P = 0.03$). The mean time at <54 mg/dL decreased from 0.32 to 0.24% ($P = 0.42$). The mean $HbA_{1c}$ decreased from 7.9 to 7.1% ($P < 0.001$). No significant change was observed for total daily insulin dose (from 41.7 ± 9.6 to 44.4 ± 18 UI) and BMI over the 6 months (from 24.1 ± 3.2 to 24.1 ± 3.2 kg/$m^2$).

The CLS was in functional mode an average of 85% of the total time (15.4; 42–97%). One participant lost the smartphone running the algorithm and the device was replaced only after 2 months; another patient struggled with personal concerns in such a way that he alternated between treatment with the DBLG1 system and reverting to a multi-injection therapy. After exclusion of these patients, the range was 72–97%, with a significant correlation between the percentage of time in the CLS and the TIR after 6 months ($P = 0.02$). In addition, one patient stopped using the system after 2 months because of repeated system disconnections.

Fifty percent of patients had to change their Dexcom sensor at least once before the scheduled date, 25% of patients had to replace one of their two Kaleido pumps. One patient had a skin reaction related to the glucose sensor. No severe adverse event (i.e., one requiring medical intervention), due to the algorithm or not, was reported.

## CONCLUSIONS

The results of this real-world survey confirmed the safety, reliability, and efficiency of the DBLG1 system and the results obtained in a 3-month randomized study (1) using the same device, with only one patient dropping out of the study during the 6-month follow-up. This survey can be compared with a real-world study conducted with the Medtronic 670G CLS (5) during which 34% of patients had interrupted the CLS after 6 months: 40% of patients had a CLS operating >70% of the time versus 90% in our study. In our prelaunch survey, $HbA_{1c}$ decreased from 7.9 to 7.1%, TIR increased by 33%, and TBR decreased by 46%. In the Medtronic 670G real-world study (5), in adult patients who continued to use the system at 1 year ($n = 23$ of 79), $HbA_{1c}$ decreased from 7.7 to 7.5%, which probably is explained by the low use of closed-loop mode.

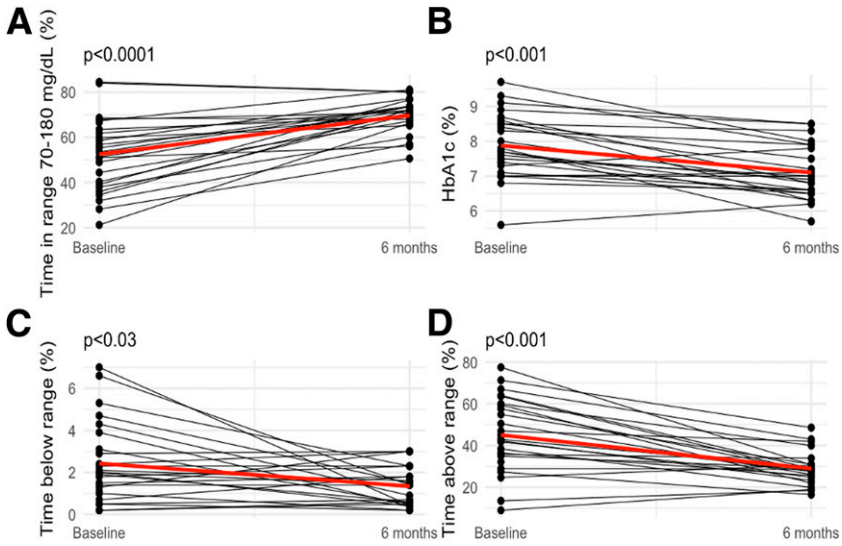


**Figure 1**—Individual trajectories from baseline to 6 months of follow-up ($n = 24$) for (*A*) TIR, (*B*) $HbA_{1c}$, (*C*) TBR (<70 mg/dL), and (*D*) time at >180 mg/dL. The red line represents the mean.

Akturk et al. (6) reported on the largest series of users of the Medtronic 670G CLS from a retrospective cohort of 127 adults. The mean $HbA_{1c}$ improved from 7.6 to 7.2% at 6 months and TIR increased from 59.5 to 70.1%. TBR decreased from 3.2 to 2.2%. Pinsker et al. (7) recently reported real-world data after the initiation of Control-IQ technology in early 2020. After a mean of 64 days, the mean TIR was 79.2%. However, mean baseline TIR was already high (67%) in participants with open-loop data.

International guidelines (8) recommend patients have a TIR >70% of the time and <4% at TBR. In our survey, the percentage of patients with a TIR >70% increased from 8 to 58%, versus 28–58% in the retrospective study with the 670G system (6).

In our study, the percentage of patients with TBR <4% increased from 80 to 100% and the percentage of patients who achieved both objectives (TIR and TBR<4%) increased from 4 to 58%. In the retrospective cohort study (6), this double objective increased from 16% at baseline to 47% of patients after 6 months.

In summary, the DBLG1 system resulted in an average reduction of the time spent in hyperglycemia (>180 mg/dL) of 4 h/day (from 10.8 to 7 h/day) and an increase in time spent in the target range of 70–180 mg/dL of an equivalent duration (4.1 h; from 12.6 to 16.7 h), without an increase in time spent in hypoglycemia. The main limit of this real-world study was the small number of patients with possible selection bias. We assumed that women were more interested in the project and therefore were more likely to be selected. Of note, women made up 60.6% of patients in the study of Akturk et al. (6). In any case, this preferential selection of women was not intentional.

Also, the optimal number of days needed to analyze sensor outcomes reliably was not reached for every patient. Therefore, we compared the correlation coefficient between TIR and $HbA_{1c}$ at baseline and after 6 months. This coefficient was significant and close both times (−0.53 and −0.59).

In conclusion, this real-world survey shows potentially high acceptance and appropriation of this CLS, with only one patient dropping out of the study. There was significant improvement of glycemic control after 6 months (TIR >70% for 58% of patients and <4% of TBR for all patients). The results confirm safety and reliability of the device, with no severe adverse events and the CLS operating 85% of the time.

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The findings and conclusions in this study are those of the authors and do not necessarily represent the views of the sponsors.

**Duality of Interest.** C.A. has received a congress invitation from Eli Lilly and Company. S.F. declares congress invitations from Sanofi, Eli Lilly and Company, MSD, Novo Nordisk, Roche, Abbott, and Boehringer Ingelheim; has received speaker honoraria from Eli Lilly and Company and Novo Nordisk; has served on advisory board panels for Novo Nordisk, Diabeloop, Sanofi, Janssen, and Lifescan; and owns shares in Diabeloop SA. P.-Y.B. has received speaker honoraria from Abbott, Roche, Eli Lilly and Company, Novo Nordisk, and Sanofi and served on advisory board panels for Abbott, Diabeloop, Roche, Medtronic, Dexcom, Insulet, Lifescan, Eli Lilly and Company, Novo Nordisk, and Sanofi. S.L. has received speaker honoraria from Abbott, Novo Nordisk, Sanofi, Eli Lilly and Company, and Insulet, and has served on advisory board panels for Diabeloop and Medtronic. E.H. owns shares in Diabeloop SA. G.C. has received congress invitations, honoraria, and consultancy fees from Abbott, Dexcom, and Medtronic, and owns shares in Diabeloop SA. A.P. has received congress invitations, speaker honoraria, and consultancy fees from Abbott, Eli Lilly and Company, Lifescan, Medtronic, Novo Nordisk, and Sanofi, and has served on advisory board panels for Abbott, Insulet, Novo Nordisk, and Sanofi.

**Author Contributions.** C.A. and A.P. collected the study data and wrote the first draft of the manuscript. C.A. analyzed the data. All authors contributed to the interpretation of the data and writing of the article, revised critically each version of the draft, and globally participated to the whole aspect of the work. C.A. and A.P. are the guarantors for this work and, as such, had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

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