ACCURACY OF CONTINUOUS GLUCOSE MONITORING DURING POSTPRANDIAL PERIOD AND ITS INFLUENCE ON CLOSED-LOOP PERFORMANCE

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Introduction

Development of more accurate sensors is needed and will contribute to increase the performance of closed-loop (CL) systems in patients with diabetes.

Although glucose sensors are minimally invasive and are associated with users increasing acceptance, the mismatch of the reported glucose values by the sensors in relation to the blood glucose measurements is still present [1]. Consequently, these differences diminish controller's performance and glycemic management [2,3].

An extensive evaluation of numerical and clinical accuracy of Medtronic® Paradigm® Veo™ system with the enhanced Enlite™ sensor (Medtronic, MiniMed, Northridge, CA, USA) was performed during postprandial period, using data obtained from a previous closed-loop clinical trial. In addition to this, the individual performance of all closed-loop trials across the study was also assessed according to the accuracy of the continuous glucose monitors (CGM) in each trial.

Materials and Methods

We analyzed data from a randomized, prospective, one-way, crossover study in subjects with T1D under CSII. The study was designed to compare randomly the efficacy and safety of a new developed CL algorithm with the current open-loop (OL) therapy during the postprandial period (PP) [4]. Patients were admitted in the clinical research units at 08:00, in fasting state. They wore two Paradigm Veo® devices connected to two continuous glucose sensors (CGM, Enlite-2®). Plasma glucose (PG) samples were measured every 15 min using YSI 2300 Stat Plus Glucose Analyzer (YSI Inc., Yellow Springs, OH, USA). CGM devices were calibrated 30 minutes before a 60g carbohydrate lunch meal, which occurred at 12:00 PM. Just before the meal the corresponding insulin prandial bolus was delivered. After this, during an 8-h period, postprandial glucose was monitored and OL or CL insulin therapies were applied.

Accuracy and precision of the CGM sensors were evaluated by the MARD and PARD [5]. Figure 1 shows an illustration of CGMs readings and PG reference for the session with the highest absolute difference between the MARDs of both sensors. The performance of the CL trials was assessed according to the 10 better and worst accurate sensors, sorted by the MARD, based on time spent in specifics ranges.

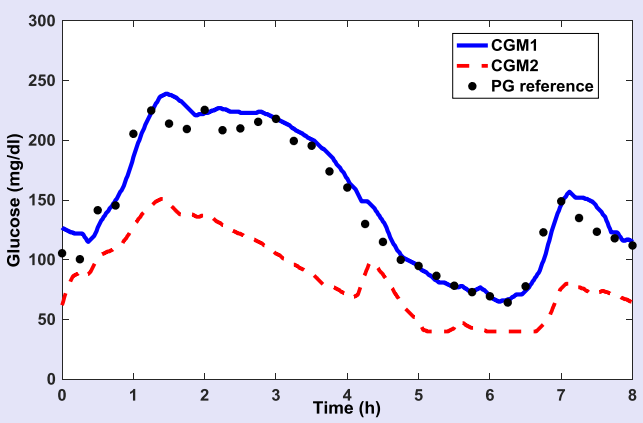

Figure 1 – CGMs and PG readings for the session with the highest absolute difference between the MARDs of both sensors.

Results

Table 1 – Overall CGMs accuracy and precision.

	MARD, %		PARD, %	
	Average	Aggregated	Average	Aggregated
Overall	12.0±7.5 n = 148	12.0±11.2 n = 4851	13.4±12.9 n = 74	13.4±15.8 n = 35196
< 70 mg/dl	18.9±11.9 n = 42	18.8±14.0 n = 182	25.4±18.9 n = 24	29.7±20.8 n = 1248
70-180 mg/dl	12.5±8.2 n = 148	12.3±11.5 n = 3216	13.5±13.1 n = 74	13.7±16.5 n = 23922
> 180 mg/dl	10.3±8.7 n = 112	10.4±9.6 n = 1453	11.3±12.0 n = 57	10.7±11.3 n = 10026

Table 2 – Accuracy of the 10 best sensors and 10 worst sensors.

	Main CGM - MARD, %	
	Average	Aggregated
10 best sensors	4.5±0.9 n = 10	4.5±4.7 n = 327
10 worst sensors	19.8±7.5 n = 10	19.8±13.0 n = 335

Table 3 – Influence of sensor's accuracy in CL performance.

Variable	Study	Time below range (min) <70 mg/dl	
		Mean	Median (IQ range)
PG	**10 best sensors**	2±7	0 (0-0)
	10 worst sensors	32±38	19 (0-65)
			p = 0.0313
CGM	**10 best sensors**	4±11	0 (0-0)
	10 worst sensors	65±61	71 (0-126)
			p = 0.0313

Table 4 – Glucose rescues during CL therapy.

	Trials with glucose rescue	Total of rescues
10 best sensors	1	1
10 worst sensors	4	11

Conclusions

Medtronic® Paradigm® Veo™ Enlite™ CGM system analysis during postprandial period:

- numerical and clinical accuracy closed to that previously reported in previous studies [6].
- no other publications reported PARD results for the system, impeding a direct comparison and evaluation of our results.
- accuracy depends on the rate of change of glucose and it tends to be higher with lower rates of change.
- CGM accuracy seems to be related to the controller's performance in CL trials:
  - 10 trials with the worst sensors spent more time in hypoglycemia than the 10 trials with the best sensors,
  - more glucose rescues were necessary for the trials with the worst sensors.

References

[1] Cengiz E, Tamborlane W V. A Tale of Two Compartments: Interstitial Versus Blood Glucose Monitoring. *Diabetes Technol Ther*. 2009;11(S1):11-16.
[2] Keenan DB, Grosman B, Clark HW, et al. Continuous glucose monitoring considerations for the development of a closed-loop artificial pancreas system. *J Diabetes Sci Technol*. 2011;5(6):1327-1336.
[3] Van Bon AC, Jonker LD, Koebrugge R, Koops R, Hoekstra JBL, DeVries JH. Feasibility of a bihormonal closed-loop system to control postexercise and postprandial glucose excursions. *J Diabetes Sci Technol*. 2012;6(5):1114-1122.
[4] ClinicalTrials.gov, "Improving postprandial glycaemia by a new developed closed-loop control system - closedloop4meals (CL4M-Controls) - NCT02100488," 2015. [Online]. Available: https://clinicaltrials.gov/ct2/show/study/NCT02100488
[5] Pleus S, Schmid C, Link M, et al. Performance evaluation of a continuous glucose monitoring system under conditions similar to daily life. *J Diabetes Sci Technol*. 2013;7(4):833-841.
[6] Kropff J, Bruttomesso D, Doll W, et al. To-Head Comparison Under Clinical Research Centre and Daily Life. *Diabetes, Obes Andm*. 2015;17(4):343-349.