Performance of continuous glucose monitoring devices during intensive exercise conditions in people with diabetes

Fokkert, M; van Dijk, P R; Edens, M; Díez, A; Slingerland, R; Gans, R; Delgado, E; Bilo, H

Published in:
Diabetic Medicine

DOI:
10.1111/dme.14259

Letters

DOI: 10.1111/dme.14259

Performance of continuous glucose monitoring devices during intensive exercise conditions in people with diabetes: the Mont Blanc experience

Diabet. Med. 37, 1204–1205 (2020)

With increasing use of both flash glucose monitoring and real-time continuous glucose monitoring and the reliance of users on these readings, accuracy is important, in particular during intensive exercise. We investigated the performance of the FreeStyle Libre 1 flash glucose monitor and the Guardian Connect Enlite™ real-time continuous glucose monitor by comparing readings with self-monitored blood glucose values during intensive exercise.

Measurements were performed in 14 participants with type 1 diabetes and three participants with type 2 diabetes during 6 days of mountain biking in the Mont Blanc massif. The distance cycled was up to 218 km and the maximum altitude reached was 2523 m. Participants were asked to perform blood glucose measurements (after cleaning their finger) at least seven times each day. Self-monitored (capillary) blood glucose measurements were performed using Precision NeoPro strips that are aligned to the 'gold standard' reference method with National Institute of Standards and Technology standards [1]. Flash glucose monitoring and real-time continuous glucose monitoring readings were obtained within 2 min of the self-monitored blood glucose measurement. Both the data registered during the exercise period and those registered during the rest of the day were included in the analysis.

The median [interquartile range (IQR)] age of the study participants was 41 (29–56) years, the median (IQR) HbA_{1c} was 52 (38–77) mmol/mol [6.9 (5.6–9.2)%], median (IQR) BMI was 24 (22–30) kg/m^2, and median (IQR) diabetes duration was 21 (4–45) years.

Of the total of 676 self-monitored blood glucose readings that could be coupled to the FreeStyle Libre 1 flash glucose monitor and/or Guardian Connect Enlite™ readings, 414 datasets were considered suitable for comparing the FreeStyle Libre 1 flash glucose monitor with the Precision NeoPro strips readings, and 311 for comparison of the Guardian Connect Enlite™ with the Precision NeoPro strips readings.

Point accuracy of FreeStyle Libre 1 flash glucose monitor and Guardian Connect Enlite™ based glucose values vs the Precision NeoPro strips measurements was determined as a percentage within Parkes error zones, where values in zones A and B were deemed clinically acceptable, whereas those in zones C, D and E were considered potentially unsafe [2]. When comparing FreeStyle Libre 1 flash glucose monitor with Precision NeoPro strips readings, 96.2% of measurements were in zones A+B and 3.8% in zones C+D. For the Guardian Connect Enlite™ vs Precision NeoPro strips comparison, these numbers were: 90% in zones A+B and 10% in zones C+D.

The mean absolute relative difference (MARD) when comparing FreeStyle Libre 1 flash glucose monitor with NeoPro strip readings in the hypoglycaemic range (glucose < 4 mmol/l) was 23% (n = 42), in the euglycaemic range (glucose 4–10 mmol/ l) it was 25% (n = 273), and in the hyperglycaemic range (glucose > 10 mmol/l) it was 16% (n = 99). When comparing the Guardian Connect Enlite™ with the Precision NeoPro strip readings, the MARDs were 64% (n = 42), 26% (n = 203) and 16% (n = 66), respectively. The overall MARD for the FreeStyle Libre 1 flash glucose monitor was 22% and for the Guardian Connect Enlite™ monitor it was 29%.

When assessing our results using the thresholds described in the recently formulated guidelines for Integrated Continuous Glucose Monitoring Approvals [Class II–510(K)] [3], none of the results reached the proposed thresholds for accuracy (Table 1).

Table 1 Performance of FreeStyle Libre 1 flash glucose monitor and Guardian Connect Enlite™ with Precision NeoPro strips according to Guidelines for Integrated Continuous Glucose Monitoring Approvals [Class II–510(K)], using Precision NeoPro strips as reference

	Glucose	FreeStyle Libre 1 flash glucose monitor, n = 414 % (n/N)	Guardian Connect Enlite™, n = 311 % (n/N)	New Guidelines for Integrated CGM Approvals accuracy %: lower bound of one-sided 95% CI
Hypoglycaemia	< 4 mmol/l	64 (27/42)	21 (9/42)	>85: within ± 0.7 mmol/
		95 (40/42)	74 (31/42)	>98: within ± 2.2 mmol/l
Euglycaemia	4–10 mmol/l	47 (129/273)	43 (87/203)	>70: within ± 15%
		82 (223/273)	81 (164/203)	>99: within ± 40%
Hyperglycaemia	>10 mmol/l	57 (56/99)	59 (39/66)	>80: within ± 15%
		95 (94/99)	89 (59/66)	>99: within ± 40%
Overall	-	62 (257/414)	53 (165/311)	>87: within ± 20%

Taken together, our results, obtained in a real-life setting, demonstrate that during periods of daily intensive exercise, interstitial glucose measurements often show inaccurate and frequently higher readings compared to capillary measurements. Clinically relevant glucose concentration differences were present when comparing different glucose measurements, especially in the lower regions. This confirms findings obtained previously in controlled settings [4,5].

We did not examine the possible mechanisms for the considerable differences observed. Nevertheless, from a clinical point of view, our data emphasize the necessity to instruct people with diabetes that, if doubtful interstitial readings are obtained on days during which intensive exercise has been performed (especially readings in the hypoglycaemic ranges), confirmation with a capillary measurement is necessary.

Funding sources

None.

Competing interests

None declared.

Ethical approval

The study was performed according to Good Clinical Practice and the Principles of the Declaration of Helsinki. The Ethics Review Committee of the Isala hospital approved the protocol (Study number: NL62519.075.17; METC number 170704). All participants gave written informed consent prior to the start of the study.

M. J. Fokkert[1], P. R.van Dijk[3,4,5], M. A. Edens[2], A. Díez[6], R. J. Slingerland[1], R. O. B. Gans[4], E. Delgado[7,8,9] and H. J. G. Bilo[2,4]

[1]Department of Clinical Chemistry, [2]Department of Innovation and Science, [3]Diabetes Research Centre, Isala, Zwolle, [4]Department of Internal Medicine, [5]Department of Endocrinology, University of Groningen, University Medical Centre Groningen, Groningen, The Netherlands, [6]Hospital del Bierzo,Sección de Endocrinología, Ponferrada, [7]Department of Endocrinology and Nutrition, University of Oviedo, [8]Central University Hospital of Asturias, and [9]Health Research Institute of the Principality of Asturias (ISPA), Oviedo, Spain

E.D. and H.J.G.B contributed equally.

References

1 TüV Rheinland. (z.d.). Approved blood glucose measurement devices. Available at https://www.tuv.com/nl/netherlands/services_nl/product_testing_nl/medical_devices_nl/tested_medical_device.html. Last accessed 15 January 2019.

2 Parkes JL, Slatin SL, Pardo S, Ginsberg BH. A new consensus error grid to evaluate the clinical significance of inaccuracies in the measurement of blood glucose. *Diabetes Care*. 2000; **23**: 1143–1148.

3 Garg SK, Akturk HK. A New Era in Continuous Glucose Monitoring: Food and Drug Administration Creates a New Category of Factory-Calibrated Nonadjunctive, Interoperable Class II Medical Devices. *Diabetes Technol Ther*. 2018; **20**: 391–394.

4 Zaharieva DP, Turksoy K, McGaugh SM, Pooni R, Vienneau T, Ly T *et al*. Lag Time Remains with Newer Real-Time Continuous Glucose Monitoring Technology During Aerobic Exercise in Adults Living with Type 1 Diabetes. *Diabetes Technol Ther*. 2019; **21**: 313–321.

5 Moser O, Eckstein ML, McCarthy O, Deere R, Pitt J, Williams DM *et al*. Performance of the Freestyle Libre flash glucose monitoring (flash GM) system in individuals with type 1 diabetes: A secondary outcome analysis of a randomized crossover trial. *Diabetes Obes Metab*. 2019; **21**: 2505–2512.

DOI: 10.1111/dme.14288

Some young adults with cystic fibrosis-related diabetes may safely stop insulin without any adverse clinical sequelae

Diabet. Med. 37, 1205–1208 (2020)

Cystic fibrosis (CF) is a genetic condition that presents with reduced lung function and pancreatic exocrine and endocrine insufficiency. Although insulin sensitivity is generally normal or only mildly impaired in people with CF [1], reduced insulin secretion occurs frequently and CF-related diabetes (CFRD) is one of the commonest comorbidities, with an estimated prevalence of 12.4% in Europe [2]. It is most often diagnosed between the ages of 18 and 25 years.

During puberty there is a 25–30% physiological decline in insulin sensitivity that recovers post puberty and is on a par with that seen during pregnancy [3]. Many people with CFRD start insulin therapy during puberty or early adulthood to maintain normoglycaemia, prevent decline in lung function and support growth and weight gain. Once started, insulin is seldom stopped. Although pubertal insulin resistance is rarely the reason for insulin initiation, once insulin sensitivity improves post-puberty, the need for insulin may diminish. In the present study, we examined whether young adults with CFRD who had started insulin during puberty or early adulthood could stop their treatment without any clinical deterioration. The study protocol was approved by the University of Southampton Ethics and Research Governance Online committee (ID 41862).

University Hospital Southampton NHS Foundation Trust hosts the Wessex regional CFRD service. In 2018, there were 45 men and 31 women aged 18–25 years attending the service. Of these, 34 had CRFD, 12 had impaired glucose tolerance and 30 had normal glucose tolerance. Of the 34 with CFRD, 29 were treated with insulin at transition from the paediatric to adult services. The organization of care across our region