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Two-year use of flash glucose monitoring is associated with sustained improvement of glycemic control and quality of life (FLARE-NL-6)

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ABSTRACT

Introduction The FreeStyle Libre (FSL) is a flash glucose monitoring (FGM) system. The Flash Monitor Register in the Netherlands (FLARE-NL-4) study previously demonstrated the positive effects of FSL-FGM use during 1 year on glycemic control, quality of life and disease burden among persons with diabetes mellitus (DM). The present follow-up study assesses the effects of FSL-FGM after 2 years.

Research design and methods Patients included in the FLARE-NL-4 study who continued FSL-FGM during the 1-year study period were invited to participate (n=687). Data were collected using questionnaires (the 12-Item Short Form Health Survey version 2 (SF-12^{v2}) and the EuroQol 5-Dimension 3-Level (EQ-5D-3L) for quality of life), including self-reported hemoglobin A1c (HbA1c).

Results A total of 342 patients agreed to participate: mean age 48.0 (±15.6) years, 52% men and 79.5% with type 1 DM. HbA1c decreased from 60.7 (95% CI 59.1 to 62.3) mmol/mol before use of FSL-FGM to 57.3 (95% CI 55.8 to 58.8) mmol/mol after 1 year and 57.8 (95% CI 56.0 to 59.5) mmol/mol after 2 years. At the end of the 2-year follow-up period, 260 (76%) persons were still using the FSL-FGM and 82 (24%) had stopped. The main reason for stopping FSL-FGM was financial constraints (55%). Concerning the whole 2-year period, there was a significant decrease in HbA1c among persons who continued use of FSL-FGM (−3.5 mmol/mol, 95% CI −6.4 to −0.7), while HbA1c was unaltered compared with baseline among persons who stopped FSL-FGM (−2.4 mmol/mol, 95% CI −7.5 to 2.7): difference between groups 2.2 (95% CI −1.3 to 5.8) mmol/mol. After 2 years, persons who continued use of FSL-FGM had higher SF-12 mental component score and higher EQ-5D Dutch tariff score and felt less often anxious or depressed compared with persons who discontinued FSL-FGM.

Conclusions Although the considerable number of non-responders limits generalizability, this study suggests that persons who continue to use FSL-FGM for 2 years may experience sustained improvement in glycemic control and quality of life.

SIGNIFICANCE OF THIS STUDY

WHAT IS ALREADY KNOWN ABOUT THIS SUBJECT?

⇒ Use of FreeStyle Libre flash glucose monitoring (FSL-FGM) system is often associated with (short-term) improved glycemic control and quality of life.

WHAT ARE THE NEW FINDINGS?

⇒ This study demonstrates that use of FSL-FGM for 2 years is associated with sustained improvement in (self-reported) hemoglobin A1c.

⇒ Persons who continued use of FSL-FGM for at least 2 years experience improvements in quality of life as compared with persons who stopped FSL-FGM use.

⇒ In this study, financial constraints were the main reason for stopping FSL-FGM.

HOW MIGHT THESE RESULTS CHANGE THE FOCUS OF RESEARCH OR CLINICAL PRACTICE?

⇒ This study is one of the first to emphasize the valuable impact of FSL-FGM use in clinical practice over a longer period of time.

INTRODUCTION

During the last decades real-time continuous glucose measurement (rt-CGM) has been introduced to measure glucose concentrations in the interstitial fluid. Flash glucose monitoring is a variant of rt-CGM in which the user obtains results intermittently by using a reader. In 2014, Freestyle Libre flash glucose monitoring (FSL-FGM, Abbott) was introduced. In contrast to most CGM devices, the FSL-FGM is already factory-calibrated with no need for daily calibration. Compared with fingerprick testing, FSL-FGM readings can be performed painless after insertion and provide additional information on trends in glucose levels during day and night.

In order to acquire evidence on the effects, efficacy and safety of use of FSL-FGM in the Netherlands, a nationwide registry ('FLAsh monitor REgistry - NetherLands FLARE-NL') was established in 2016.[1] The FLARE-NL-4 study demonstrated a decrease

in hemoglobin A1c (HbA1c) (from 64 to 60 mmol/mol) over a 1-year study period and, importantly, improved the quality of life, decreasing rates of work absenteeism and fewer diabetes-related hospital admissions.[1] These results were confirmed by other studies that also demonstrated improved glycemic control and quality of life.[2–6] However, most of these studies are hampered by a limited study period (often <1 year).

In order to provide insight into the long-term use of FSL-FGM, the results of 2-year follow-up measurements among persons who participated in the FLARE-NL-4 study are described in the current study. Next to glycemic control, outcomes concerning quality of life and disease burden are presented.

METHODS

Study design, patient selection and aims

The FLARE-NL-4 register study had a prospective, observational design. Detailed information concerning the FLARE-NL registry and the 1-year outcomes have been published earlier.[1 7] The present study aims to describe the effects of FSL-FGM at 2-year follow-up. We invited patients who participated in the 1-year FLARE-NL-4 study (n=1365) who had continued to use FSL-FGM for a minimum of 1 year (n=687). Invitations to participants were sent by email. A total of 342 patients agreed to participate in this 2-year follow-up study.

Outcomes

The primary outcome was glycemic control over the 2-year study period. Furthermore, changes in health-related quality of life and disease burden were investigated and comparisons were made between persons who continued use of FSL-FGM for at least 2 years and persons who stopped FSL-FGM before the 2-year follow-up was completed. Additionally, data were analyzed for persons with type 1 and type 2 diabetes mellitus (DM) separately.

Study procedures

After informed consent was obtained, study participants received a link to report their most recent HbA1c values and to fill out the online questionnaires regarding glycemic control, quality of life and disease burden. Glycemic control was assessed using self-reported most recent HbA1c values and the number of self-reported clinically significant hypoglycemias (defined as a glucose <3 mmol/L[8]) in the past 6 months, measured with FSL-FGM or finger-prick testing. Additionally, participants were asked if they had experienced any hypoglycemic event during the past 6 months. Quality of life in the previous year was assessed by the EuroQol 5-Dimension 3-Level (EQ-5D-3L) questionnaire and the 12-Item Short Form Health Survey version 2 (SF-12^{v2}). The EuroQol is a generic measure developed by researchers from five European countries, including the Netherlands.[9]

The EQ-5D-3L is one of the most widely used instruments for measuring health-related quality of life.[10] This questionnaire consists of two parts. The first is a descriptive system which comprises the following five dimensions: mobility, self-care, usual activities, pain or discomfort, and anxiety or depression. Each dimension has three levels: no problems, some problems and extreme problems. The second is the EQ-5D Visual Analogue Scale from which a single overall score for self-rated health status can be elicited, ranging from 0 to 100.[10 11] The EQ-5D Dutch tariff is a valuation of all possible EQ-5D-3L health states, based on estimated regression coefficients. This score ranges from 0 to 1, where 1 refers to full health and 0 refers to death.[12] The SF-12 questionnaire measures eight health dimensions, among others general health, limitations in physical activities due to health problems, social functioning and vitality (energy/fatigue). The Physical Component Summary (PCS) and the Mental Component Summary (MCS) are two subscales derived from the SF-12.[13] To investigate disease burden, the number of hospitalizations related to DM in the previous year and work absenteeism rate in the previous 6 months were measured using the questionnaire. In the FLARE-NL-4 study we strived for a more value-based healthcare approach. As such, the study also focused on patient-reported outcome measures (PROMs), using a list compiled in collaboration with the Dutch Diabetes Patient Association (Diabetes Vereniging Nederland; DVN) to assess the degree of disease burden experienced by the study population in relation to their DM and the usefulness of FSL-FGM. This questionnaire has been described in more detail previously and the questions as asked in the DVN-PROM can be found in the supplemental material attached to the FLARE-NL-4 paper.[1]

Statistical analyses

Categorical data were expressed as n (%). To determine if variables were normally distributed, Q-Q plots and histograms were used. Normally distributed data were expressed as mean±SD and skewed distributed data as median with IQR. The Fisher's exact test was used to analyze categorical variables. The Mann-Whitney U test was used to compare continuous variables if the data were distributed skewed. Linear mixed models with Bonferroni corrections were used to calculate estimated values (with 95% CI) and to test for differences between the three moments in time (t=0, t=1 and t=2 years) and between groups. In the model the fixed factors continued and stopped FSL-FGM were used as determinants. The difference in scores was determined based on the b-coefficient of each particular (continued or stopped FSL-FGM use) group. Significance of the b-coefficient was investigated with the Wald test based on p<0.05. The quantity of the b-coefficient, with 95% CI, gives the

Table 1 Baseline characteristics

	All (N=342)	Continued FSL-FGM (n=260)	Stopped FSL-FGM (n=82)
Male gender, n (%)	178 (52.0)	140 (53.8)	38 (46.3)
Age, years	48.0 (15.6)	47.7 (15.8)	49.0 (15.1)
HbA1c, mmol/mol	61.2 (12.9)	62.1 (13.3)	58.2 (11.4)*
HbA1c, %	7.8 (1.2)	7.8 (1.2)	7.5 (1.0)*
Type of diabetes, n (%)			
Type 1 diabetes	272 (79.5)	214 (82.3)	58 (70.7)
Type 2 diabetes	45 (13.2)	30 (11.5)	15 (18.3)
Latent autoimmune diabetes in adults (LADA)	16 (4.7)	10 (3.8)	6 (7.3)
Maturity-onset diabetes of the young (MODY)	2 (0.6)	1 (0.4)	1 (1.2)
Other forms of diabetes	7 (2.0)	5 (1.9)	2 (2.4)
Complications, n (%)			
Microvascular complications	121 (35.4)	89 (34.2)	32 (39.0)
Neuropathy	71 (20.8)†	52 (20.0)	19 (23.2)
Albuminuria	62 (18.1)	47 (18.1)	15 (18.3)
Retinopathy	72 (21.1)	50 (19.2)	22 (26.8)
Macrovascular complications	50 (14.6)	38 (14.6)	12 (14.6)

Data are presented as number (%) or mean (SD).
*P<0.05.
†Data available for 108 persons (80 persons who continued and 28 who stopped FSL-FGM).
FSL-FGM, FreeStyle Libre flash glucose monitoring; HbA1c, hemoglobin A1c.

difference between both treatment modalities over the study period adjusted for baseline differences. Statistical analyses were performed using SPSS V.26.0. A significance level of 5% (two-sided) was used.

RESULTS

A total of 342 persons of the invited 687 (49.8%) agreed to participate in this follow-up study. As presented in table 1, 178 (52.0%) of the participants were men, with a mean age of 48.0 (±15.6) years and the majority of the population (79.5%) with type 1 DM.

Changes over time among all participants are presented in table 2. HbA1c decreased significantly from 60.7 (95% CI 59.1 to 62.3) mmol/mol before use of FSL-FGM to 57.3 (95% CI 55.8 to 58.8) mmol/mol after 1 year and 57.8 (95% CI 56.0 to 59.5) after 2 years.

Concerning quality of life, the SF-12 PCS increased during the study period. The number of working days lost and the hospital admission rate were not different as compared with baseline (table 2).

After 2 years, 260 (76.0%) persons were still using FSL-FGM and 82 (24.0%) had stopped before the 2-year follow-up was completed. Financial constraints (54.9%) and termination of the FLARE-NL-4 study (13.4%) were the main reasons for stopping FSL-FGM (table 3). Besides a higher baseline HbA1c among persons who continued FSL-FGM, there were no significant differences between groups at baseline. Among persons who continued FSL-FGM, 114 (43.8%) had reimbursement of the FSL-FGM by their healthcare insurance and 146 (56.2%) paid for the FSL-FGM themselves.

Changes over time among persons who continued and stopped FSL-FGM use are presented in table 4. HbA1c decreased significantly over the whole 2-year study period among persons who continued FSL-CGM (mean difference −3.5 mmol/mol, 95% CI −6.4 to −0.7), while this was −2.4 mmol/mol (95% CI −7.5 to 2.7) mmol/mol for persons who stopped FSL-FGM. The overall difference between groups was 2.2 (95% CI −1.3 to 5.8) mmol/mol.

The number of hypoglycemic events was not different after 2 years of follow-up in both groups. At 2 years, the percentage of persons who reported at least one hypoglycemic event during the past 6 months was higher in the continued versus the group that stopped FSL-FGM use (88.5% vs 79.3%, p<0.05; online supplemental table 4).

The SF-12 MCS remained stable among persons who continued FSL-FGM use over the 2-year period. Over the whole study period, the difference in SF-12 MCS change, as well as the difference in change of the EQ-5D Dutch tariff score, was significantly better among persons who continued FSL-FGM use as compared with persons who stopped (difference: 5.0 (95% CI 2.7 to 7.3) and 0.07 (95% CI 0.02 to 0.1), respectively). The SF-12 PCS increased in both groups. After 2 years, the percentage of persons who reported work absenteeism and hospital admission was lower for persons who continued FSL-FGM as compared with persons who stopped FSL-FGM (5.0% vs 14.6% (p<0.01) and 5.4% vs 12.2% (p<0.05), respectively, presented in online supplemental table 4).

Online supplemental table 2 and 3 show the effects of use of FSL-FGM on changes in glycemic control, quality of life and disease burden for persons with type 1 DM (n=272) and type 2 DM (n=45) separately. The significant changes described above concerning HbA1c, SF-12 PCS, SF-12 MCS and EQ-5D Dutch tariff score among persons who continued FSL-FGM were also observed among persons with type 1 DM who continued FSL-FGM.

As presented in online supplemental table 5, when comparing the outcomes of the DVN-PROM questionnaire after 2 years of follow-up between persons who continued and persons who stopped FSL-FGM, persons who continued FSL-FGM reported their hypoglycemic episodes were less severe (81.9% vs 11.4%), performed more adjustments of insulin dose (81.9% vs 30.4%), had a better understanding of glucose fluctuations (94.5% vs 7.6%), more often measured their glucose levels prior to traffic participation (65.4% vs 39.2%) and participated more frequently in sports activities (42.9% vs 3.8%). Importantly, persons who used the FSL-CGM felt more secure (77.2% vs 8.9%). Furthermore, people with whom they live together were less concerned about the glucose regulation of their partner (65.0% vs 9.0%).

Table 2 Changes in glycemic control, quality of life and disease burden among all participants

	Baseline (A)	1 year (B)	2 years (C)	B vs A	C vs A	C vs B
Glycemia						
HbA1c	60.7 (59.1 to 62.3)	57.3 (55.8 to 58.8)	57.8 (56.0 to 59.5)	−3.4 (−6.1 to −0.7)	−2.9 (−5.9 to −0.02)	0.5 (−2.4 to 3.3)
n	341	253	342			
Hypoglycemic events in the past 6 months	64.7 (55.3 to 74.0)	66.3 (55.0 to 77.6)	51.0 (42.1 to 59.9)	1.6 (−16.2 to 19.5)	−13.6 (−29.4 to 2.1)	−15.3 (−32.8 to 2.3)
n	325	311	294			
Quality of life						
EQ-5D-3L Dutch tariff	0.8 (0.8 to 0.9)	0.9 (0.8 to 0.9)	0.8 (0.8 to 0.9)	0.01 (−0.03 to 0.05)	0.0 (−0.04 to 0.04)	−0.01 (−0.05 to 0.03)
n	342	342	336			
EQ-VAS	69.8 (67.4 to 72.2)	71.7 (69.0 to 74.4)	73.9 (71.0 to 76.9)	1.9 (−2.5 to 6.3)	4.1 (−0.5 to 8.7)	2.2 (−2.6 to 7.1)
n	342	342	336			
SF-12^{v2} PCS score	38.2 (37.4 to 38.9)	47.2 (46.2 to 48.2)	46.9 (45.9 to 47.9)	9.1 (7.6 to 10.6)	8.7 (7.2 to 10.2)	−0.4 (−2.1 to 1.4)
n	342	342	342			
SF-12^{v2} MCS score	48.8 (47.6 to 50.1)	49.4 (48.3 to 50.5)	47.5 (46.4 to 48.7)	0.6 (−1.5 to 2.6)	−1.3 (−3.4 to 0.8)	−1.9 (−3.8 to 0.03)
n	342	333	333			
Disease burden						
Hospital admissions	0.1 (0.04 to 0.2)	0.1 (−0.01 to 0.1)	1.3 (−2.2 to 4.8)	−0.1 (−0.2 to 0.1)	1.2 (−3.1 to 5.5)	1.3 (−3.0 to 5.6)
n	342	342	341			
Lost working days	6.0 (2.7 to 9.3)	5.1 (2.2 to 8.0)	5.7 (1.5 to 9.9)	−0.9 (−6.3 to 4.5)	−0.3 (−6.8 to 5.6)	0.6 (−5.6 to 6.8)
n	342	342	339			

Data are presented as mean (difference) with 95% CI.
HbA1c concentrations are presented in mmol/mol.
EQ-5D-3L, three-level version of EuroQol 5 Dimension; EQ-VAS, EQ-Visual Analogue Scale; HbA1c, hemoglobin A1c; MCS, Mental Component Summary; PCS, Physical Component Summary; SF-12^{v2}, 12-Item Short Form Health Survey version 2.

DISCUSSION

In the present study we describe follow-up data concerning FSL-FGM derived from a nationwide registry. HbA1c decreased significantly after 2 years of follow-up. Among persons who continued FSL-FGM during the whole 2-year period, there was HbA1c reduction of −3.5 mmol/mol (95% CI −6.4 to −0.7), while HbA1c remained unchanged among persons who stopped FSL-FGM. Importantly, we observed significant (sustained) improvements in readouts of quality of life (SF-12 MCS, EQ-5D Dutch tariff score, and levels of anxiety and depression) among persons who continued FSL-FGM compared with persons who stopped.

Table 3 Reasons for discontinuing FSL-FGM

Reason for stopping FSL-FGM	n (%)
Financial constraints	45 (54.9)
End of the study	11 (13.4)
Unsatisfied with ease of use	3 (3.7)
Allergy to the adhesives	3 (3.7)
Use of an alternative to FSL-FGM	3 (3.7)
Inadequate glucose regulation despite FSL-FGM	1 (1.2)
FSL-FSG is regarded unreliable	1 (1.2)
Undefined	15 (18.3)
Total	82 (100)

FSL-FGM, FreeStyle Libre flash glucose monitoring.

The observed association between HbA1c improvement and FSL-FGM use is in line with recent publications.[1 2 5 14–16] The current study adds by demonstrating a significant HbA1c improvement over a 2-year period among FSL-FGM users. We were unable to demonstrate a difference in change of HbA1c over the 2-year study period between persons who continued FSL-FGM and those who stopped before the 2-year follow-up was completed. We hypothesize that this is related to the fact that the group of persons who stopped FSL-FGM had already used FSL-FGM for at least 1 year, which likely has provided them with more insight into their glucose regulation (and fluctuations).[14] We expect this 'learning effect' to have a positive influence on glycemic control during the following months after discontinuation of FSL-FGM.

The number of reported hypoglycemic events after 2 years of FSL-FGM use was not different as compared with baseline. However, the percentage of persons who detected at least one episode of hypoglycemia was higher among FSL-FGM users compared with persons who stopped. Importantly, in the DVN-PROM questionnaire, FSL-FGM users reported their hypoglycemic episodes to be less severe. Charleer *et al*[15] found a higher number of perceived hypoglycemic episodes among FSL-FGM users as compared with the period when they used self-monitoring of blood glucose (SMBG), possibly related to more detailed insight into glucose fluctuations

Table 4 Changes in glycemic control, quality of life and disease burden among persons who continued FSL-FGM for at least 2 years and persons who had stopped FSL-FGM before the 2-year follow-up period was completed

	Baseline (A)		1 year (B)		2 years (C)		C vs A		C vs B		Overall difference between groups
	Continued FSL-FGM	Stopped FSL-FGM	Continued FSL-FGM	Stopped FSL-FGM	Continued FSL-FGM	Stopped FSL-FGM	Continued FSL-FGM	Stopped FSL-FGM	Continued FSL-FGM	Stopped FSL-FGM	
Glycemia											
HbA1c	62.4 (60.8 to 64.0)	59.0 (56.2 to 61.8)	58.3 (56.8 to 59.7)	56.4 (53.8 to 58.9)	58.9 (57.2 to 60.6)	56.7 (53.6 to 59.8)	3.5 (–6.4 to –0.7)	–2.4 (–7.5 to 2.7)	0.6 (–2.1 to 3.4)	0.3 (–4.6 to 5.2)	2.2 (–1.3 to 5.8)
n	259	82	191	62	260	82					
Hypoglycemic events	61.8 (52.8 to 70.8)	67.5 (51.1 to 83.9)	60.3 (49.7 to 70.9)	72.3 (52.4 to 92.2)	51.3 (43.0 to 59.7)	50.7 (35.0 to 66.4)	–10.5 (–25.4 to 4.5)	–16.8 (–44.5 to 10.9)	–9.0 (–25.5 to 7.5)	–21.6 (–52.5 to 9.4)	0.6 (–17.2 to 18.4)
n	250	75	242	69	229	65					
Quality of life											
EQ-VAS	70.9 (69.5 to 74.2)	67.7 (63.6 to 71.9)	73.8 (71.2 to 76.4)	69.6 (64.9 to 74.2)	74.8 (71.9 to 77.6)	74.8 (71.9 to 77.6)	2.9 (–1.7 to 7.4)	5.3 (–2.8 to 13.4)	0.9 (–3.8 to 5.7)	3.5 (–5.0 to 12.0)	1.7 (–4.2 to 7.6)
n	260	82	260	82	265	80					
EQ-5D-3L Dutch tariff	0.85 (0.83 to 0.87)	0.84 (0.80 to 0.88)	0.87 (0.85 to 0.90)	0.84 (0.80 to 0.88)	0.88 (0.85 to 0.90)	0.81 (0.77 to 0.85)	0.02 (–0.02 to 0.06)	–0.03 (–0.10 to 0.04)	0.002 (–0.04 to 0.04)	–0.03 (–0.1 to 0.04)	0.07 (0.02 to 0.1)
n	260	82	260	82	256	80					
SF-12^{v2} PCS score	37.6 (36.9 to 38.3)	38.7 (37.5 to 40.0)	47.4 (46.4 to 48.4)	47.1 (45.3 to 48.8)	47.2 (46.2 to 48.2)	46.5 (44.8 to 48.3)	9.6 (8.1 to 11.0)	7.8 (5.2 to 11.5)	–0.2 (–1.9 to 1.5)	–0.5 (–3.5 to 2.5)	0.7 (–1.4 to 2.7)
n	260	82	260	82	260	82					
SF-12^{v2} MCS score	50.1 (48.8 to 51.3)	47.6 (45.4 to 49.9)	51.1 (50.0 to 52.1)	47.8 (45.9 to 49.6)	50.0 (48.9 to 51.1)	45.0 (43.1 to 47.0)	–0.03 (–2.1 to 2.0)	–2.6 (–6.2 to 1.1)	–1.1 (–2.9 to 0.8)	–2.7 (–6.1 to 0.6)	5.0 (2.7 to 7.3)
n	260	82	254	79	254	79					
Disease burden											
Hospital admissions	0.1 (0.07 to 0.2)	0.1 (–0.04 to 0.2)	0.1 (0.03 to 0.2)	0.02 (–1.0 to 0.1)	2.1 (–1.4 to 5.5)	0.6 (–5.5 to 6.7)	1.9 (–2.3 to 6.1)	0.5 (–7.0 to 8.0)	2.0 (–2.2 to 6.2)	0.6 (–6.9 to 8.1)	2.1 (–1.4 to 5.5)
n	260	82	260	82	259	82					
Lost working days	4.9 (1.6 to 8.1)	7.2 (1.4 to 13.0)	2.2 (–0.7 to 5.0)	8.0 (3.0 to 13.1)	3.4 (–0.7 to 7.5)	8.0 (3.0 to 13.1)	–1.5 (–7.9 to 4.9)	0.9 (–10.5 to 12.2)	1.2 (–4.9 to 7.3)	0.01 (–10.8 to 10.8)	–4.6 (–13.0 to 3.7)
n	260	82	260	82	257	82					

Data are presented as mean (difference) with 95% CI.
HbA1c concentrations are presented in mmol/mol.
EQ-5D-3L, three-level version of EuroQol 5-Dimension; EQ-VAS, EQ-Visual Analogue Scale; FSL-FGM, FreeStyle Libre flash glucose monitoring; HbA1c, hemoglobin A1c; MCS, Mental Component Summary; PCS, Physical Component Summary; SF-12^{v2}, 12-Item Short Form Health Survey version 2.

with FSL-FGM and a reduction of self-reported severe hypoglycemia.

Overall, continuing FSL-FGM was associated with improved quality of life, as compared with patients stopping FSL-FGM. Other studies have highlighted the positive influence of FSL-FGM on quality of life among persons with DM.[4–6 15–19] Overend *et al*[17] reported a positive impact of FSL-FGM on psychological well-being and self-esteem as patients with type 1 DM experienced more control over their blood glucose values. The authors attributed a reduction in frequency, severity and fear of hypoglycemia as the key positive impact on well-being. In line with these observations, the current study showed an improvement in understanding of glucose fluctuations among FSL-FGM users, and possibly related to this enhancement they felt more secure. The positive impact of FSL-FGM on quality of life is also supported by the results of the EQ-5D-3L questionnaire: among patients who continued use of FSL-FGM for 2 years, the reported level of anxiety and depression was significantly lower compared with patients who stopped FSL-FGM (online supplemental table 3).

In the FLARE-NL-4 study a decrease in work absenteeism rate (within 6 months) and in annual diabetes-related hospital admission rate was observed. Previous studies also showed a decrease in diabetes-related work absenteeism and hospital admissions after initiation of FSL-FGM.[5 15] The current follow-up study showed that stopping FSL-FGM was associated with a deterioration in the percentage of persons who reported work absenteeism and diabetes-related hospital admissions, compared with persons who continued FSL-FGM.

Of note, during the 1-year FLARE-NL-4 study, patients had to finance half of the cost of the FSL-FGM themselves if they did not fulfill the Dutch criteria for FSL-FGM reimbursement, and during the second year of use this group (56% of persons) had to pay the full amount (approximately €120 per month) themselves. This study demonstrated that 24% of persons stopped FSL-FGM use after the first year. For these persons financial constraints were the main reason for stopping.

This study has several limitations. Data were obtained from a nationwide registry and follow-up questionnaires and as such lacked a comparator. As discussed, a considerable number of persons included in the original FLARE-NL-4 study did not participate in the present follow-up study, potentially resulting in selection bias. Importantly, in this study we did not have access to FSL-FGM data; therefore, information concerning glucose metrics such as time in range is not available. Furthermore, information about the frequency of glucose monitoring, known to be associated with better glycemic control,[20] was not included in the database. As data were patient-reported, recall bias may be present. The exact time point when participants stopped using FSL-FGM is unknown.

Since the majority of participants had to finance the costs of the FSL-FGM themselves after 1 year, this inevitably will contribute to selection bias, since the actual participants probably will be more affluent than the average DM population, which may be related to a higher quality of life among FSL-FGM users. Patients used FSL-FGM for several indications, as described in the FLARE-NL-4 study.[1]

Finally, it should be mentioned that one of the questionnaires (the 'DVN-PROM') used in this study has not been validated yet. Although the DVN-PROM was non-validated, we still find the results valuable and useful as they represent the results of a collaboration with a DM patient organization and FSL-FGM users and the questions asked are very recognizable for both caregivers and patients.

CONCLUSION

Although a considerable number of persons from the original FLARE-NL-4 study were unavailable for this follow-up study, the data suggest that FSL-FGM use by persons with DM for a 2-year period was associated with sustained improvement of self-reported HbA1c compared with the period before FSL-FGM use. Aspects of experienced quality of life were higher among persons who continued FSL-FGM as compared with persons who discontinued FSL-FGM before the 2-year follow-up period was completed. Financial motives were the main reason for discontinuing FSL-FGM.

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