

*This is an Accepted Manuscript of an article published by Elsevier in **Diabetes research and clinical practice** on December 07 2021, available online:*  
<https://doi.org/10.1016/j.diabres.2021.109157>

# Diabetes Research and Clinical Practice

## The impact of flash glucose monitoring on the clinical practice of healthcare professionals working in diabetes care

--Manuscript Draft--

<b>Manuscript Number:</b>	
<b>Article Type:</b>	Research Paper
<b>Section/Category:</b>	Clinical care and education
<b>Keywords:</b>	flash glucose monitoring; diabetes healthcare professionals; self-management support; adherence; consultations
<b>Corresponding Author:</b>	Katherine A. Finlay, Ph.D, CPsychol University of Reading School of Psychology and Clinical Language Sciences Reading, Berkshire UNITED KINGDOM
<b>First Author:</b>	Abigail L Wright, BSc, MSc
<b>Order of Authors:</b>	Abigail L Wright, BSc, MSc Emily L Mattacola, PhD Lynsey Burgess Lauren Smith Katherine A Finlay, PhD
<b>Abstract:</b>	<p><b>Aims.</b> Research has identified that healthcare professionals' attitudes in clinical consultations impact the efficacy of their communication with service users and the blood glucose monitoring behaviours of their clients. Yet no research has sought to understand the impact of flash glucose monitoring on the experience of undertaking clinical consultations. This qualitative study aimed to explore the impact that flash glucose monitoring has on the clinical practice of healthcare professionals.</p> <p><b>Methods.</b> Semi-structured interviews were conducted with seventeen Healthcare Professionals (female: n=13; male: n=4) working with flash glucose monitoring and analysed via Thematic Analysis.</p> <p><b>Results.</b> Three themes were identified: (1) Delivering Person-Centred Care; (2) Shift in Diabetes Management; and (3) Time Burden. These themes highlight that flash glucose monitoring facilitates person-centred care through the provision of comprehensive data which improves communication between healthcare professionals and service users. However, preparing for consultations which integrate flash glucose monitoring requires a significant, potentially burdensome time investment.</p> <p><b>Conclusions.</b> Flash glucose monitoring enhances the strategic ability of healthcare professionals to provide evidence-based patient-centred care. This facilitates growth in service users' self-efficacy and encourages targeted diabetes self-management. However, further training is needed to optimise the ability of clinicians to rapidly interrogate and present monitoring data to users.</p>
<b>Suggested Reviewers:</b>	<p>Sophie Harris sophieharris1@nhs.net Sophie Harris has published a paper on the attitude of healthcare professionals role in the uptake of diabetes self-management education</p> <p>Louise Overend Louise.Overend@cumbria.nhs.uk Louise Overend has published a paper on a qualitative analysis of patient responses to the ABCD FreeStyle Libre audit questionnaire</p> <p>Emma Wilmot emma.g.wilmot@gmail.com Emma Wilmot has published a review of flash glucose monitoring</p> <p>Lucy Moore l.e.moore@exeter.ac.uk Lucy Moore has published a paper on barriers and facilitators to the implementation of</p>

	person-centred care
	Nick Oliver nick.oliver@imperial.ac.uk Nick Oliver has published a clinical review on supporting self management in adults living with Type 1 diabetes
<b>Opposed Reviewers:</b>	

The University of Buckingham  
Buckingham  
MK18 1EG  
United Kingdom

Tel +44(0) 1280 814080  
Fax +44(0) 1280 822245  
info@buckingham.ac.uk  
www.buckingham.ac.uk

Professor Antonio Ceriello  
Editor in Chief  
Diabetes Research and Clinical Practice

Tuesday 9<sup>th</sup> November 2021

Dear Prof. Ceriello,

Please accept as a candidate for publication our paper entitled: "The Impact of Flash Glucose Monitoring on the Clinical Practice of Healthcare Professionals Working in Diabetes Care."

**Context of Research:**

Research has identified good communication with healthcare professionals and positive attitudes of healthcare professionals as influential factors in enabling effective blood glucose monitoring. Therefore it is important to explore the influence of healthcare professionals' thoughts, feelings, and behaviours around blood glucose monitoring strategies in order to understand patient experience. Flash glucose monitoring has advanced self-management of diabetes by eliminating the need for finger-pricks and assisting with the identification of patterns in blood glucose by providing instant access to visual data. Since November 2017, flash glucose monitoring has become available on prescription in the UK, enabling healthcare professionals to use this technology in their clinical practice. Whilst there is evidence that flash glucose monitoring improves life satisfaction for those that use it, there is little research seeking to understand the impact of flash glucose monitoring on healthcare professionals and their care delivery. Given the aforementioned need to discern healthcare professionals' perspectives in diabetes management, this paucity of knowledge should be addressed in order to truly comprehend the impact of flash glucose monitoring on patient experience.

**The current study:**

This research utilised semi-structured interviews to explore the impact of flash glucose monitoring on the clinical practice of healthcare professionals in an NHS diabetes multidisciplinary team. Using thematic analysis, the impact flash glucose monitoring was investigated in relation to delivering patient-centred care, self-monitoring blood glucose, and healthcare professional communication with patients.

**Original contributions:**

Whilst literature has previously focused on the benefits of flash glucose monitoring for users, no research could be identified which focuses on clinicians' perceptions of flash glucose monitoring, and in particular, the communication and support they can offer when working with patients. Findings suggest that flash glucose monitoring enables healthcare professionals to go beyond standard care and changes the dynamic between healthcare professionals and service users, but that it also increases time burden. As a result, whilst the current study supports that flash glucose monitoring enhances patient-centred care, recommendations are made to facilitate more time efficient use of flash glucose monitoring for healthcare professionals.

**Conflicts of Interest:** The authors know of no conflicts of interest.

Thank you for your consideration of this paper.

Yours faithfully,

**Abigail L. Wright** (First Author, University of Buckingham)

**Dr Emily Mattacola** (Senior Lecturer in Psychology, University of Buckingham)

**Lynsey Burgess** (Diabetes Specialist Nurse and Diabetes Pathway Lead, Northamptonshire Healthcare Foundation Trust)

**Lauren Smith** (Senior Diabetes Specialist Nurse, Northamptonshire Healthcare Foundation Trust)

**Dr Katherine A. Finlay** (Corresponding Author, Lecturer in Psychology, University of Reading)

## Highlights

- Clinicians feel flash glucose monitoring facilitates improved person-centred care
- Clinicians perceive flash glucose monitoring improves service users' self-efficacy
- Clinicians argue consultations using flash glucose monitoring require more preparation and time

# **Title: The impact of flash glucose monitoring on the clinical practice of healthcare professionals working in diabetes care**

Short title: *Flash Glucose Monitoring and Clinical Practice*

Wright<sup>a</sup>, A. L., Mattacola<sup>a</sup>, E. L. (PhD, CPsychol), Burgess<sup>b</sup>, L. (RGN), Smith<sup>b</sup>, L. (RGN), and Finlay<sup>\*c</sup>, K. A. (PhD, CPsychol)

<sup>a</sup> Department of Psychology, University of Buckingham, Buckingham, MK18 1EG, UK

<sup>b</sup> Diabetes Multidisciplinary Team, Northamptonshire Healthcare Foundation Trust, St Mary's Hospital, Kettering, Northamptonshire, NN15 7PW. UK

<sup>c</sup> School of Psychology and Clinical Language Sciences, University of Reading, Reading, RG6 6BE, UK

\*Corresponding author information: Dr Katherine Finlay, University of Reading, Harry Pitt Building, Earley Gate, Reading, Berks. RG6 6BE, UK (e-mail: [katherine.finlay@reading.ac.uk](mailto:katherine.finlay@reading.ac.uk)).

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## Introduction

Type 1 diabetes is estimated to be prevalent in 10% of the 3.9 million people living with diabetes in the UK, and can be managed through a combination of lifestyle modifications and medication [1,2]. Diabetes self-management requires monitoring blood glucose to inform insulin doses administered between four and ten times per day [3]. How well a patient adheres to this will determine their glycaemic control (indicated by glycated haemoglobin, or HbA1c; [4]). Without it, hyperglycaemia will occur, risking diabetic ketoacidosis, and macro and microvascular complications [5]. Poorer glycaemic control is associated with higher diabetes distress, defined as worries and threats linked with having and managing diabetes [6], and lower quality of life [7]. Therefore, improving the ease of self-managing blood glucose (SMBG) is a primary target for improving diabetes care, enabling people with diabetes to live long-term with their condition with minimal complications or diabetes distress, and higher quality of life.

Prioritising patient-centred care is one means of achieving this. It has been found to reduce HbA1c, an improvement which is sustained even after discharge from services [8]. Diabetes healthcare professionals (HCPs) therefore work closely with people living with diabetes (PLWD) to devise individual care plans [9]. Core to formulating patient-centred care plans is engaging PLWD in shared decision-making, thereby increasing patient autonomy in treatment [10]. Perceptions of autonomy in self-management heighten a patient's ability to make informed condition-related decisions and this is directly linked to feeling understood by HCPs [11]. In particular, HCPs play a key role in encouraging PLWD to engage with opportunities for diabetes education [12,13], which improve knowledge and SMBG. The collaborative relationship between HCPs and PLWD is therefore of paramount importance to effective diabetes self-management.

However, changes have occurred in care delivery in diabetes management in recent years. Continuous Flash Glucose Monitoring through the FreeStyle Libre device (FSL-CGM) is one such innovation. The FSL-CGM became available on prescription within certain NHS Trusts in November

2017 [14] and is currently the only flash monitoring system available in the UK. The FSL-CGM is worn on the back of the upper arm, accurately measuring the glucose in the interstitial fluid and eliminating the need for finger pricks to allow blood glucose monitoring [15]. The device is scanned to get a glucose reading, simultaneously recording results from the preceding eight hours [15], meaning users have access to more data than facilitated by capillary glucose monitors. FSL-CGM has been found to improve quality of life and promote self-management [16], and has been labelled as life-changing by PLWD [17]. Promotion of self-management is facilitated by FSL-CGM increasing the frequency of blood glucose monitoring and improving HbA1c levels [18]. It also provides users with instant access to visual data to assist identification of blood glucose patterns [17], enabling users to increase the amount of time they spend in glucose target ranges, and reducing incidence of hypoglycaemia [19]. The device also informs users of the direction their blood glucose levels are travelling, giving the readings additional context and allowing tailored choices to be made regarding appropriate courses of action [19]. Such technology therefore offers evidence-based, collaborative exploration of behavioural patterns and SMBG by patients and clinicians together, enabling better development of self-management skills, improving satisfaction with care from clinicians, and increasing frequency of contact with HCPs [20]. FSL-GCM therefore has the potential to enhance patient education and autonomy, whilst also improving SMBG by collaboratively working with patients to promote better understanding of and responsiveness to SMBG.

The responsibility of ensuring users have sufficient education on SMBG and FSL-CGM lies with HCPs [19]. HCP input is paramount to successful adoption of the FSL-CGM and SMBG. Indeed, barriers to patient centred care include HCP appointment time constraints, the negative attitudes of HCPs [21] and barriers to effective glucose monitoring have been found to include inadequate communication with HCPs [22]. Individual care plans offer a gateway for patients to safely explore their use of FSL-CGM through discussion with their HCP [23], but this means HCPs must balance effective communication with patients alongside responsiveness to their patients' FSL-CGM data. This may present a significant challenge to patient-centred care delivery and may have implications



for future service improvement. Literature has previously focused on the benefits of FSL-CGM to users, but none could be identified which sought to understand clinicians' perceptions of the changes that the FSL-CGM has had on the communication and support they can offer when working with patients. This study therefore aimed to qualitatively explore how working with the FSL-CGM impacts perceptions of patient-centred care delivery, SMBG, and communication for HCPs of all seniority levels working with patients in a diabetes service multidisciplinary team (MDT). The current research aimed to identify: (1) how FSL-CGM impacts upon HCPs' ability to deliver patient-centred care; and (2) how FSL-CGM impacts HCP communication with other HCPs and service users.

## **Method**

### **Design and Setting**

This research was a service evaluation conducted within an NHS diabetes MDT. A semi-structured interview design was used as it offered an appropriate interview style for exploring perceptions of a sample group with diverse job hierarchies and backgrounds [24] and had been previously used successfully in diabetes clinical research [25].

### **Participants**

Seventeen diabetes HCPs (female  $n=13$ , male  $n=4$ ) were interviewed. Job seniority hierarchies are presented in Table 1. Purposive sampling was used due to the need for participants to be HCPs working with service users utilising FSL-CGM. Therefore, recruitment was restricted by the specific participant characteristics needed [26]. Inclusion criteria were being a member of the diabetes MDT, working with service users utilising FSL-CGM, and being aged 18 or over. Previous research suggested a sample of sixteen [27] or ten +/- three participants, with recruitment continuing until data saturation is reached [28]. Data saturation occurred at 14 participants and was confirmed in a further 3 interviews. Therefore the current study met sample size recommendations.

[INSERT TABLE 1 ABOUT HERE]

## **Materials**

A semi-structured interview schedule with eight open-ended questions was devised to guide the interviews, as presented in Table 2. The schedule was devised to encourage participants to explore how FSL-CGM impacted their work as diabetes HCPs, their interaction with service users and other HCPs, perceptions of working with FSL-CGM, and recommended ways to improve the use of FSL-CGM in consultations. The interview schedule was informed by previous literature around HCPs and new technology implementation [29,30], and the working environments of HCPs [31].

[INSERT TABLE 2 ABOUT HERE]

## **Procedure**

Informed consent and demographic forms were sent via email prior to interviews and were returned before interviews were scheduled. Interviews were conducted between June and August 2020 via Zoom ( $N=13$ ), Microsoft Teams ( $N=2$ ), or in person ( $N=2$ ), depending on participant preference. The interviews lasted on average 26.5 minutes, ranging from 15-50 minutes. Participants received both a verbal and written debrief after the interview.

## **Ethics**

The current research was a service evaluation, confirmed by the NHS Health Research Authority, and was granted approval by the relevant institution and NHS Research and Development Department. The BPS Code of Human Research Ethics was adhered to throughout [32].

## **Analysis**

The interviews were analysed using inductive thematic analysis [33]. They were transcribed verbatim by the first author to improve data familiarity [33]. Audio recordings were checked against completed transcripts for accuracy to check for data quality. All identifying information was removed

from transcripts and participants were given pseudonyms to maintain anonymity. The six phases of thematic analysis as explained by Braun and Clarke [33] were followed, using the data analysis software NVivo. The first author read through each transcript multiple times, building familiarity with the data and making notes of patterns (1). Initial codes were identified from transcripts, focusing on the pertinent research questions (2). Themes were developed through collating these codes (3). These themes were reviewed and refined (4), then defined and named (5), and finally written up (6). Triangulation was conducted by cross-validation of themes, subthemes, and quotes by the last author to increase trustworthiness of findings [34], following the process outlined by Lincoln and Guba [35]. Agreement rates were calculated using Miles and Huberman's inter-rater reliability formula [36], resulting in 90.7% agreement between researchers. Any discrepancies were discussed and resolved with the research team before finalising themes.

## **Results**

Three themes were identified: (1) Delivering Person-Centred Care; (2) Shifts in User Management; and (3) Time Burden. Themes and subthemes are presented in Figure 1.

[INSERT FIGURE 1 ABOUT HERE]

### **Theme 1: Delivering Person-Centred Care**

This theme demonstrated how flash glucose monitoring enabled HCPs to deliver individualised care. FSL-CGM facilitated accurate virtual care delivery and increased the confidence of HCPs who could be more responsive to patient data. This theme is divided into the subthemes of (1) User-Focused Targets, (2) Meaningful Consultations, (3) Confidence in Advice, and (4) Supporting Users Virtually.

#### ***Subtheme 1.1: User-Focused Targets***

FSL-CGM provided data such as time in glucose target range, including the visual presentation of graphs, which assisted HCPs in collaboratively developing targets for service users to improve diabetes management:

We have a lot of focus and specific guidelines on times, the range and time in hypoglycaemia. It helps giving targets to the patients, helping motivate them to meet specific targets they can easily see. (Yiannis, line 56).

FSL-CGM data enabled personalised medication recommendations to be prioritised by improving HCP-HCP communication:

We [the care team] can look at it [FSL-CGM data] together and see what changes need to be made to medications to make it more specific and tailored to the patient. (Casey, line 117)

The additional data such as information on insulin, exercise, and carbohydrates, which service users input manually, assisted HCPs to set specific targets:

You can look at the data and try to use other knowledge, such as their insulin and exercise, to come up with a treatment plan. (Darius, line 54)

Therefore, FSL-CGM enables HCPs to suggest targets to service users, further individualising their care.

### ***Subtheme 1.2: Meaningful Consultations***

FSL-CGM data was experienced as driving more honest, meaningful conversations with patients, which specifically addressed eating behaviours and insulin regimes through visual representation:

It allows better conversation because you can discuss their carb counting, if their ratios and things are right, because they can see their levels from morning to lunch have dropped. (Linda, line 86)

The additional FSL-CGM information which service users input manually, such as carbohydrate intake, exercise, and insulin administered led to increases in the precision of conversations around the impact of these factors on glucose levels:

If people are very motivated like that, you can really get a lot from it with learning from how all the variables affect your blood sugar, then we can have a meaningful conversation about what you could try and do. (Natalie, line 75)

The visual presentation of FSL-CGM data alongside discussions with HCPs was perceived to influence service users' understanding of the consultation and thus the self-management of the service users:

The consultation tends to be more meaningful, for them and for me, because you know they're going to go away and they might have a lightbulb moment or might go "actually, you're right, I can see that now". (Polly, line 187)

### ***Subtheme 1.3: Confidence in Advice***

FSL-CGM heightened the confidence of HCPs to target core concerns:

I feel a lot more confident in the advice I'm giving because I can definitely identify where the issues are. (Samantha, line 24)

The additional FSL-CGM data and more specific conversation enhanced the relationship between HCP and service users, creating a more collaborative team which increased HCP confidence:

You feel more confident as a professional; I do feel confident whilst making changes because you're seeing more data. You feel it's more of a collaborative approach because you're questioning more with the patients. (Natalie, line 125)

The collective confidence across the team and collaboration with service users made treatment plans more responsive:

It gives us a lot more confidence to be able to advise and support our patients and make changes with them for their insulin doses. (Mary, line 52)

#### ***Subtheme 1.4: Supporting Users Virtually***

Since using FSL-CGM, consultations have been able to be virtual without the need for service users to attend clinic. This has been particularly advantageous during the COVID-19 pandemic:

Once they're on Libre [FSL-CGM], we're able to support them virtually, which has been really important in the last few months [COVID-19]. We're able to have an accurate picture of their glucose levels because it's recorded, then contact them virtually to support them. (Eliza, line 36)

The implementation of virtual consultations increased service user engagement with HCPs:

They just ring up and have a virtual review, rather than having to come into clinic which they don't want to do. I'm getting a lot more engagement from the patient. (Samantha, line 59)

The virtual nature of FSL-CGM gave HCPs immediate access to data when required:

They've got an emergency, something is going on with their readings, they're really high, they can't figure out why and what's going on, you've got that data in front of you to help support. (Belinda, line 83)

Therefore, by prioritising evidence-led, virtual consultations, more service users could be reached through the extended delivery of the service.

#### **Theme 2: Shift in User Management**

This theme encompassed how FSL-CGM has advanced diabetes management. Management has moved away from HCPs relying on service users to provide them with accurate and consistent glucose readings, to allowing instant access to a continuous, comprehensive history of readings. This progression has enabled successful communication of data but has not been inclusive of all service

users' ability to use essential functions of FSL-CGM beneficially, such as the need to upload data and the visual direction of glucose level. This theme is divided into the subthemes of (1) Information Sharing, (2) Accessible 24-Hour Data, (3) Nurturing Autonomous Users, and (4) Reactive Self-Management.

### ***Subtheme 2.1. Information Sharing***

The online uploading of FSL-CGM data enabled data to be shared from service user to HCPs instantly through a cloud-based system:

[HCPs] sometimes go into homes and download it for people. They can message us, "I've downloaded Mrs X's data, can you have a look at it?". We get more information without them having to write down lots of blood glucose readings. (Clara, line 108)

The sharing of FSL-CGM data enabled HCPs to support service users who were unwilling to disclose information themselves about extreme glucose levels:

I've had patients who are worried about having readings that are too high or low and what other people will think. They don't always share that information; the Libre [FSL-CGM] shares everything and allows you to hopefully support them more. (Eliza, line 55)

Therefore, information sharing allowed HCPs to access important data needed for effective support of self-management, encompassing better care of service users unwilling to disclose information.

### ***Subtheme 2.2: Accessible 24-Hour Data***

FSL-CGM records up to 24-hours of data per day, when service users scan correctly:

Using Libre [FSL-CGM], you've got a picture of what's happening up to 24 hours a day, depending on how often they're scanning. (Eliza, line 21)

The records of data enabled HCPs to utilise accurate glucose levels across a larger time frame without needing to ask service users to provide their blood glucose readings:

You can look if their glucose readings are in target over a 24-hour period then you could look back at what's been happening over 2 weeks, three months. You're able to view much more data. (Eliza, line 81)

FSL-CGM visually presented the 24-hour data to service users, enabling more control over diabetes self-management through the documentation of glucose changes in relation to changes service users have made:

It helps them see what is happening all the time; this gives them a better understanding of the decisions they have made. (Yiannis, line 51)

Therefore, FSL-CGM has progressed HCP access to service user glucose data.

### ***Subtheme 2.3: Nurturing Autonomous Users***

The visual presentation of FSL-CGM data and the discussions this facilitated enabled HCPs to support service users to be independent in diabetes management:

[It] helps them to become more independent because they can start to notice patterns, which is better for them because *they* live with diabetes; it's better *they* can adjust their own insulin where possible. (Linda, line 37)

The increase in user autonomy due to FSL-CGM allowed HCPs to prevent some service users from requiring community nursing support:

[FSL-CGM] meant she didn't need that support, she actually remained independent. It's really quite empowering, making you feel you can empower patients and keep them independent for longer. (Casey, line 64)

Therefore, more service users were able to stay independent in their diabetes management and have more autonomous control over their diabetes.

### ***Subtheme 2.4: Reactive Self-Management***



The continuous recording of FSL-CGM data for up to eight hours enabled episodes of hypoglycaemia to be identified:

One thing that has been valuable for is nocturnal hypos. Ordinarily with a finger prick, might go to bed with a reading of 7.5 then when they wake up in the morning, they find it's 9.2.

From the readings alone, you've seen that rise, but what actually might have happened, and what we now know with [FSL-CGM], is it goes down then you get that sudden rise. (Polly, line 100)

FSL-CGM data enabled service users who experienced nocturnal hypoglycaemia to be identified and supported with their hypoglycaemia unawareness by HCPs:

This wouldn't have been picked up without Libre because she might have woken up with a blood sugar of four and the practice nurse might have said "you've got really good control; your HbA1c is 52" but she was just hypoing loads; it means I've been able to capture those kinds of people. (Samantha, line 101)

However, the abundance of FSL-CGM data also allowed service users to overcorrect glucose levels due to the accessibility of data, which was found to be problematic:

If they see it too high, they take some insulin and they do that too often. Then they go hypo later because they've made too many corrections. They haven't had the patience to say, "it's a bit high at the moment, but I need to wait to see what happens". (Jill, line 103)

Service users who overcorrect required more support from HCPs to understand when not to react to data and how FSL-CGM should be utilised:

They've just given themselves some extra insulin, and they say, "I've scanned and I'm still high!". You need to let that insulin work before you make another response. (Belinda, line 37)

Therefore, whilst FSL-CGM gave service users the data to be able to instantly react to their glucose levels, this was at times found to lead to overcorrections.

### **Theme 3. Time Burden**

This theme encompassed the time-consuming areas of FSL-CGM which HCPs had to incorporate into clinical practice. This included the time involved setting up service users with FSL-CGM and the need for additional time to make decisions prior to and during consultations, in response to service user data. This theme is divided into the subthemes of Start-Up Time Commitment, (2) Interpretation Time Constraints, and (3) Stretched Consultation Time.

#### ***Subtheme 3.1: Start-Up Time Commitment***

The initial task of setting up service users with FSL-CGM was found to place a burden on working hours:

It felt like a whole other piece of work we had to do on top of what we were already doing; it felt quite onerous. Setting up the groups, dealing with referrals, the paperwork and administration we had to do alongside it were challenging. (Clara, line 18)

More support for service users was required of HCPs when starting up with the technology:

When you're trying to get everybody started up, there's a lot of paperwork, education and supporting. Quite a few people need that extra support. (Belinda, line 77)

Therefore, FSL-CGM was time-consuming for HCPs to facilitate service users to begin working with the technology.

#### ***Subtheme 3.2: Interpretation Time Constraints***

FSL-CGM required HCPs to learn how to interpret data when it was initially introduced:

The amount of information and knowledge you had to learn to interpret the charts and graphs it shows you, I found quite complex and a lot of extra learning to try and figure these things out so I would support the patients better. (Casey, line 41)

HCPs felt interpretation of FSL-CGM data was best done before consultations to allow time to be spent on discussions and advice with service users:

You need to spend a lot of time interpreting the results in order to come with advice.

(Yiannis, line 29)

The need to interpret prior to consultations enabled more time for service user views to be incorporated, as an equal partnership:

You've got all that information readily available for you on the platform. You feel you have to read it before you see them so you can get your head around all that information. Then you can have a conversation with them and find out what their thoughts and concerns are.

(Mary, line 96)

Therefore, whilst beneficial to patient-centred care, interpreting data before consultations was an additional time burden for HCPs.

### ***Subtheme 3.3: Stretched Consultation Time***

HCPs felt the lengths of consultations are too short for in-depth interpretation of data with service users:

The patients on this technology need a bigger time slot. They currently have a 15-minute time slot, so it's difficult sometimes to go through the data in depth (Amar, line 61).

HCPs felt the inputting of service user data required after follow-up consultations was time-demanding:

It had a huge time impact suddenly and I felt it more with the follow ups because you'd have a follow up 6-months later and those appointments in clinic were 20 minutes. That seems a reasonable amount of time, but not to do all that paperwork and inputting. (Polly, line 174)

Therefore, HCPs felt consultations were too short to be able to complete all work for each service user seen.

### **Discussion**

This research contributes to current literature through exploration of the impact FSL-CGM has on HCPs perception of patient-centred care delivery, SMBG, and communication. The findings emphasise the importance FSL-CGM has on HCPs' ability to provide tailored person-centred care and to progress the management of diabetes through different measurements supplementing HbA1c. However, working with FSL-CGM is time-consuming.

The first theme *Delivery of Person-Centred Care* involves communication with service users being specific to their needs through data provided by FSL-CGM and the ability for virtual consultations, meaning delivery and communication is more person-centred. This links to FSL-CGM allowing specific choices to be made for treatment plans [19]. The current study elaborates this further, suggesting FSL-CGM facilitates person-centred care through detailed data provision, meaning collaborative decisions around self-management and targets can be made. FSL-CGM enables visual identification of glucose patterns which assists HCPs to support self-management. FSL-CGM allows points of discussion during consultations to be identified afterwards and HCPs to become aware of glucose changes which would otherwise be unknown. HCPs can provide education in response to additional data garnered from FSL-CGM, such as exercise, insulin doses, and carbohydrate consumption, and through continuous glucose readings. Opportunities for diabetes education such as this have previously been found to improve self-management through effective HCP-patient communication [13]. Therefore, FSL-CGM acts as a tool for HCPs to facilitate education to enhance their support of service users. Through this, HCPs can provide service users with the necessary skills

to improve self-management, which has been previously found to improve self-efficacy and ultimately adherence [37]. Patient-centred care is preferred by users [10] and significantly improves diabetes outcomes, such as HbA1c [8]. The ability to support service users virtually during the COVID-19 pandemic aligns with research which has previously highlighted the role of technology in delivering patient-centred care [20]. Therefore, FSL-CGM enables more patient-centred care, and may result in more engaged service users, improved self-management, and improved diabetes outcomes.

The second theme *Shifts in User Management* highlights how technological advancement offered by FSL-CGM, such as the uploading of 24-hour data to be instantly shared with HCPs, creates opportunities for enhanced care. HCPs no longer rely on service users to report blood glucose readings. This has changed the dynamic of communication between HCPs and service users. However, the advantages offered by FSL-CGM are not always inclusive of all users. Those who do not have compatible computer technology or the technological skills to use all capabilities of FSL-CGM have been left behind, resulting in them requiring extra support from HCPs. Previous recommendations have stated that diabetes management technology should be tailored to individual's abilities [38], which is reiterated here. Additionally, the enhanced data offered by FSL-CGM is not always responded to appropriately by service users, and may encourage overcorrection of blood glucose. This is supported by previous findings suggesting patients need guidance regarding how to use data from FSL-CGM [39]. Previous research has found that service users may be unwilling to discuss imperfect self-management as they do not wish to disappoint or be judged by HCPs, resulting in them concealing glucose management difficulties [40]. The capability of FSL-CGM to share comprehensive, validated blood glucose data overcomes this, and opens up discussion around changes that need to be made to care regimes to enhance glycaemic control. Therefore, FSL-CGM is a tool for HCPs to be made aware of concerns around effective glycaemic control and facilitate sensitive conversations with service users, increasing the effectiveness of consultations.

The third theme *Time Burden* includes the initial time taken to educate service users in the use of FSL-CGM, the time needed to appropriately view and interpret FSL-CGM data prior to consultations, and the limitations placed on effective communication by the length of consultation appointments. Whilst FSL-CGM enables more meaningful consultations, to do so demands a lot of time not currently facilitated by appointment lengths. Time constraints have previously been stated to be a barrier to patient-centred care [21]. This data supports the notion that, whilst FSL-CGM may facilitate more data to support enhanced patient-centred care, this is limited by the time available. HCP training on interpreting FSL-CGM data may assist in reducing time spent preparing for consultations without compromising quality of person-centred care. HCP education on diabetes technology to increase skills in using technology and increase time available to use them has previously been recommended [25], and is therefore reiterated here.

### **Limitations and Future Recommendations**

The current research was conducted with one NHS diabetes MDT. Other teams may have different experiences of how FSL-CGM impacts clinical practice, therefore future research should explore other diabetes MDTs' perceptions of FSL-CGM. However, the job roles of participants in this research are comparable to other diabetes service MDTs, and so should be considered generalisable.

### **Implications**

Further research is needed to investigate how HCPs can best use the limited time available in consultations to offer person-centred care informed by FSL-CGM data. One proposed avenue for this is to investigate the efficacy of HCP education in interpretation of FSL-CGM data.

Diabetes management has progressed with instant data sharing; however, this is not inclusive of all service users. Means of engaging service users with limited technology access and literacy need to be investigated.

### **Conclusion**

This research has shown HCPs perceive FSL-CGM to enhance their ability to provide individualised care and to progress data to enhance HCP communication. This adds to previous knowledge that FSL-CGM assists HCPs to support PLWD with self-management. However, HCP training should be considered to be able to utilise time in consultations efficiently given the abundance of data made available by FSL-CGM. Overall, HCPs perceive FSL-CGM as a useful tool to enable person-centred care and increase the effectiveness of consultations.

## References

- [1] Diabetes UK. Diabetes Prevalence 2019. Diabetes UK 2019.  
<https://www.diabetes.org.uk/professionals/position-statements-reports/statistics/diabetes-prevalence-2019> (accessed 28 August 2020).
- [2] Public Health England. Health Profile for England: 2018. 2018.
- [3] Reddy M, Rilstone S, Cooper P, Oliver NS. Type 1 diabetes in adults: Supporting self management. *BMJ* 2016;352:1–7. <https://doi.org/10.1136/bmj.i998>.
- [4] Jacobson AM, Braffett BH, Cleary PA, Gubitosi-Klug RA, Larkin ME. The Long-Term Effects of Type 1 Diabetes Treatment and Complications on Health-Related Quality of Life: A 23-year follow-up of the Diabetes Control and Complications/Epidemiology of Diabetes Interventions and Complications cohort. *Diabetes Care* 2013;36:3131–8. <https://doi.org/10.2337/dc12-2109>.
- [5] NHS UK. Hyperglycaemia (high blood sugar). NHS UK 2018.  
<https://www.nhs.uk/conditions/high-blood-sugar-hyperglycaemia/> (accessed 14 February 2021).
- [6] Fisher L, Polonsky WH, Hessler D. Invited Review Addressing diabetes distress in clinical care: a practical guide 2019:803–12. <https://doi.org/10.1111/dme.13967>.
- [7] Saleh F, Mumu SJ, Ara F, Hafez MA, Ali L. Non-adherence to self-care practices & medication and health related quality of life among patients with type 2 diabetes: A cross-sectional study. *BMC Public Health* 2014;14:1–8. <https://doi.org/10.1186/1471-2458-14-431>.
- [8] Titchener J. A patient-centred clinical approach to diabetes care assists long-term reduction in HbA1c. *J Prim Health Care* 2014;6:195–202. <https://doi.org/10.1071/HC14195>.
- [9] National Institute for Health and Care Excellence. Type 1 diabetes in adults: diagnosis and



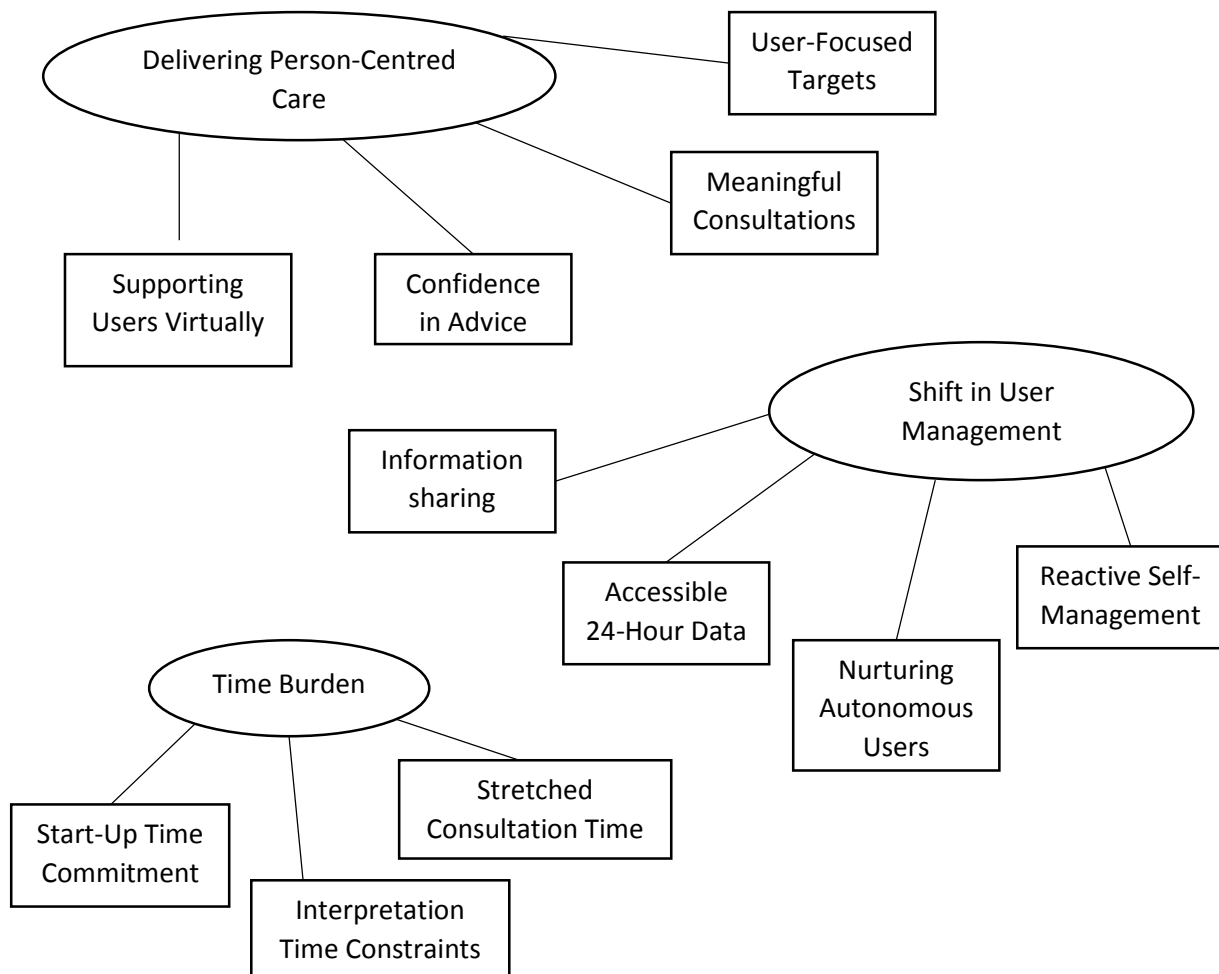
- management. NICE Guidel 2015. <https://www.nice.org.uk/guidance/ng17/chapter/1-Recommendations#blood-glucose-management-2> (accessed 29 August 2020).
- [10] Simms MJ, Baumann K, Monaghan M. Health communication experiences of emerging adults with Type 1 diabetes. *Clin Pract Pediatr Psychol* 2017;5:415–25. <https://doi.org/10.1037/cpp0000211>.
- [11] Miežienė B, Šinkariova L, Adomavičiūtė E. The Importance Of Perceived Autonomy Support And Previous Behaviour For Autonomous Motivation In Patients With Type 1 Diabetes. *Int J Psychol a Biopsychosoc Approach* 2015;17:57–78. <https://doi.org/10.7220/2345-024X.17.4>.
- [12] Harris SM, Joyce H, Miller A, Connor C, Amiel SA, Mulnier H. The attitude of healthcare professionals plays an important role in the uptake of diabetes self-management education: analysis of the Barriers to Uptake of Type 1 Diabetes Education (BUD1E) study survey. *Diabet Med* 2018;35:1189–96. <https://doi.org/10.1111/dme.13704>.
- [13] Bundesmann R, Kaplowitz SA. Provider communication and patient participation in diabetes self-care. *Patient Educ Couns* 2011;85:143–7. <https://doi.org/10.1016/j.pec.2010.09.025>.
- [14] Haines B. NHS England flash glucose monitoring guidelines for CCGs. *NHS Engl Blog* 2019. <https://www.england.nhs.uk/blog/nhs-england-flash-glucose-monitoring-guidelines-for-ccgs/> (accessed 5 February 2021).
- [15] Bailey T, Bode BW, Christiansen MP, Klaff LJ, Alva S. The Performance and Usability of a Factory-Calibrated Flash Glucose Monitoring System. *Diabetes Technol Ther* 2015;17:787–94. <https://doi.org/10.1089/dia.2014.0378>.
- [16] Overend L, Simpson E, Grimwood T. Qualitative analysis of patient responses to the ABCD FreeStyle Libre audit questionnaire. *Pract Diabetes* 2019;36:45–50. <https://doi.org/10.1002/pdi.2213>.
- [17] Leelarathna L, Wilmot EG. Flash forward: a review of flash glucose monitoring. *Diabet Med*

- 2018;35:472–82. <https://doi.org/10.1111/dme.13584>.
- [18] Al Hayek AA, Robert AA, Al Dawish MA. Evaluation of FreeStyle Libre Flash Glucose Monitoring System on Glycemic Control, Health-Related Quality of Life, and Fear of Hypoglycemia in Patients with Type 1 Diabetes. *Clin Med Insights Endocrinol Diabetes* 2017;10:1–6. <https://doi.org/10.1177/1179551417746957>.
- [19] Bruttomesso D, Laviola L, Avogaro A, Bonora E, Del Prato S, Frontoni S, et al. The use of real time continuous glucose monitoring or flash glucose monitoring in the management of diabetes: A consensus view of Italian diabetes experts using the Delphi method. *Nutr Metab Cardiovasc Dis* 2019;29:421–31. <https://doi.org/10.1016/j.numecd.2019.01.018>.
- [20] Prahalad P, Tanenbaum M, Hood K, Maahs DM. Diabetes technology: improving care, improving patient-reported outcomes and preventing complications in young people with Type 1 diabetes. *Diabet Med* 2018;35:419–29. <https://doi.org/10.1111/dme.13588>.
- [21] Moore L, Britten N, Lydahl D, Naldemirci Ö, Elam M, Wolf A. Barriers and facilitators to the implementation of person-centred care in different healthcare contexts. *Scand J Caring Sci* 2017;31:662–73. <https://doi.org/10.1111/scs.12376>.
- [22] Ahola AJ, Groop P-H. Barriers to self-management of diabetes. *Diabet Med* 2013;30:413–20. <https://doi.org/10.1111/dme.12105>.
- [23] Dadgar M, Joshi KD. The Role of Information and Communication Technology in Self-Management of Chronic Diseases: An Empirical Investigation through Value Sensitive Design. *J Assoc Inf Syst* 2018;19:86–112. <https://doi.org/10.17705/1jais.00485>.
- [24] Barriball KL, While A. Collecting data using a semi-structured interview: a discussion paper. *J Adv Nurs* 1994;19:328–35. <https://doi.org/10.1111/j.1365-2648.1994.tb01088.x>.
- [25] James S, Perry L, Gallagher R, Lowe J. Diabetes Educators: Perceived Experiences, Supports and Barriers to Use of Common Diabetes-Related Technologies. *J Diabetes Sci Technol*

- 2016;10:1115–21. <https://doi.org/10.1177/1932296816660326>.
- [26] Etikan I. Comparison of Convenience Sampling and Purposive Sampling. *Am J Theor Appl Stat* 2016;5:1. <https://doi.org/10.11648/j.ajtas.20160501.11>.
- [27] Hagaman AK, Wutich A. How Many Interviews Are Enough to Identify Metathemes in Multisited and Cross-cultural Research? Another Perspective on Guest, Bunce, and Johnson's (2006) Landmark Study. *Field Methods* 2017;29:23–41. <https://doi.org/10.1177/1525822X16640447>.
- [28] Francis JJ, Johnston M, Robertson C, Glidewell L, Entwistle V, Eccles MP, et al. What is an adequate sample size? Operationalising data saturation for theory-based interview studies. *Psychol Health* 2010;25:1229–45. <https://doi.org/10.1080/08870440903194015>.
- [29] Galinto J, Montie M, Lance P, Titler M. Perspectives of Nurses and Patients on Call Light Technology. *CIN Comput Informatics, Nurs* 2015;33:359–67. <https://doi.org/10.1097/CIN.000000000000177>.
- [30] Zadvinskis IM, Garvey Smith J, Yen P-Y. Nurses' Experience With Health Information Technology: Longitudinal Qualitative Study. *JMIR Med Informatics* 2018;6:e38. <https://doi.org/10.2196/medinform.8734>.
- [31] Doe E. Stress in the 'rabbit warren': understanding the impact of the physical and social environment on nurses in the neonatal intensive care unit (NICU). Pap. Present. Br. Psychol. Soc. Div. Heal. Psychol. Conf. Bright. UK., 2013.
- [32] The British Psychological Society. Code of Human Research Ethics. *Br Psychol Soc* 2014;1:1–44. [http://www.bps.org.uk/sites/default/files/documents/code\\_of\\_human\\_research\\_ethics.pdf](http://www.bps.org.uk/sites/default/files/documents/code_of_human_research_ethics.pdf) (accessed 15 February 2020).
- [33] Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol* 2006;3:77–101.

<https://doi.org/10.1191/1478088706qp063oa>.

- [34] Nowell LS, Norris JM, White DE, Moules NJ. Thematic Analysis: Striving to Meet the Trustworthiness Criteria. *Int J Qual Methods* 2017;16:160940691773384. <https://doi.org/10.1177/1609406917733847>.
- [35] Lincoln YS, Guba EG. *Naturalistic Inquiry*. Newbury Park, CA: Sage Publications; 1985.
- [36] Miles MB, Huberman AM. *Qualitative data analysis: An expanded sourcebook*. 2nd ed. Sage Publications, Inc.; 1994.
- [37] Náfrádi L, Nakamoto K, Schulz PJ. Is patient empowerment the key to promote adherence? A systematic review of the relationship between self-efficacy, health locus of control and medication adherence. *PLoS One* 2017;12:e0186458. <https://doi.org/10.1371/journal.pone.0186458>.
- [38] Allen NA, Litchman ML. Using diabetes technology in older adults. *Diabetes Digit. Heal., Elsevier*; 2020, p. 131–43. <https://doi.org/10.1016/B978-0-12-817485-2.00010-9>.
- [39] Kudva YC, Ahmann AJ, Bergenstal RM, Gavin JR, Kruger DF, Midyett LK, et al. Approach to Using Trend Arrows in the FreeStyle Libre Flash Glucose Monitoring Systems in Adults. *J Endocr Soc* 2018;2:1320–37. <https://doi.org/10.1210/js.2018-00294>.
- [40] Beverly EA, Ganda OP, Ritholz MD, Lee Y, Brooks KM, Lewis-Schroeder NF, et al. Look who's (not) talking: Diabetic patients' willingness to discuss self-care with physicians. *Diabetes Care* 2012;35:1466–72. <https://doi.org/10.2337/dc11-2422>.

**Figure 1.***Thematic Map of Themes and Subthemes*

**Table 1.***Participant Demographics Table*

Pseudonym	Gender	Age (Years)	Job Title	Years Spent		
				In Clinical Practice	In Diabetes Care/Management	Working With FSL-CGM
Amar	Male	40	Diabetes Consultant	17	6	1.5
Belinda	Female	47	SDSN	26	1	1
Casey	Female	40	SDSSW	19	12	2-3
Clara	Female	61	DSN	43	9	3
Darius	Male	47	Diabetes Consultant	15	12	3
Eliza	Female	43	SDSN	20	11	3
Jill	Female	70	Diabetes Consultant	45	40	4
Linda	Female	40	DSN	21	7	4
Lisa	Female	48	DSN	30	2.5	1.5
Mary	Female	58	DSN	40	27	2
Melissa	Female	48	DSN	15	2	2
Natalie	Female	32	DSN	11	8	3
Polly	Female	57	DSN	20	7	2

Samantha	Female	41	DSN	20	7	2.5
Stavros	Male	43	Diabetes Consultant	15	10	5
Tanya	Female	55	DSSW	14	9	3
Yiannis	Male	37	Diabetes Consultant	9	4	1

---

*Note.* SDSN = Senior Diabetes Specialist Nurse

SDSSW = Senior Diabetes Specialist Support Worker

DSN = Diabetes Specialist Nurse

DSSW = Diabetes Specialist Support Worker

**Table 2.**

*Interview Schedule*

---

<b>Interview Schedule</b>
1. Can you tell me a bit about your background in working as a diabetes healthcare professional?
2. How would you describe working with the Libre?
3. How does the Libre work for you as a healthcare professional?
4. How does working with the Libre compare to working with other methods of glucose monitoring?
5. How do you feel the Libre impacts your work as a diabetes healthcare professional?
6. What do you feel the positives of working with the Libre are for you?
7. What do you feel the negatives of working with the Libre are for you?
8. What do you think could be done to improve how the Libre works for you as a healthcare professional?

---