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Cost calculation for a flash glucose monitoring system for UK adults with type 1 diabetes mellitus receiving intensive insulin treatment

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ABSTRACT

Aims: To estimate the costs associated with a flash glucose monitoring system as a replacement for routine self-monitoring of blood glucose (SMBG) in patients with type 1 diabetes mellitus (T1DM) using intensive insulin, from a UK National Health Service (NHS) perspective.
Methods: The base-case cost calculation was created using the maximum frequency of glucose monitoring recommended by the 2015 National Institute for Health and Care Excellence guidelines (4–10 tests per day). Scenario analyses considered SMBG at the frequency observed in the IMPACT clinical trial (5.6 tests per day) and at the frequency of flash monitoring observed in a real-world analysis (16 tests per day). A further scenario included potential costs associated with severe hypoglycaemia.
Results: In the base case, the annual cost per patient using flash monitoring was £234 (19%) lower compared with routine SMBG (10 tests per day). In scenario analyses, the annual cost per patient of flash monitoring compared with 5.6 and 16 SMBG tests per day was £296 higher and £957 lower, respectively. The annual cost of severe hypoglycaemia for flash monitoring users was estimated to be £221 per patient, compared with £428 for routine SMBG users (based on 5.6 tests/day), corresponding to a reduction in costs of £207.
Conclusions: The flash monitoring system has a modest impact on glucose monitoring costs for the UK NHS for patients with T1DM using intensive insulin. For people requiring frequent tests, flash monitoring may be cost saving, especially when taking into account potential reductions in the rate of severe hypoglycaemia.

1. Introduction

1.1. *Unmet needs for people with type 1 diabetes mellitus using intensive insulin*

Disease management for people with type 1 diabetes mellitus (T1DM) using intensive insulin involves a balance between reducing hyperglycaemia and minimizing the risk of hypoglycaemia [1]. Barriers to achieving optimal glycaemic control include the complexity of daily management, which involves frequent glucose monitoring and insulin dose adjustments, and fear of hypoglycaemia [2]. Insulin is an effective and universally accepted treatment for T1DM [3], but it is also the most common cause of hypoglycaemia, which is associated

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with adverse clinical outcomes including increased risk of cardiovascular events and reduced survival [1,4–6]. As patients improve their long-term glucose control, typically through the use of intensive insulin therapy, their risk of hypoglycaemia increases [1]. It has been estimated that people with T1DM managing their diabetes using insulin and routine self-monitoring of blood glucose (SMBG) experience a mean of 3.20 severe hypoglycaemic events per year [4].

1.2. *Economic burden of type 1 diabetes mellitus*

Management of T1DM places a large financial burden on healthcare systems owing to the cost of glucose monitoring, insulin and essential medicines such as agents that lower blood pressure and lipid levels [7]. In 2011, the UK National Health Service (NHS) spent £158 million on SMBG, which accounted for 21% of prescription costs associated with diabetes [8]. T1DM also has a significant financial impact as a result of sustained periods of hyperglycaemia, long-term complications of suboptimal glucose control, and acute hypoglycaemic events associated with insulin use, which can lead to unplanned primary care visits and hospital admissions [9–11]. In 2010–2011, the total annual cost of T1DM was estimated to be £1.9 billion in the UK. This comprised £1.0 billion in direct costs, of which 71% was due to long-term complications, and £0.9 billion in productivity and social costs due to death, sickness, presenteeism and caregiver burden [11]. Hypoglycaemia is costly to treat [11–15]. The cost of a severe hypoglycaemic event treated in hospital in the UK for a person with T1DM was estimated to be £1034 in 2012 [15].

1.3. *Glucose monitoring for people with type 1 diabetes mellitus using intensive insulin*

1.3.1. *Self-monitoring of blood glucose*

Glucose monitoring is an essential process that helps people with T1DM to self-manage their disease and maintain their glucose levels within the recommended range. The current standard of care is SMBG using blood glucose meters, lancets and test strips. The 2015 UK National Institute for Health and Care Excellence (NICE) guideline for the diagnosis and management of T1DM recommends that adults with T1DM test at least four times per day, and up to 10 times per day. Adults with T1DM are advised to test glucose before each meal, before bed, and in certain circumstances including: if the desired target for blood glucose control, measured by glycated haemoglobin (HbA_{1c}) level, is not achieved; if the frequency of hypoglycaemic episodes increases; before, during and after sport; before driving; when planning pregnancy, during pregnancy and while breastfeeding; during periods of illness; if partaking in high-risk activities; and if the patient has impaired awareness of hypoglycaemia [16]. Similarly, the 2017 American Diabetes Association guidelines specify that patients using intensive insulin regimens should test 6–10 times (or more) daily [17]. However, although SMBG is widely used, many patients do not test at the required frequency owing to various factors including the inconvenience and invasiveness of the test procedure, pain and social stigma [18,19]. Inadequate adherence to SMBG testing is associated with poor long-term outcomes [20]. Therefore, increasing glucose monitoring in people with T1DM using intensive insulin in an affordable manner is an important goal.

1.3.2. *Flash glucose monitoring system*

The FreeStyle Libre™ system (Abbott Diabetes Care, Witney, UK) is a minimally invasive sensor-based flash glucose monitoring system, indicated for use in adults and children with diabetes mellitus, which measures glucose levels in a patient's interstitial fluid. Data are wirelessly transferred from a sensor (which is applied to the back of the upper arm and lasts for up to 14 days) to a handheld reader. The flash monitoring system is factory-calibrated and does not require SMBG calibration. People using the flash monitoring system need to use SMBG to check readings in only three circumstances: (1) during times of rapidly changing glucose levels; (2) in order to confirm hypoglycaemia or impending hypoglycaemia; and (3) if their symptoms do not correlate with the flash monitoring system reading.

The clinical benefit of the flash monitoring system for people with T1DM has been demonstrated in the randomized clinical trial IMPACT [21]. The IMPACT trial was designed to reflect real-world clinical practice; there were no protocol-mandated insulin regimen adjustments, and investigators could make treatment decisions as they saw fit. In total, 241 people with T1DM using intensive insulin were enrolled (flash monitoring group, n = 120; SMBG group, n = 121) at 23 sites across Austria, Germany, Spain, Sweden and the Netherlands. At baseline, the mean age in the overall IMPACT trial population was 43.7 years (range: 18–80), and the mean (± standard deviation) total daily dose of insulin for multiple daily injections and continuous subcutaneous insulin infusion users was 46.5 (21.9) and 38.6 (16.5) units, respectively. Glucose control was generally good, with a mean baseline HbA_{1c} level of 6.8% (range: 4.4–8.4%; 51 mmol/mol [25–68 mmol/mol]), and 25.1% of participants had concomitant disease(s) or a previous history of other disease(s) (Table 1). At 6 months, patients using the flash monitoring system had experienced substantial decreases in the mean number (−25.8%) and duration (−38.0%) of hypoglycaemic events (glucose <70 mg/dL [3.9 mmol/L]) compared with routine SMBG users, including significant reductions in the number (–33.2%) and duration (–39.8%) of nocturnal events, with no associated increase in mean HbA_{1c} [21]. These decreases were not considered to be due to reductions in insulin dose, because participants in each group changed their insulin dose by a similar amount over the study period (−2.7 vs −3.0 units per day for participants receiving multiple daily injections of insulin). In addition, compared with SMBG, use of the flash monitoring system was associated with a 19.1% decrease in overall duration of hyperglycaemia (glucose level >240 mg/dL), an additional 1.0 h per day in the target glucose range and reduced all-cause healthcare resource use. Patients using the flash monitoring system were highly satisfied with the system, with a significant improvement in total treatment satisfaction score, compared with SMBG. Furthermore, flash monitoring system users reduced their SMBG use by approximately 90%, from a mean of 5.5 tests per day at baseline to 0.5 in the treatment phase of the trial, while scanning with the flash monitoring system a mean of 15 times per day [21]. A similar

Table 1 – Baseline patient characteristics in the IMPACT trial (full analysis set).

	Flash glucose monitoring system (n = 119)[a]	SMBG (n = 120)[a]
MDI (pen or syringe)/CSII (insulin pump), %	68.1/31.9	65.8/33.3
Mean age, years (SD; range)	42.4 (13.1; 18–71)	45.0 (14.6; 20–80)
Mean HbA_{1c}, % (SD; range)	6.8 (0.5; 4.4–8.0)	6.8 (0.6; 4.8–8.4)
Mean HbA_{1c}, mmol/mol (SD; range)	51 (25–64)	51 (29–68)
Mean duration of diabetes, years (SD; range)	21 (10; 5–47)	23 (13; 5–59)
Mean total daily dose of insulin (SD), MDI/CSII	49.8 (23.8)/41.4 (17.1)	43.1 (19.3)/35.9 (15.6)
Patients with concomitant disease or history of disease,[b] %	23.5	26.7
Mean frequency of SMBG, tests per day (SD; range)	5.4 (2.0; 3–12)	5.6 (2.3; 3–12)

CSII, continuous subcutaneous insulin infusion; HbA_{1c}, glycated haemoglobin; MDI, multiple daily injections; SD, standard deviation; SMBG, self-monitoring of blood glucose.

[a] One patient in each group was excluded from the full analysis set due to pregnancy [21].

[b] Including retinopathy, neuropathy, renal complications, cataract, cardiovascular complications, depression, foot ulcer complications, macular oedema.

high rate of scanning with the flash monitoring system has been revealed by an analysis of data uploaded to a real-world database from over 50,000 readers [22], which showed that users scanned a mean of 16 (median, 14) times per day. The high rate of scanning observed in both the IMPACT trial and the real-world analysis suggests that patients using intensive insulin will test their glucose at the rate recommended by guidelines when they have access to the flash monitoring system.

1.4. *Objectives*

The objective of this cost calculation was to estimate the costs associated with the flash monitoring system as a replacement for routine SMBG in people with T1DM using intensive insulin who need to test their glucose levels frequently. A cost calculation was developed from a NHS perspective using inputs from the current UK treatment guidelines, the IMPACT trial, real-world data from flash monitoring system users, and recent literature.

2. Materials and methods

In this per-patient cost calculation, the base case and scenarios include different frequencies of glucose monitoring to reflect variability in testing frequency in clinical practice. The base-case cost calculation was created using the maximum frequency of glucose monitoring recommended by the 2015 NICE guidelines for the diagnosis and management of T1DM [16]. Three scenarios were considered: scenario 1 used the SMBG frequency observed in the IMPACT trial [21]; scenario 2 included potential costs associated with severe hypoglycaemia; and scenario 3 used the SMBG frequency equivalent to the rate of flash monitoring observed in a real-world analysis [22].

Annual costs of glucose monitoring were assessed for a single patient with T1DM using intensive insulin and either the flash monitoring system or routine SMBG. Costs were calculated from the perspective of the UK NHS in the 2015–2016 financial year, and include the acquisition costs of the flash monitoring system sensors (£35.00 per sensor) and the costs of lancets (£0.04 per lancet) and test strips (£0.29 per test strip) [23]. From 1 November 2017 the UK NHS has listed the flash monitoring system, subject to local health economy approval. SMBG consumable costs were based on the mean weighted prices for the top 10 suppliers in the UK market, according to IMS Health data. For the purpose of this calculation the flash monitoring reader is assumed to be provided at no cost. Sensor duration is defined in the product label as up to 14 days. The calculation has assumed a 14 day duration for each sensor, which is supported by the median sensor duration of 13.6 days observed in the IMPACT trial. In the base case and in all scenarios, flash monitoring system users were assumed to conduct a mean of 0.5 SMBG tests per day, as observed over the 6-month treatment period of the IMPACT trial [21].

2.1. *Base case: routine SMBG according to NICE guideline recommendations*

Despite performing a mean of 5.5 SMBG tests per day at baseline, patients in the IMPACT trial experienced frequent hypoglycaemia, with a mean of 1.30 symptomatic hypoglycaemic events per week and 1.74 biochemical hypoglycaemic events (glucose <70 mg/dL) per day recorded at baseline. The mean duration of hypoglycaemia at baseline was 3 h and 25 min daily [21]. Based on the high frequency and duration of hypoglycaemia observed in the IMPACT trial at baseline, patients with similar characteristics may need to perform SMBG up to 10 times per day, according to the 2015 NICE guidelines [16]. Therefore, in the base case, the cost of SMBG was calculated using a testing frequency of 10 SMBG tests per day.

The preference for a high rate of glucose monitoring by these patients is supported by the high rate of scanning with the flash monitoring system observed in the IMPACT trial and in the real world (means of 15 and 16 scans per day, respectively) [21,22].

2.2. *Scenario 1: routine SMBG at the frequency observed in the IMPACT trial*

In the first scenario, SMBG use was based on the testing frequency observed in the IMPACT trial. Routine SMBG users carried out a mean of 5.6 SMBG tests per day in the final phase of the IMPACT trial [21].

2.3. *Scenario 2: routine SMBG at the frequency observed in the IMPACT trial, including potential costs of severe hypoglycaemia*

In this population with a relatively high risk of severe hypoglycaemia, flash monitoring has the potential to reduce the rate of severe hypoglycaemia. The rate of severe hypoglycaemic events experienced by routine SMBG users in the calculation was 3.20 events per patient per year – as reported for people with T1DM for over 15 years in the UK Hypoglycaemia Study [4]. Flash monitoring system users were assumed to experience a mean of 1.65 severe hypoglycaemic events per year. This 48.5% reduction in the rate of severe hypoglycaemic events with flash monitoring versus routine SMBG was based on a proxy measure, which was the reduction in the rate of episodes with glucose levels below 45 mg/dL observed in the IMPACT trial. The proportion of severe events that require medical assistance (11.8%) was taken from a recent literature review conducted by Foos et al. [24]. Hypoglycaemia costs used in the calculation were based on a UK retrospective cohort study [15], adjusted for inflation using the Office for National Statistics Consumer Price Inflation dataset [25].

2.4. *Scenario 3: routine SMBG at the scanning frequency of flash monitoring in the real world*

There was a consistently high scanning frequency over the 6-month IMPACT trial (15 times per day), and this was reflected in the real world. The real-world database showed that flash monitoring system users scanned a mean of 16 (median, 14) times per day (the anonymized database does not record which participants had T1DM and which had type 2 diabetes mellitus [T2DM]). Scenario 3 considered a rate of 16 tests per day for routine SMBG users, equivalent to the rate of flash monitoring observed in the real world.

3. Results

3.1. *Base case: routine SMBG according to NICE guideline recommendations*

Using the frequency of SMBG recommended by the 2015 NICE guidelines for patients with T1DM who experience a high frequency of hypoglycaemia (maximum of 10 lancets and test strips per day), the annual cost per patient of glucose monitoring for routine SMBG users was estimated to be £1205 (Fig. 1). The annual cost of testing with the flash monitoring system is £910, and when this was combined with SMBG costs of £60 (based on the 0.5 tests per day observed in the IMPACT trial), the annual cost per patient using the flash monitoring system was estimated to be £234 (19%) lower than that for a routine SMBG user (Table 2).

3.2. *Scenario 1: routine SMBG at the frequency observed in the IMPACT trial*

Using the frequency of SMBG observed in the IMPACT trial (5.6 lancets and test strips per day), the annual per-patient cost of glucose monitoring with SMBG was estimated to be £675 (Fig. 1). When considering this SMBG frequency, the additional annual cost of glucose monitoring per patient using flash monitoring compared with a routine SMBG user was estimated to be £296 (44% increase; Table 2). In the IMPACT trial, flash monitoring was associated with a 48.5% reduction in low glucose events (<45 mg/dL) compared with SMBG. Therefore, the additional cost of flash monitoring may be offset by reductions in costs due to severe hypoglycaemia [21].

3.3. *Scenario 2: routine SMBG at the frequency observed in the IMPACT trial, including potential costs of severe hypoglycaemia*

In the UK, severe hypoglycaemic events requiring medical assistance cost the healthcare system a mean of £1134 (2016 costs) [15,25]. Based on the assumptions described in the methods section, the cost of severe hypoglycaemia for flash monitoring users was estimated to be £221 per patient per year, compared with £428 per patient per year for routine SMBG users. This corresponds to a reduction in costs due to severe hypoglycaemia of £207 per patient per year with flash monitoring compared with SMBG (Table 3). Adding the estimated costs of severe hypoglycaemia to those of glucose monitoring (using the calculation in scenario 1) gives a combined annual cost of £1191 and £1103 for flash monitoring users and routine SMBG users, respectively, equating to an 8% increase in costs for flash monitoring users compared with SMBG users, almost offsetting the additional cost of flash monitoring (Fig. 1). However, in addition to reductions in hypoglycaemia compared with SMBG at this frequency, flash monitoring provides significant improvements in glucose control, as observed in the IMPACT trial [21], which may lead to reductions in the cost of diabetes complications.

3.4. *Scenario 3: routine SMBG at the scanning frequency of flash monitoring in the real world*

If a frequency of 16 SMBG tests per day is considered, which is the rate of flash monitoring observed in the real world, the annual cost for routine SMBG users is £1927 per patient (Fig. 1). The annual cost of glucose monitoring for flash monitoring users scanning 16 times per day is £957 (50%) less than that for SMBG users (Table 2).

4. Discussion

Recent NICE guidelines and evidence from real-world studies support frequent glucose testing in order to achieve effective management of both HbA_{1c} levels and the risk of hypoglycaemia associated with intensive insulin use [16,20]. Given the limitations of SMBG and the direct relationship between SMBG testing frequency and cost, the use of alternative systems such as flash monitoring may have clinical and practical benefits without a major impact on overall costs. The benefits of the flash monitoring system compared with SMBG on outcomes in patients with T1DM using intensive insulin have been demonstrated in the IMPACT trial [21]. This calculation assesses the costs associated with different levels of glucose monitoring with the flash monitoring system or SMBG in people with T1DM using intensive insulin.

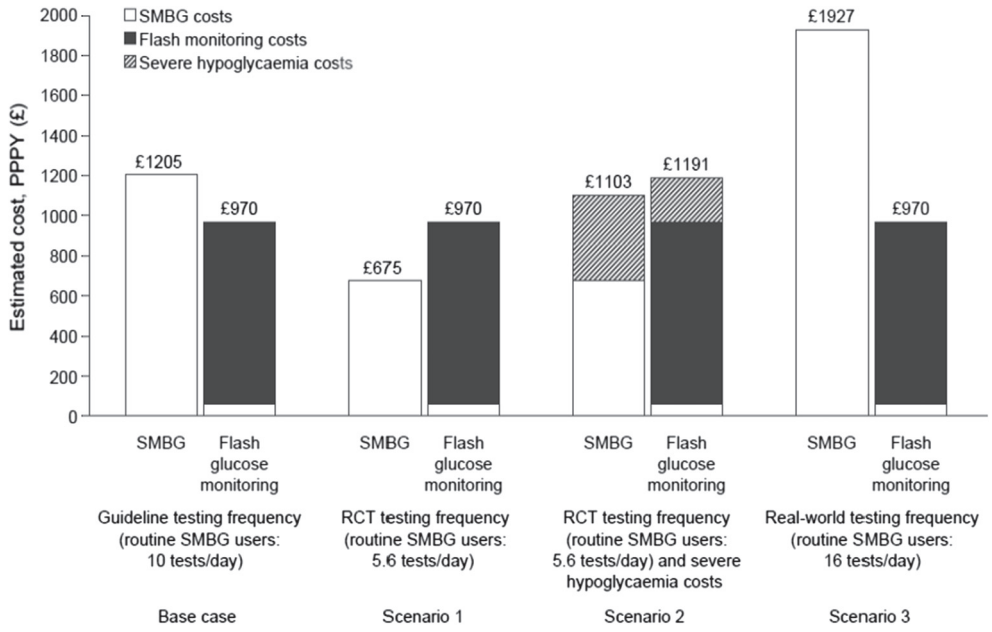

Fig. 1 – Costs of glucose monitoring and severe hypoglycaemia using the flash monitoring system compared with SMBG. PPPY, per patient per year; RCT, randomized controlled trial; SMBG, self-monitoring of blood glucose.

Based on UK NHS costs and a sensor price of £35.00, the flash monitoring system has an equivalent acquisition cost to approximately eight SMBG tests per day; at a frequency of 10 tests per day the cost saving associated with use of flash monitoring is £234 per patient per year. Consequently, compared with SMBG, flash monitoring may be a less costly way to achieve greater adherence to NICE recommended monitoring frequencies for patients with T1DM using intensive insulin who need to test their glucose levels frequently. Additionally, NICE have found SMBG at a frequency of 10 tests per day to be a more cost-effective strategy than 2, 4, 6 or 8 tests per day for patients with T1DM [26], and recommend 10 tests per day for those patients who need to test frequently due to physical activity, driving or a high rate of hypoglycaemia [16].

Since there is no incremental cost associated with additional testing using the flash monitoring system, the cost calculation is less favourable to flash monitoring at lower frequencies of glucose testing. In scenario 1, flash monitoring was more costly than routine SMBG at the frequency observed in the IMPACT trial (5.6 tests per day). However, this lower level of utilization of SMBG was associated with increased hypoglycaemia when compared with flash monitoring; in the IMPACT trial there was a 48.5% reduction in low glucose

Table 2 – Estimated annual glucose monitoring costs using the flash glucose monitoring system and using SMBG.

	Base case (routine SMBG users: 10 tests per day)[a]	Scenarios 1 and 2 (routine SMBG users: 5.6 tests per day)	Scenario 3 (routine SMBG users: 16 tests per day)
Flash monitoring (£)			
Cost per reader	0	0	0
Cost per sensor	35.00	35.00	35.00
Cost of reader and sensor, PPPY[b]	910.00	910.00	910.00
SMBG (£)			
Cost per lancet [23]	0.04	0.04	0.04
Cost per test strip [23]	0.29	0.29	0.29
Cost of lancet and test strip	0.33	0.33	0.33
For flash monitoring system users, PPPY	60.23[c]	60.23[c]	60.23[c]
For routine SMBG users, PPPY	1204.50	674.52	1927.20
Cost of flash monitoring, PPPY (£)	**970.23**	**970.23**	**970.23**
Additional cost of flash monitoring vs SMBG, PPPY (£)	**−234.28**	**295.71**	**−956.98**

PPPY, per patient per year; SMBG, self-monitoring of blood glucose.
[a] Assumption: use of 10 SMBG tests per day according to the maximum frequency recommended by the 2015 NICE guidelines.
[b] Assumption: use of 26 sensors per year (sensor life is up to 14 days).
[c] Assumption (in all scenarios): flash monitoring system users use 0.5 SMBG tests per day, as observed in the IMPACT trial.

Table 3 – Estimated costs of severe hypoglycaemic events calculated from data observed in the IMPACT trial.

Severe hypoglycaemia	
SMBG	
Estimated rate, PPPY [4]	3.20
% events requiring medical assistance [24]	11.8
Estimated number requiring medical assistance, PPPY	0.3776
Cost per event requiring medical assistance (£) [15,25]	1133.78
Estimated medical cost, PPPY (£)	428.12
Flash monitoring	
Proxy for % reduction in rate of severe events vs SMBG[a]	48.5
Estimated rate, PPPY	1.65
% events requiring medical assistance [24]	11.8
Estimated number requiring medical assistance, PPPY	0.1947
Cost per event requiring medical assistance (£) [15,25]	1133.78
Estimated medical cost, PPPY (£)	220.75
Reduction in cost (flash monitoring vs SMBG), PPPY (£)	**207.37**

PPPY, per patient per year; SMBG, self-monitoring of blood glucose.
[a] Assumption: reduction in rate of episodes <45 mg/dL, based on the IMPACT trial.

Table 4 – All-cause resource utilization per patient over 6 months in the IMPACT trial.

Resource use per patient over 6 months	Flash monitoring (n = 119), number of events (mean rate)	SMBG (n = 120), number of events (mean rate)
Emergency department visits	2 (0.017)	3 (0.025)
Ambulance callouts	2 (0.017)	5 (0.042)
Hospital admissions	2 (0.017)	3 (0.025)
Days in hospital	4 (0.034)	11 (0.092)

SMBG, self-monitoring of blood glucose.
Data are secondary evidence from the IMPACT trial [21].

events (<45 mg/dL) observed in the flash monitoring system group compared with the SMBG group [21].

Reductions in the rate of severe hypoglycaemia were incorporated into the calculation in scenario 2. Because the IMPACT trial was not designed to assess differences in severe hypoglycaemia rates, two proxy measures were used. First, for the SMBG group, the rate of severe hypoglycaemic events was based on the results of the UK Hypoglycaemia Study, which assessed the rate of hypoglycaemia for people with T1DM for over 15 years treated at six secondary care diabetes centres [4]. Second, the reduction in the rate of severe hypoglycaemia in the flash monitoring system group compared with the SMBG group was based on the reduction in the rate of events with glucose levels below 45 mg/dL observed in the IMPACT trial. This approach is consistent with the HypoDE real-time continuous glucose monitoring study, in which glucose levels below 55 mg/dL are used as a marker for severe hypoglycaemic events [27]. Flash monitoring was close to cost neutral in this scenario.

Scenario 3 found substantial reductions in costs with flash monitoring for patients testing at a rate of 16 tests per day. Although this rate is higher than recommended by NICE guidelines, people with T1DM in the IMPACT trial and in the real world typically tested their glucose at a high rate when they had access to the flash monitoring system (means of 15 and 16 scans per day, respectively) [21,22]. Flash monitoring is particularly cost saving for patients who need to conduct frequent tests in order to manage their high risk of hypoglycaemia. This may include patients with T1DM who experience high rates of nocturnal hypoglycaemia [28]. Although in this scenario the cost of 16 SMBG tests per day has been calculated, the clinical benefits associated with 16 scans per day in the IMPACT trial may not be realistically achievable with SMBG even for motivated patients; for example, a recent Swedish study found that only around 5% of patients with T1DM tested 10 times per day [29].

The results of the IMPACT trial showed that in addition to reductions in hypoglycaemia, patients using the flash monitoring system had significant improvements in glucose control, compared with SMBG users [21]. Poor glucose control is associated with an increased risk of microvascular complications, while frequent hypoglycaemia is associated with cardiovascular disease [30]. Treating complications in T1DM imposes a substantial burden on healthcare systems: for example managing complications in people with T1DM accounted for approximately 72% of the total direct costs of T1DM to the UK healthcare system in 2010–2011 [11]. In the longer term, therefore, the clinical benefits provided by flash monitoring may lead to reductions in the incidence of cardiovascular events and other complications, reducing associated costs [30].

The possibility that use of the flash monitoring system could lead to reductions in healthcare costs is supported by secondary evidence from the IMPACT trial, which showed a

numerical reduction in utilization of healthcare resources (emergency department visits, ambulance callouts and hospital admissions) compared with the SMBG group, on an all-cause basis (Table 4) [21]. However, because the number of events in each group was small, the IMPACT resource utilization data were not included in the cost calculation.

In addition to the frequency of testing, the cost to the payer of SMBG is affected by the acquisition cost of test strips, which can vary. In this calculation, test strip costs are based on weighted average UK prices based on real-world prescription data, hence they are considered representative. However, the exact cost difference between flash monitoring and SMBG will depend on the specific test strips used, and on local commercial agreements. Based on data from IMS Health, the lower quartile price per test strip paid by UK Clinical Commissioning Groups in September 2017 was 23.9 pence. At this test strip price, the annual per-patient cost saving with flash monitoring in the base-case analysis would be £57 (6%); however this price is not as representative as the one used in the base case and scenarios in this calculation.

Test strip prices vary from country to country. In cases where test strip prices are higher than in the UK, the flash monitoring system may be budget neutral at a lower glucose test frequency than estimated in these calculations. Flash monitoring has widespread reimbursement in European countries, Canada and Japan for patients with diabetes using intensive insulin. This includes national reimbursement in Austria, Belgium, France, Switzerland and Japan, as well as regional reimbursement in Germany, Italy and Finland.

Healthcare spending on T1DM is expected to rise owing to the increasing prevalence of the disease [9]. In the UK, costs of managing T1DM are projected to double from £1.9 billion in 2010–2011 to £4.2 billion in 2035 [11]. Given this high cost, the flash monitoring system provides an opportunity to reduce the cost of managing intensive insulin users, while increasing patient satisfaction [21]. In addition, any intervention for T1DM that can reduce patients' risk of hypoglycaemia without compromising their HbA_{1c} levels may reduce the number of hospital admissions and hospital bed-days due to hypoglycaemia, which present a substantial burden to the UK NHS given current hospital capacity constraints [31].

In conclusion, based on UK NHS costs, the flash glucose monitoring system is affordable compared with SMBG in patients with T1DM using intensive insulin who need to monitor their glucose levels frequently. In this population, flash monitoring is associated with changes in behaviour leading to improved adherence to NICE guidelines for glucose monitoring frequency. Reduction in hypoglycaemia rates by use of the flash glucose monitoring system may contribute to cost effectiveness.

Conflicts of interest

RH is a full-time employee of Abbott Diabetes Care and is a stock holder.

RW serves as a consultant and has received lecture fees from Abbott Diabetes Care.

DB has been paid to act as an independent health economic consultant on behalf of Abbott Diabetes Care.

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Author contributions

All authors reviewed each draft of the manuscript, and approved the final version of the manuscript.

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