Research Article

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Journal of **Comparative Effectiveness Research**

Cost-utility of real-time continuous glucose monitoring versus self-monitoring of blood glucose in people with insulin-treated Type 2 diabetes in Canada

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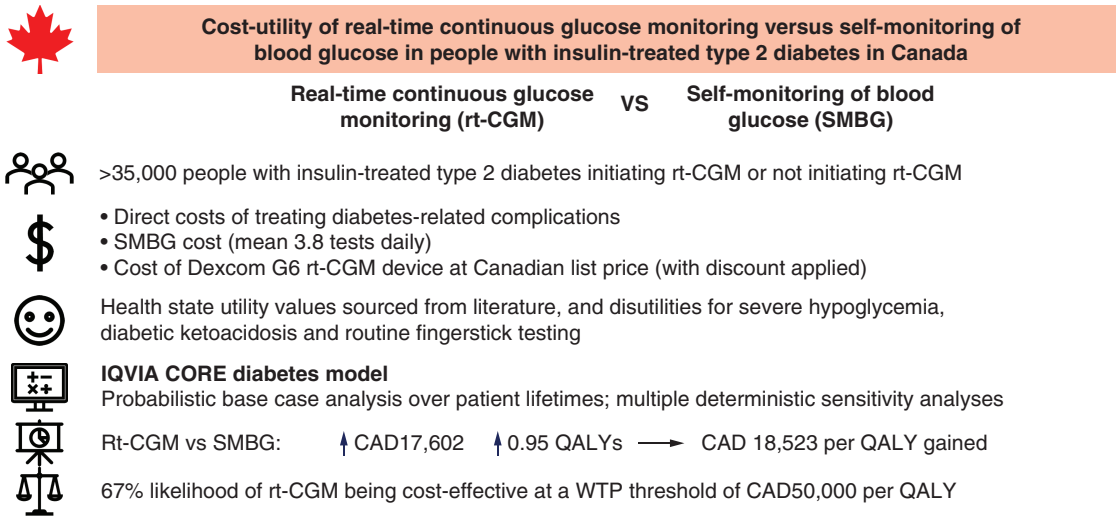
Aim: Clinical trials and real-world data for Type 2 diabetes have shown that real-time continuous glucose monitoring (rt-CGM) lowers glycated hemoglobin (A1c) and reduces hypoglycemia relative to self-monitoring of blood glucose (SMBG). This analysis examined the long-term health and economic outcomes associated with using rt-CGM versus SMBG in people with insulin-treated Type 2 diabetes in Canada. **Materials & methods:** Clinical data were sourced from a real-world study, in which rt-CGM reduced A1C by 0.56% versus continued SMBG. The analysis was performed using the IQVIA Core Diabetes Model, from a Canadian payer perspective over a lifetime horizon for a cohort aged 65 years with an A1C of 8.3% at baseline. Future costs and clinical outcomes were discounted at 1.5% annually. **Results:** Projected total mean lifetime costs were CAD 207,466 for rt-CGM versus CAD 189,863 for SMBG (difference: CAD 17,602) and projected mean quality-adjusted life expectancy was 9.97 quality-adjusted life years (QALYs) for rt-CGM versus 9.02 QALYs for SMBG (difference: 0.95 QALYs), resulting in an incremental cost-utility ratio (ICUR) of CAD 18,523 per QALY gained for rt-CGM versus SMBG. Findings were sensitive to changes in the A1C treatment effect, annual cost and quality of life benefit associated with using rt-CGM, SMBG frequency, and baseline age, but ICURs remained below CAD 50,000 per QALY in all analyses. **Conclusion:** For people in Canada with insulin-treated Type 2 diabetes and poor glycemic control, use of rt-CGM is likely to be cost-effective relative to SMBG.

Plain language summary: Value for money of using real-time continuous glucose monitoring compared with using self-monitoring of blood glucose in patients who have Type 2 diabetes and received insulin in Canada

- **What is this article about?** People with Type 2 diabetes have limited access to real-time continuous glucose monitoring (rt-CGM) in many parts of Canada. We investigated the long-term health and economic outcomes of rt-CGM relative to self-monitoring of blood glucose (SMBG) in people with insulin-treated Type 2 diabetes in Canada.
- **What were the results?** Using rt-CGM over SMBG is likely cost-effective in people with insulin-treated Type 2 diabetes, with an estimated incremental cost-utility ratio of Canadian $18,523 per quality-adjusted life-year gained with rt-CGM versus SMBG.
- **What do the results mean?** Our findings imply that wider use of rt-CGM in Canada could be considered when managing insulin-treated Type 2 diabetes.

Tweetable abstract: A cost-utility analysis for Canada shows that real-time continuous glucose monitoring for people who live with #type2diabetes and receive insulin is likely cost-effective relative to self-monitoring of blood glucose. #healtheconomics

Graphical abstract:



QALY: Quality-adjusted life year; WTP: Willingness-to-pay.

First draft submitted: 12 May 2023; Accepted for publication: 17 July 2023; Published online: 5 September 2023

Keywords: Canada • cost-utility analysis • rt-CGM • SMBG • Type 2 diabetes

In Canada, the number of people living with diabetes has increased substantially in the past two decades, such that the prevalence of diabetes (including both type 1 and Type 2 diabetes) among Canadians is now estimated at 10% [1,2]. Moreover, it is estimated that each day at least 480 people in Canada are newly diagnosed with diabetes and at least 20 people die due to diabetes-related complications [1].

This increase in the number of people with diabetes has led to an increase in the overall economic burden of the disease. In 2008, the total annual cost associated with the treatment of diabetes was estimated at Canadian dollar (CAD) 14 billion; however, by 2019, this figure had more than doubled to a staggering CAD 30 billion [3]. The management of long-term diabetes-related complications represents a key component of overall costs. For example, in 2013, the cost of hospitalization for a myocardial infarction exceeded CAD 11,500 [4] and the annual treatment cost for a diabetic foot ulcer has been estimated at over CAD 21,000 per case (2011 CAD) [5]. Consequently, new treatments or technologies that can improve the management of people with Type 2 diabetes and reduce the risk of long-term complications are of great interest not only to patients and their treating physicians, but also to healthcare payers.

In particular, the use of real-time continuous glucose monitoring (rt-CGM) has been shown to improve glycemic control in people with Type 2 diabetes both in randomized controlled trials (RCTs) and in real-world analyses. For example, in both the DIAMOND Type 2 diabetes study and the MOBILE study (conducted in people on basal insulin only) the use of rt-CGM was associated with improvements in both glycated hemoglobin (A1C) and time in range compared with usual care [6,7]. Similarly, a recent large-scale real-world analysis in people with insulin-treated diabetes in the USA examined outcomes in people initiating rt-CGM (primarily in patients using basal-bolus insulin) relative to those continuing to use self-monitoring of blood glucose (SMBG) and the findings here corroborated those reported in RCTs [8]. In people with Type 2 diabetes, initiation of rt-CGM was associated with a 0.56% reduction in A1C (from 8.20% to 7.64%), while those continuing on SMBG had an A1C reduction of 0.09% over the study period (from 8.27% to 8.18%). The use of rt-CGM was also associated with a reduction in the rate of hypoglycemia, as well as hospitalizations and emergency department visits due to severe hypoglycemia relative to SMBG [8]. These clinical benefits of rt-CGM were found in a recent cost-utility analysis for the United Kingdom to translate into improved lifetime clinical outcomes for patients with insulin-treated Type 2 diabetes, with rt-CGM likely cost-effective versus SMBG [9].

Table 1. Baseline characteristics of the simulated patient cohort.

Characteristic	Baseline value
Mean (SD) age, years	64.5 (12.2)
Mean (SD) duration of diabetes, years	15.8 (8.8)
Proportion male, %	50.5
Mean A1C, mmol/mol	67
Mean (SD) A1C, %	8.27 (1.59)

A1C: Glycated hemoglobin; SD: Standard deviation.
Sourced from Karter *et al.* [8].

Canadian national guidelines recommend the use of rt-CGM in adults with Type 2 diabetes, who are using basal-bolus insulin regimens, failing to achieve A1C targets, willing to use CGM on an almost daily basis, and where the treatment goals are to reduce A1C and the duration of hypoglycemia [10]. It should be noted that these guidelines only considered evidence published up to 28 October 2020, which pre-dated the publication of the MOBILE RCT, demonstrating the benefits of rt-CGM in people with Type 2 diabetes on basal insulin only [6]. Similarly, a 2021 policy statement issued by Diabetes Canada recommended that rt-CGM should be reimbursed by payers in this patient group [11]; however, despite these recommendations, in many provinces, access to rt-CGM is limited and in some instances largely restricted to people with Type 1 diabetes [12]. As of January 2023, British Columbia and Prince Edward Island were the only two government programs to provide coverage for children and adults living with either type 1 or Type 2 diabetes on intensive insulin, with Manitoba expanding access to eligible people of all ages with type 1 or Type 2 diabetes in March 2023 [13,14].

In light of these recommendations, the aim of the current analysis was to examine the long-term health and economic outcomes associated with the use of rt-CGM compared with SMBG in people with insulin-treated Type 2 diabetes living in Canada based on clinical input data from a real-world study conducted in the USA and utilizing Canadian cost data.

Materials & methods

Model structure

The analysis was performed using the IQVIA CORE Diabetes Model (CDM; version 9.0 E360). The CDM is a non-product-specific computer simulation model capable of modeling long-term clinical and economic outcomes in people with type 1 or Type 2 diabetes. Details of the model structure and validation have been previously published [15]. Briefly, the CDM contains a total of seventeen interdependent Markov models covering microvascular (retinopathy, nephropathy, and diabetic foot) and macrovascular (stroke, cardiovascular disease) complications as well as morbidity and mortality outcomes. In the current analysis, outcomes of interest included total lifetime direct costs, quality-adjusted life expectancy, projected incidence of complications, and the incremental cost-utility ratio (ICUR).

Baseline cohort characteristics & treatment effects

The baseline characteristics for the simulated patient cohort were sourced primarily from a US-based retrospective real-world cohort study in predominantly basal-bolus insulin-treated diabetes, which included a group of over 35,000 people with Type 2 diabetes [8]. Where data gaps existed, input data were sourced from other studies [16–23]. At baseline, the mean (standard deviation [SD]) A1C was 8.3 (1.6), the mean age was 64.5 (12.2) years, and the mean duration of diabetes was 15.8 (8.8) years (Table 1).

Treatment effects and adverse event rates were obtained from Karter *et al.* [8]. An A1C treatment effect of -0.56% in favor of rt-CGM was assumed based on the adjusted mean difference between rt-CGM and SMBG. The projected incidence rates of severe hypoglycemic events (SHEs; defined here as an event requiring emergency room [ER] visits or hospitalization) were based on the mean adjusted difference in the percentage of patients with at least one hypoglycemic event during the 1-year follow-up and calculated 0 per 100 person-years for the rt-CGM arm and 4 per 100 person-years for the SMBG arm [8]. Hyperglycemic events were also included; all events were assumed to be diabetic ketoacidosis (DKA), based on US data that suggested that nearly 75% of people with Type 2 diabetes who had a hyperglycemic crisis experienced DKA only while another 23% experienced DKA with hyperglycemic hyperosmolar state (HHS) [24]. The rates of DKA events requiring hospitalization were derived from Karter *et al.* as

Table 2. Direct costs of diabetes-related complications.

Description of event or state	Complication cost, 2021 CAD	Ref.
Myocardial Infarction, year of event	21,172	[25]
Myocardial Infarction, subsequent years	3311	[25]
Angina, year of event	4565	[26]
Angina, subsequent years	2130	[26]
Congestive heart failure, year of onset	20,280	[25]
Congestive heart failure, subsequent years	5686	[25]
Stroke, year of event	28,838	[25]
Stroke, subsequent years	4001	[25]
Stroke death within 30 days	11,104	[25]
Peripheral vascular disease, annual	6869	[25]
Hemodialysis, annual	87,468	[26]
Peritoneal dialysis, annual	61,952	[26]
Renal transplant, year of event	111,407	[26]
Renal transplant, subsequent years	111,407	[26]
Laser eye treatment	710	[26]
Severe vision loss/blindness, year of onset	3542	[26]
Severe vision loss/blindness, subsequent years	2525	[26]
Cataract extraction	5315	[28]
Cataract treatment, subsequent years	2963	[26]
Neuropathy, each year	212	[26]
Standard uninfected ulcer	1495	[26]
Infected foot ulcer	3131	[26]
Gangrene treatment	11,190	[26]
Amputation, year of event	11,030	[28]
Amputation, prosthesis	6156	[26]
Severe hypoglycemic event requiring medical assistance	2262	[25]
Severe hyperglycemic event (diabetic ketoacidosis)	12,160	[26]
Annual cost aspirin	60.55	[26]
Annual cost statins (20 mg)	383	[29]
Annual costs ACE inhibitor (ramipril 5 mg)	86.62	[29]
Annual costs stopping ACEs due to adverse events	84.55	[27]
Costs of screening for retinopathy	90.13	[27]
Costs of screening for microalbuminuria	33.86	[26]
Costs of screening for gross proteinuria	33.86	[26]
Costs of foot screening program	84.55	[27]

0 per 100 person-years for rt-CGM and 2.5 per 100 person-years for SMBG, based on the mean adjusted difference in the percentage of patients with at least one hyperglycemic event during the 1-year follow-up [8].

Costs

Direct costs for the treatment of diabetes-related complications were sourced from previously published studies (Table 2) [25–29]. The rt-CGM device used for the analysis was the Dexcom G6 rt-CGM device. Its current Canadian list price with discount applied was CAD 3588 per year and included a total of 36 sensors and 4 transmitters (Table 3). In the SMBG arm, patients were assumed to perform a mean of 3.8 tests per day, based on the findings of the DIAMOND Type 2 diabetes study [7]. The cost of SMBG tests was sourced from a report by Diabetes Canada [30]. Where necessary, costs were inflated to 2021 CAD, using the Canadian consumer price index for health and personal.

Table 3. Annual treatment and device costs.

	Unit cost, CAD	Units	Net cost, CAD
rt-CGM annual cost[†] Total discounted annual cost/patient for rt-CGM (includes 36 sensors and 4 transmitters) in Canada	3588	1	3588
SMBG annual cost Single-use blood glucose test strip. Testing frequency assumed to be 3.8-times per day[‡]	0.79 per test[§]	1387	1095.73

[†]Cost provided by the manufacturer.
[‡]As reported in the DIAMOND Type 2 diabetes study [7].
[§]As reported by Diabetes Canada [28].
rt-CGM: Real-time continuous glucose monitoring; SMBG: Self-monitoring of blood glucose.

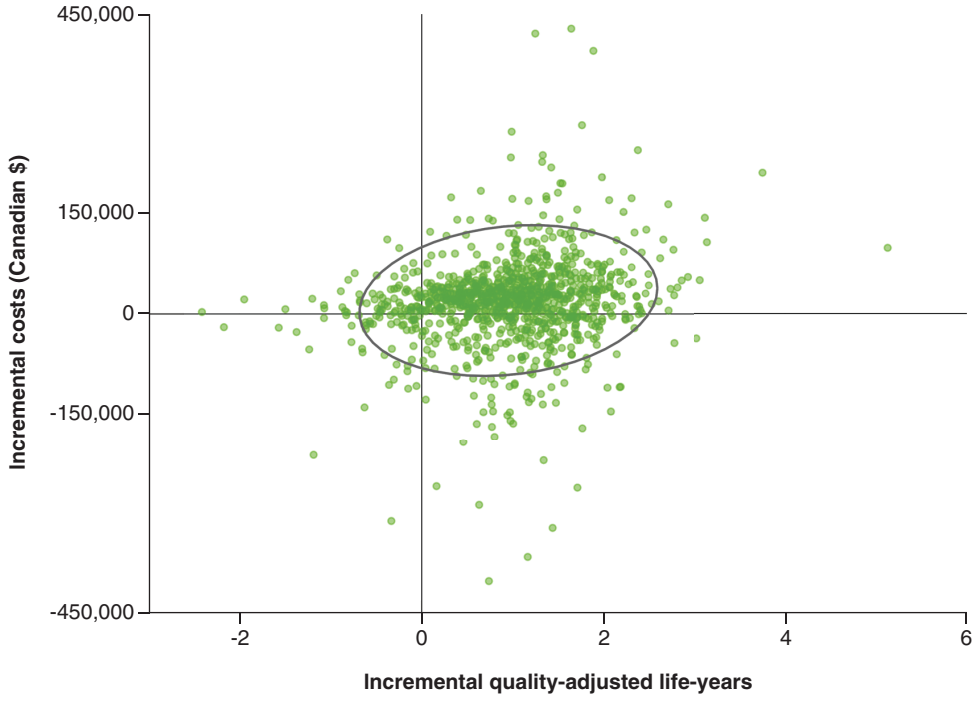


Figure 1. Cost-effectiveness scatterplot showing incremental costs and quality-adjusted life expectancy from the probabilistic sensitivity analysis of real-time continuous glucose monitoring versus self-monitoring of blood glucose.

Utilities

Disutilities for long-term complications were sourced from a review by Beaudet *et al.* [31]. Based on this review, the baseline utility value for people with no complications was assumed to be 0.82. Disutilities associated with SHEs were sourced from a multinational study [32]. A recent cost-effectiveness analysis utilized a disutility of -0.0367 for a DKA event for people with Type 1 diabetes [33]. However, no disutility data for people with Type 2 diabetes were identified; therefore, the disutility associated with DKA for people with Type 2 diabetes was conservatively assumed to be -0.01. An additional utility benefit of 0.03 was applied only to the rt-CGM arm, owing to the avoidance of routine fingerstick testing [34].

Time horizon, perspective & discounting

The analysis was performed over a lifetime time horizon from the payer perspective; as such, only direct costs were included in the analysis. An annual discount rate of 1.5% was applied to future costs and clinical outcomes.

Sensitivity analyses

The base case analysis was performed as a probabilistic sensitivity analysis (Figure 1) and a range of one-way sensitivity analyses was performed to determine key drivers of outcomes. Specifically, sensitivity analyses were

Table 4. Summary of base case findings.

	rt-CGM	SMBG	Difference
Total mean lifetime costs, CAD	207,466	189,863	17,602
Treatment costs, CAD	51,305	15,323	35,983
Management costs, CAD	5931	5790	141
Cardiovascular complication costs, CAD	35,088	35,224	-136
Renal complication costs, CAD	94,137	110,352	-16,215
Ulcer/amputation/neuropathy complication costs, CAD	7123	7372	-249
Ophthalmic complication costs, CAD	13,882	14,228	-347
Severe hypoglycemia costs, CAD	0	1272	-1272
Diabetic ketoacidosis costs, CAD	0	303	-303
Mean quality-adjusted life expectancy, QALYs	9.971	9.021	0.950
ICUR, CAD per QALY gained	18,523		
Probability of rt-CGM being cost-effective vs SMBG at a WTP threshold of CAD 50,000 per QALY gained (%)	67.1		

CAD: Canadian Dollar; ICUR: Incremental cost-utility ratio; QALY: Quality-adjusted life year; rt-CGM: Real-time continuous glucose monitoring; SMBG: Self-monitoring of blood glucose; WTP: Willingness-to-pay.

performed around the utility benefit associated with reduced fingerstick testing, and a further analysis was conducted in which it was assumed that rt-CGM was associated with an additional QoL benefit associated with a reduction in fear of hypoglycemia (FoH), as seen in studies conducted in people with Type 1 diabetes [35]. The influence of the A1C treatment effect was also examined in sensitivity analyses in which the base case treatment effect (-0.56% in favor of rt-CGM) was either increased or decreased by 50%. The disutility associated with a DKA event was conservatively assumed to be -0.01; a sensitivity analysis was performed using a disutility of -0.0367 based on the findings of Zhao *et al.* [33]. Sensitivity analyses were also performed around the number of SMBG tests performed per day [36], time horizon, mean age of the simulated patient cohort, discount rate, costs of treating diabetes-related complications, cost of rt-CGM, and incidence of SHEs in the rt-CGM arm.

Results

Base case analysis

In the base case analysis, total lifetime costs were CAD 207,466 for the rt-CGM arm and CAD 189,863 for the SMBG arm. The mean remaining quality-adjusted life expectancy was estimated at 9.97 quality-adjusted life years (QALYs) in the rt-CGM arm compared with 9.02 QALYs in the SMBG arm, resulting in an incremental gain in quality-adjusted life expectancy of 0.95 QALYs for the rt-CGM arm (Table 4).

Although total lifetime treatment costs were higher with rt-CGM (CAD 51,305 vs CAD 15,323), total mean lifetime complication costs were lower with rt-CGM, in particular due to reduced costs for treating renal complications and for treatment of severe hypoglycemia. The combination of higher lifetime costs but increased quality-adjusted life expectancy resulted in an ICUR of CAD 18,523 per QALY gained for rt-CGM versus SMBG. At a willingness-to-pay threshold of CAD 50,000 per QALY gained, the likelihood of rt-CGM being considered cost-effective relative to SMBG was 67% (Figure 2).

Sensitivity analyses

Sensitivity analyses revealed that the results were particularly sensitive to changes in assumptions around the QoL benefit associated with the use of rt-CGM, the A1C treatment effect, frequency of SMBG in the comparator arm, the mean baseline age of the simulated patient cohort and the annual cost of rt-CGM, although in all the sensitivity analysis performed here the ICUR remained below the commonly cited willingness-to-pay threshold of CAD 50,000 per QALY gained (Table 5) [37].

The utility benefit associated with the use of rt-CGM was a key determinant of the gain in quality-adjusted life expectancy. If this benefit was removed completely, the incremental gain in quality-adjusted life expectancy with rt-CGM was reduced to 0.52 QALYs (compared with 0.95 QALYs in the base case) resulting in an ICUR of CAD 33,761 per QALY gained. If an additional QoL benefit in terms of reduced FoH, as seen in rt-CGM studies conducted in Type 1 diabetes [32,35,38,39] was also included, the incremental gain in quality-adjusted life expectancy

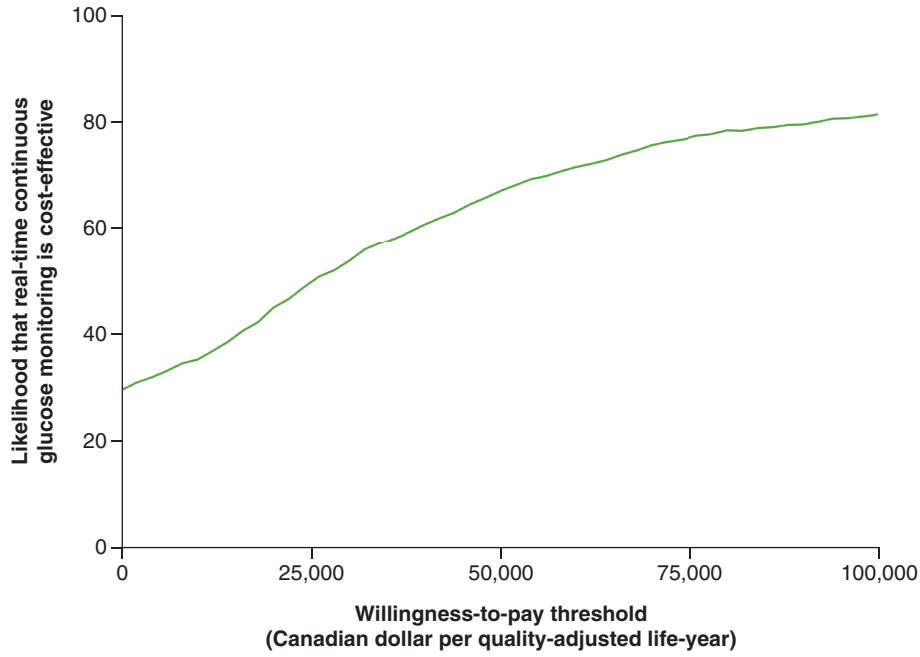


Figure 2. Cost-effectiveness acceptability curve showing the likelihood of real-time continuous glucose monitoring being cost-effective versus self-monitoring of blood glucose over a range of willingness-to-pay thresholds.

with rt-CGM increased to 1.31 QALYs, which in turn resulted in the ICUR decreasing to CAD 13,407 per QALY gained.

In terms of treatment effect, in the base case analysis, the use of rt-CGM was assumed to reduce A1C by -0.56% relative to the use of SMBG. However, if this benefit was reduced by 50% to -0.28%, the ICUR increased substantially to CAD 30,631 per QALY gained. The ICUR was also sensitive to the frequency of daily SMBG in the comparator arm. At a frequency of one SMBG test per day, the ICUR was CAD 30,404 per QALY gained; however, at a frequency of 10 tests per day the increase in total lifetime costs in the SMBG arm was such that rt-CGM was dominant to SMBG. The mean age at baseline of the simulated patient cohort also had a large influence on the results, with rt-CGM being dominant to SMBG if the mean baseline age was either 30 or 40 years. As anticipated, the annual cost of rt-CGM use also had a notable impact on total lifetime costs, with a 50% reduction in the device resulting in cost-savings over a lifetime time horizon, but an increase of 25% resulting in incremental lifetime costs of CAD 30,429, which in turn resulted in an ICUR of CAD 32,021 per QALY gained for rt-CGM versus SMBG.

Discussion

Current estimates suggest that there are approximately 5.7 million people in Canada diagnosed with diabetes, of whom approximately 90% have Type 2 diabetes [1,3]. Of those with Type 2 diabetes, it is estimated that over 60% (i.e., over 3 million people) are treated with either insulin alone or in combination with other treatments [40]. The findings of the current analysis indicate that for this patient group meeting the criteria for using rt-CGM, the use of rt-CGM is likely cost-effective relative to SMBG, based on a commonly cited willingness-to-pay threshold of CAD 50,000 per QALY gained [37]. Indeed, in the base case analysis, switching from SMBG to rt-CGM was associated with an incremental gain in quality-adjusted life expectancy of 0.95 QALYs and an ICUR of below CAD 20,000 per QALY gained.

Sensitivity analyses revealed that the results were sensitive to changes in assumptions around a number of key input parameters including the frequency of SMBG in the comparator arm, A1C treatment effect, baseline age, and the cost of the rt-CGM device. With regard to the frequency of SMBG, sensitivity analyses showed that in this simulated patient cohort, rt-CGM became progressively more cost-effective as the frequency of SMBG was increased and was cost-saving in patients testing more than ten-times per day. In the base case, a mean SMBG frequency of 3.8 tests per day was assumed, based on the findings of the DIAMOND Type 2 diabetes study [7]. Data from the 2011 Survey on Living with Chronic Diseases have suggested that the frequency of SMBG in

Table 5. Summary findings of sensitivity analyses rt-CGM versus SMBG.

Analysis	Total costs, CAD			Quality-adjusted life expectancy, QALYs			ICUR, CAD per QALY gained
	rt-CGM	SMBG	Difference	rt-CGM	SMBG	Difference	
Base case	207,466	189,863	17,603	9.97	9.02	0.95	18,523
No QoL benefit with rt-CGM	207,466	189,683	17,603	9.54	9.02	0.52	33,761
QoL benefit with rt-CGM -50%	207,466	189,683	17,603	9.76	9.02	0.74	23,923
QoL benefit with rt-CGM +50%	207,466	189,683	17,603	10.19	9.02	1.17	15,112
Added QoL benefit for reduced FoH with rt-CGM	207,466	189,683	17,603	10.33	9.02	1.31	13,407
A1C treatment effect -50%	214,904	189,863	25,041	9.84	9.02	0.82	30,631
A1C treatment effect +50%	199,612	189,863	9749	10.11	9.02	1.09	8978
Number of SMBG per day = 1	207,446	178,573	28,893	9.97	9.02	0.95	30,404
Number of SMBG per day = 2	207,466	182,605	24,861	9.97	9.02	0.95	26,161
Number of SMBG per day = 4	207,466	190,670	16,796	9.97	9.02	0.95	17,675
Number of SMBG per day = 5	207,466	194,702	12,764	9.97	9.02	0.95	13,432
Number of SMBG per day = 10	207,466	214,863	-7397	9.97	9.02	0.95	Dominant
Time horizon = 10 years	82,086	68,150	13,936	5.73	5.29	0.44	31,666
Time horizon = 15 years	120,519	104,206	16,313	7.51	6.88	0.63	26,101
Time horizon = 20 years	154,492	138,214	16,278	8.71	7.95	0.76	21,413
Baseline mean age 30 years	857,949	876,976	-19,027	19.48	17.76	1.72	Dominant
Baseline mean age 40 years	635,293	639,649	-4356	17.02	15.44	1.58	Dominant
Baseline mean age 50 years	402,555	392,433	10,122	13.95	12.63	1.32	7651
Discount rate = 0%	257,059	237,559	19,500	11.71	10.56	1.16	16,853
Discount rate = 3%	170,486	154,476	16,010	8.61	7.81	0.79	20,172
Complication costs -20%	176,234	154,955	21,279	9.97	9.02	0.95	22,392
Complication costs +20%	238,698	224,771	13,927	9.97	9.02	0.95	14,655
Annual cost of rt-CGM -50%	181,813	189,863	-8050	9.97	9.02	0.95	Dominant
Annual cost of rt-CGM -25%	194,640	189,863	4777	9.97	9.02	0.95	5026
Annual cost of rt-CGM +25%	220,292	189,863	30,429	9.97	9.02	0.95	32,021
SHE rate in rt-CGM arm 2 per 100 person-years	207,791	189,863	17,928	9.95	9.02	0.93	19,269
SHE rate in rt-CGM arm 4 per 100 person-years	208,455	189,863	18,592	9.935	9.02	0.91	20,344
Ketoacidosis disutility -0.0367	207,466	189,863	17,603	9.971	9.02	0.95	18,510

A1C: Glycated hemoglobin; FoH: Fear of hypoglycemia; ICUR: Incremental cost-utility ratio; QALY: Quality-adjusted life year; QoL: Quality of life; rt-CGM: Real-time continuous glucose monitoring; SMBG: Self-monitoring of blood glucose.

insulin-treated Type 2 diabetes in Canada is lower than assumed in the base case, at a mean of 2.7 per day (18.7 per week) [41]. Even in the sensitivity analysis in which an SMBG frequency of two tests per day was assumed, the ICUR was still below CAD 30,000 per QALY gained. However, a key limitation of these sensitivity analyses was that only the cost of SMBG was taken into consideration. The analyses did not account for any improvement in A1C that may be related to more frequent SMBG, with evidence from Europe indeed indicating that a higher frequency of SMBG is linked to better glycemic control [42]. Additionally, these analyses did not account for any negative QoL impact of a higher SMBG frequency.

Sensitivity analyses also indicated that mean patient age at baseline was an important determinant of outcomes, with rt-CGM becoming more cost-effective as age at diagnosis was lower, likely driven to some extent by the QoL benefits associated with rt-CGM use being accrued over a longer period. This finding may be of particular relevance in the coming decades – evidence from the Manitoba Center for Health Policy has shown that the mean age at diagnosis of diabetes (any type) has decreased from 59 years over the period 1985–1987 to 55 years in 2015–2017 [43]. Alongside this, the prevalence of diabetes in younger people has steadily increased. For example, in Manitoba in 2015–2017, the overall prevalence of diabetes in people aged 35–39 years was 3.9% compared with just 1.2% in 1985–1987. The higher prevalence reflects an increasing incidence particularly in younger people,

including children and young adults, and a consequently prolonged disease burden as many patients fail to achieve recommended levels of glycemic control [43].

In the current analysis, the overall rates of SHEs were low; however, an SHE was defined as an event requiring either an ER visit or hospitalization, which is a relatively strict definition. As such, the analysis did not capture the costs or QoL implications of hypoglycemic events requiring third-party assistance from a family member, friend, or colleague, nor minor hypoglycemic events that can be self-remedied. A real-world analysis from Canada, wherein 37% of people with Type 2 diabetes were using CGM, showed that the rate of SHEs requiring third-party assistance in people with Type 2 diabetes was 2.5 per person-year [44]. Additionally, the disutility value for an SHE in the current analysis was sourced from a study wherein an SHE was defined as an event requiring third-party assistance [32]. In another Canadian study, it was also noted that not all SHEs are treated, or even reported, to healthcare professionals [45]. The same authors also drew attention to the emotional impact of SHEs, noting that such events can result in patients feeling helpless and scared. Moreover, utility studies also suggest that even non-severe hypoglycemic events are associated with a disutility, although the magnitude of this is small [32]. Further, the present analysis did not account for any indirect costs attributable to hypoglycemic events. In Canada, the mean annual cost associated with sick leave related to hypoglycemia in people with Type 2 diabetes has been reported to be over CAD 600 per person [46]. Considering the strict definition of SHEs that was applied, together with the omission of indirect costs, the findings of the current analysis possibly present a conservative picture of the cost-effectiveness of rt-CGM relative to SMBG in this patient population from a societal perspective.

The analysis presented here has limitations and strengths. In particular, the generalizability of the findings may be limited to people with characteristics similar to the simulated patient cohort. Furthermore, the effectiveness and adverse event data were derived from an observational study whose authors acknowledge that even after propensity score matching (PSM), unmeasured differences likely remained between participants treated with rt-CGM and SMBG [8]. These unmeasured differences may have confounded the estimated glycemic benefit and, while Karter *et al.* employed overlap weighting-based PSM to mitigate certain limitations associated with the conventional inverse probability of treatment weighting approach, the magnitude of confounding, if any, is difficult to quantify [8]. Another limitation is that in the absence of recent data, some complication data were sourced from previous economic analyses published in 2013–2014, with original source costs dating from 2003 onwards. Although costs were inflated to 2021 values, this may not capture the costs of any new, more costly treatments or diagnostic procedures introduced over that period. A further limitation was the inability to model HHS in the IQVIA CORE Diabetes Model, which necessitated the assumption that all hyperglycemic events experienced in the modelled cohort were DKA [15,24]. This assumption was likely to underestimate the benefits of rt-CGM as the rates of mortality associated with HHS are considerably higher than those associated with DKA [47].

Strengths of the analysis included the use of real-world data from a large population of people with Type 2 diabetes, although only a minority (n = 344 of 36,080 with Type 2 diabetes) initiated rt-CGM. However, real-world data are reflective of the patient population encountered in everyday clinical practice and therefore include patients across a broad spectrum of self-efficacy, in terms of the degree of engagement in managing their disease, as well as comorbid conditions that may influence disease management. It should also be reiterated that a majority (97%) of patients initiating rt-CGM in the real-world study were using a basal-bolus insulin regimen [8]. Some caution should therefore be exercised when extrapolating the findings of the present study to patients using only basal insulin, but studies conducted exclusively in patients using basal insulin, such as MOBILE, have shown that the A1C reductions with CGM versus SMBG may be greater still, especially in patients with higher baseline HbA1c.

Conclusion

In conclusion, the findings of the analysis presented here suggest that in Canada, as in the UK [9], rt-CGM is likely cost-effective relative to SMBG for people with Type 2 diabetes and baseline age and A1C similar to the 65 years and of 8.3%, respectively, used in the present analysis. Moreover, rt-CGM was projected to be dominant to SMBG when the mean baseline age of patients was 30 or 40 years, the cost of rt-CGM was reduced by 50% or the frequency of SMBG was at least ten per day.

10.57264/cer-2023-0075

Author contributions

H Alshannaq, G Cogswell, PM Lynch and GJ Norman conceived of the study. JJ Isitt and S Roze designed the analyses and conducted the analyses. RF Pollock drafted the manuscript. All authors contributed to data interpretation and all authors reviewed and edited the manuscript. All authors approved the final version of the manuscript.

Financial & competing interests disclosure

JJ Isitt and S Roze are current employees of Vyoo Agency, which has received consulting fees from Dexcom for this analysis. JJ Isitt also reports payment or honoraria from Dexcom to oral presentations at ADA meetings and support from Dexcom to attend the 2022 ADA conference. RF Pollock is a current employee at Covalence Research Ltd., which has received consulting fees from Dexcom for this analysis. H Alshannaq, G Cogswell, PM Lynch and GJ Norman are current employees of Dexcom. G Cogswell, JJ Isitt, GJ Norman, and PM Lynch hold stock or stock options in Dexcom. The authors have no other relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript apart from those disclosed.

No writing assistance was utilized in the production of this manuscript.

Summary points

- People with Type 2 diabetes have limited access to real-time continuous glucose monitoring (rt-CGM) in many parts of Canada.
- Long-term outcomes of rt-CGM were evaluated versus self-monitoring of blood glucose (SMBG) for people with insulin-treated Type 2 diabetes, using the IQVIA CORE Diabetes model.
- Cohort characteristics and treatment effects were sourced from a real-world US study that investigated more than 35,000 people with insulin-treated diabetes who initiated or did not initiate rt-CGM.
- Direct costs of treatment for diabetes-related complications were included in the analysis, in addition to costs of the Dexcom G6 rt-CGM device (at the Canadian list price) and SMBG (mean 3.8 tests daily).
- Health state utility values were sourced from the published literature and included disutilities for severe hypoglycemia, diabetic ketoacidosis, and routine fingerstick testing.
- In the base case analysis, using rt-CGM was associated with additional costs of CAD 17,602 and an additional 0.95 quality-adjusted life-years (QALYs), leading to an incremental cost-utility ratio of CAD 18,523 per QALY gained.
- Findings were robust to assumptions and confirmed in deterministic and probabilistic sensitivity analyses.
- At a willingness-to-pay threshold of CAD 50,000 per QALY gained, there was a 67% likelihood that rt-CGM is cost-effective versus SMBG. The use of rt-CGM is therefore likely good value for money relative to SMBG in patients with insulin-treated Type 2 diabetes in Canada.

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