EnM
ENDOCRINOLOGY AND METABOLISM

Review Article

Endocrinol Metab 2023;38:472-481
https://doi.org/10.3803/EnM.2023.1805
pISSN 2093-596X · eISSN 2093-5978

The Benefits of Continuous Glucose Monitoring in Pregnancy

Jee Hee Yoo[1], Jae Hyeon Kim[2,3]

[1]Division of Endocrinology and Metabolism, Department of Medicine, Yonsei University Wonju College of Medicine, Wonju; [2]Division of Endocrinology and Metabolism, Department of Medicine, Samsung Medical Center, Sungkyunkwan University School of Medicine; [3]Department of Clinical Research Design and Evaluation, Samsung Advanced Institute for Health Sciences & Technology, Sungkyunkwan University, Seoul, Korea

Previous studies have consistently demonstrated the positive effects of continuous glucose monitoring (CGM) on glycemic outcomes and complications of diabetes in people with type 1 diabetes. Guidelines now consider CGM to be an essential and cost-effective device for managing type 1 diabetes. As a result, insurance coverage for it is available. Evidence supporting CGM continues to grow and expand to broader populations, such as pregnant people with type 1 diabetes, people with type 2 diabetes treated only with basal insulin therapy, and even type 2 diabetes that does not require insulin treatment. However, despite the significant risk of hyperglycemia in pregnancy, which leads to complications in more than half of affected newborns, CGM indications and insurance coverage for those patients are unresolved. In this review article, we discuss the latest evidence for using CGM to offer glycemic control and reduce perinatal complications, along with its cost-effectiveness in pregestational type 1 and type 2 diabetes and gestational diabetes mellitus. In addition, we discuss future prospects for CGM coverage and indications based on this evidence.

Keywords: Blood glucose; Diabetes mellitus, type 1; Diabetes mellitus, type 2; Diabetes, gestational; Pregnancy in diabetics; Pregnancy outcome

INTRODUCTION

The prevalence of diabetes in pregnancy is increasing worldwide. The number of women with type 1 or 2 diabetes or gestational diabetes mellitus (GDM) doubled during the past 15 years [1-3]. Because poor glycemic status is closely related to maternal and neonatal complications, including preeclampsia, preterm delivery, neonatal hypoglycemia, large for gestational age (LGA), macrosomia, congenital deformity, stillbirth, and fetal death, it is of great concern [4]. The complications of poor glycemic status also increase medical costs [3,5,6].

Therefore, achieving euglycemia is fundamentally important. Furthermore, it is crucial to attain glycemic targets before conception or the first trimester, as organogenesis occurs during the first trimester. Indeed, a hemoglobin A1c (HbA1c) above 6.5% in the first trimester is associated with a 3-fold risk of perinatal death and nearly a 2-fold risk of congenital anomaly and preterm birth [4]. However, fewer than half of mothers with type 1 or 2 diabetes achieve the target of an HbA1c below 6.5% in early pregnancy [7]. Even though guidelines recommend that the

Received: 18 August 2023, **Revised:** 4 September 2023, **Accepted:** 6 September 2023

Corresponding author: Jae Hyeon Kim
Division of Endocrinology and Metabolism, Department of Medicine, Samsung Medical Center, Sungkyunkwan University School of Medicine, 81 Irwon-ro, Gangnam-gu, Seoul 06351, Korea
Tel: +82-2-3410-1580, **Fax:** +82-2-3410-3849, **E-mail:** jaehyeon@skku.edu

% time in range (%TIR 63 to 140 mg/dL) be higher than 70%, that target is often reached too late in pregnancy to reduce neonatal complications [8].

HbA1c is a standard maker for assessing glycemic status and complications in diabetes. However, during pregnancy, the accuracy of HbA1c tests decreases because of the higher than usual turnover rate for red blood cells. Thus, frequent self-monitoring blood glucose (SMBG) monitoring was essential to compensate for inaccuracies of HbA1c [9].

Continuous glucose monitoring (CGM) has emerged as a promising technology that can diagnose the full range of glycemic status by measuring glucose levels accurately every 1 to 5 minutes replacing frequent fingerstick monitoring. Numerous studies have shed new light on its benefits for glycemic outcomes [10-14], including evidence that CGM could be useful in pregnancy, improving maternal glycemia and neonatal outcomes [8,15-17]. CGM also can detect hidden hypoglycemia and hyperglycemia, which fingerstick monitoring cannot find. Thus, the decision to initiate insulin therapy in people with GDM can be made promptly [18].

In this review, we discuss the benefits of CGM in pregnant women with type 1 or 2 diabetes or GDM. We discuss whether CGM has a role in glycemic and other maternal and neonatal outcomes. In addition, although the cost of CGM devices is high, which glucose monitoring approach (SMBG, real-time CGM [rt-CGM], or intermittently scanned CGM [is-CGM]) is most cost-effective, and whether those changes depending on insulin use during pregnancy, is unclear. Additionally, we discuss potential future developments in insurance coverage for CGM in these populations by considering any evidence that might alter current indications.

ACCURACY OF CGM IN PREGNANCY

Because glucose targets during pregnancy are more stringent (1st trimester: HbA1c <6.5%; 2nd and 3rd trimesters: HbA1c <6.0%) and much narrower (%TIR 64 to 140 mg/dL) than at other times, choosing a CGM device with adequate accuracy is particularly important [19]. Most rt-CGM devices Conformité Européenne (CE) marked for use in pregnancy (Dexcom G6, Dexcom G7, Dexcom, San Diego, CA, USA; FreeStyle Libre 1, 2 and 3, Abbott, Abbott Park, IL, USA; and Guardian 3 and 4, Medtronic, Minneapolis, MN, USA) provide accurate readings [20,21]. Furthermore, Dexcom G7 and FreeStyle Libre 2 and 3 have been approved by the U.S. Food and Drug Administration. However, caution is needed when using is-CGM (e.g., FreeStyle Libre 1) because it measures higher time below range (%TBR <63 mg/dL) than rt-CGM during the nighttime in pregnant women with type 1 diabetes [22]. Thus, to avoid overtreatment of hypoglycemia, such as reducing insulin doses or consuming unnecessary carbohydrates, hypoglycemia should be confirmed by blood glucose meter measurements while using is-CGM.

GLYCEMIC TARGETS AND ACHIEVEMENT IN PREGNANCY

Hyperglycemia is well known to be associated with increased adverse pregnancy outcomes [19,23,24]. The most recent American Diabetes Association (ADA) guideline suggests an HbA1c target <6% to 6.5% in early pregnancy and <6.0% in the second and third trimesters, if it can be achieved without causing severe hypoglycemia (Table 1).

For pregnant women with type 1 diabetes using CGM, the ADA guideline suggests glycemic targets of %TIR (63 to 140 mg/dL) >70%, time above range (%TAR >140 mg/dL) <25%, and %TBR <63 mg/dL <4%. Because people with type 2 diabetes have lower glycemic variability and less severe hypoglycemia than those with type 1 diabetes, the more stringent target of %TIR >90% is recommended [19,25].

However, it is challenging to achieve tight pregnancy glucose targets and simultaneously avoid hypoglycemic events without frequently monitoring glucose levels because insulin sensitivity and absorption varies during pregnancy [19,26]. The risk of hypoglycemia is relatively high in early pregnancy because insulin

Table 1. Guideline-Recommended Glycemic Targets for Pregnancy

Metrics	Target of American Diabetes Association 2023	
	Type 1 diabetes	Type 2 diabetes[a]
HbA1c, %	<6.5 (1st trimester) <6.0 (2nd and 3rd trimester)	
Fasting plasma, glucose, mg/dL	≤95	
Postprandial glucose, mg/dL	<140 (1 hr) <120 (2 hr)	
Time in range (63–140 mg/dL), %	>70	>90
Time above range (>140 mg/dL), %	<25	<5
Time below range (<63 mg/dL), %	<4	<4
Time below range (<54 mg/dL), %	<1	<1

HbA1c, hemoglobin A1c.
[a]Glycemic targets for type 2 diabetes are from Yamamoto et al. [25].

sensitivity increases during the first 16 weeks of pregnancy, but then the insulin requirement increases sharply from 16 to 37 weeks of pregnancy, and insulin absorption varies day-to-day during late pregnancy [26]. Among individuals with type 1 diabetes, only 20% to 30% are able to reach HbA1c and %TIR targets in the ADA guideline. This matters because even a 5% difference in %TIR can affect pregnancy-related outcomes, including LGA [27]. Additionally, fewer than half of individuals meet the %TBR target when glucose monitoring is limited to SMBG [28].

GLYCEMIC AND PERINATAL OUTCOMES WITH CGM USE DURING PREGNANCY

Type 1 diabetes

Many studies have collected evidence to support the benefits of rt-CGM in type 1 diabetes during pregnancy (Table 2) [8,15,16,29]. The largest randomized controlled trial (RCT, continuous glucose monitoring in pregnancy women with type 1 diabetes [CONCEPTT] trial) to compare the effectiveness of rt-CGM (Guardian REAL-Time or MiniMed Minilink system, Medtronic, Minneapolis, MN, USA) with that of SMBG showed 0.2% lower HbA1c at 34 weeks gestation in those using rt-CGM [15]. In addition, %TIR was 7% (1 hour 41 min/day, 68% vs. 61%, P=0.0034) higher and %TAR was 5% lower (1 hour 12 min/day, 27% vs. 32%, P=0.0279) in the rt-CGM group than the control group, without an increase in hypoglycemia. This glycemic improvement led to improved neonatal outcomes, including LGA (53% vs. 69%, P=0.0210), neonatal hypoglycemia requiring intravenous dextrose (15% vs. 28%, P=0.025), and admission to the neonatal intensive care unit (NICU) in the first 24 hours (27% vs. 43%, P=0.0157). However, even with rt-CGM, only 66% reached the target HbA1c of ≤6.5%, mean %TIR (68%) did not reach the target of 70%, and one in two neonates experienced LGA (53%).

In a real-world study of a Swedish population of 186 pregnant women with type 1 diabetes using CGM (rt-CGM or is-CGM), %TIR, and %TAR tended to improve with increasing gestational age [8]. The %TIR increased from 50% (1st trimester) to 60% (3rd trimester), and %TAR decreased from 43.0% (1st trimester) to 33.7% (3rd trimester). The people using rt-CGM spent less time in hypoglycemia (%TBR <64 mg/dL) than those using is-CGM during all trimesters, probably because of the hypoglycemia alarm on the rt-CGM device. Mothers whose babies were and were not LGA had a clear difference in their %TIR and %TAR, suggesting that %TIR is an important predictor of neonatal outcomes. However, only 36% of that study population reached the HbA1c targets of <6.5% in the 1st trimester and 70% reached the target in the 2nd and 3rd trimesters despite the use of CGM. To achieve glycemic targets and lower the risk of diabetes-related complications during pregnancy in patients with type 1 diabetes, other advanced technology, such as automated insulin delivery systems, needs to be combined [30,31]. Ongoing studies such as automated insulin delivery amongst pregnant women with type 1 diabetes (AiDAPT) [32], and closed-loop insulin delivery in type 1 diabetes pregnancies (CIRCUIT, NCT04902378) are expected to demonstrate the advantages of a closed-loop system in pregnancy.

Type 2 diabetes

The risk of diabetes-related complications during pregnancy is higher for those with type 1 diabetes than type 2 diabetes. However, in cases of pregestational type 2 diabetes, the risk of complications that lead to stillbirths and neonatal deaths is even greater than in type 1 diabetes [4]. Improving glycemic outcomes for people with type 2 diabetes is therefore just as important as it is for those with type 1 diabetes. Until now, evidence to support the use of CGM in individuals with type 2 diabetes has been insufficient. A study by Murphy et al. [7] demonstrated that even intermittent use of rt-CGM can lead to a 0.6% improvement in HbA1c and a reduced risk of macrosomia in pregnant women with type 1 (n=46) or 2 diabetes (n=25) who are on insulin therapy. The positive outcome from Murphy et al.'s [7] study might be attributed to the researchers' consistent use of rt-CGM (for up to 7 days every 4–6 weeks between 8 and 32 weeks) as a tool for patient education, rather than relying on patients to adjust their insulin levels on their own. Another RCT assessed the effects of blinded CGM on 300 pregnant patients with type 1 or 2 diabetes who were receiving insulin therapy at the gestational age of <16 weeks and on patients with GDM undergoing insulin treatment at the gestational age of <30 weeks [33]. Neither the HbA1c nor pregnancy outcomes showed any improvement. We assume that the negative results of that study derived from a sample size too small to identify complications and blinded CGM wear that patient could not respond to the real-time glucose level. Since the CGM was worn at long intervals of 6 weeks, the overall wearing time was too short to optimize insulin treatment. Furthermore, achieving additional improvement in HbA1c levels was challenging because the initial HbA1c levels were already close to the target. The baseline HbA1c in the study with negative results was lower (6.8%) than that in Murphy et al.'s [7] study with positive re-

Table 2. Evidence Supporting CGM in Terms of Glycemic Efficacy and Perinatal Complications

Study	Study design	Study population (*n*)	Insulin regimen	CGM type and duration	Baseline HbA1c (%) (CGM vs. SMBG)	Primary outcomes	Results (CGM vs. SMBG)
Feig et al. (2017) [15]	RCT	325 T1D: Pregnant (215) Planning pregnancy (110)	MDI or insulin pump (46%)	Continuous use of rt-CGM (Guardian REAL-Time or MiniMed Minilink system)	Pregnant participants: 6.5%–10.0% Planning pregnancy: 7.0%–10.0% Mean HbA1c: 6.8% vs. 6.9%	Difference in change in HbA1c Pregnancy: at 34 weeks' gestation Planning pregnancy: at 24 weeks or conception	Adjusted between-group differences: HbA1c (%): −0.19 (P=0.02) 6.35% vs. 6.53% TIR (%)[a]: 68 vs. 61 (P=0.003) LGA[b]: 53% vs. 69% (P=0.02) Neonatal hypoglycemia requiring IV dextrose: 15% vs. 28% (P=0.02) NICU care >24 hr: 27% vs. 43% (P=0.015)
Kristensen et al. (2019) [8]	Observational study	186 T1D	MDI or insulin pump (29%)	At least 2 weeks of rt-CGM (Dexcom G4, n=92) or is-CGM (FreeStyle Libre 1, n=94) wear		Differences in glycemic status according to the presence of LGA[c]	LGA vs. No LGA TIR (%): 1st trimester: 48.2 vs. 51.9 (P=0.07) 2nd trimester: 51.8 vs. 57.9 (P<0.001) 3rd trimester: 57.6 vs. 62.2 (P=0.04)
Voormolen et al. (2018) [33]	RCT	300 adults: T1D (109) T2D (82) GDM (109) who were on insulin therapy	Insulin-based therapy or insulin pump (19%)	5–7 days of blinded CGM (iPro2) wear every 6 weeks	6.8% vs. 7.0%	LGA[b]	Adjusted between-group HR, 1.06 (P<0.001), 31.0% vs. 28.4%
Murphy et al. (2008) [16]	RCT	70 adults: T1D (46) T2D (25)	Insulin-based therapy or insulin pump	Up to 7 days of rt-CGM wear every 4–6 weeks	6.1% vs. 6.4%	Difference in change in HbA1c LGA[b]	HbA1c (%): 5.8 vs. 6.4 (P=0.007) LGA: OR, 0.36 (P=0.05), 35% vs. 60%
Majewska et al. (2023) [17]	RCT	100 GDM	Initially not on insulin therapy	Intermittent use of is-CGM (FreeStyle Libre 1) during the first 4 weeks after GDM diagnosis	FPG (mg/dL): 87 vs. 92 PP1 (mg/dL): 186 vs. 181.5	FPG and PP1 during the first 4 weeks after GDM diagnosis	FPG (mg/dL) 86.7 vs. 85.1 (P=0.437) PP1 (mg/dL): 113.9 vs. 109.5 (P=0.011) Macrosomia[d]: OR, 5.62 (95% CI, 1.16–27.2), 4.1% vs. 30%
Paramasivam et al. (2018) [37]	RCT	50 GDM	Insulin-based therapy	6 days of blinded CGM (iPro 2 Enlite) wear in weeks 28, 32, and 36 weeks of gestational age	5.1% vs. 5.3%	Change in HbA1c from 28–37 weeks	Adjusted between-group differences: HbA1c (%), –0.4 (P=0.006) Macrosomia[d]: OR, 1.0 (P=NA)
Alfadhli et al. (2016) [38]	RCT	130 GDM	Initially not on insulin therapy	3–7 days of rt-CGM (Guardian REAL-Time) wear within 2 weeks of GDM diagnosis	5.6% vs. 5.9%	Change in HbA1c, FPG, and PP1	HbA1c (%): 5.7 vs. 6.1 (P=0.168) FPG (mg/dL): 85 vs. 90 (P=0.09) PP1 (mg/dL): 103 vs. 113 (P=0.057) Macrosomia[d]: No difference between groups
Yu et al. (2014) [39]	RCT	340 GDM	Initially not on insulin therapy	3 days of blinded CGM (Medtronic Minimed) wear every 2–4 weeks	5.3% vs. 5.3%	Difference in mean glucose and glycemic variability in the 5th week of the study	Mean glucose (mg/dL): 103 vs. 103 (P=0.253) SD (mg/dL): 14.4 vs. 19.8 (P<0.001) TAR$^{>140\ mg/dL}$ (%): 0 vs. 4.2 (P<0.001) Subjects with TBR$^{<60\ mg/dL}$ >30 min/day (%): 3.4 vs. 19.4 Macrosomia[d]: 4.1% vs. 10.8% (P=0.025) Preeclampsia: 3.4% vs. 10.1% (P=0.019)

CGM, continuous glucose monitoring; HbA1c, hemoglobin A1c; SMBG, self-monitoring blood glucose; RCT, randomized controlled trial; T1D, type 1 diabetes; MDI, multiple daily insulin injections; rt-CGM, real-time continuous glucose monitoring; TIR, time in range; LGA, large for gestational age; NICU, neonatal intensive care unit; T2D, type 2 diabetes; GDM, gestational diabetes mellitus; HR, hazard ratio; OR, odds ratio; is-CGM, intermittent scanning continuous glucose monitoring; FPG, fasting plasma glucose; PP1, postprandial glucose 1 hour; CI, confidence interval; NA, not applicable; SD, standard deviation; TAR, time above range; TBR, time below range.

[a]Time in target ranging from 63 to 140 mg/dL; [b]LGA was defined as birth weight percentile >90th; [c]LGA was defined as birth weight >2 SD above the expected birthweight for gestational age; [d]Macrosomia was defined as birth weight ≥4,000 g.

sults (7.3%). An ongoing clinical trial is evaluating the effects of rt-CGM (Dexcom G6) in 40 pregnant people with type 2 diabetes (adopting technology for glucose optimization and lifestyle in pregnancy [AT GOAL] study, NCT05370612).

Gestational diabetes mellitus

GDM is the most prevalent form of hyperglycemia during pregnancy; thus, the need for evidence to support the benefits of CGM in managing GDM is urgent [34]. So far, little evidence is available. Two meta-analyses have evaluated the effects of rt-CGM [35,36]. In a meta-analysis of six RCTs involving 482 people with GDM, CGM led to an overall HbA1c reduction of 0.22% [35]. However, of all the studies examined, only two were able to improve glycemic status, and only one decreased the HbA1c level [37]. The study with the HbA1c decrease included only participants who were using insulin treatment, which suggests that the benefits of CGM are primarily limited to individuals using insulin [37]. Unfortunately, CGM did not have positive effects on maternal or neonatal outcomes. We assert that the benefits of CGM in GDM patients who are using insulin might have been underestimated for the same reasons given in studies of type 2 diabetes. The other study from that meta-analysis with positive results improved postprandial glucose levels [38]. That study used CGM as a tool to support structured education [38]. Another study reported a reduction in perinatal complications [36]. It had a large sample size (340 GDM patients), and although blinded CGM was used intermittently, it was used frequently (every 2 to 4 weeks) with a strict education protocol [39]. These results also emphasize the importance of education and CGM data as an education tool.

Recently, one study showed a benefit of is-CGM for perinatal complications in GDM [17]. That study found that the SMBG group had a 5.63 times higher risk of fetal macrosomia than the is-CGM group, who used it intermittently in the first 4 weeks after a GDM diagnosis [17]. These results indicate that GDM patients not taking insulin might benefit by using is-CGM to provide valuable feedback and reinforce optimal self-management of diet and physical activity. An RCT in 372 people with GDM is ongoing [40].

CURRENT GUIDELINES FOR CGM USE IN PREGNANCY

Based on findings from the CONCEPTT trial [15] and a real-world study of a Swedish cohort with type 1 diabetes [8], the 2023 ADA guidelines suggest that rt-CGM can decrease the incidence of macrosomia and neonatal hypoglycemia in pregnancy complicated by GDM [19]. The UK National Institute for Health and Care Excellence (NICE) guidelines updated in 2020 suggest that rt-CGM should be offered to all pregnant people with type 1 diabetes [41]. Furthermore, the UK government funds 12 months of rt-CGM for pregnant people with type 1 diabetes. The 2023 Korean Diabetes Association guideline advises pregnant people with type 1 diabetes to use rt-CGM to enhance glycemic control, minimize hypoglycemia, and mitigate pregnancy complications [42].

Currently, there is not enough evidence to fully support the use of CGM in individuals with type 2 diabetes or GDM. Therefore, guidelines do not strongly recommend the use of CGM in those individuals, though CGM might have potential benefits during pregnancy. The ADA mentions only that CGM combined with SMBG can help to achieve the HbA1c target [19]. The NICE guidelines have a stronger recommendation than the ADA guidelines, indicating that rt-CGM use should be considered during pregnancy in patients receiving insulin therapy [41].

COST-EFFECTIVENESS OF CGM USE IN PREGNANCY

Despite the known benefits of rt-CGM in pregnancies complicated by diabetes, it is crucial to determine whether consistent use of CGM will produce cost savings in clinical practice by reducing the risk of diabetes-related pregnancy complications, because rt-CGM is expensive. Cost-effectiveness analyses of CGM use could lead to optimal reimbursement decisions.

Two studies that analyzed the cost-effectiveness of rt-CGM in pregnancy are summarized in Table 3. One of them was conducted in the UK among 1,441 women with type 1 diabetes to determine the cost difference and potential cost savings between the CGM group (using about 7 months) and the SMBG only group [43]. Even though the cost of glucose monitoring per pregnancy was higher in the rt-CGM group (£1,820) than the SMBG group (£588), the total annual medical costs for those people were approximately £9,560,461 lower in the CGM group (CGM group: £14,165,187 vs. SMBG group: £23,725,648). The main reasons for the cost savings in the CGM group were shorter NICU stays and lower costs during NICU admission. A *post hoc* cost analysis of data from the CONCEPTT trials for Canadians was conducted to determine whether the CGM group's medical expenses were lower than those of the SMBG group [5]. When the costs of CGM devices and sensors were excluded, the mean costs for services or wards used by all

Table 3. Cost-Effectiveness of rt-CGM in Pregnant People with T1D

	rt-CGM	SMBG	Differences
UK for pregnant people with T1D			
Total cost, £	14,165,187	23,725,648	–9,560,461
Glucose monitoring cost per pregnancy, £	1,820	588	1,232
Mean NICU stay, day	6.6	9.1	
Canadian for pregnant people with T1D patients			
Total mean cost, $			
Ontario	17,881.01	19,699.65	–1,818.64[a]
British Columbia	18,091.32	19,996.61	–1,905.29[a]
Alberta	17,905.15	19,908.89	–2,003.74[a]
Glucose monitoring cost per pregnancy, $			
Ontario	4,610.76	1,531.40	3,079.36
British Columbia	4,610.75	1,234.44	3,376.31
Alberta	4,610.76	1,234.44	3,376.32
Mean NICU stay, day	6.0	8.7	

rt-CGM, real-time continuous glucose monitoring; T1D, type 1 diabetes; SMBG, self-monitoring blood glucose; NICU, neonatal intensive care unit.
[a]There was no significant difference in the mean values between the CGM group and SMBG group.

mothers and their infants were $5,300 lower for the CGM group than SMBG group. When the mean costs were compared including the cost that the Canadian provincial governments paid for CGM devices, the groups did not differ. Although the overall cost was comparable in both groups, CGM use produced notable benefits such as increased rates of spontaneous vaginal deliveries, fewer urgent cesarean deliveries, shorter maternal hospital stays, and decreased percentages and durations of NICU admissions, compared with the SMBG group. Therefore, routine rt-CGM use could offer important clinical benefits to type 1 diabetes patients during pregnancy. Indeed, based on those results, government funding is now suggested in Australia, England, and Wales.

However, those studies were derived from the previous generation of CGM devices. Thus, the results might be underestimated, and analyses of advanced CGM devices such as Dexcom G6 or FreeStyle Libre 3 might show better results. Though it did not consider pregnancy, a health economic analysis was performed to establish the cost-effectiveness of advanced rt-CGM (Dexcom G6), which has a longer sensor duration and higher accuracy than previous devices and a predictive hypoglycemia alarm to inspire patients to take action before hypoglycemia appears [44]. That analysis compared the new device with SMBG alone in United Kingdom-based patients with type 1 diabetes over a lifetime horizon [45] and found that the CGM group gained £20,000 per quality adjusted life year versus the SMBG group via a lower cumulative incidence of long-term complications. Similar analyses were made for patients with type 2 diabetes who were not on prandial insulin, and rt-CGM was more cost-effective than SMBG alone in people with type 2 diabetes treated with insulin [46,47]. These results might be similar or better in an analysis of rt-CGM during pregnancy.

There is also a result from the Korean Health Insurance Claims Database [3]. That study did not compare a CGM group with an SMBG group, but it does highlight the significant increase in costs associated with pregestational diabetes and GDM caused by pregnancy-related complications. Although the expense of CGM devices and medical costs related to pregnancy differ across countries, the cost-effectiveness of rt-CGM is expected to remain consistent.

NEED TO EXPAND CGM INDICATIONS AND REIMBURSEMENT DURING PREGNANCY

Reimbursement restrictions on CGM use in pregnancy

Despite growing evidence supporting CGM use in the broader population, including people receiving insulin treatment regardless of diabetes type, and even in people with diabetes without insulin treatment, current reimbursement criteria deny CGM to pregnant women with diabetes, who could value from it. In Korea, CGM coverage is available only for type 1 diabetes, excluding patients with type 2 diabetes or GDM although some people rely on insulin treatment.

Indications for CGM according to β-cell function

Decisions about the indications and reimbursement for CGM should consider various factors, such as scientific evidence for complications and outcomes and cost-effectiveness. In addition, they should also consider patients' pancreatic β-cell function, regardless of diabetes type. When a definite insulin deficiency state is caused by β-cell destruction, glycemic variability is high, making it difficult to reach the narrow and strict glycemic targets for pregnant people. It is difficult to lower the mean glucose target without risking hypoglycemia, especially in early pregnancy when insulin sensitivity increases. Most patients have a %TBR of 7 to 8% in early pregnancy in type 1 diabetes, which is far above the target [29]. But the visualization of complete

glycemic status made available by continuous use of rt-CGM can potentially allow individuals to in improve their ability to use insulin flexibly, ultimately reducing glycemic variability and hypoglycemia [11,48-51]. The positive effects of rt-CGM on perinatal complications in people with type 1 diabetes have already been validated in the CONCEPTT trial [15].

For pregnant patients with type 2 diabetes who rely on insulin treatment, both multiple daily insulin injections and the basal-insulin-only method, consistent use of rt-CGM could be as helpful as in patients with type 1 diabetes. Even though individuals with type 2 diabetes can have lower glycemic variability than those with type 1 diabetes, they still experience hypoglycemia due to insulin deficiency from β-cell failure. Consistent rt-CGM use has already shown positive effects on glycemic outcomes in type 2 diabetes patients taking basal-insulin-only, though that study did not enroll pregnant participants [11]. Those results showed 0.4% differences, mainly due to lifestyle differences between the CGM and SMBG groups (P=0.02). We expect that this effect might also be valid among pregnant patients with type 2 diabetes who take insulin.

For those with GDM, type 2 diabetes, or prediabetes who do not take insulin and have remaining β-cell function, making lifestyle modifications in response to real-time glucose levels from CGM can lead to positive pregnancy outcomes. Even intermittent use of CGM can be beneficial. The flash glucose monitoring in gestational diabetes mellitus (FLAMINGO) study compared fasting glucose and 1-hour postprandial glucose between an is-CGM group (FreeStyle Libre 1) and an SMBG group for the first 4 weeks after a GDM diagnosis [17]. The risk of fetal macrosomia was 5.63-fold higher in the SMBG group than the CGM group (20% vs. 4.1%) due to the difference in postprandial glucose, even though the mean glucose did not differ between the groups. Those findings suggest that the outcomes of GDM patients not taking insulin can be improved by intermittent use of is-CGM. In an RCT, Alfadhli et al. [38] compared the glycemic and pregnancy outcomes of 130 people with GDM between those who used rt-CGM (Guardian REAL-Time system) for 3 to 7 days beginning within 2 weeks of the GDM diagnosis and those who used SMBG. They taught the rt-CGM participants to modify their lifestyle in response to the real-time glucose data. Though HbA1c did not differ between the groups and the results were not significant, postprandial glucose tended to be lower in the CGM group than the SMBG group (103 mg/dL vs. 113 mg/dL, P=0.057). Furthermore, during CGM wear, both mean glucose and the standard deviation, which indicates glycemic variability, were significantly lower in the CGM group. We assume that the similar HbA1c outcomes occurred because the populations were already well-controlled, with baseline HbA1c below 6.0%. Thus, we should not underestimate the benefit of intermittent CGM use in people with GDM who are not taking insulin. Though evidence supporting CGM use for type 2 diabetes and prediabetes is lacking, people with diabetes who are not on insulin, including those with GDM, might benefit for intermittent use of is-CGM from patient-driven lifestyle modification like people with GDM. Additionally, intermittent use of CGM help clinicians make earlier decisions about initiating insulin use during pregnancy by detecting hidden hyper- or hypoglycemia that even frequent SMBG does not observe [18].

CONCLUSIONS

Managing diabetes during pregnancy is challenging because insulin sensitivity and absorption can vary. However, achieving glycemic targets is essential to both the mother and newborn because it protects against perinatal complications. Advanced technology such as CGM shows promise for improving glycemic status and reducing complications in women with type 1 diabetes during pregnancy. Although the cost of CGM is higher than that of SMBG, it can help to reduce the duration of NICU stays and overall costs, making it a cost-effective option for managing diabetes. Unfortunately, evidence for its benefits in pregestational type 2 diabetes and GDM is lacking. It is important to consider that lack of evidence in terms of study design limitations. For instance, some studies used older versions of CGM technology retrospectively or intermittently, not consistently. Additionally, the wear time for CGM was often too short. It is worth noting that sample sizes were insufficient to analyze the perinatal complications of GDM. It has been shown that rt-CGM is beneficial for people with type 2 diabetes who use insulin. It is reasonable to expect that that outcome would also apply during pregnancy. Recently, a study demonstrated the benefit of intermittent is-CGM use in GDM patients who were not initially receiving insulin therapy. Based on the overall evidence, we carefully recommend continuous use of rt-CGM in diabetes patients who use insulin beyond type 1 diabetes. In addition, we suggest that GDM patients who are not receiving insulin should use rt-CGM or is-CGM intermittently. Nonetheless, the effects and cost-effectiveness of CGM in people with type 2 diabetes and GDM should be explored to guide clinicians in using CGM during pregnancy.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

ORCID

Jee Hee Yoo *https://orcid.org/0000-0002-2536-6274*
Jae Hyeon Kim *https://orcid.org/0000-0001-5001-963X*

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