Effects of Implementing a Routine Postpartum Fasting Blood Glucose on the Completion of the Gold Standard 2-Hour Oral Glucose Tolerance Test in Gestational Diabetics

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Abstract

Objective Rates of completion of the gold standard 2-hour oral glucose tolerance test (OGTT) for impaired glucose intolerance postpartum in patients with gestational diabetes mellitus (GDM) are consistently less than 50%. Screening tests performed prior to hospital discharge, including fasting blood glucose (FBG) to detect persistent hyperglycemia, have been investigated. We lack evidence, however, on whether implementation of routine postpartum FBG impacts the likelihood of obtaining the routine 2-hour OGTT. We sought to retrospectively compare the rates of completion of the 2-hour OGTT pre- and postimplementation of a routine FBG screen.

Study Design We performed a single-center retrospective cohort study comparing the completion of the 2-hour OGTT pre- and postimplementation of a routine FBG screen. Our primary outcome was the completion of the postpartum OGTT. Bivariate analyses assessed associations between demographic and preinduction clinical characteristics by pre- and post-implementation groups, as well as OGTT completion. Multivariable logistic regression was used to control for possible confounders. A sensitivity analysis was performed to account for the overlap with the coronavirus disease 2019pandemic.

Results In total, 468 patients met the inclusion and exclusion criteria. In our post-intervention group, 64% of patients completed a postpartum FBG. For our primary outcome, completion of the 2-hour OGTT significantly decreased in our postintervention group from 37.1 to 25.9% ($p = 0.009$), adjusted odds ratio (aOR): 0.62, confidence interval (CI): 0.41–0.92. This difference was no longer statistically significant when

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excluding patients during the pandemic, from 40.3 to 33.1% ($p = 0.228$), aOR: 0.76, CI: 0.455–1.27.

Conclusion Implementation of a routine FBG was associated with a negative impact on patients completing a 2-hour OGTT. The difference was no longer significant when excluding patients who would have obtained the OGTT during the pandemic, which may have been due to the smaller cohort. Future work should investigate patient perceptions of the FBG and its impact on their decision-making around the OGTT.

Key Points

- Screening for postpartum glucose intolerance is imperative for gestational diabetics.
- A fasting blood glucose is recommended as a postpartum screen for hyperglycemia in GDM patients.
- Implementation of an FBG was associated with a decrease in completion of the gold standard OGTT.

Gestational diabetes mellitus (GDM) complicates 3.5 to 7.1% of pregnancies in the United States annually and rates are increasing.[1,2] Postpartum glucose intolerance, either in the form of impaired fasting glucose, impaired glucose tolerance, or overt type 2 diabetes mellitus (T2DM), is a condition which may appear in the early postpartum period. In fact, up to one-third of women who experience GDM will have impaired glucose metabolism postpartum, and 15 to 70% of women will develop T2DM within the decades following the affected pregnancy.[3–5]

Fortunately, postpartum follow-up with treatment has been proven to delay progression to type 2 diabetes. The Diabetes Prevention Program demonstrated that for women with both a history of GDM and abnormal glucose metabolism postpartum, lifestyle intervention, and/or metformin reduces the risk of developing T2DM by 50% over 3 years.[6] Therefore, the American College of Obstetricians and Gynecologists, the American Diabetes Association, and other governing bodies recommend screening for glucose intolerance with a 2-hour 75-g oral glucose tolerance test (OGTT) at 6 to 12 weeks postpartum.[7,8] Unfortunately, rates of compliance with this gold standard test are generally less than 50%,[5,9,10] and initiatives to improve testing have only been moderately effective and required allocation of staff time.[11–13]

To increase compliance with screening, investigators have initiated screening tests while in the hospital, concluding that this is a feasible option which needs further investigation.[14–17] Currently, the Endocrine Society recommends obtaining fasting blood glucose (FBG) at 24 to 72 hours after delivery to rule out ongoing hyperglycemia, and initiating treatment if the fasting glucose suggests overt diabetes.[18] We lack evidence, however, on whether implementation of routine postpartum FBG impacts the likelihood of obtaining the gold standard OGTT. Therefore, we sought to retrospectively compare the rates of completion with the 2-hour OGTT pre- and postimplementation of a routine FBG screening test at our hospital.

Materials and Methods

We performed a single-center retrospective cohort study comparing patients with the diagnosis of gestational diabetes in pregnancy before and after implementation of a routine FBG screening test during their postpartum hospital admission. The preimplementation period was from August 1, 2018 to July 31, 2019. FBG was implemented into routine care on August 1, 2019, and the postimplementation period was from August 1, 2019 to July 31, 2020. The project was approved by our university Institutional Review Board.

At our institution, immediate postpartum screening was used to identify women with persistent glucose intolerance postpartum, defined as levels greater than or equal to 126 mg/dL on FBG. If elevated $\geq$ 126 mg/dL, blood glucose levels were monitored four times daily during their hospital stay and these patients were referred for early follow-up with a family medicine practice in 2 to 4 weeks after hospital discharge. A confirmatory test with a 2-hour OGTT after 4 weeks postpartum was still recommended in this group if FBG was $<$ 200 mg/dL. If FBG was elevated $\geq$200 mg/dL, we considered an endocrinology consult to initiate treatment for overt diabetes, and diagnostic testing was not necessary. If FBG was $<$ 126 mg/dL, routine 6 to 8 week follow-up was scheduled. The protocol is illustrated in ►Fig. 1.

Our analysis included women who delivered a fetus more than 20 weeks gestation at our academic center with a diagnosis of GDM by Carpenter–Coustan criteria for 3-hour OGTT or 1-hour value greater than or equal to 200 mg/dL. We excluded women with preexisting diabetes mellitus or those whose postpartum OGTT was performed at an outside hospital. Our primary outcome was the completion of the postpartum OGTT between 4 weeks and 1 year postpartum. Baseline demographic data, medical and obstetrical history, labor and delivery, and postpartum data were collected by chart abstraction on all patients meeting inclusion criteria. Our institution delivers approximately 4,700 patients per year, with a baseline rate of GDM of 5% (235 patients with

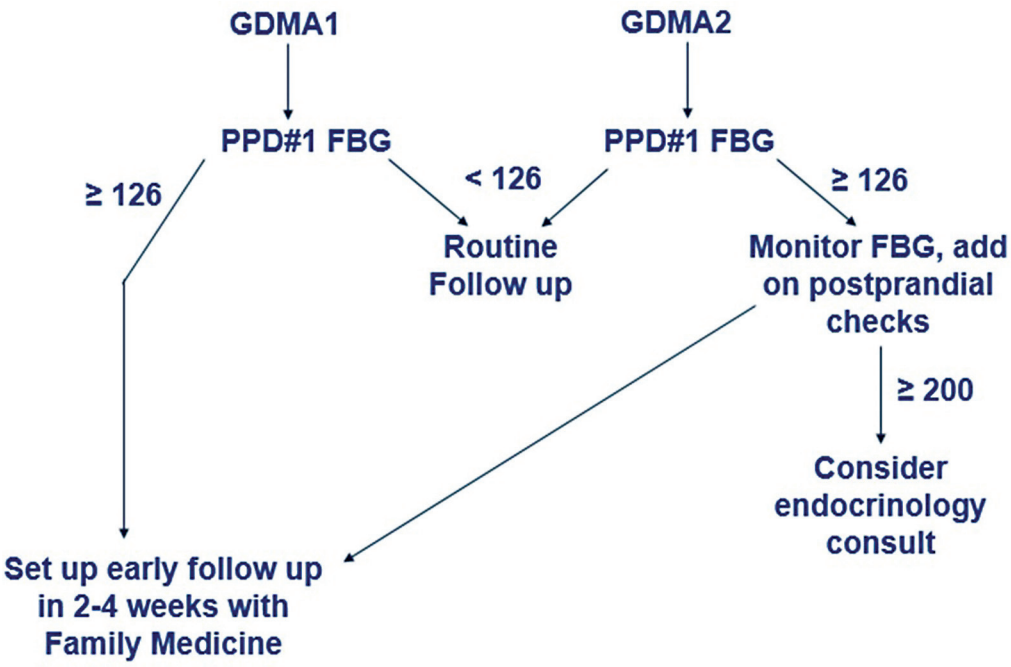

Fig. 1 Postpartum fasting blood glucose screening protocol. Caption: Protocol for postpartum fasting blood glucose screening for patients with gestational diabetes mellitus, initiated on August 1, 2019.

GDM per year). In prior work of our health system, the baseline rate of postpartum OGTT completion is approximately 30%. To demonstrate a clinically significant improvement to 42.5%, we would require 231 patients per group. Thus, 1 year each pre- and postimplementation was determined to be more than sufficient to meet the desired sample size.

Bivariate comparisons of demographic and preinduction clinical characteristics by pre- and postimplementation groups, as well as postpartum OGTT completion, were performed with Fisher's exact tests and chi-square tests for categorical variables and *t*-tests or Wilcoxon rank sum tests for continuous variables, where appropriate. Logistic regression was used to control for possible confounders of the relationship between the implementation of the postpartum FBG screening and postpartum OGTT completion. Thus, we evaluated demographic and clinical characteristics associated on bivariate tests ($p < 0.20$) with the exposure (pre- vs. postimplementation) as well as the outcome of interest (postpartum OGTT completion) as potential covariates. After backward stepwise elimination, covariates with $p < 0.10$ in multivariable modeling were retained in the final models. Thus, race was evaluated as a confounder in all multivariable models.

As the postimplementation period overlapped with the coronavirus disease 2019 (COVID-19) pandemic, we performed a sensitivity analysis excluding those who would have been <6 weeks postpartum at the initiation of the pandemic and compared those to the same calendar months in the preimplementation group (August 1, 2018–January 31, 2019 vs. August 1, 2019–January 31, 2020). Statistical analyses were performed with Stata 15 (StataCorp, College Station, TX). All tests were 2-tailed, and *p*-values <0.05 were considered statistically significant.

Results

There were 468 women during our study period from August 1, 2018 to July 31, 2020 who met the inclusion and exclusion criteria. Our population was 23% black, 9% Hispanic, and 21% Medicaid-insured. There were 205 women in the preimplementation group and 263 women in the postimplementation group.

Demographic and diabetes characteristics of the pre- and postimplementation groups are detailed in ►Table 1. There were no significant differences in parity, prepregnancy body mass index, or insurance status (private vs. Medicaid insured) between groups. There were significantly more black patients in the postimplementation group (19.0 vs. 27.4%, $p = 0.04$). There were also significant differences in GDM treatment modality, with more GDM patients controlled by diet in the postimplementation group. The values of the 1-hour and 3-hour OGTTs to diagnose GDM were not significantly different between groups.

Labor, delivery, and postpartum data are detailed in ►Table 2. There were no significant differences in mode of delivery, third or fourth degree laceration, estimated blood loss, or NICU admission between groups. The postpartum FBG was performed in 0% of the pregroup and in 64% ($n = 170$) of the post-group patients. The FBG value was < 100 mg/dL in 65.9% ($n = 112$) of our patients, 100–126 mg/dL in 26.5% ($n = 45$), and ≥ 126 mg/dL in 7.7% ($n = 13$). There were no patients with a FBG ≥ 200 mg/dL.

For our primary outcome, there was a significant decrease in the completion of the 2-hour OGTT from 37.1% ($n = 76$) in the preimplementation to 25.9% ($n = 68$) in the postimplementation group ($p = 0.009$). Even when controlling for confounders, there remained a nearly 40% reduction in the

Table 1 Demographic and diabetes characteristics by the pre- and post implementation groups. This study sample includes patients who delivered a fetus >20 weeks gestation with a diagnosis of GDM between August 1, 2018, and July 31, 2020

		Pre ($n = 205$)	Post ($n = 263$)	*p*-Value
		n (%)	*n* (%)	
Race	Non-Black	166 (81.0)	191 (72.6)	0.035
	Black	39 (19.0)	72 (27.4)	
Ethnicity	Hispanic	15 (7.3)	27 (10.3)	0.27
Insurance	Private/individual	167 (81.5)	201 (76.4)	0.19
	Medicaid/Medicare	38 (18.5)	62 (23.6)	
Nulliparity		102 (49.8)	132 (50.2)	0.93
BMI[a]		28.5 (24.2, 34.8)	27.9 (23.4, 33.1)	0.3
Screening HbA1c[b]		5.2 (0.35)	5.3 (0.34)	0.05
Early GDM diagnosis		5 (0.02)	4 (0.02)	1
Value of 1-h GTT[a, c]		162 (148, 180)	167 (151, 185)	0.1
Values of normal 3-h GTT[a, d]	Fasting	85 (78, 95)	85 (77, 94)	0.7
	1 h	194 (185, 207)	194 (183, 210)	0.81
	2 h	170 (158, 186)	173 (162, 188)	0.17
	3 h	128 (105, 148)	131 (10, 148)	0.97
GDM treatment	Diet	133 (64.9)	195 (74.1)	0.04
	Insulin	66 (32.2)	66 (25.1)	
	Oral hypoglycemic	6 (2.9)	2 (0.8)	

Abbreviation: BMI, body mass index; GDM, gestational diabetes mellitus; GTT, glucose tolerance test; IQR, interquartile range; SD, standard deviation.
[a]Median (IQR).
[b]Mean (SD).
[c]Values only among women who did not have an early GDM diagnosis and who did not skip to a third trimester 3 hour GTT ($n = 446$).
[d]Values only among women not diagnosed with early GDM and who had a 1 hour GTT <200 ($n = 394$).

completion of the 2-hour OGTT in the postimplementation period (adjusted odds ratio [aOR]: 0.62, 95% confidence interval [CI]: 0.41–0.91). There were no differences in the completion of the 2-hour OGTT by the FBG value (<100 mg/dL: 30.4%, 100–126 mg/dL: 22.2%, ≥ 126 mg/dL: 30.8%, $p = 0.58$). There was also no difference in provider ordering the 2-hour OGTT, with the test ordered in 121 patients (59.0%) in the preperiod and 139 patients (52.9%) in the postperiod ($p = 0.18$). ►Fig. 2 demonstrates 2-hour OGTT completion over time, which indicates that there was no trend toward reduction in 2-hour OGTT completion prior to FBG implementation.

Table 2 Labor, delivery, and postpartum data of the pre- and post- intervention groups. Variables predicted to influence a patient completing an interval 2-hour OGTT were evaluated

		Pre ($n = 205$)	Post ($n = 263$)	*p*-Value
		n (%)	*n* (%)	
Mode of delivery	Vaginal	129 (62.9)	143 (54.4)	0.06
	Cesarean section	76 (37.1)	120 (45.6)	
Third or fourth degree laceration		7 (5.4)	4 (2.8)	0.36
Estimated blood loss[a]		400 (300, 800)	500 (300, 975)	0.51
Fetal birth weight (g)[a]		3,270 (2,990, 3,520)	3,230 (2,880, 3,590)	0.55
APGAR at 5 min[a]		9 (9, 9)	9 (9, 9)	0.67
NICU admission		44 (21.5)	57 (21.7)	0.96
Postpartum FBG performed		0 (0)	170 (64.6)	NA
Value of postpartum FBG[a]		NA	91 (82, 104)	NA

Abbreviations: APGAR, Appearance, Pulse, Grimace, Activity, and Respiration; FBG, fasting blood glucose; IQR, interquartile range; NICU, neonatal intensive care unit; OGTT, oral glucose tolerance test.
[a]Median [IQR].

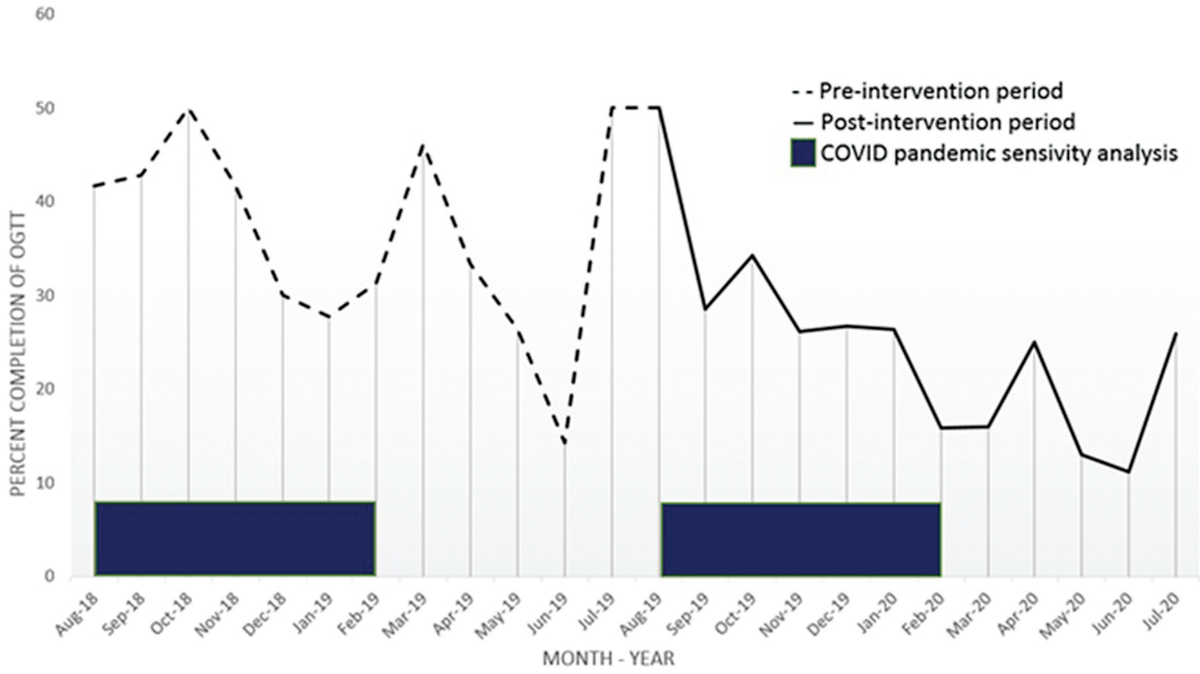

Fig. 2 Rates of completion of the 2-hour OGTT. Caption: Rates of completion (%) of the routine 2-hour OGTT during study period by month. As the postimplementation period overlapped with the COVID pandemic, we performed a sensitivity analysis excluding those who would have been <6 weeks postpartum at the initiation of the pandemic and compared those to the same calendar months in the pre-implementation group (August 1, 2018–January 31, 2019 vs. August 1, 2019–January 31, 2020).

In our sensitivity analysis to exclude patients whose completion of the 2-hour OGTT would have been affected by the COVID pandemic, there were 258 patients included, with 119 in the pre- and 139 in the postgroup. 40.3% completed the 2-hour OGTT preimplementation compared with 33.1% postimplementation, but this was no longer a significant decrease ($p = 0.23$, aOR: 0.76 95% CI: 0.46–1.27; ►Fig. 2)

Discussion

The results of this study demonstrate that implementing a routine FBG negatively impacts the likelihood of GDM patients obtaining the gold standard postpartum OGTT as a screen for glucose intolerance postpartum. Our postimplementation group had a nearly 40% reduction in the completion of the gold standard 2-hour OGTT when compared with the preimplementation group. This difference, however, was no longer significant when excluding patients who would have obtained a 2-hour OGTT during the COVID-19 pandemic.

In patients with GDM in pregnancy, there have been several research efforts to improve screening for glucose intolerance postpartum. Efforts to improve compliance with the 2-hour OGTT, including electronic reminder systems, education programs, and calling patients, have only led to modest increases in compliance and are labor intensive.[11–13] Investigators have also initiated screening tests while in the hospital, including an immediate FBG or 2-hour OGTT,[14–17] concluding this is a feasible option for screening. Our retrospective study evaluates a new prospective, however, that initiating these inpatient tests could affect compliance with the gold standard screening test.

One hypothesis for the decrease in our primary outcome was that implementing the FBG could provide patients with false reassurance of normal glucose tolerance, and therefore, they were less likely to complete the standard 2-hour OGTT. Another hypothesis is that this decrease was due to the COVID-19 pandemic creating barriers to routine care. A recent retrospective cohort study analyzing the use of telehealth in the postpartum period recently demonstrated that there was no significant difference in the completion of the standard 2-hour OGTT during the COVID-19 pandemic.[19] Therefore, the lack in significant reduction of completion in our subgroup analysis could be due to the smaller cohort and we were simply underpowered to show a significant difference.

To explain the decrease in our primary outcome, further studies need to be performed on patients' perceptions of an immediate inpatient FBG. In addition, patient education with implementation of the FBG or other inpatient tests, and patients' opinion of the importance of routine glucose intolerance testing, should be investigated.

Strengths of this study include its diverse study population and large sample size. It is also unique in its goal to determine if initiation of an immediate hospital screening test to detect persistent hyperglycemia in the immediate postpartum period can affect the compliance with the gold standard outpatient postpartum test. This study also has several limitations. This was a single-center retrospective study and although our population is diverse may not be generalizable to other centers. Second, as our postimplementation period overlapped

with the COVID pandemic, a sensitivity analysis to account for this resulted in a significantly smaller cohort, making it more difficult to draw significant conclusions about our primary outcome. Finally, we chose to include patients who completed a 2-hour OGTT up to 1 year postpartum. Providers may have elected to perform a different screening test for glucose intolerance during this period and that measurement is not captured in this study.

Race was associated with both exposures and outcomes in our study. Specifically, more Black patients were diagnosed with GDM in our post-implementation group, and they were less likely to perform a 2-hour OGTT. Thus, race is likely a marker for other social determinants of health that could affect health care utilization which were not measured in this study. These social determinants may have become more prominent during the COVID-19 pandemic.

In patients with GDM in pregnancy, postpartum screening for impaired glucose metabolism is vital to delay the progression to or prevent the development of T2DM in their lifetime. Unfortunately, in our study population, only 30% of patients completed the interval 2-hour OGTT, which is consistent with previous research.[5,9,10] In our postintervention group, 64% of patients completed an immediate postpartum FBG. This validates the idea that to increase compliance with screening, consideration should be given to screening prior to hospital discharge. Further, in a recent prospective cohort study, a 2-day postpartum 2-hour OGTT was performed and had similar diagnostic value as the gold standard 4- to 12-week postpartum glucose tolerance tests in predicting impaired glucose metabolism and diabetes at 1 year after delivery.[14] Through incentives, the 2-day OGTT was completed in 99% of their study population. Future work will assess implementation of the inpatient postpartum 2-day OGTT, as well as evaluate whether a postpartum FBG might be used as a screening tool in place of the standard 2-hour OGTT.

Conflict of Interest

None declared.

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