OBSTETRICS

A system-based intervention to improve postpartum diabetes screening among women with gestational diabetes

Kimberly K. Vesco, MD, MPH; Patricia M. Dietz, DrPH, MPH; Joanna Bulkley, PhD; F. Carol Bruce, BSN, MPH; William M. Callaghan, MD, MPH; Lucinda England, MD, MSPH; Terry Kimes, MS; Donald J. Bachman, MS; Karen J. Hartinger, RN; Mark C. Hornbrook, PhD

OBJECTIVE: We sought to determine whether our process improvement program led to increased postpartum diabetes screening rates among women with gestational diabetes mellitus (GDM).

STUDY DESIGN: In early 2009, we conducted obstetrics department staff education sessions, revised GDM patient care protocols, and developed an electronic system to trigger reminder calls to patients who had not completed diabetes mellitus screening by 3 months postpartum. We then evaluated the rates of postpartum glucose test order entry and completion for women with GDM delivering from July 2009 through June 2010 (n = 179) and July 2007 through June 2008 (n = 200).

RESULTS: After the program's implementation, the proportion of women receiving an order for a postpartum glucose test within 3 months of delivery increased from 77.5-88.8% ($P = .004$), and test completion increased from 59.5-71.5% (hazard ratio, 1.37; 95% confidence interval, 1.07–1.75).

CONCLUSION: Rates of postpartum diabetes testing can be improved with system changes and reminders.

Key words: gestational diabetes, postpartum, reminders, screening

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Women who have had gestational diabetes mellitus (GDM) have a 35-60% risk of developing diabetes mellitus in the next 10-20 years.[1] In the immediate postpartum period, up to 10% of women who had GDM will be diagnosed with diabetes and an additional 12-36% will have impaired fasting glucose or impaired glucose tolerance.[1,2] Postpartum screening of women with pregnancies complicated by GDM is recommended by both the American Congress of Obstetricians and Gynecologists[3] and the American Diabetes Association[4] to identify women with glucose abnormalities and provide appropriate counseling and referrals. Previous studies of postpartum diabetes screening among women with GDM-affected pregnancies have noted test completion rates ranging from 14-61%.[5-7] In a previous study at Kaiser Permanente Northwest (KPNW), we used electronic medical record data to evaluate the proportion of women with a GDM-affected pregnancy who received an order for a postpartum fasting glucose or oral glucose tolerance test (OGTT) and the proportion of women with GDM who completed a postpartum glucose test. We found that 79% of affected women received an order for a postpartum glucose test, but only 58% of the women completed screening.[6] Order receipt and test completion rates varied substantially by clinical practice site within KPNW; order receipt rates ranged from 29–94% and test completion rates among women who received an order ranged from 42–85%, suggesting some clinics could improve their postpartum order entry and test completion rates with additional training and improvements in clinical systems.

In an effort to improve postpartum screening rates within the KPNW health system, we implemented a 2-tiered process improvement program. The first step targeted obstetrics department staff (clinicians, nurses, and medical assistants) with the goal of increasing both order entry and postpartum test completion rates within the first 90 days of delivery. The second step directly targeted

From the Center for Health Research, Northwest/Hawaii/Southeast, Kaiser Permanente Northwest, Portland, OR (Drs Vesco and Bulkley, Ms Kimes, Mr Bachman, Ms Hartinger, and Dr Hornbrook), and the Division of Reproductive Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, GA (Drs Dietz, Callaghan, and England, and Ms Bruce).

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Reprints: Kimberly K. Vesco, MD, MPH, Center for Health Research, Kaiser Permanente Northwest, 3800 N. Interstate Ave., Portland, OR 97227-1110. Kimberly.k.vesco@kpchr.org.

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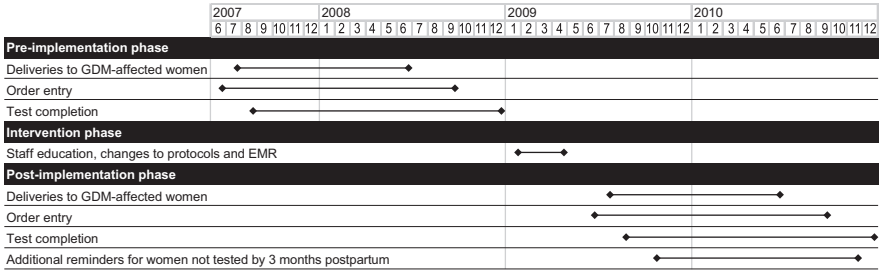
FIGURE 1
Project timeline by calendar month (June 2007 through December 2010)



EMR, electronic medical record; *GDM,* gestational diabetes mellitus.

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women with GDM-affected pregnancies who had not completed testing within the first 90 days to further improve the rate of postpartum testing beyond the immediate postpartum period. This manuscript describes our process improvement project and results of postpartum diabetes testing before and after implementation. Our objective was to determine whether our process improvement program increased the number of women who received orders for testing and the number who completed testing.

Materials and Methods

KPNW GDM care

KPNW is a large, nonprofit, prepaid, federally certified, Joint Commission–accredited, group practice health maintenance organization with 470,000 members in western Oregon and Washington state. Most members receive prenatal care at 1 of 8 practice sites; 1 site serves as a maternal-fetal medicine referral practice. Screening for GDM is a component of usual care for pregnant women at KPNW. During the study period (June 2007 through December 2010), the standard of care was to screen all pregnant women between 24-28 weeks' gestation with a 50-g, 1-hour glucose challenge test (GCT). Screening is also performed in early pregnancy for women with risk factors such as previous history of GDM. Those with 1-hour values ≥130 mg/dL are offered a 100-g, 3-hour OGTT. In the preintervention period (deliveries occurring July 2007 through June 2008), the National Diabetes Data Group (NDDG) criteria (fasting glucose >105 mg/dL, 1-hour >190 mg/dL, 2-hour >165 mg/dL, 3-hour >145 mg/dL) were used to establish a laboratory diagnosis of GDM.[3] Standard clinical practice at that time was to diagnose a woman as having GDM if she had a fasting glucose >105 mg/dL alone, any 2 abnormal values on the 3-hour OGTT, or a 1-hour GCT ≥200 mg/dL. During the postintervention period (deliveries occurring July 2009 through June 2010), KPNW switched to the Carpenter and Coustan cut-points (fasting glucose >95 mg/dL, 1-hour >180 mg/dL, 2-hour >155 mg/dL, 3-hour >140 mg/dL) for the 3-hour OGTT.[3] Because the switch occurred midway during our postimplementation period, we considered only NDDG cut-points and the results of the 1-hour GCT for establishing the diagnosis of GDM for this analysis.

Within KPNW, a fasting plasma glucose (FPG) test is the usual method of postpartum screening for diabetes mellitus; however, clinicians may order a 2-hour OGTT if they prefer.

Design

We used a pre-/postintervention design to assess the efficacy of our process improvement project. The study included 3 main periods from June 1, 2007, through Dec. 31, 2010: preimplementation (June 1, 2007, through Dec. 31, 2008), implementation (Jan. 1, 2009, through May 31, 2009), and postimplementation (June 1, 2009, through Dec. 31, 2010). Figure 1 outlines the study design. The preimplementation cohort included all women with GDM-affected pregnancies who delivered from July 1, 2007, through June 30, 2008. The postimplementation cohort included all women with GDM-affected pregnancies who delivered from July 1, 2009, through June 30, 2010. The implementation phase was from Jan. 1, 2009, through May 31, 2009, during which time provider education (Jan. 1, 2009, through April 1, 2009) and system changes took place.

Process improvement intervention

The goal of the project was to increase the proportion of women for whom a postpartum glucose test was ordered (provider behavior) and to increase the proportion of women who completed the screening test (patient behavior). We employed multiple strategies including revising the nursing protocol for care of pregnant women with GDM, enhancing the electronic medical record system, educating clinical staff, and providing additional reminders to women who did not complete the test within 3 months of delivery.

The GDM nurse protocol was revised as part of our project to allow the GDM nurse care managers to place the order for the postpartum FPG, increasing the likelihood for order placement. As an enhancement to the electronic medical record system, we revised electronic order entry sets (a set of commonly placed orders that have been grouped together for quick identification and order entry) for women with diabetes (used primarily by nurses and clinicians) and for women attending postpartum visits (used primarily by clinicians and medical assistants) to include a check box for the postpartum fasting glucose testing as a reminder to order the FPG for women with GDM. In addition, the postpartum order entry set was revised to trigger a second reminder to clinicians to order a test or remind women to complete the test. During the intervention period, all GDM nurse care managers were encouraged to make at least 1 postpartum reminder call.

Staff education

After revision of the protocol and electronic order entry sets, the first author (K.K.V.) gave a series of presentations on postpartum screening for women with

recent GDM at regional department and local clinic meetings. In addition, a half-day diabetes training program was provided to the obstetrics department nursing staff. We also provided the clinic staff a handout to give to women with GDM that describes the importance of follow-up screening and the long-term risks of developing diabetes mellitus.[8]

Additional screening reminders

The intervention included development of an electronic algorithm that automatically searched the electronic data systems and created a list identifying women who had not completed their glucose test by 3 months postpartum. We set an a priori goal for our GDM nurse care manager (K.J.H.) to call each woman who appeared on the tracking list up to 3 times to remind her to go to the laboratory to complete her screening. If after the third attempt the patient could not be reached, our nurse would send her an e-mail if she had an active e-mail account, otherwise, she would send a letter by US mail. All attempts to contact participants ended 1 month prior (Nov. 30, 2010) to the end of the follow-up period (Dec. 31, 2010).

Process and outcome evaluation

We evaluated the intervention process by assessing the proportion of the obstetrics department staff (medical assistants, nurses, and clinicians) that attended at least 1 educational meeting and we collected and summarized satisfaction ratings of the attendees regarding the presentations. The date and type (telephone contact, letters, e-mails, and verbal in-person reminders) of all glucose test screening reminders were abstracted from medical records. Reminders were categorized as occurring within the first 3 months after delivery or >3 months' postpartum.

Two main outcomes were evaluated: (1) clinician orders for either a fasting blood glucose test or 2-hour 75-g OGTT placed from 1 month before through 3 months after delivery; and (2) completed fasting glucose or 2-hour OGTT tests performed between 14 days after delivery and Dec. 31, 2008, for the preimplementation period and Dec. 31, 2010, for the postimplementation period. Test re-

TABLE 1
Characteristics of women with gestational diabetes mellitus–affected pregnancy

Chracteristic	Preimplementation period, n = 200, %	Postimplementation period, n = 179, %	*P* value[a]
Method of diagnosis			
1-h OGCT >200 mg/dL	14.0	12.3	.89
2 abnormal values on 3-h OGTT	63.5	64.8	
Fasting glucose >105 mg/dL	22.5	22.9	
Timing of test during pregnancy			.76
<20 wk' gestation	14.5	13.4	
≥20 wk' gestation	85.5	86.6	
Prepregnancy BMI			
<25.0	25.0	24.0	.83
25.0-29.9	21.5	24.0	
≥30.0	41.5	38.0	
Missing	12.0	14.0	
Age, y			.19
<35	70.0	63.7	
≥35	30.0	36.3	
Parity			.63
0	41.5	38.0	
1	28.0	31.8	
≥2	29.5	27.9	
Unknown	1.0	2.2	
Race/ethnicity			.27
Non-Hispanic white	51.5	46.9	
Black/other	7.5	3.9	
Hispanic	9.5	12.9	
Asian	17.0	16.2	
Missing	14.5	20.1	
English not primary language			.66
Yes	13.5	15.1	
No	86.5	84.9	
Nutrition visit during pregnancy			.09
Yes	75.5	82.7	
No	24.5	17.3	
Insulin or glyburide during pregnancy			.07
Yes	26.0	34.6	
No	74.0	65.4	

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TABLE 1
Characteristics of women with gestational diabetes mellitus–affected pregnancy *(continued)*

Chracteristic	Preimplementation period, n = 200, %	Postimplementation period, n = 179, %	*P* value[a]
Initiated prenatal care in first trimester			.69
Yes	84.0	85.5	
No	16.0	14.5	
Attended postpartum clinic visit			.93
Yes	92.5	92.7	
No	7.5	7.3	
Site of postpartum clinic visit			.25
Clinic 1	22.5	26.3	
Clinic 2	7.0	8.4	
Clinic 3	9.0	9.5	
Clinic 4	18.5	15.1	
Clinic 5	11.0	4.5	
Clinic 6	8.5	9.5	
Clinic 7	13.0	14.5	
Other clinic or non-KP provider	3.0	5.0	
No visit/no clinic	7.5	7.3	
Infant birthweight >4000 g			.67
Yes	10.5	13.4	
No	85.0	82.7	
Missing	4.5	3.9	

BMI, body mass index; *KP,* Kaiser Permanente; *OGCT,* oral glucose challenge test; *OGTT,* oral glucose tolerance test.

[a] χ^2 *test for independence.*

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sults were defined as normal (fasting <100 mg/dL or 2 hours after a 75-g glucose load <140 mg/dL), impaired (fasting 100-125 mg/dL or 2-hour 140-200 mg/dL), or diabetes (fasting >125 mg/dL or 2-hour >200 mg/dL). For women who had both a fasting and a 2-hour glucose test, the most abnormal result of the 2 is reported.

We compared women in both study periods by demographic and clinical characteristics. Prepregnancy body mass index, maternal age, parity, race/ethnicity, the woman's primary language (English, yes/no), having a clinical visit with a nutritionist during pregnancy, use of insulin or glyburide during pregnancy, trimester of entry into prenatal care (initiated prenatal care in first trimester, yes/no), having a postpartum visit within 3 months of delivery, practice site where the woman received her postpartum visit, and infant birthweight (>4000 g, yes/no) were obtained from KPNW electronic medical records.

Differences in pre- and postimplementation cohort characteristics were assessed using *t* tests and χ^2 tests for independence. The primary independent variable was the period (preimplementation vs postimplementation). Cox proportional hazards models were used to evaluate test completion. None of the tested covariates was significantly related to period. Therefore, testing of the intervention effect on orders placed and tests completed was done without controlling for covariates. For Cox models, the time variable was calculated as time from the date of delivery to the date of test completion. Women who did not complete glucose testing were censored at the end of their respective study periods (Dec. 31, 2008, for preimplementation and Dec. 31, 2010, for postimplementation), or at the date a new pregnancy was identified, or at time of discontinuation of insurance coverage through KPNW if these occurred first.

We used software (SAS, version 9.2; SAS Institute Inc, Cary, NC) for all statistical programming. This study was approved by the institutional review boards of the Centers for Disease Control and Prevention and KPNW.

RESULTS

Staff education

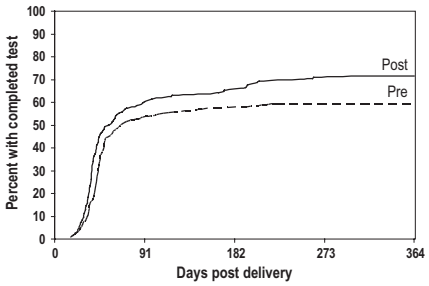
Approximately 72% (64/89) of clinicians, 90% (45/50) of registered nurses, and 66% (35/53) of medical assistants within the obstetrics department attended at least 1 education meeting. Mean satisfaction with the educational meetings was 4.82 (SD = 0.39) on a scale of 1 (poor) to 5 (outstanding).

Primary outcome data

From the 5250 live and stillbirths occurring within the preimplementation period and the 4765 in the postimplementation period, we identified 379 women with GDM (n = 200 pre, n = 179 post), yielding a GDM prevalence of 3.8% in both periods. There were no significant differences in patient characteristics between the 2 time periods (Table 1).

During the preimplementation period, 77.5% of women with GDM received an order for postpartum glucose screening; this increased to 88.8% during the postimplementation period (P = .004). During the preimplementation period, 53.5% of women with GDM completed postpartum glucose screening within 3 months (92 days) of delivery. This rate increased to 60.3% during the postimplementation period, although the increase was not statistically significant (P = .18). However, with the second round of reminders, there was an additional increase in test completions, yielding, by the end of the follow-up, an overall higher proportion of completed tests between the pre- and postimplementation periods (59.5% vs 71.5%,

FIGURE 2
Patterns of test completion by implementation period



Solid line, postimplementation period; *broken line,* preimplementation period.

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P = .01). The Cox model showed a higher rate of test completion (hazard ratio, 1.37; 95% confidence interval, 1.10–1.70) among women in the postimplementation study period compared with women in the preintervention. Figure 2 demonstrates the pattern of test completion for both study periods. The longest time from delivery to test completion was 223 days in the preimplementation and 321 days in the postimplementation periods.

Over the entire study period, the proportion of women who received at least 1 reminder to complete a postpartum glucose test was higher for the postimplementation group (159 of 179, 89%) compared to the preimplementation group (154 of 200, 77%, P = .002). A similar pattern was seen for reminders provided <3 months postpartum (82% vs 71%, P = .016) as well as for reminders provided >3 months postpartum to women who had not yet completed a test (59% vs 27%, P < .0001) (Table 2). The types of reminders provided to women in the first 3 months postpartum did not differ between the pre- and postimplementation groups (Table 2); however, in the postimplementation period, women not tested by 3 months postpartum were more likely to get a telephone call (22 of 71 women [31%] vs 3 of 93 women [3%], P < .0001) or letter or e-mail (25 of 71 women [35%], vs 0 of 93 women [0%], P < .0001).

Using data from women delivering in the postimplementation period, we found that the greatest yield for test completion was seen at the first reminder (80% of women who received 1 reminder completed the test). However, a continuing return for testing was observed even among women who required >1 reminder; 41% of women who received 2 reminders and 28% of women who received ≥3 reminders completed testing.

Of the 247 women who completed postpartum glucose testing, 238 (96%) completed a fasting glucose only and 9 (4%) completed a fasting and 2-hour glucose test. Of completed tests, 84% were normal, 14% had values consistent with impaired fasting glucose or impaired glucose tolerance, and 2% had values consistent with diabetes.

Comment

We hypothesized that education of staff and department-wide process changes would lead to both a significant increase in ordering of glucose tests for postpartum screening (provider behavior) and in increased glucose test completion (patient behavior). Our intervention resulted in a significant increase in glucose order placement. In fact, >90% of women delivering in the postimplementation period received a glucose test order. While the test completion rate appeared to be higher in the first 90 days after delivery for women in the postimplementation compared to preimplementation period, a statistically significant increase in postpartum testing was only observed after longer term follow-up. Evaluation of cumulative test completion shows an additional increase bump in testing after the first 3 months postpartum for women delivering in the postimplementation period that is not seen in the preimplementation period. Thus, it appears that the patient-focused component of our intervention (tracking test completion and providing a reminder to those who did not complete the test) augmented the provider-

TABLE 2
Number of reminders to women with gestational diabetes mellitus–affected pregnancy

	Reminders performed within 3 mo of delivery[a]			Reminders to women not tested by 3 mo after delivery		
Variable	Pre n = 200 n (%)	Post n = 179 n (%)	*P* value	Pre n = 93 n (%)	Post n = 71 n (%)	*P* value
At least 1 reminder of any type						
Yes	142 (71)	146 (82)	.016	25 (27)	42 (59)	< .0001
No	58 (29)	33 (18)		68 (73)	29 (41)	
No. of reminders by type						
≥1 telephone call	94 (47)	94 (53)	.28	3 (3)	22 (31)	< .0001
≥1 e-mail or letter	17 (9)	11 (6)	.38	0 (0)	25 (35)	< .0001
≥1 in-person reminder	71 (36)	70 (39)	.47	24 (26)	10 (14)	.07

[a] All gestational diabetes mellitus–affected women are included regardless of their test completion status.

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focused education and process changes we implemented.

We were not able to examine the independent effects of patient- and provider-directed reminders on test completion. This was explored in a randomized trial by Clark et al.[7] In that trial, reminders that glucose testing was due were mailed approximately 3 months after delivery to either the woman or her physician, to both, or to neither (no reminder), and test completion rates by 1 year postpartum were examined for each group. The highest rate of test completion was among the group in which both the woman and her clinician received a reminder (60.5%, compared to no reminder, 14.3%); however, patient-only reminders and physician-only reminders also increased testing (55.3% and 51.6%, respectively, completed testing, $\chi^2 = 22.3$; $P < .05$, for the 4-group comparison).[7]

Our preimplementation period test completion rates (59.5%) were similar to the test completion rates in the highest intensity intervention group (reminders to both women and physicians) in the study of Clark et al[7] (60.5%). This is likely due to systems in place in KPNW prior to our intervention. In our initial retrospective cohort study,[6] we found postpartum glucose test completion increased substantially from 9% in 1999 to 57.8% in 2004, an improvement which corresponded with the implementation of our first GDM nurse care manager protocol. Both our study and the study by Clark et al[7] found that reminders to both physicians and patients were effective for increasing test completion rates. Furthermore, our study findings suggest that >1 round of reminders may be needed, with a second round occurring beyond the first 90 days after delivery.

The results of our study should be (or are likely to be) generalizable to other health care systems of insured women that use electronic medical records. While our processes could be applied in clinics caring for women without health insurance, they may not yield the same results, as there could be additional financial or social barriers to testing for the uninsured population beyond the 6-week postpartum visit. In addition, several components of our process improvement project utilized our electronic medical record and electronic order entry systems not universally available in patient care settings across the United States.

As this study was conducted as part of a Plan-Do-Study-Act quality improvement cycle within a dynamic health system, we experienced many difficulties that could be expected to occur in a real-world setting. For example, it was difficult to reach all members of our obstetrics department for training through educational meetings. While online education could increase accessibility to the content, it does not provide the same opportunity for group discussion, shared learning, and social reinforcement. Events occurring within the health care system, such as changes in staffing among GDM care managers and the switch from NDDG to Carpenter and Coustan cut-points, both of which increased the GDM care managers' case loads, made follow-up telephone calls to women with GDM more difficult. However, despite these limitations, we demonstrated that a multilevel approach including provider education and electronic provider and patient reminder systems can improve postpartum diabetes testing rates in women with GDM, if patient reminders are extended >90 days after delivery. We have also provided a good example of the use of the Plan-Do-Study-Act cycle for leading to system change and improved health care service delivery in the field of obstetrics. ■

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