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Referral to telephonic nurse management improves outcomes in women with gestational diabetes

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Abstract

Objective—To determine whether, among women with gestational diabetes (GDM), referral to a telephonic nurse management program was associated with lower risk of macrosomia and increased postpartum glucose testing.

Study Design—There was medical center-level variation in the percent of patients referred to a telephonic nurse management program at 12 Kaiser Permanente medical centers, allowing to examine in a quasi-experimental design the associations between referral and outcomes.

Results—Compared with women from centers where the annual proportion of referral nurse management was <30%, women who delivered from centers with an annual referral proportion >70% were less likely to have a macrosomic infant and more likely to have postpartum glucose testing [multiple-adjusted OR (95% CI): 0.75 (0.57–0.98) and 22.96 (2.56–3.42), respectively].

Conclusion—Receiving care at the centers with higher referral frequency to a telephonic nurse management for GDM was associated with decreased risk of macrosomic infant and increased postpartum glucose testing.

Keywords

gestational diabetes; macrosomia; nurse management; postpartum glucose screening

INTRODUCTION

Gestational diabetes mellitus (GDM) is defined as glucose intolerance first recognized during pregnancy.¹ Along with greater risk of macrosomia, GDM is associated with a high risk of postpartum glucose intolerance.² Therefore, management of women during their GDM pregnancy focuses on medical nutritional therapy, physical activity and glucose regulation to improve perinatal outcomes,³ while management of women after their GDM pregnancy ideally focuses on postpartum glucose screening and lifestyle modification.^{4;5} To

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date, few studies have considered how such management is best achieved; the majority of studies have focused on type of medication and the threshold for glycemic control.⁶

Among non-pregnant adults with diabetes, nurse-based management programs can improve intermediate measures such as hemoglobin A1c (HbA1c) levels⁷ and reduce urgent visits and hospitalizations.⁸ Such management may occur by telephone, as nurse-based telephone management programs may serve to offload care for primary providers^{4;9} without increasing physician visits.¹⁰

Among women with GDM, examinations of whether nurse-based programs improve perinatal outcomes and postpartum glucose screenings are few.^{11;12} None of these previous programs were based on telephonic counseling despite the fact that telehealth interventions have been shown to be highly effective means of supporting self-care in a variety of populations with diabetes^{13;14} and in multiple health care systems. Telephonic counseling may also be more cost effective and more accessible for women of reproductive age.

We examined whether referral to a nurse-based management program delivered via telephone counseling was associated with improved perinatal outcomes (represented by macrosomia and low birthweight infants) and a higher frequency of postpartum glucose testing among women with GDM.

MATERIALS AND METHODS

Setting

Kaiser Permanente Northern California (KPNC) is an integrated health care delivery system that provides comprehensive medical services to over 3 million members located in a 14-county region in northern California. The sociodemographic characteristics of KPNC membership closely approximate the general population ethnically and socioeconomically and represent approximately 30% of the general population in the geographic areas covered.¹⁵

We used data from the KPNC GDM registry to identify women who had a pregnancy complicated by GDM from 1997 to 2006. The registry used the KPNC hospital discharge and billing claim databases to identify all live births and stillbirths and referenced the KPNC laboratory database to obtain all plasma glucose values measured during screening glucose challenge tests (GCTs) and diagnostic 3-hour oral glucose tolerance tests (OGTTs). We restricted our cohort to women with GDM according to National Diabetes Data Group criteria¹⁶ (which were used for GDM diagnosis during the study period) who delivered between January 1, 1997 and December 31, 2006. During the study period, 96% of all pregnant women without pre-existing diabetes who delivered an infant were screened for GDM. We limited our study population to GDM women who delivered at 12 medical centers in the KPNC region that referred at least some patients during the study period. We excluded women who delivered multiple births due to their increased risk of perinatal complications. Overall, we identified 11,435 women with GDM at the 12 medical centers, of whom 44.5% were referred to the Perinatal Service Center.

Nurse-based management program

The KPNC Regional Perinatal Service Center is a nurse-based management program for women with GDM and which offers supplemental care via telephone counseling to women with high risk pregnancies, including those complicated by GDM, for the KPNC Region. The program includes a call center with 32 registered nurses and 2 registered dietitians who offer telephone counseling 7 days a week on glucose monitoring and control, diet, and physical activity. Through a 1—800 number, the nurses are available to patients 24 hours a

day, 7 days a week, while the dietitians are available to patients 8 a.m. to 8 p.m. 5 days a week. In addition to the care provided by obstetricians, women referred to the center receive 1–2 counseling calls per week to help them manage their blood glucose levels during pregnancy; women can initiate additional calls if needed. The center also sends a lab slip for postpartum glucose testing and a reminder telephone call if the screening test was not performed.

The KPNC Regional Perinatal Service Center's GDM program was first implemented in 1997 in 2 KPNC medical centers and gradually disseminated to 12 more KPNC medical centers. By 2006, the program was implemented in all KPNC medical centers. Due to the timeline for program implementation throughout the KPNC region, there was substantial medical center-level variation in the percent of GDM patients referred to the program. This quasi-experimental design allowed us to examine the association between referral to the program and infant adverse outcomes (such as macrosomia and low birthweight) and to measure processes such as women's postpartum glucose testing.

Infant Outcomes

Infant birthweight was obtained from the electronic medical record. Macrosomia was defined as birthweight $\geq 4,500$ grams. Low birthweight was defined as an infant weighing $< 2,500$ grams.

Postpartum Screening

Postpartum screening was defined as a fasting plasma glucose (FPG) or 75-gram, 2-hour OGTT performed during the postpartum period. This definition excluded testing performed during the first 7 days postpartum, since several weeks may elapse before glucose metabolism returns to normal in most women with GDM. Both the ADA¹³ and ACOG¹⁷ recommend that postpartum glucose screening be performed at 6 weeks postpartum or later. We considered the postpartum screening performed only if it was done during the first year after delivery.

Covariates

Age, race-ethnicity and maternal body weight measured during the beginning of the second trimester were ascertained from the computerized medical records. Use of insulin or glyburide during pregnancy was obtained from the electronic pharmacy database. Education was obtained by linkage with the state of California birth certificate database.

Early second trimester body weight was obtained from an electronic database which collected weights reported at the time of the alpha-feta protein test, performed between 9 and 20 weeks' gestation. Because we had data on body weight but not on height, a woman was considered obese if her weight was at or above the 90th percentile of the weight distribution of women of her race/ethnicity in this study population.

Statistical Analysis

In order to characterize medical center referral practices, we categorized each medical center's proportion of referrals according to the following pre-defined categories: $<30\%$, $30\text{--}70\%$, or $>70\%$ for each year. Subsequently a woman was classified according to the annual referral proportion of her medical center for the year she delivered. The chi-square test was used to assess differences in women's clinical characteristics by referral level.

Using the proportion from each woman's delivery year, we assessed the association between referral level and women's outcomes. The associations between annual referral proportion and outcomes of interest, with control for potential confounders, were examined via

hierarchical mixed effects logistic regression, with a random facility effect to account for the non-independence among women nested within facilities.

The medical center annual referral proportion was calculated for patients at each center and odds ratios (ORs) and 95% confidence intervals (CI) generated for the associations between category of medical center referral proportion to nurse management (<30%, 30–70% and >70%) and outcomes. Centers with referral proportions <30% were considered the reference group.

Models were adjusted for the following variables: maternal age (18–24, 25–34 and 35+ years), race-ethnicity (white, African American, Asian, Hispanic, other and missing), obesity (yes, no and missing), education (high school or less, some college, bachelor degree, graduate degree and missing); fasting plasma glucose (FPG) (continuous) and time period (1997–2001 and 2002–2006). We chose to adjust for FPG out of the 4 glucose measures available from the OGTT because the FPG association with macrosomia has been shown to be stronger than the associations observed with plasma glucose levels measured at the other time points of the OGTT.^{18–20}

This study was approved by the human subjects committee of the Kaiser Foundation Research Institute and the California State IRB.

RESULTS

At medical centers where the proportion of referrals to the telephonic nurse management program was greater than 70% at the time of delivery, women were more likely to be 35 years of age or older, of non-white race-ethnicity and obese. They were also more likely to have higher education and to have used glyburide during pregnancy. Women who were referred to the program also had slightly lower fasting, 1 hour and 2 hour glucose values during the 3-hour OGTT (Table 1).

Compared with patients with GDM from medical centers where the annual proportion of referrals to telephonic nurse management was less than 30%, patients from medical centers with an annual referral proportion greater than 70% at the time of delivery were less likely to have a macrosomic infant [OR (95% CI): 0.75 (0.57–0.98)] (Table 2). Women from medical centers with 30–70% of GDM patients referred were less likely to have macrosomic infants, however, this finding did not reach statistical significance [OR (95% CI): 0.72 (0.51–1.01)]. Women from medical centers with an annual referral proportion >70% at the time of delivery were slightly less likely to have a low birthweight infant when compared with women from medical centers with less than 30% of GDM patients referred, however, this finding did not reach statistical significance [OR (95% CI): 0.86 (0.65–1.14)].

The odds of having a postpartum glucose test increased with medical centers' referral levels. GDM patients who delivered from a medical center with an annual referral proportion of 30–70% were 67% (95% CI: 1.45–1.94) more likely to be tested and patients who delivered from medical centers with an annual referral proportion greater than 70% at the time of delivery were approximately 3 (95% CI: 2.56–3.42) times as likely to be tested compared to women from medical centers with referral proportions < 30% (Table 2).

COMMENT

Our results suggest that women receiving care at the medical centers with higher referral to a telephonic nurse management program for women with GDM was associated with a reduced likelihood of having a macrosomic infant without increasing the risk of having a low birthweight infant. Referral to such a program was associated with an increase in postpartum

glucose testing. Few evaluations of nurse management programs exist among women with GDM¹¹ and none of these programs used telephone counseling, despite the fact that telehealth interventions have been shown to be a highly effective means of supporting self-care in a variety of populations with diabetes^{13;14} as well as other diseases.⁹ In addition, telephonic counseling may be more convenient for women with young children.

Only one study has evaluated a nurse management program in relation to infant outcomes. Garcia-Patterson and colleagues compared perinatal outcomes in GDM women cared for by specially-trained nurses versus endocrinologists and found no significant differences in macrosomia.¹¹ Three studies have evaluated nurse referral or mailed reminders in relation to increased postpartum glucose screening among women with GDM. Hunt and Conway found that nurse case management was associated with increased postpartum glucose screening,²¹ while Clark and colleagues found that randomization to mailed reminders increased postpartum glucose screening.²² More recently, an in-person educational counseling session with a nurse educator was associated with a two-fold increase in postpartum glucose screening compared with usual care.¹² In our study, among medical centers with high annual referrals to the nurse management program, there was an approximately three-fold increase in postpartum glucose testing among women with GDM, compared to centers with low referral levels. Of GDM patients from centers with greater than 70% of patients referred to the program, 60% completed a postpartum glucose test, thus demonstrating similar²² and better¹² postpartum testing levels than previous postpartum screening interventions. Therefore, using a telephonic nurse management system may be a highly effective program that also serves to offload work for primary care providers.

This study has some noteworthy strengths. The progressive increase in the proportion of women with GDM referred to the telephonic nurse management program with variation by medical centers allowed us to evaluate the effectiveness of this program on macrosomia and postpartum glucose testing independently of possible trends in medical care and patient populations over time, given our ability to control for patient's demographic characteristics and time period. The use of the KPNC GDM registry, a comprehensive registry based on glucose testing, ensured that all women with GDM were included in the study, thus further reducing possible selection bias. Similarly, the use of the electronic medical record allowed a comprehensive assessment of outcomes, unbiased by participation rates. This study has also some limitations. The study was not a randomized controlled trial but rather used a quasi-experimental design. Although we carefully adjusted our analyses for possible confounders such as for age, race-ethnicity, obesity, education, and pregnancy glycemia, it is possible that there was some residual confounding due to individual level differences in patients across medical centers (i.e. lifestyle factors and adherence to medical therapy and recommendations) that we were unable to adjust for in these analyses. We also evaluated the effectiveness of the telephonic nurse management program at the health system level rather than at the individual patient level.

Increased use of the KPNC telephonic nurse management program for women with GDM was associated with decreased likelihood of having a macrosomic infant and increased postpartum glucose testing relative to prior provider-based programs. However, there is still a need to further improve postpartum glucose testing, given that women with GDM are seven times as likely to develop type 2 diabetes after pregnancy,² in order to identify those at higher risk who may benefit from diabetes prevention programs.^{5;23} This evidence suggests that telephonic nurse management programs have great potential to improve this aspect of care for women with GDM during and after pregnancy.

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Condensation: Referral to telephonic nurse management is associated with improved outcomes in women with gestational diabetes.

Table 1

Characteristics of women with gestational diabetes mellitus by the annual referral proportion to a telephonic nurse management program, Kaiser Permanente Northern California.

	Annual referral proportion <30% N =5,267 (46.1%)	Annual referral proportion 30–70% N =1,751 (15.3%)	Annual referral proportion >70% N =4,417 (38.6%)	P-value
Age (years)				<0.0001
< 18	76 (1.4%)	55 (3.1%)	68 (1.5%)	
18–34	3,239 (61.5%)	1,071 (61.2%)	2,561 (58.0%)	
35+	1,952 (37.1%)	625 (35.7%)	1,788 (40.5%)	
Race/ethnicity				<0.0001
White	1,670 (31.7%)	501 (28.6%)	1,105 (25.0%)	
African American	354 (6.7%)	80 (4.6%)	109 (2.5%)	
Asian	1,488 (28.3%)	432 (24.7%)	1,395 (31.6%)	
Hispanic	1,086 (20.6%)	502 (28.7%)	1,235 (28.0%)	
Other	380 (7.2%)	153 (8.7%)	471 (10.7%)	
Missing	289 (5.5%)	83 (4.7%)	102 (2.3%)	
Obese				0.002
Yes	378 (7.2%)	138 (7.9%)	281 (6.4%)	
No	3,332 (63.3%)	1,091 (62.3%)	2,683 (60.7%)	
Missing	1,557 (29.6%)	522 (29.8%)	1,453 (32.9%)	
Diabetes medications use during pregnancy				<0.0001
No Medications	4,109 (78.0%)	1,349 (77.0%)	3,252 (73.6%)	
Glyburide only	323 (6.1%)	209 (11.9%)	611 (13.8%)	
Insulin only	793 (15.1%)	169 (9.7%)	484 (11.0%)	
Both Glyburide and Insulin	42 (0.8%)	24 (1.4%)	70 (1.6%)	
Education				<0.0001
High school or less	2,037 (38.7%)	682 (38.9%)	1,615 (36.6%)	
Some college	1,458 (27.7%)	559 (31.9%)	1,125 (25.5%)	
Bachelor degree	882 (16.7%)	297 (17.0%)	985 (22.3%)	
Graduate degree	677 (12.9%)	189 (10.8%)	639 (14.5%)	
Missing	213 (4.0%)	24 (1.4%)	53 (1.2%)	
Infant birth weight <= 2500g	278 (5.3%)	81 (4.6%)	245 (5.5%)	0.34
Postpartum glucose test	1,445 (27.4%)	745 (42.5%)	2,631 (59.6%)	<0.0001

Plasma glucose levels obtained during the 3-hour OGTT	Mean (SD)	Mean (SD)	Mean (SD)	
Fasting, mmol/l	5.28 (0.93)	5.19 (0.86)	5.17 (0.83)	<0.0001
1-hour, mmol/l	11.70 (1.55)	11.58 (1.43)	11.55 (1.42)	<0.0001
2-hours, mmol/l	10.61 (1.67)	10.49 (1.57)	10.47 (1.49)	<0.0001
3-hours, mmol/l	7.62 (2.04)	7.64 (1.93)	7.60 (1.96)	0.73

The chi-square test was used to assess differences in women's clinical characteristics by referral level."

OGTT = oral glucose tolerance test

Table 2

Hierarchical models assessing the adjusted* odd ratios for the associations between annual referral proportion to telephonic nurse management for patients with GDM and outcomes.

	Annual referral proportion to telephonic nurse management		
	<30%	30–70%	>70%
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Macrosomia (Birthweight $\geq$ 4500g)	1.0	0.72 (0.51–1.01)	0.75 (0.57–0.98)
Birth weight $\leq$ 2500g	1.0	0.93 (0.69–1.27)	0.86 (0.65–1.14)
Postpartum glucose test	1.0	1.67 (1.45–1.94)	2.96 (2.56–3.42)

Data are generated from a hierarchical mixed effects logistic regression model, with a random facility effect to account for the non-independence among women nested within facilities.

* Adjusted for age, race-ethnicity, education, pregnancy fasting plasma glucose levels, obesity and calendar period.