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Who returns for postpartum glucose screening following gestational diabetes mellitus?

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Abstract

Objective—To determine the prevalence of postpartum impaired glucose regulation (IGR) and factors associated with glucose screening following gestational diabetes mellitus (GDM).

Study Design—A prospective cohort study of 707 women with GDM who delivered at University Hospital in San Antonio, Texas.

Results—35.5% of 400 women with any postpartum glucose testing had IGR postpartum. 40.6% of 288 women who completed an oral glucose tolerance test had IGR – one third of whom had isolated elevated 2-hour glucose levels. Women who failed to return for postpartum glucose testing (n=308) were more likely to report prior GDM, have higher diagnostic glucose levels, and require insulin during pregnancy than women who returned for postpartum glucose testing.

Conclusion—Women who returned for postpartum glucose testing had less severe GDM than women who failed to return, suggesting that the true prevalence of postpartum IGR may be even higher than identified in our population.

Keywords

Gestational Diabetes Mellitus; Postpartum Testing; Prediabetes

Introduction

Once diagnosed with gestational diabetes mellitus (GDM), a woman has a high chance of developing type 2 diabetes following delivery, with several studies reporting a 5 year cumulative incidence rate of over 50%¹. However, while women are often motivated when pregnant to improve their health and are able to control diabetes during pregnancy, in many

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Condensation

Women with GDM who returned for postpartum glucose screening (prevalence of abnormal glucose levels, 35.5%) had less severe GDM than women who failed to return.

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settings the majority of women with GDM fail to return for postpartum glucose testing despite clinical guidelines recommending such testing²⁻⁷. In an earlier study of women with GDM who delivered at University Hospital in San Antonio, Texas, only 18% returned for postpartum glucose testing². Therefore, to increase postpartum screening for diabetes during the current study period a case-manager nurse was utilized and a postpartum return rate of 57% was achieved.

Elevation in postpartum glucose levels that fall below the threshold to diagnose overt diabetes are strong indicators of future diabetes risk. Identifying women at high risk of diabetes postpartum provides an opportunity to delay or prevent the onset of overt diabetes with lifestyle modifications or medications⁸⁻¹². Preventing or delaying the onset of overt diabetes in women of child bearing age also protects future offspring from the harmful *in utero* effects of hyperglycemia, which is associated with birth defects, and predisposes offspring to increased risk of obesity and diabetes later in life^{13, 14}.

Why women with GDM fail to return for postpartum glucose screening is not well understood. Moreover, only a single study has examined the prevalence of impaired fasting glucose (IFG) and isolated elevated 2-hour glucose following GDM using the new IFG cut-point (100–125 mg/dL)¹⁵. Because the oral glucose tolerance test (OGTT) currently recommended following GDM requires two hours to complete, it is costly and inconvenient. Therefore, our aims were to compare characteristics of women who did and did not return for postpartum glucose screening, and to determine the prevalence and type of postpartum impaired glucose regulation (IGR) under a program designed to increase postpartum testing for diabetes mellitus.

Materials and Methods

The Diabetes in Pregnancy Program Study Population

The study population was composed of 707 women with GDM who delivered at University Hospital in San Antonio between March 29, 2001, and August 31, 2003. These women represent 93.5% of all women with GDM who delivered at our hospital during this time period. Women were excluded if they were not seen in our Diabetes in Pregnancy antenatal care program (n=42), or if they delivered twice during this time period (n=7). In these seven cases the pregnancy with postpartum information or the second pregnancy was retained. The study population is largely socioeconomically disadvantaged Mexican and Mexican American women. All participants received prenatal care at either the Diabetes in Pregnancy Program (95.9%) or at a private clinic staffed by faculty affiliated with University Hospital (4.1%). They were asked to return for glucose screening 6 weeks postpartum. The Institutional Review Board of the University of Texas Health Science Center at San Antonio approved prospective data collection on all patients with diabetes during pregnancy at the University Hospital in San Antonio, TX.

The diagnosis of GDM was made according to the criteria adopted by the Fourth International Workshop-Conference on Gestational Diabetes Mellitus¹⁶. All pregnant women were first screened for GDM with a 50 gram, 1-hour glucose challenge test, either at 24 to 28 weeks' gestation or on entry to prenatal care when risk factors for diabetes were present. Risk factors that led to early screening included a history of GDM; a first-degree relative with diabetes; a history of having had a macrosomic, stillborn, or anomalous infant; and a body mass index (BMI) greater than 29 kg/m². Glucose challenge test values greater than or equal to 130 mg/dL were considered abnormal and prompted performance of a 100 gram 3-hour oral glucose tolerance test (OGTT). Women having two or more abnormal values during their three hour OGTT using the following cut-points were considered to have GDM: fasting glucose level ≥ 95 mg/dL, 1-hour glucose level ≥ 180 mg/dL, 2-hour glucose level ≥ 155 mg/dL and 3-hour glucose level ≥ 140 mg/dL. Plasma glucose levels were measured at the hospital laboratory using the

hexokinase method. All participants performed self monitored blood glucose readings, and insulin initiation and glycemic control during pregnancy were managed according to stringent guidelines¹⁶.

To increase postpartum screening for diabetes during the study period a case-manager nurse followed the GDM patients. The nurse instructed patients on the importance of follow-up testing and the life-long risk of diabetes, collected contact information, including information on a secondary contact person, and facilitated postpartum testing. The nurse had three contacts with patients prior to postpartum testing: the first at the clinic during the third trimester, the second at the hospital during delivery and the third postpartum by mail and/or telephone. All women with GDM were instructed to undergo a postpartum OGTT 4 to 6 weeks after their delivery date, and were provided with laboratory requisition slips when they were dismissed from the hospital following delivery. Failure to accomplish this testing by the time of the routine postpartum examination triggered an additional contact by the case manager nurse. When women indicated that they were unable to come in for postpartum testing, the case-manager nurse provided in-home glucose testing using an oral glucose load bought from the hospital laboratory. During in-home glucose testing blood samples were drawn and plasma was assayed in the hospital laboratory.

Information Collected

During prenatal exams and at delivery medical information pertaining to a participant's current pregnancy and delivery were collected. The majority of women diagnosed with GDM (96.0%) completed both a 50 gram 1-hour glucose challenge test (GCT) and a 100 gram 3-hour OGTT. Area under the glucose curve (AUC_{glucose}) for the oral glucose tolerance test was calculated using the trapezoid method with the fasting value as basal value. Information on gestational age when GDM was first tested, gestational age when GDM was first diagnosed, and medication required to treat GDM was collected. Pre-pregnancy weight was either self-reported ($n = 692$) or in a few cases ($n = 10$) measured during the first trimester of pregnancy. Pre-pregnancy body mass index (BMI) was calculated based on pre-pregnancy weight and measured height. Weight gain during pregnancy was calculated as delivery weight as measured at admission minus pre-pregnancy weight. Information on compliance and control of GDM was obtained from maternal self-monitoring with a memory-reflectance meter. Women were instructed to monitor their glucose 7 times a day, routinely collecting information on fasting, pre- and 2-hour post-prandial glucose levels. Information on whether or not the mother had pre-eclampsia, gestational age at delivery and the infant's birth weight was also recorded.

Demographic information collected included self-reported ethnic group and number of living children. Information on medical history collected included family history of diabetes, previous GDM or previous delivery of an infant with macrosomia.

Diabetes was defined as fasting glucose ≥ 126 mg/dL and/or 2-hour postload glucose ≥ 200 mg/dL¹⁷; for clinical purposes, the diagnosis was confirmed by testing on a subsequent day, and all diagnoses were confirmed. Impaired glucose tolerance (IGT) was defined as a 2-hour glucose level of 140–199 mg/dL¹⁷, and IFG was defined as fasting plasma glucose level of 100–125 mg/dL¹⁸. IGR was defined as having IFG, IGT or diabetes.

Statistical Analysis

A cross-sectional analysis was completed in which clinical information collected during an individual's pregnancy and delivery was compared in women who did and did not receive postpartum glucose screening using two-tailed t test and the chi-squared test. In addition, among women who completed postpartum glucose screening the prevalence and type of postpartum IGR were determined stratified by whether or not an OGTT was completed.

Results

Of the 707 women in our study population 400 (57%) returned for postpartum glucose screening, 288 who completed a 75 gram 2-hour OGTT and 112 who had only fasting glucose levels measured. Moreover, although the clinical protocol was to complete postpartum glucose screening 4 to 6 weeks post delivery, only 19.8% of the 400 participants who completed screening completed it within this timeframe. The majority (59.3%) of women who completed glucose screening completed it by 8 weeks postpartum and 94.3% completed it by 12 weeks postpartum.

Participant characteristics, stratified by whether or not a woman returned for postpartum glucose screening, are found in Table I. Women who returned for postpartum glucose screening were a similar age, but had fewer living children and were more likely to be Mexican American than women who failed to return for postpartum glucose screening. Moreover, women who failed to return for postpartum glucose screening had higher fasting glucose levels at diagnosis of GDM (99 versus 95 mg/dL), weighed more prior to pregnancy (165 versus 158 pounds) and were more likely to have a history of GDM (29.0% versus 18.0%), require medication to treat their GDM (28.3% versus 19.5%) and require insulin to treat their GDM (19.9% versus 10.3%) than women who returned for postpartum glucose screening. Regarding compliance and control of GDM, women who failed to return self-monitored their glucose levels similarly to women who returned (4.2 versus 4.4 times per day), but their mean fasting, pre- and post-prandial glucose levels were higher indicating tighter control of GDM among women who returned for post-partum glucose testing.

Women who completed an OGTT postpartum were a similar age, had a similar number of living children and were equally likely to be Mexican American as women who had only fasting glucose levels measured postpartum. Women who completed an OGTT postpartum were similar to women who had only fasting glucose levels measured postpartum with the exception of a lower prevalence of a history of macrosomia (15.7 versus 25.9%, p -value < 0.05), a higher 2-hour glucose level at diagnosis of GDM (174 versus 167 mg/dL, p -value < 0.05), a higher AUC_{glucose} (12.4 versus 11.4 g·min/dL, p -value < 0.01) and tighter control of GDM as indicated by lower fasting (82 versus 85 mg/dL, p -value < 0.05), pre- (85 versus 88 mg/dL, p -value < 0.05) and post-prandial (98 versus 102 mg/dL, p -value < 0.05) glucose levels obtained from self-monitoring.

Of the 288 women who completed a 75 gram 2-hour OGTT postpartum 13 (4.5%) had diabetes, 37 (12.8%) had isolated IGT, 54 (18.8%) had isolated IFG and 13 (4.5%) had both IGT and IFG. In summary, of the women with a post-partum OGTT with IGR, 35.0% (41 of 117) had isolated elevated 2-hour glucose levels (either IGT or diabetes) and normal fasting glucose levels. Of the 13 women with postpartum diabetes, 9 (69.2%) had fasting glucose levels below 126 mg/dL: 5 met the criteria for IFG and 4 had normal fasting glucose levels. Of the 112 individuals who had only fasting glucose levels measured postpartum 4.5% had diabetes and 17.9% had IFG. Combined, of the 400 women who had postpartum glucose testing 35.5% had documented IGR.

Women who failed to return for postpartum glucose screening were more likely to have glucose levels indicative of type 2 diabetes (i.e., fasting glucose ≥ 126 and/or 2 hour glucose ≥ 200) at their GDM diagnostic 100 gram 3-hour OGTT than women who returned for postpartum glucose screening (27.4% versus 17.1%). Of the 151 women with glucose levels indicative of type 2 diabetes, postpartum 52 (34.4%) completed an OGTT while 16 (10.6%) had only fasting glucose levels measured. Twenty eight (53.9%) of the 52 women who completed a 75 gram 2-hour OGTT postpartum had IGR postpartum.

Comment

Our study of a case-manager program to enhance detection of postpartum glucose intolerance in women with GDM reveals two principle findings: first, those women who failed to return for post-partum glucose screening had more severe GDM than women who did not return. Women who failed to return were more likely to have previously had GDM, had higher pre-pregnancy weight and higher point estimates for all glucose levels at diagnosis of GDM, were more likely to require medication and specifically insulin to treat their GDM, and had less control of their GDM than women who returned for post-partum glucose screening. Our second principal finding was the high prevalence of isolated elevated 2-hour glucose levels (either IGT or diabetes) with normal fasting glucose values, even using the new lower cut-point for IFG of 100 mg/dl. Of the women with a post-partum OGTT with IGR, approximately one-third had abnormalities of the 2-hour value alone: 31% (4 of 13) of the women with diabetes and 35% (41 of 117) of those with IGR; therefore, if only fasting glucose levels were obtained a substantial proportion of women with IGT would not be identified.

Our results are similar to results recently published by Russell et al who report that only 45% of women with GDM in their multi racial/ethnic cohort of 344 women underwent postpartum glucose testing of whom 36% had IGR postpartum¹⁵. However, in contrast to our results the only factor they identified as being strongly associated with postpartum glucose testing was attendance at the postpartum visit¹⁵.

The prevalence of IGR immediately following GDM was high in our population; over one third of the women who returned for post-partum screening (fasting only or a complete OGTT) had IGR. Moreover, this likely underestimates the true prevalence of IGR following GDM in our population because markers for GDM severity were lower in women that returned than in women who failed to return, and an OGTT was not completed by all study participants. Explanations for the high prevalence of IGR in our study include the change in the cut-point for IFG from 110 mg/dl to 100 mg/dl as well as the high background risk of type 2 diabetes in our predominantly Mexican and Mexican American study population¹⁹.

The high rate of IGR we found in the current study also appears to represent an increase over the previously detected rate of IGR within our own population². From 1995–1997, approximately 28% of the women who returned to our clinic met the criteria for IGR based on 1997 ADA criteria²⁰. The cohort of women represented in that study was substantively different from the more recent cohort described in the current paper only in the degree of effort made to ensure follow-up testing, and therefore the resultant follow-up testing rate (18% versus 57% respectively). This would appear to corroborate our current finding that it is the women at highest risk who do not return for testing.

Recently, the Diabetes Prevention Program was one of several clinical trials to indicate that either through diet and exercise, or with the aid of a pharmacological agent, it was possible to lower the incidence or delay the onset of diabetes among individuals at high risk of the disease^{8–12}. Hence, the optimum way to reduce the risk associated with diabetes may be preventing diabetes itself, either by altering lifestyle, or by using pharmacologic agents. The burden of diabetes is especially high in women who acquire it at a young age, such as those with IFG or IGT in the early postpartum period following GDM.

Reducing the incidence of type 2 diabetes following GDM also reduces the inherent risks to future offspring of exposure to a diabetic intrauterine environment. Early in pregnancy uncontrolled type 2 diabetes is associated with increased risk of congenital malformations and spontaneous miscarriages. In a study in the UK, 9.9% of women with uncontrolled type 2 diabetes had an infant with a congenital malformation, an 11-fold greater risk than the national statistics report²¹. In a study of Hispanic women who had NIDDM in southern California

11.7% of infants were born with major congenital anomalies compared to 2% in the background non-diabetic population²². In that study, the only independent predictor of anomalies was the A1C value in the first trimester, emphasizing the importance of recognition of the diabetic state prior to and early in pregnancy. In addition, maternal diabetes during gestation has been associated with high birth weight, increased childhood and adult obesity, increased risk of type 2 diabetes, and earlier onset of type 2 diabetes in the offspring^{23–29}.

Moreover, children exposed *in utero* to maternal diabetes are at higher risks of obesity and diabetes than their unexposed siblings, suggesting that the increased risk to the exposed offspring is not exclusively genetic, nor affected exclusively by post-natal exposures, such as family nutritional practices^{30, 31}.

Our population is over 90% Mexican American women; therefore, the results may not apply to women in the general U.S. population. However, Mexican Americans comprise 60% of Hispanics in the U.S. and Hispanics are the fastest growing and largest ethnic minority group³². Mexican Americans are not only more likely to have diabetes, but their diabetes is more severe^{33, 34} and they have higher cardiovascular mortality risk^{35–37} than non-Hispanic whites. Evidence from NHANES III, the San Antonio Heart Study, and a study of school aged children in San Antonio suggests that the prevalence of obesity and diabetes is rapidly increasing in Mexican Americans^{19, 38–42}. Hence, it is imperative that diabetes research include the Mexican American population to ensure generalizability to this fast growing segment of our population. Finally, because the Institutional Review Board approved prospective data collection on all patients with diabetes during pregnancy at the University Hospital in San Antonio, TX, our study does not suffer from volunteer bias which improves the generalizability of our study to its source population, namely low income Mexican American women.

Additional limitations of our study included the absence of information on socioeconomic status at the level of the individual and the absence of information directly addressing why women may not return for postpartum glucose testing. We have examined clinical factors and their relationship to whether or not a woman returns for postpartum glucose screening; however, to improve our ability to screen women postpartum it would be pertinent to also examine socio-cultural explanations. Interestingly, the single factor we had information on which may address logistically why women were unable to return for postpartum testing was associated in the expected direction with whether a woman returned. That is, women who failed to return on average had more living children than women who returned for postpartum glucose testing.

In summary, in a population largely composed of Mexican American women postpartum glucose screening including an OGTT following GDM identifies a significant proportion of the population with IGR. Standard clinical procedures should be developed and utilized to enable and encourage all women to return for postpartum glucose screening.

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Figure.

Table I
 Characteristics (percent or mean and 95% confidence interval) of the women stratified by whether they returned for glucose testing postpartum.

	No (n=307)	Post-partum Screening Yes (n=400)
Demographics and Medical History		
Age (years)	29.9 (29.2, 30.5)	29.6 (29.0, 30.2)
Mexican American (%)	88.6 (84.9, 92.2)	94.0 (91.7, 96.4)*
Living children (n)	1.9 (1.7, 2.0)	1.4 (1.3, 1.6)*
Family History of diabetes (%)	67.0 (61.7, 72.3)	71.4 (66.9, 75.8)
Prior GDM (%)	28.9 (23.8, 34.0)	18.0 (14.2, 21.8)**
Prior Macrosomia (%)	17.6 (13.3, 21.8)	18.5 (14.7, 22.4)
Diagnosis and Treatment		
GA glucose first tested (weeks)	20.0 (19.0, 21.0)	18.8 (17.9, 19.7)
GA diagnosed (weeks)	27.0 (26.1, 27.9)	26.8 (26.0, 27.6)*
GDM Medication – Any (%)	28.3 (23.3, 33.4)	19.5 (15.6, 23.4)**
Glyburide – Only (%)	8.5 (5.4, 11.6)	9.3 (6.4, 12.1)
Insulin (%)	19.9 (15.4, 24.3)	10.3 (7.3, 13.2)**
Glucose Levels – 1 Hour Test		
1-Hour test	169 (164, 173)	163 (160, 166)
Glucose Levels – 3 Hour Test		
Fasting (mg/dL)	99 (96, 101)	95 (94, 97)*
1-Hour (mg/dL)	203 (199, 206)	198 (196, 201)*
2-Hour (mg/dL)	177 (173, 182)	172 (169, 175)
3-Hour (mg/dL)	136 (132, 141)	133 (129, 136)
AUC _{glucose} (g·min/dL)	12.5 (12.1, 12.9)	12.1 (11.8, 12.4)
Memory-reflectance Meter		
Self-monitoring (n/day)	4.2 (4.1, 4.4)	4.4 (4.3, 4.5)
Mean fasting glucose (mg/dL)	86 (84, 88)	83 (82, 84)**
Mean pre-prandial glucose (mg/dL)	89 (87, 91)	86 (85, 87)*
Mean 2-hr post-prandial glucose (mg/dL)	104 (101, 106)	99 (98, 101)**
Pre-pregnancy, pregnancy and delivery		
Pre-pregnancy Weight (lbs)	165 (160, 170)	158 (154, 161)*
Pre-pregnancy BMI (kg/m ²)	30.1 (29.3, 30.9)	29.1 (28.5, 29.7)
Weight Gain during pregnancy (lbs)	25.5 (23.4, 27.7)	24.0 (22.5, 25.5)
Pre-eclampsia (%)	15.7 (11.6, 19.8)	15.8 (12.2, 19.4)
Delivered early: ≤37.0 weeks GA (%)	14.0 (10.1, 17.9)	12.5 (9.3, 15.7)
Cesarean section (%)	38.1 (32.7, 43.5)	39.3 (34.5, 44.1)
Birth weight [†] (kg)	3.36 (3.31, 3.41)	3.34 (3.29, 3.38)
Macrosomia (%)	9.8 (6.5, 13.1)	8.8 (6.0, 11.5)

AUC, area under the curve; GA, gestational age;

* p<0.05;

** p<0.01;

[†] adjusted for GA