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Should women with gestational diabetes be screened at delivery hospitalization for type 2 diabetes?

Thaddeus P. Waters, MD, **Shin Y. Kim, MPH**, **Erika Werner, MD**, **Cheryl Dinglas, DO**, **Ebony B. Carter, MD, MPH**, **Roshni Patel, MPH**, **Andrea J. Sharma, PhD, MPH**, **Patrick Catalano, MD**

Department of Obstetrics and Gynecology, Loyola University Medical Center, Maywood, IL (Dr Waters); Division of Reproductive Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, GA (Drs Kim and Sharma, Ms Patel); Department of Obstetrics and Gynecology, Alpert Medical School of Brown University, Providence, RI (Dr Werner); NYU Winthrop Hospital, Mineola, NY (Dr Dinglas); Department of Obstetrics and Gynecology, Division of Maternal Fetal Medicine, Washington University School of Medicine, St Louis, MO (Dr Carter); DB Consulting Group (Ms Patel) and US Public Health Service Commissioned Corps, Atlanta, GA (Dr Sharma), Atlanta, GA; and Department of Obstetrics and Gynecology, Center for Reproductive Health, Case Western Reserve University, MetroHealth Medical Center, Cleveland, OH (Dr Catalano).

Abstract

BACKGROUND: Less than one-half of women with gestational diabetes mellitus are screened for type 2 diabetes postpartum. Other approaches to postpartum screening need to be evaluated, including the role of screening during the delivery hospitalization.

OBJECTIVE: To assess the performance of an oral glucose tolerance test administered during the delivery hospitalization compared with the oral glucose tolerance test administered at a 4- to 12-week postpartum visit.

STUDY DESIGN: We conducted a combined analysis of patient-level data from 4 centers (6 clinical sites) assessing the utility of an immediate postpartum 75-g oral glucose tolerance test during the delivery hospitalization (PP1) for the diagnosis of type 2 diabetes compared with a routine 4- to 12-week postpartum oral glucose tolerance test (PP2). Eligible women underwent a 75-g oral glucose tolerance test at both PP1 and PP2. Sensitivity, specificity, and negative and positive predictive values of the PP1 test were estimated for diagnosis of type 2 diabetes, impaired fasting glucose, or impaired glucose tolerance.

RESULTS: In total, 319 women completed a PP1 screening, with 152 (47.6%) lost to follow-up for the PP2 oral glucose tolerance test. None of the women with a normal PP1 oral glucose tolerance test (n=73) later tested as having type 2 diabetes at PP2. Overall, 12.6% of subjects (n=21) had a change from normal to impaired fasting glucose/impaired glucose tolerance or a change from impaired fasting glucose/impaired glucose tolerance to type 2 diabetes. The PP1 oral glucose tolerance test had 50% sensitivity (11.8–88.2), 95.7% specificity (91.3–98.2%) with a

Corresponding author: Thaddeus P. Waters, MD. tedwatersmd@gmail.com.

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98.1% (94.5–99.6%) negative predictive value and a 30% (95% confidence interval, 6.7–65.3) positive predictive value for type 2 diabetes vs normal/impaired fasting glucose/impaired glucose tolerance result. The negative predictive value of having type 2 diabetes at PP2 compared with a normal oral glucose tolerance test (excluding impaired fasting glucose/impaired glucose tolerance) at PP1 was 100% (95% confidence interval, 93.5–100) with a specificity of 96.5% (95% confidence interval, 87.9–99.6).

CONCLUSION: A normal oral glucose tolerance test during the delivery hospitalization appears to exclude postpartum type 2 diabetes mellitus. However, the results of the immediate postpartum oral glucose tolerance test were mixed when including impaired fasting glucose or impaired glucose tolerance. As a majority of women do not return for postpartum diabetic screening, an oral glucose tolerance test during the delivery hospitalization may be of use in certain circumstances in which postpartum follow-up is challenging and resources could be focused on women with an abnormal screening immediately after the delivery hospitalization.

Keywords

diabetes mellitus; gestational diabetes; postpartum; pregnancy; screening

Gestational diabetes mellitus (GDM) is a metabolic complication of pregnancy, affecting 2%–16% of all pregnancies in the United States.[1] GDM is hyperglycemia diagnosed during pregnancy when the progressive increases in insulin resistance cannot be adequately accommodated by an additional pancreatic β-cell response. Among women with a GDM-affected pregnancy, the postpartum prevalence (4–20 weeks after delivery) of impaired glucose tolerance (IGT) is 17%–23% and type 2 diabetes (DM) is 5%–14%.[2–4] The American Congress of Obstetricians and Gynecologists recommends that all women with a GDM-affected pregnancy have a 2-hour, 75-g oral glucose tolerance test (OGTT) performed at 4–12 weeks' postpartum to screen for disorders of glucose metabolism, including DM.[5] However, less than one half of women with GDM receive postpartum OGTT screening.[6,7] Multiple barriers exist to receiving postpartum screening, such as lack of a physician order for the postpartum glucose test, failure by the woman to obtain the glucose test, and loss of health insurance.[8–10] Factors associated with poor follow-up include low education, lack of awareness for risks of DM, low health literacy, and public insurance.[11,12]

To reduce barriers to postpartum glucose testing and improve compliance, and because the optimal timing of testing has not been determined definitively, both American Congress of Obstetricians and Gynecologists and the American Diabetes Association recently have extended the time window for postpartum testing from 6–12 weeks to 4–12 weeks.[13] However, limited data support the rationale for waiting until 4–12 weeks postpartum to screen for DM.[14] Recently, several studies published compared the relationship between a 75-g OGTT at the delivery hospitalization and at the traditional 6 weeks' postpartum among women who had GDM.[14–16] The results across these studies showed high sensitivity and specificity for diabetes from the OGTT performed during the delivery hospitalization. Yet, all of these studies were underpowered due to poor follow-up for the recommended 4- to 12-week OGTT. Therefore, the purpose of this study was to combine individual patient-level data across 6 centers to report sensitivity, specificity, and positive predictive values (PPVs) and negative predictive values (NPVs) of a delivery hospitalization 75-g OGTT compared

with the gold standard 4- to 12-week 75-g OGTT for the diagnosis of DM, IGT, and impaired fasting glucose (IFG).

Materials and Methods

We conducted a combined analysis of patient-level data collected from 2012 to 2016 at 4 centers (6 clinical sites) that evaluated the results of an immediate postpartum 75-g OGTT during the delivery hospitalization (PP1) for the diagnosis of DM when compared with a routine 4- to 12-week postpartum OGTT (PP2) for women who had GDM during their pregnancy. We analyzed previously collected data from Women & Infants Hospital, Providence, RI; Johns Hopkins Hospital, Baltimore, MD; MetroHealth Medical Center and University Hospital, Cleveland, OH; Washington University Medical Center, Saint Louis, MO; and New York University-Winthrop, Mineola, NY. Each center had variable inclusion, exclusion, and diagnostic criteria (see Supplemental Table 1 for a complete description of inclusion, exclusion, and diagnostic criteria for GDM[17]). For this combined analysis, we limited the dataset to women who had a complete OGTT at PP1 and PP2. In addition, as all centers had a high rate of loss to follow-up, characteristics of study eligible women with a PP1 visit who were lost to follow-up (defined as absent PP2 testing) were compared with women who completed both study visits to evaluate for potential bias. To improve compliance, some centers offered stipends (MetroHealth and University Hospitals) or gift cards (Women & Infants Hospital) once patients completed all postpartum OGTT testing. Each institution obtained approval from their respective institutional review boards.

Each study center contributed deidentified data on maternal demographic and clinical information, including medical history, height, prepregnancy weight (self-reported), body mass index, medication use, delivery date, maternal weight at delivery, gestational weight gain, maternal and infant health at delivery (including newborn weight and mode of delivery), postpartum tobacco use, and breastfeeding status at discharge. Prepregnancy weight and total gestational weight gain were not available for either MetroHealth or University Hospital, and tobacco use was not available for Johns Hopkins Hospital. Demographic data were compared by center of enrollment for all women meeting inclusion into the final analysis. Significant differences were assessed via χ^2 tests or analysis of variance as appropriate. Furthermore, the Fisher exact test was used to assess differences where χ^2 tests were not sufficient due to small cell size in comparison groups. A P value of $<.05$ was considered significant.

Based on the 75-g OGTT, we used the American Diabetes Association criteria[18] for defining IGT, IFG, and DM. IGT was defined as having a 2-hour value of 140–199 mg/dL, and IFG was defined as having a fasting blood glucose of 100–125 mg/dL. DM was defined on postpartum OGTT as a fasting value ≥126 mg/dL or 2-hour value ≥200 mg/dL. The results of the OGTT for all centers were dichotomized in 2 ways: any glucose intolerance (IFG, IGT, or DM) or those with only DM. We estimated the sensitivity, specificity, PPV, and NPV with 95% confidence intervals (CIs) for a diagnosis of DM (vs IFG/IGT/normal) and for any glucose intolerance (IFG/IGT/DM vs normal) for OGTT results during delivery hospitalization (PP1) compared with 4- to 12-weeks postpartum (PP2). Furthermore, we estimated the sensitivity, specificity, PPV, and NPV with 95% CIs for a diagnosis of DM (vs

normal only) for OGTT results at PP1 compared with PP2. Finally, we estimated unadjusted odds ratios with 95% CIs using logistic regression to determine which maternal factors are related to an abnormal OGTT at PP2 among women who had a normal OGTT at PP1.

Results

When data from all 6 centers were combined, 319 women completed a PP1 screening; 152 were lost to follow-up for the PP2 OGTT (47.6%). Table 1 presents maternal demographic data by each enrolling center for the 167 women who completed both a PP1 and a PP2 visit for our analysis. Although mean age at enrollment was not significantly different across centers, race/ethnicity, education, prepregnancy weight, weight at delivery, frequency of cesarean delivery, and frequency of breastfeeding were significantly different among centers. In addition, a disproportionate number of women with an abnormal PP2 OGTT were enrolled in Ohio (n=35, MetroHealth and University Hospital). Loss to follow-up ranged from 17% to 71%. When we compared the women lost to follow-up with those who completed both PP1 and PP2 study visits (Supplemental Table 2), significant differences were noted in the frequency of loss to follow-up by center of recruitment and gestational age at delivery. In addition, women lost to follow-up had a lower mean 2-hour glucose level result on the PP1 OGTT compared with women who completed both study visits.

Table 2 presents the results of the OGTT categorized as normal, IFG/IGT, or DM at both PP1 and PP2 time points. Overall, the OGTTs were completed within 1–5 days for PP1 and within 24–196 days for PP2. None of the women with normal glucose tolerance at PP1 (n=73) later tested as having DM at PP2. Of the 84 women with IFG/IGT at PP1, 39.2% (n=33) had either IFG, IGT, or DM at the PP2 visit. For the 10 women who tested positive for DM immediately postpartum, 70% (n=7) had either DM, IFG, or IGT at the PP2 visit. Overall, 12.6% of subjects (n=21) had a PP2 results that revealed a change from normal to IFG/IGT or a change from IFG/IGT to DM; the majority of these were 18 women who progressed to IFG/IGT at PP2 from a previously normal PP1 OGTT. In addition, 34.7% (n=58) showed improvement between PP1 and PP2, and 52.7% (n=88) had a PP2 result unchanged from PP1.

Table 3 presents the sensitivity, specificity, PPV, and NPV of the PP1 OGTT compared with the PP2 OGTT. The NPV of having DM at PP2 compared with a normal, IFG, or IGT OGTT at PP1 was 98.1% (95% CI, 94.5–99.6). The NPV of any abnormal result (IFG, IGT, or DM) at the PP2 compared with a normal OGTT at PP1 was 75.3% (95% CI, 63.9–84.7). The sensitivity of the PP1 OGTT was 50% (95% CI, 11.8–88.2) for DM and 69% (95% CI, 55.5–80.5) for any abnormal result with a PPV of 30% (95% CI, 6.7–65.3) and 42.6% (95% CI, 32.4–53.2), respectively. When we excluded those with IFG or IGT, the NPV of having DM at PP2 compared with a normal OGTT (excluding IFG/IGT) at PP1 was 100% (95% CI, 93.5–100) with a specificity of 96.5% (95% CI, 87.9–99.6) (data not shown).

To better understand characteristics related to an abnormal PP2 OGTT (IFG, IGT, or DM), particularly among women with a normal PP1 OGTT (n=73), we performed a separate evaluation estimating the odds ratios for the outcome of an abnormal PP2 OGTT by maternal demographic characteristics (Table 4). For this analysis, among women with a

normal PP1 OGTT, we compared those with an abnormal PP2 OGTT (n=18) with those with a normal PP2 OGTT (n=55) for differences in baseline maternal characteristics. A modest increased odds of an abnormal PP2 OGTT was noted for women with a greater mean weight at delivery (odds ratio, 1.03; 95% CI, 1.01–1.05) in unadjusted analysis.

Discussion

Principal findings

In this combined analysis of patient-level data from 4 independent studies of women with GDM, we observed that among women without evidence of DM on a 75-g OGTT immediately postpartum, the probability of not having DM 4–12 weeks later is 98.1% (NPV, 98.1%; 95% CI, 94.5%–99.6%) with a 95.7% (95% CI, 91.3%–98.2%) specificity. This means only 1.9% of women who tested normal or impaired at PP1 had DM diagnosed at PP2. For women with a positive test for diabetes at the PP1 visit, 70% continued to have an abnormal OGTT at the time of the PP2 visit (DM, IFG, or IGT). For women with a normal 75-g OGTT immediately postpartum (excluding those with IFG or IGT), none had evidence of DM 4–12 weeks later (100% NPV). When we evaluated the PP1 OGTT for any abnormal glucose testing (including the diagnosis of IFG or IGT), the postpartum test during delivery hospitalization had an NPV of 75.3% (95% CI, 63.7%–84.7%). In other words, among women with a normal postpartum OGTT during delivery hospitalization, 25% had IFG or IGT at their postpartum test.

Results

Pregnancy traditionally has been described as a “diabetogenic state.” Once delivery of the placenta occurs, the contributions of several factors to insulin resistance (including placental hormones such as human placental lactogen, progesterone, cytokines, and estrogens) are removed,[19,20] with improvements in maternal insulin resistance within days after delivery.[21] Postpartum screening for women with GDM is important because of the increased risk of developing DM[22] (and the high prevalence of recurrence in a subsequent pregnancy).[23] In addition, women with a history of GDM who participated in a lifestyle-intervention program, such as the National Diabetes Prevention Program,[24] have reported significant decreases in the progression to DM using either intensive lifestyle intervention or Metformin. Therefore, postpartum screening offers an opportunity to potentially affect long-term health outcomes. Because the current approach of waiting until at least 4 weeks postpartum to complete diabetes screening has several drawbacks, as nearly two-thirds of women with GDM do not complete postpartum testing,[7,25] other potential approaches to postpartum screening are needed. The immediate postpartum period, while the patient is still in the hospital setting, may provide an alternative opportunity to offer postpartum screening.

Our current study builds on previous investigations evaluating the utility of immediate postpartum screening[14–16] and suggests immediate screening for DM before hospital discharge after delivery appears plausible with limitations. As the specificity of the postpartum test during delivery hospitalization for diabetes vs normal/impaired was high, with a similarly high NPV, the immediate postpartum test appears to reasonably exclude the diagnosis of postpartum diabetes in the majority of women evaluated. The overall likelihood

for a false-negative screen for diabetes immediately postpartum was 1.9%. Although the postpartum test during the delivery hospitalization had a sensitivity of 50% for DM (with a wide CI) and a low PPV, the high specificity highlights the potential of screening during the delivery hospitalization to exclude (but not diagnose) DM postpartum. When we expanded the diagnosis to include those with IFG or IGT testing, the NPV of a normal PP1 OGTT decreased to 75.3% but with an improved sensitivity of 69.0% with an overall greater likelihood for a false-negative result at 24.7%. Although we observed that 12.6% of women had a PP2 result worse than the PP1 result (a change from normal to IFG/IGT or a change from IFG/IGT to DM), none of the women with a normal PP1 result had evidence of diabetes at follow-up testing.

Strengths and limitations

Our study has several strengths, including the relatively large patient sample size compared with earlier studies, the prospective nature of the study, and strict inclusion criteria of only women who had GDM in the absence of preexisting diabetes. However, we acknowledge our study also has several limitations. First, as a combined analysis, the variations in patient inclusion criteria is a potential source of bias where some centers could have patients with a greater a priori risk for DM postpartum. As the prevalence of diabetes could have varied across centers, this also could affect the test characteristic of the delivery hospitalization OGTT. In addition, patients included at each center were dissimilar in several ways, including variations in race/ethnicity, weight, and frequency of having patients lost to follow-up, and variance in having similar covariates available for analysis. These issues could result in different centers having patients with dissimilar risks for postpartum DM. As the overall frequency of loss to follow-up was high among all included studies, this is also a potential source for attrition or selection bias and could affect the observed results if patients with or without diabetes were more likely to complete postpartum testing. The difficulty in having women complete the 4- to 12-week test underscores the overall problem of postpartum follow-up for these patients. In addition, even with a combined analysis, we were still underpowered to detect associations across maternal characteristics. Therefore, future larger powered studies may be warranted.

Conclusions

In conclusion, the current study demonstrates that postpartum screening of women with GDM during the delivery hospitalization appears to exclude postpartum DM. However, it is also important to highlight the limitations we observed of immediate postdelivery testing, including the 12.6% of women who progressed from a normal OGTT to either IFG or IGT from PP1 to PP2 and the 34.7% of women who had improvement in their testing from PP1 to PP2. On the basis of these results, it is unclear whether immediate postpartum testing should replace traditional testing for all women with GDM. In low-resource centers or for populations with difficulty completing a traditional postpartum OGTT, a delivery hospitalization OGTT may be a reasonable alternative to evaluate for postpartum diabetes. If a delivery hospitalization OGTT is used, women should be counseled on the potential limitations of this approach and be encouraged to have a confirmatory test, particularly if the results are IFG, IGT, or DM. In certain circumstances, focusing resources on women with an

abnormal result at PP1 to return for additional testing and management 4 to 12 weeks' postpartum may improve on the current paradigm of attempting to initially screen all women 4–12 weeks after delivery, during which more than two-thirds of women are lost to follow-up.

Research implications

Investigations are needed to improve our understanding of the physiologic changes in insulin sensitivity and insulin response after delivery, particularly for women with persistent evidence of insulin resistance or β-cell dysfunction immediately postpartum. Our findings also need to be reproduced in a larger observation trial that attempts to address the limitations and potential biases present in our report.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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AJOG at a Glance

Why was this study conducted?

Few women with gestational diabetes mellitus, completing the postpartum screening for type 2 diabetes is recommended. Other screening approaches, including the utility of an immediate screen for diabetes during the delivery hospitalization, need to be evaluated.

Key findings

A normal oral glucose tolerance test result during the delivery hospitalization appears to exclude type 2 diabetes. The performance of the delivery oral glucose tolerance test was mixed when evaluating other outcomes, including impaired fasting glucose or impaired glucose tolerance.

What does this add to what is known?

These data suggest an oral glucose tolerance test during the delivery hospitalization may reasonably exclude type 2 diabetes. However, the limitations of the immediate postpartum oral glucose tolerance test need to be considered and further evaluated. An oral glucose tolerance test during the delivery hospitalization may be appropriate in certain populations or low-resource centers where follow-up after discharge is challenging.

Am J Obstet Gynecol. Author manuscript; available in PMC 2020 May 08.

TABLE 1

Maternal characteristics by center of enrollment

Characteristic	Aggregate across all 4 centers N=167	Women and Infants and Johns Hopkins N=47	New York University-Winthrop N=24	MetroHealth and University Hospital N=67	Washington University N=29	*P* value[a]
Mean age at enrollment, y	31.8	31.6	34.4	31.1	31.6	.1
Race/ethnicity (%)						<.0001[b]
White	31.7	40.4	16.7	31.3	31.0	
African American	37.1	25.5	12.5	52.2	41.4	
Hispanic	15.6	10.6	37.5	10.5	17.2	
Asian	11.4	12.8	33.3	4.5	6.9	
Other	4.2	10.6	N/A	1.5	3.5	
Education, %[c]						.02[b]
Less than high school	10.9	5.3	25.0	9.2	N/A	
High school	31.8	21.1	20.8	43.1	N/A	
More than high school	57.4	73.7	54.2	47.7	100.0	
Nulliparous, %	34.1	44.7	33.3	35.8	13.8	.05
Mean prepregnancy weight, kg[d,e]	81.3	83.1	69.3	N/A	91.6	.006
Prepregnancy body mass index, %[f]						.1[b]
Normal weight (18.5–<25 kg/m^2)	25.8	24.4	37.5	N/A	15.0	
Overweight (25–<30 kg/m^2)	23.6	20.0	33.3	N/A	20.0	
Obesity (30+ kg/m^2)	50.6	55.6	29.2	N/A	65.0	
Mean weight at delivery, kg[g]	97.5	93.2	83.6	99.5	112.2	.003
Mean gestational weight gain, kg[e]	13.9	10.3	14.3	N/A	21.4	.08
Medication for glucose control during pregnancy, %	54.5	48.9	66.7	49.3	65.5	.2
Mean gestational age at delivery, wk	38.4	38.5	38.7	38.5	37.8	.06
Cesarean delivery, %	47.9	34.0	45.8	46.3	75.9	.005
Breastfeeding at discharge, %	76.7	89.4	87.5	70.2	62.1	.01

Characteristic	Aggregate across all 4 centers N=167	Women and Infants and Johns Hopkins N=47	New York University-Winthrop N=24	MetroHealth and University Hospital N=67	Washington University N=29	*P* value[a]
Tobacco use postpartum, %[h]						.08[b]
Users	16.7	N/A	8.3	23.9	6.9	
Non-users	83.3	N/A	91.7	76.1	93.1	
Mean time from delivery to immediate PP OGTT, d (range)	2.2 (1.0–5.0)	2.0 (2.0–2.0)	2.5 (2.0–4.0)	2.1 (1.0–5.0)	2.6 (1.0–4.0)	.0002
Mean time from delivery to late PP OGTT, d (range)	55.0 (24.0–196.0)	53.5 (24.0–95.0)	61.5 (40.0–196.0)	54.9 (38.0–90.0)	51.6 (34.0–83.0)	.3
Loss to follow-up (has complete PP visit 1 but no complete PP visit 2) (%)	47.7	51.6	71.1	17.3	50.0	<.0001

N/A, not available; *OGTT*, oral glucose tolerance test; *PP*, postpartum.

[a] χ^2 test for proportions and analysis of variance for means unless otherwise noted;

[b] Fisher exact test for proportions due to high percentage of <5 cell size;

[c] Years of education used for NYU-W and Ohio;

[d] For Washington, prepregnancy weight could be either self-reported or weight at first prenatal visit weight. If the weight was from the first prenatal visit, which occurred >14 weeks of gestation, weight was removed;

[e] Ohio data are not included;

[f] The underweight (<18.5 kg/m^2) category was examined but not presented as all cells were a value of 0 across all centers;

[g] For Ohio, used weight at first postnatal care visit was used for weight at delivery for Metro Health only;

[h] Tobacco use not available for Brown-Hopkins data. For NYU-W, only current smokers included not those that quit in pregnancy.

Waters TP, Kim SY, Werner E et al. Should women with gestational diabetes be screened at delivery hospitalization for type 2 diabetes? Am J Obstet Gynecol 2019.

TABLE 2

Normal, IFG, IGT, or type 2 diabetes status at the delivery hospitalization (postpartum 1) and at 4–12 weeks' postpartum (postpartum 2)

	Postpartum 2: screening 4–12 weeks' postpartum			
Postpartum 1: screening during delivery hospitalization	**Normal**	**IFG/IGT**	**Type 2 diabetes**	**Total**
Normal	55	18	0	73
IFG/IGT	51	30	3	84
Type 2 diabetes	3	4	3	10
Total	109	52	6	167

IFG, impaired fasting glucose; *IGT*, impaired glucose tolerance.

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TABLE 3

Sensitivity analysis of results of the OGTT for DM vs impaired/normal and any abnormal results vs normal, N=167

	Diabetes (vs impaired/normal)		Any abnormal (DM, impaired) vs normal	
OGTT at delivery (PP1) compared with at 6 weeks (PP2)	**Sample size**	**% (95% CI)**	**Sample size**	**% (95% CI)**
Sensitivity	6	50.0 (11.8–88.2)	58	69.0 (55.5–80.5)
Specificity	161	95.7 (91.3–98.2)	109	50.5 (40.7–60.2)
Positive predictive value	10	30.00 (6.7–65.3)	94	42.6 (32.4–53.2)
Negative predictive value	157	98.1 (94.5–99.6)	73	75.3 (63.9–84.7)

CI, confidence interval; *DM*, type 2 diabetes; *OGTT*, oral glucose tolerance test.

Waters TP, Kim SY, Werner E et al. Should women with gestational diabetes be screened at delivery hospitalization for type 2 diabetes? Am J Obstet Gynecol 2019.

TABLE 4

Among those who had normal OGTT during delivery hospitalization, associations for abnormal vs normal OGTT at 4–12 weeks' postpartum, N=73

Characteristic	OR (95% CI)
Mean age at enrollment, y	1.0 (0.9–1.1)
Race/ethnicity	
White	Ref
African American	2.4 (0.7–8.4)
Hispanic	0.4 (0.0–3.9)
Other	0.6 (0.1–5.8)
Education[a]	
High school or less	Ref
More than high school	1.8 (0.5–6.2)
Parity	
Nulliparous	1.78 (0.6–5.3)
≥1 live birth	Ref
Mean prepregnancy weight, kg[b,c]	1.04 (1.0–1.1)
Prepregnancy BMI, kg/m^2[c,d]	1.1 (0.5–2.4)
Mean weight at delivery, kg[e]	1.03 (1.0–1.1)
Mean gestational weight gain, kg[c]	1.02 (1.0–1.1)
Medication for glucose control during pregnancy	
Yes	2.0 (0.7–5.9)
No	Ref
Mean gestational age at delivery, wk	1.1 (0.7–1.7)
Cesarean delivery	
Yes	1.6 (0.6–4.7)
No	Ref
Breastfeeding at discharge	
Yes	1.4 (0.3–5.6)

Characteristic	OR (95% CI)
No	Ref
Tobacco use[f]	
Users	0.9 (0.2–4.1)
Non-users	Ref

BMI, body mass index; *CI*, confidence interval; *OGTT*, oral glucose tolerance test; *OR*, odds ratio.

[a]Years of education used for NYU-W and Ohio;

[b]For Washington, prepregnancy weight could be either self-reported or weight at first prenatal visit weight. If the weight was from the first prenatal visit which occurred >14 weeks' gestation, weight was removed;

[c]Ohio data are not included;

[d]Underweight category not included due to small cells;

[e]For Ohio, we used weight at first postnatal care visit was used for weight at delivery for Metro Health only;

[f]Tobacco use not available for Brown-Hopkins data. For NYU-W, only current smokers included not those that quit in pregnancy.

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