Effect of Selective Screening for Gestational Diabetes

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OBJECTIVE — To estimate the percentage of pregnant women who would not be screened and the percentage of women with gestational diabetes mellitus (GDM) who would possibly remain undiagnosed if the American Diabetes Association's (ADA's) new selective screening recommendations are used rather than universal screening for GDM.

RESEARCH DESIGN AND METHODS — Since 1987, the University of Michigan Health System has performed universal screening for GDM. In 1997, the ADA recommended that women having all four of the following characteristics need not be screened: age <25 years, not members of an ethnic/racial group with a high prevalence of diabetes, normal body weight, and no family history of diabetes. We studied a random sample of the 25,118 deliveries at the University of Michigan between 1987 and 1997 to determine the prevalence of these four characteristics in our obstetric population. We also studied the prevalence of these four characteristics in 200 women who were diagnosed with GDM in the Endocrine Testing Unit and delivered at the University of Michigan between 1987 and 1997.

RESULTS — Approximately 10–11% of women who delivered possessed all four low-risk characteristics and would not have been screened for GDM according to the new ADA recommendations. Only 4% of women (5 of 141) with GDM who delivered and for whom data on all four characteristics were reported possessed all four low-risk characteristics and would not have been screened.

CONCLUSIONS — If the new ADA selective screening recommendations are used, few women with GDM will be missed (4%) but approximately 90% of pregnant women will still need to be screened for GDM.

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Gestational diabetes mellitus (GDM) is defined as the onset or first recognition of glucose intolerance during pregnancy (1). GDM is important in that it poses a risk to the pregnant woman and her infant. Women with GDM have an increased risk of developing diabetes later in life (2), and infants of mothers with GDM are at increased risk for macrosomia (3). Appropriate diagnosis and management can improve outcomes (3,4).

In 1980, the First International Workshop-Conference on Gestational Diabetes Mellitus recommended that all pregnant women be screened for GDM (5). This was reiterated by the Second and Third International Workshop-Conferences in 1985 and 1991 (1,6). Until 1994, the American College of Obstetricians and Gynecologists (ACOG) advocated selective screening for GDM. In 1994, ACOG stated that whereas selective screening for GDM may be appropriate in some clinical settings such as teen clinics, universal screening may be more appropriate in other settings (7). ACOG further stated that universal testing may be appropriate in patient populations at high risk (7).

In 1997, the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus, a committee of the American Diabetes Association (ADA), recommended selective screening for GDM based on four maternal characteristics (8). The following characteristics were said to predict a low risk of GDM: age <25 years, not a member of an ethnic/racial group with a high prevalence of diabetes (e.g., Hispanic, Native American, Asian, African-American), normal body weight, and no family history of diabetes. To be excluded from screening, a woman must possess all four of these characteristics.

Several studies have examined the sensitivity and specificity of historical risk factors (age, race, family history), clinical risk factors (obesity, weight gain, hypertension, glycosuria), and reproductive risk factors (previous macrosomic infant, infant with congenital anomaly, or fetal or neonatal death) as screening indicators for GDM (9–14). In general, historical and clinical risk factors were found to have low sensitivity and specificity compared with the 50 g glucose challenge test (GCT), and reliance on reproductive risk factors had the disadvantage of excluding from screening primigravidas who otherwise might be at risk for GDM. More recently, a study by Naylor et al. (14) suggested that selective screening might be preferable to universal screening; however, the screening criteria that they used differed from those recommended by the ADA.

Unfortunately, no study has examined the performance of the specific recommendations put forth by the ADA in 1997. Clearly, fewer screening tests will be performed, but some women with GDM will not be diagnosed if selective rather than universal screening is employed. The purpose of this study was to estimate the per-

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Abbreviations: ACOG, American College of Obstetricians and Gynecologists; ADA, American Diabetes Association; GCT, glucose challenge test; GDM, gestational diabetes mellitus; OGTT, oral glucose tolerance test; SLE, systemic lupus erythematosus.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

centage of pregnant women who would not be screened and the percentage of women with GDM who would not be screened and therefore would possibly remain undiagnosed if the ADA's selective screening recommendations were used.

RESEARCH DESIGN AND METHODS

— Since 1987, the University of Michigan has followed the recommendations of the Second International Workshop-Conference on Gestational Diabetes Mellitus. All pregnant women are screened for GDM with a 50 g GCT between 24 and 28 weeks of gestation without regard to time of day or time of the last meal (2). Plasma glucose levels are measured 1 h after the glucose load, and women who have a venous plasma glucose ≥140 mg/dl are considered to have a positive screening test. Women who have a positive screening test undergo a 3-h 100 g oral glucose tolerance test (OGTT). The OGTT is performed in the morning after an overnight fast following a 3-day preparatory diet of at least 250 g of carbohydrate per day. A positive 3-h OGTT is defined using National Diabetes Data Group criteria, that is, two or more venous plasma glucose values meeting or exceeding 105 mg/dl fasting, 190 mg/dl at 1 h, 165 mg/dl at 2 h, or 145 mg/dl at 3 h.

To apply the new ADA selective screening recommendations, we first had to define them more clearly. According to the new ADA recommendations, Hispanics, Native Americans, Asians, and African-Americans are at increased risk for GDM. Whites were therefore defined as the race/ethnicity at no increased risk for GDM. Normal body weight was not defined in the recommendations. We defined normal body weight according to World Health Organization criteria as a prepregnancy BMI <27 kg/m^2. Prepregnancy BMI was calculated using a woman's weight and height recorded at the time of a visit occurring between 24 and 28 weeks' gestation; weight was then corrected for gestational age using a standard weight gain of 1.60 kg in the first trimester and 0.44 kg per week in the remaining trimesters (15). We hypothesized that calculating weight in this manner would be more accurate than relying on self-reported prepregnancy weight or last recorded prepregnancy weight, since there were none recorded for many of the patients. No family history of diabetes was defined as no history of diabetes in a grandparent, parent, sibling, or child.

This study was reviewed and approved by the University of Michigan Institutional Review Board. Permission to proceed was granted provided that participants signed a form consenting to have their medical records reviewed. That form was routinely completed by women during inpatient admissions for delivery.

To estimate how many fewer screening tests would have been performed if the new ADA selective screening recommendations were employed, we determined what proportion of women delivering at the University of Michigan had all four low-risk characteristics. To identify all deliveries that occurred at our institution between 1987 and 1997, we performed a computer search using obstetric procedure codes associated with deliveries: *International Classification of Diseases, Ninth Revision* procedure codes 72.x (all forceps, vacuum, and breech deliveries), 73.2 (version and extraction), 73.5 (manually assisted delivery), and 74.x (all cesarean deliveries except those for ectopic pregnancy and for termination of pregnancy). In this way, we identified 25,118 deliveries that occurred between 1987 and 1997. We used hospital administrative data to determine the ages and races/ethnicities of the women delivering. A total of 4,629 deliveries were to women who were <25 years of age and white. Since 12.5% were to women classified as race "unknown/other," we analyzed the data both with them excluded and with them included and classified as white. By doing so, we gained an upper and lower approximation of the percentage of women who gave birth and who were white. To estimate the proportion of women delivering who had all four low-risk characteristics, we took a random sample of 250 of the deliveries to women who were both <25 years of age and white. This sample was identified by assigning random numbers to the women who were <25 years of age and white and selecting the 250 women with the lowest random numbers. We then reviewed the charts to identify the proportion who had a prepregnancy BMI <27 kg/m^2 and a negative family history of diabetes; 224 records were available for review. The proportion of women fulfilling all four criteria was estimated as the product of the proportion of women who delivered between 1987 and 1997 who were white and <25 years of age and the proportion of women who had BMI <27 kg/m^2 and no family history of diabetes in the subsample of deliveries to women who were both white and <25 years of age.

The proportion of women with GDM who would not have been screened under the new recommendations was estimated from the records of women with GDM identified through the Endocrine Testing Unit who delivered at the University of Michigan between 1987 and 1997. The Endocrine Testing Unit diagnosed 200 women with GDM who underwent 210 deliveries at the University of Michigan (10 women with GDM had 2 deliveries each). Data on age, race/ethnicity, height, weight, and family history of diabetes were abstracted from the medical records. Women followed at off-site clinics were screened and diagnosed using the same protocols but at the off-site clinics. Since they did not receive their OGTTs in the Endocrine Testing Unit, they are not included in the sample of women with GDM who were studied. They were, however, included in the population delivering at the University of Michigan.

RESULTS

— A total of 25,118 deliveries occurred at the University of Michigan between 1987 and 1997. Of the 21,971 deliveries with race/ethnicity specified, 4,629 (21.1%) were to women who were both white and <25 years of age. If the women of unknown race are classified as white, 22.3% (5,601 of 25,118) would be classified as both white and <25 years of age. In the random sample of women who were both white and <25 years of age, 171 records reported the presence or absence of a family history and both weight and height. Of these 171 records, 85 (49.7%) had no family history of diabetes and a BMI <27 kg/m^2. Therefore, the estimate of the proportion of women with all four low-risk characteristics is 49.7% × 21.2% = 10.5% or 49.7% × 22.3% = 11.1%, depending how women of unknown race are classified. The standard error of these estimates is 1.6%.

The prevalence of low-risk characteristics among the women with GDM is shown in Table 1. The denominators indicate the number of women for whom information on a characteristic was available. Family history of diabetes was the least likely of the four characteristics to be recorded. One hundred forty-one charts contained information on all four characteristics, and five women (4%) were determined to be at low-risk for all characteristics. Therefore, these women would not have been screened and possibly would have remained undiagnosed had selective rather than universal screening been performed.

Table 1—*Percentage of women with GDM possessing one or more low-risk characteristics*

Low-risk characteristics	Women with GDM
Age <25 years	20.0 (42/210)
Negative family history of diabetes	38.5 (57/148)
BMI <27	55.0 (110/200)
White (not Hispanic, Native American, Asian, or African-American)	73.8 (149/202)
Age <25 years and negative family history	4.7 (7/148)
Age <25 years and BMI <27	8.0 (16/200)
Age <25 years and white	16.3 (33/202)
Age <25 years, BMI <27, and negative family history	3.5 (5/147)
Age <25 years, negative family history, and white	4.9 (7/142)
Age <25 years, BMI <27, and white	7.8 (15/192)
Age <25 years, BMI <27, negative family history, and white	3.5 (5/141)

Data are % (*n*/number of women for whom characteristics were available).

Finally, we assessed the treatment and outcomes of the five cases with GDM who would not have been detected if the new ADA selective screening recommendations were employed. Of these five women, one had systemic lupus erythematosus (SLE) and was receiving prednisone at the time of her screen. There were no multiple gestations. None of the other women had previous history of GDM or other apparent risk factors for glucose intolerance. During pregnancy, three of the women with GDM were treated with insulin, including the woman with SLE. Two women developed pre-eclampsia. There was one preterm birth, and one woman had a cesarean delivery after a failed induction. All infants were live born and none weighed >4,000 g.

CONCLUSIONS — The low-risk characteristics recommended by the Expert Committee on the Diagnosis and Classification of Diabetes of the ADA appear to be effective at predicting low risk for GDM. In our study, only about 4% of women with GDM who were identified by universal screening would have been missed using the ADA's new selective screening recommendations. On the other hand, 89–90% of our obstetric population did not have all four low-risk characteristics and therefore would have been screened. The time and possible confusion of applying these new selective screening recommendations may therefore outweigh the benefit in terms of the number of screening tests saved.

As for the low-risk characteristics themselves, our aim was not to improve on them, but rather to test them as they were proposed. Only about 20% of women with GDM were <25 years of age. The combination of age <25 years and no family history of diabetes was present in only 5% of women with GDM. The three characteristics of age <25 years, no family history of diabetes, and BMI <27 kg/m^2 were present together in only 4% of women with GDM. This was the same 4% who had all four characteristics together. Whether race/ethnicity is an independent risk factor for GDM is unknown. Two studies have found race to be an independent risk factor for GDM after adjusting for age and body weight (16,17). Another study found race to be an independent risk factor after adjusting for age, body weight, and parity (18). None have assessed race as a risk factor for GDM after adjusting for age, body weight, and family history.

The question of whether to perform universal or selective screening for GDM depends largely on the perceived benefits of detection. Those who advocate universal screening tend to believe that the risks associated with GDM are substantial and can be reduced by diagnosis, treatment, and intensified monitoring of maternal and fetal well-being. Those who argue in favor of selective screening tend to believe that with modern obstetric practices, the risk to the woman with GDM and her offspring is low, even if GDM is undiagnosed. Advocates of selective screening also tend to believe that the risk factors for GDM account for much of the increased morbidity associated with GDM. Among the five women in our study who had GDM but none of the four risk factors, three (60%) required insulin for management. In contrast, 35% (61 of 177) of all women with GDM required insulin. Therefore the five women without risk factors demonstrated at least as much glucose intolerance as the women with risk factors. Weeks et al. (11) found no difference in outcomes between women with GDM who did and did not have risk factors. In contrast, Langer and Mazze (19) and Maresh et al. (20) found that obesity was an independent risk factor for macrosomia. Therefore, there seems to be some justification for the notion that it is more important to diagnose GDM in women who are obese. Whether outcomes are worse for infants of mothers with GDM who are older, are nonwhite, or have a family history of diabetes will require further study.

Finally, we wish to acknowledge that at face value, the incidence of GDM in our population appears low—most studies have found the incidence of GDM to be 2–4% using the same screening and diagnostic criteria (21–23). The incidence of GDM in our study appears low because the population of women with GDM that we studied and the population delivering at the University of Michigan were not identical. Many women who deliver at our institution receive care, including testing for GDM, at off-site clinics, and records from those clinics were not available for review. The presence of those women would have affected direct comparisons between women with GDM and all women delivering at the University of Michigan, but should not affect our ability to determine the proportion of women with GDM who would have been missed through the Endocrine Testing Unit or our estimate of the proportion of women delivering at our institution who would not have been screened under the new ADA recommendations.

ADDENDUM — Since the submission of this manuscript, the recommendations of the 4th International Workshop Conference on Gestational Diabetes Mellitus have been published (Metzger B, Coustan B, for the Organizing Committee: Summary and Recommendations of the 4th International Workshop Conference on Gestational Diabetes Mellitus. *Diabetes Care* 21 [Suppl. 2]:161–167, 1998). This group has recommended that in addition to screening women with any one of the four characteristics we have examined (age ≥25 years, race/ethnicity with an increased prevalence of diabetes, BMI ≥27 kg/m^2, or family history of diabetes in a first-degree relative), women should be screened if they have a history of GDM or a poor obstetric outcome. The workshop also recommended new criteria for the diagnosis of GDM. These include two or more venous plasma glucose concentrations greater than or

equal to the diagnostic cutpoints of 95 mg/dl fasting, 180 mg/dl at 1 h, 155 mg/dl at 2 h, and 140 mg/dl at 3 h. To assess the impact of these recommendations on our findings, we thoroughly reviewed three years of OGTT data. Between 1 January 1991 and 31 December 1993, 338 OGTTs were performed and 104 were diagnostic of GDM by the old criteria. Applying the new criteria, 30 of the 234 that were initially nondiagnostic were diagnostic for GDM. This represents a 29% relative increase in the incidence of GDM.

Of these additional 30 women diagnosed with GDM, 29 charts were available for review. In this group, 20% (6 of 30) were <25 years of age, 44% (11 of 25) had no family history of diabetes, 37% (11 of 30) had a BMI <27 kg/m^2, and 80% (24 of 30) were white. These characteristics are similar to those of the women diagnosed by the old criteria (Table 1). Among the additional women, the two selective screening criteria of age <25 years and no family history alone would have resulted in the screening of 28 of the 29 women (97%). The woman who was <25 years old with no family history of diabetes was also low-risk for all of the other characteristics, i.e., she was white, had a BMI <27 kg/m^2, and had no prior history of GDM or poor obstetric outcome. She was, however, on glucocorticoid therapy during this pregnancy. It is therefore likely that she would have been screened for GDM for that reason, although it is not a stated risk factor.

In reviewing the pregnancy outcomes of the additional women diagnosed by the new criteria, we found the rate of macrosomia to be increased. Of the 29 pregnancies, there was one spontaneous abortion. Of the remaining 28 live births, 29% of the newborns (8 of 28) weighed >4,000 g. Among the newborns of women diagnosed with GDM by the old criteria, 13% (25 of 188) weighed >4,000 g (P = 0.0001). Rates of cesarean section also differed between the additional women diagnosed by the new criteria and those previously diagnosed with GDM. Whereas only 7% of the additional women (2 of 28) diagnosed by the new criteria were delivered by cesarean section (despite the higher rate of macrosomia seen in this group), 30% of women (55 of 184) previously diagnosed with GDM were delivered by cesarean section (P = 0.0001). This finding may represent a labeling bias, that is, a woman labeled as having GDM is more likely to be delivered by cesarean section regardless of her infant's birth weight.

We conclude that the recommended changes in the diagnostic cutpoints for GDM will have a major impact on the incidence of GDM. These changes appear to be warranted based on the high incidence of macrosomia among infants of affected mothers. The recommended changes in the diagnostic cutpoints will not affect performance of the low-risk criteria. If the six newly recommended selective screening criteria and the new diagnostic criteria for GDM are used, few women (~3%) with GDM will be missed. It is likely, however, that few pregnant women (~10%) will have none of the six selective screening criteria and will be spared from screening for GDM.

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