

# Poor sensitivity of the fifty-gram one-hour glucose screening test for hyperglycemia

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## Abstract

To determine the sensitivity and specificity of the 50-g 1-h glucose screening test (GST) for hyperglycemia established in a home-monitored glucose profile (HGP) from blood sampled 1 h after each of the main meals on the following day, we prospectively studied 415 pregnant women at increased risk for gestational diabetes and compared 1 GST with 1 HGP. At the commonly recommended GST threshold of 7.8 mmol/l and an HGP threshold of 7.0 mmol/l, the sensitivity of the GST was 27%, the specificity 89%, and the likelihood ratio for a positive test 2.4. Therefore, we conclude that the 50-g 1-h glucose screening test discriminates poorly between pregnant women with and without postprandial hyperglycemia.

*Key words:* Gestational diabetes mellitus; Screening; Hyperglycemia

## 1. Introduction

Gestational diabetes mellitus (GDM) is defined as carbohydrate intolerance recognized during pregnancy [1]. The diagnosis of GDM is generally based on an abnormal oral glucose tolerance test (OGTT) [2]. The whole blood glucose level determined 1 h after a 50-g oral glucose load (GST) is widely used to detect carbohydrate intolerance [1] and is considered the best screening test for gestational diabetes mellitus in pregnant women [2].

Causal treatment of carbohydrate intolerance in pregnancy is not yet possible. The aim of therapeutic efforts is to avoid hyperglycemia, which is associated with fetal morbidity. For that reason, it seems logical to screen and monitor blood glucose levels in pregnant women during nutrition based on their preferences, rather than to determine carbohydrate intolerance defined by an abnormal reaction to a glucose load.

In an attempt to determine the extent to which the 50-g 1-h glucose screening test can be used as a screening

test for the occurrence of hyperglycemia in a home-monitored glucose profile (HGP) on a normal diet, we compared the results of the GST and the HGP.

## 2. Subjects and methods

From July 1989 to July 1991 we prospectively studied 415 pregnant women considered to be at risk for gestational diabetes mellitus (GDM). Each woman had one or more of the following risk factors: a past history of GDM, a previous macrosomic or hypoglycemic infant, a positive family history, age 35 years or more, obesity, recurrent glucosuria, or accelerated fetal growth in the present pregnancy. Patients with known type 1 or type 2 diabetes mellitus, and women with multiple pregnancy were excluded.

In all subjects a 50-g 1-h GST was performed after the 20th week of gestation. Capillary blood was sampled 1 h after intake of the 50-g oral glucose load, without prior glucose loading or fasting. On the same day the women were instructed by a nurse to take their own capillary blood samples at home. Samples for the HGP were collected on the following day in prelabeled

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fluoride oxalate tubes, 1 h after breakfast, lunch, and dinner. All glucose levels were determined in the laboratory the next day in whole blood using the hexokinase method (Boehringer-Mannheim). One GST and one HGP were obtained from each subject and used for comparison.

In women in whom both the GST and the maximal HGP value did not exceed 7.0 mmol/l, glucose concentrations were considered normal and were not further tested. Patients in whom both the GST and the maximal HGP concentration exceeded the value of 7.0 mmol/l were treated with dietary measures alone or in combination with insulin, if necessary to maintain postprandial glucose values at or below 7.0 mmol/l. When either the GST or the maximal HGP value was above 7.0 mmol/l, but the other was not, a second home glucose profile (HGP2) was performed. Patients in this group were treated only if the HGP2 value exceeded 7.0 mmol/l. In this subgroup of 94 patients we compared the maximal glucose concentration of the first HGP with that of HGP2.

Differences in relative frequencies between groups were tested by  $\chi^2$  test, relationships between variables were tested by linear regression analysis. A *P* value <0.05 was considered significant. The study was approved by the University and Hospital Ethics Committee.

### 3. Results

The gestational age at the time of testing ranged from 20 to 35 weeks, with a median of 24 weeks. Thirty-seven (9%) of the 415 women had a glucose value that exceeded 7.0 mmol/l in the HGP. At the generally recommended GST threshold of 7.8 mmol/l [2] and an HGP threshold of 7.0 mmol/l, both the GST and the HGP did not exceed the threshold in 336 women, both were above the threshold in 10 women, and in 69 women the results of one of the tests were above the threshold value. At these thresholds, the sensitivity of the GST was 27%, the specificity 89%, the likelihood ratio for a positive test 2.4 and that for a negative test 0.8. Although the GST correlates significantly with the HGP (*P* < 0.05), Fig. 1 shows that the correlation is poor (*r* = 0.37).

Fig. 2 demonstrates the effect of changing the GST threshold — in the absence of a change in HGP threshold — on sensitivity, specificity, and the likelihood ratios of a positive and a negative test.

Fig. 3 demonstrates the absence of a significant correlation (*P* > 0.05, *r* = 0.32) between the maximal values of the first and second HGP, as determined in the 94 women in whom either the GST or the maximal value of the first HGP exceeded 7.0 mmol/l. The sensitivity of the first HGP for HGP2 was 26%, the specificity 84%, the likelihood for a positive test 1.6 and that for a negative test 0.9.

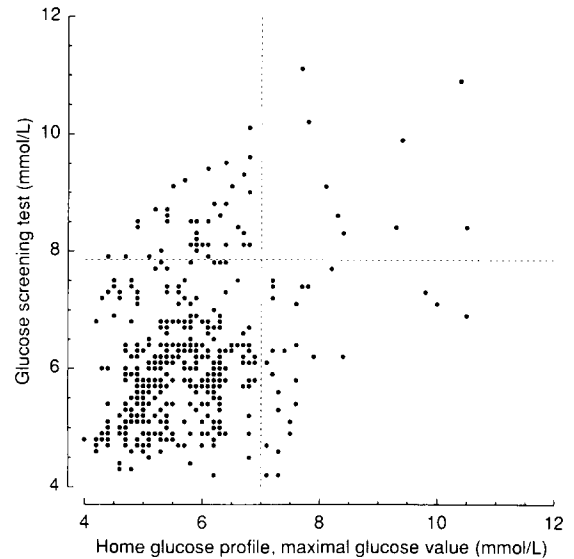


Fig. 1. The blood glucose value 1 h after a 50-g glucose load (GST) plotted against the maximal postprandial glucose value obtained in the home-monitored glucose profile (HGP), shows poor correlation (*r* = 0.37). *n* = 415.

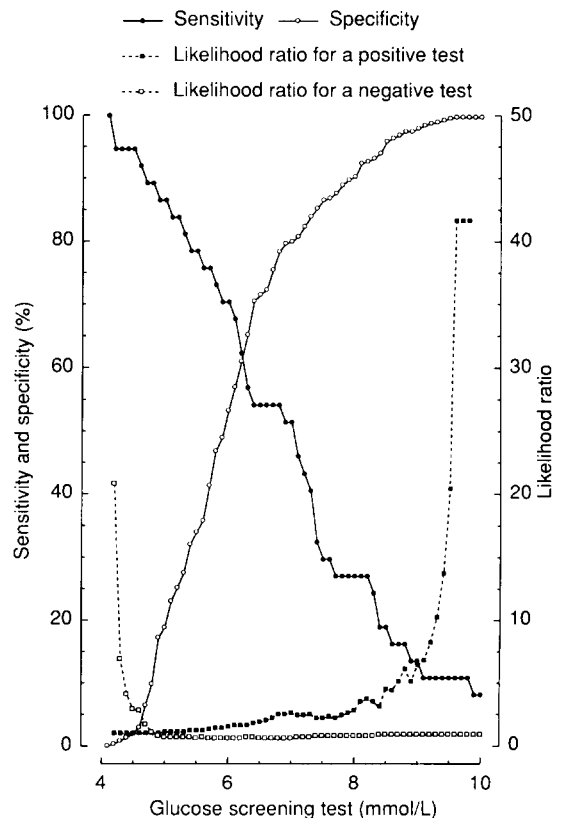


Fig. 2. The sensitivity, specificity and likelihood ratios of the 50-g 1-h glucose screening test for the occurrence of postprandial hyperglycemia in the home-monitored glucose profile were calculated at varying GST thresholds.

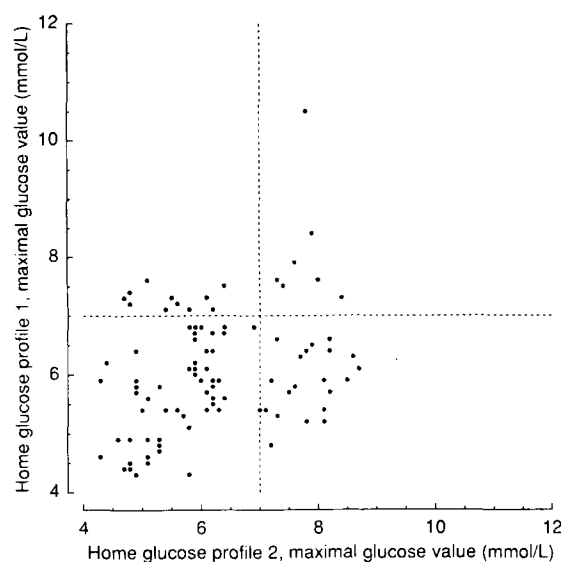


Fig. 3. The maximal postprandial glucose value obtained in one home glucose profile (1) plotted against that obtained on another day (2), shows poor correlation ( $r = 0.32$ ).  $n = 94$ .

#### 4. Discussion

It is assumed that hyperglycemia during pregnancy is harmful to the fetus and newborn, because it increases the incidence of macrosomia, birth trauma, hyperbilirubinemia, hypocalcemia and polycythemia [2]. Therefore, considerable effort is put into the detection and treatment of GDM.

Gestational diabetes mellitus is defined as carbohydrate intolerance with onset or recognition during pregnancy [1]. The diagnosis is usually based on an abnormal 2- or 3-h 50- or 100-g OGTT in the fasting state following several days of high carbohydrate diet. If the OGTT is abnormal the patient is treated with a diet containing complex carbohydrates and avoiding monosaccharides, to which insulin is added if necessary to maintain normoglycemia. Apart from the differences resulting from the various ways in which the OGTT is

performed, it has been demonstrated that the reproducibility of the OGTT is low (78%) [3] and that the 50-g OGTT overestimates the occurrence of hyperglycemia by 28% [4]. For those reasons an abnormal OGTT does not necessarily mean that glucose values under the less unphysiologic circumstances of a diet based on women's preferences are abnormal. Therefore, we chose hyperglycemia occurring in the HGP on a normal diet as the diagnostic endpoint in our study.

The disadvantage of using HGP as an endpoint is that it indicates the glycemic control at the time of the test, while hyperglycemia as a result of carbohydrate intolerance may not yet be apparent and may become manifest later in pregnancy. This implies that testing should be repeated later in pregnancy.

Determination of a plasma glucose level 1 h after a 50-g oral glucose challenge is generally considered to be the best screening test for detection of gestational diabetes mellitus [2]. Ninety-six percent of maternal-fetal specialists of the American College of Obstetricians and Gynecologists use this method [1], which may be performed in either the fasting or the fed state [5]. In screening tests a high sensitivity is preferred over a high specificity. A threshold no higher than 140 mg/dl, or 7.8 mmol/l, has been recommended for the GST to obtain a high sensitivity in universal screening programs [2]. At the threshold of 7.8 mmol/l we found that the GST failed to predict hyperglycemia in 21 of 37 women, so that the sensitivity for hyperglycemia was only 27%.

The optimal threshold of a test is determined not only by the values of sensitivity and specificity, but also by the prevalence of the condition in the population under study. When sensitivity and specificity are known, Bayes's theorem allows the calculation of predictive values for a given prevalence. Given 27% sensitivity, 89% specificity, and an assumed 5% prevalence of hyperglycemia during pregnancy in the general population, the positive and negative predictive values of the GST at the commonly used threshold of 7.8 mmol/l would be 11% and 96%, respectively. For a high-risk population with 50% prevalence, the positive and negative predictive values at the same threshold would

Table 1  
Fetal outcome related to glucose test results

|                            | n   | Greater than 90th percentile infant |      | Instrumental delivery |      | 5'-Apgar score < 7 |     | Perinatal deaths |     |
|----------------------------|-----|-------------------------------------|------|-----------------------|------|--------------------|-----|------------------|-----|
|                            |     | n                                   | %    | n                     | %    | n                  | %   | n                | %   |
| GST normal, HGP normal     | 302 | 25                                  | (8)  | 52                    | (17) | 7                  | (2) | 3                | (1) |
| GST normal, HGP abnormal   | 18  | 1                                   | (6)  | 4                     | (22) | 0                  | (0) | 0                | (0) |
| GST abnormal, HGP normal   | 76  | 6                                   | (8)  | 14                    | (18) | 2                  | (3) | 0                | (0) |
| GST abnormal, HGP abnormal | 19  | 3                                   | (16) | 4                     | (21) | 0                  | (0) | 0                | (0) |
| Total                      | 415 | 35                                  | (8)  | 74                    | (18) | 9                  | (2) | 3                | (1) |

change to 71% and 55%, respectively. This indicates that the GST at the commonly used threshold is a poor predictor of hyperglycemia in the pregnant population at large, and is far from optimal in a group of women at high risk for gestational diabetes. By increasing the threshold, the sensitivity decreases and the specificity increases, the probability of a positive test increases, and that of a negative test decreases. As illustrated by Fig. 2, it is impossible to identify a GST threshold that will provide a clinically meaningful discrimination between women with and without hyperglycemia.

As shown in Fig. 3, the reproducibility of the HGP is poor. Apparently neither a single GST nor a single HGP is a reliable indicator of hyperglycemia in women at risk for gestational diabetes. If one assumes that the GST and HGP are independent tests and that the prior odds for hyperglycemia in our study population was 0.1, the posterior odds of a positive GST and HGP can be calculated as  $0.1/0.9 \times 2.4 \times 1.6 = 0.43$ . This increases the probability of hyperglycemia only threefold, to 30%. After a negative GST and HGP, the posterior odds are 5.76, which implies a probability of 85% that hyperglycemia is indeed absent. Therefore, we must conclude that our current policy results in many false positives and false negatives.

Given the methodological shortcomings in the identi-

fication of women with hyperglycemia, the question should be asked how effective our efforts really are in terms of costs and perinatal outcome. The answer to this question requires a randomized controlled study in which pregnant women, tested for hyperglycemia, are randomly assigned to a treatment and a control group. Until the data of such a study are known, we can either continue to fool ourselves, give dietary advice to all pregnant women without further testing, or abstain from testing as well as from dietary prescriptions.

## 5. References

- 1 Summary and recommendations of the second international workshop — conference on gestational diabetes mellitus. *Diabetes* 1985; 34 (Suppl 2): 123–126.
- 2 Cousins L, Baxi L, Chez R et al. Screening recommendations for gestational diabetes. *Am J Obstet Gynecol* 1991; 165: 493–6.
- 3 Harlass FE, Brady K, Read JA. Reproducibility of the oral glucose tolerance test in pregnancy. *Am J Obstet Gynecol* 1991; 164: 564–8.
- 4 Backx CJM, Lotgering FK, Wallenburg HCS. Oral glucose tolerance test is a poor predictor of hyperglycemia during pregnancy. *J Perinat Med* 1989; 17: 253–7.
- 5 Coustan DR, Widness JA, Carpenter MW, Rotondo L, Pratt DC, Oh W. Should the fifty-gram, one-h plasma glucose screening test for gestational diabetes be administered in the fasting or fed state? *Am J Obstet Gynecol* 1986; 154: 1031–5.