50-Grams Glucose Challenge Test for Screening of Gestational Diabetes Mellitus in High Risk Pregnancy

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Objective: *To evaluate the cutoff value of the 1-hr, 50-gram glucose challenge test (GCT) for screening of gestational diabetes mellitus (GDM), in high-risk pregnancy, and to determine the prevalence of GDM in this group.*

Study design: *Descriptive study (Diagnostic test).*

Subjects: *Eight hundred and thirty-eight pregnant women, 24-28 weeks, were identified and recruited based on risk indicators between January and October 2004.*

Material and Method: *A GCT was performed in this group. All women with plasma glucose value $\geq$ 130 mg/dl were given a 3-hr, 100-gram glucose tolerance test (OGTT) to diagnose gestational diabetes mellitus using Carpenter and Coustan diagnostic criteria. The receiver-operator characteristic (ROC) curve was used to identify the cut-off value of GCT for detecting GDM.*

Main outcome measures: *The cut-off value of GCT for detecting GDM by using ROC curve with the sensitivity and specificity of various cut-off values.*

Results: *The ROC curve identified a GCT value of $\geq$ 140 mg/dl as the cut-off value for detecting GDM, which showed the sensitivity and specificity of 95.3% and 48.6% respectively. The prevalence of GDM in high-risk pregnant women was 20.17% (169/838).*

Conclusions: *Recommended threshold of 140 mg/dl used as the cut-off value of 50-gram, 1-hr GCT for screening GDM in high-risk pregnancy.*

Keywords: *1 hr; 50 gram glucose challenge test, Screening of gestational diabetes mellitus, High-risk pregnancy*

Diabetes mellitus is the most common medical complication of pregnancy. More than 90% of pregnant women with diabetes mellitus had gestational diabetes mellitus (GDM). Undetected GDM is associated with 2 to 5 fold increase in perinatal morbidity and mortality such as macrosomia, hypoglycemia, congenital anomalies, and stillbirth[1-5]. Adverse maternal effect includes an increased frequency of hypertension and cesarean delivery. Recent studies indicate that this morbidity and mortality is preventable or at least reducible by early detection and appropriate management[6,7].

The incidence of GDM increased about 40%

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from 1989 to 2002[8], and the prevalence depended upon population characteristics and diagnostic criteria. The worldwide prevalence ranges from 2-12%[9], in Thailand, the rate of 2.2% was reported by Sirirat et al in 1992[10] and 2.5% was reported by Sunsaneevithayakul et al in 2003[11]. At Bhumibol Adulyadej hospital the prevalence was 0.97%[12], which is surprisingly low. One reason could be the cut-off value used of 140 mg/dl was too high. Another reason might be the high-risk pregnant women were not screened for GDM.

Despite more than 30 years of research, there is no consensus regarding the optimal approach to screening for GDM. The major issues include whether universal or selective screening should be used and which plasma glucose level of GCT is best to identify women at risk for GDM[13,14].

Table 1 shows the variation threshold of GCT from many studies and show variability of sensitivity and specificity.

A recent study indicated that if all the pregnant women classified as high-risk pregnant were screened for GDM, the prevalence could be as high as 12.3% and 7.05%[20,21].

For these reasons, the study was conducted, and the objectives were:

1. To identify the appropriate cut off value of the GCT for screening of GDM in high-risk pregnancy.

2. To determine the prevalence of GDM in high-risk pregnancy.

Material and Method

Four thousand one hundred thirty-five pregnant women attended the antenatal care clinic at Bhumibol Adulyadej Hospital between January and October 2004. Eight hundred and thirty-eight pregnant women were identified as high-risk and recruited.

Criteria for high-risk pregnancy are either one or more of the following

1. Family history of DM
2. Previous history of GDM
3. Previous infants of macrosomia (BW $\geq$ 4,000 gram)
4. Previous infants of congenital anomalies
5. Unexplained fetal loss
6. Age of 30 years or more at the time of delivery
7. Obesity defined as Body mass index (BMI) $\geq$ 27 kg/m^2
8. Chronic hypertension
9. Pregnancy induce hypertension
10. Polyhydramnios (AFI $\geq$ 25)
11. Glucosuria by urine strip

Gestational ages at the time of screening ranged between 24-28 weeks.

All pregnant women, who had risk indicators of GDM, were performed a 1-hr, 50-grams glucose challenge test (GCT) without starvation. Venous plasma glucose was measured at 1 hour after ingestion of 50 grams of glucose. All women with plasma glucose value $\geq$ 130 mg/dl were given the 3 hr, 100 gram oral glucose tolerance test (OGTT) one week after the GCT. Venous plasma glucose were measured after overnight fasting for at least 8 hours, during which one hundred grams of glucose were ingested, then venous plasma glucose levels were measured at 1, 2, and 3 hours.

By using a threshold of 130 mg/dl of plasma glucose of GCT, the authors hoped to identify almost all of the cases of GDM and still avoid the performance of OGTT in most of the patients. O'Sullivan et al indicate that less than 1% (2 of 285 of the patient) 25 years of age or older with screening test values below 143 mg/dl would have an abnormal OGTT[15].

Definite diagnosis of GDM was defined using Carpenter and Coustan diagnostic criteria with two or more of the following venous plasma glucose values to meet or exceed.

FBS $\geq$ 95 mg/dl
1 hour $\geq$ 180 mg/dl
2 hour $\geq$ 155 mg/dl
3 hour $\geq$ 140 mg/dl

Statistical analysis

- Receiver' operator characteristic curve (ROC curve) to identify the cut-off value of GCT for screening of GDM.

- The data was used for calculating the prevalence of GDM in high-risk pregnancy.

Results
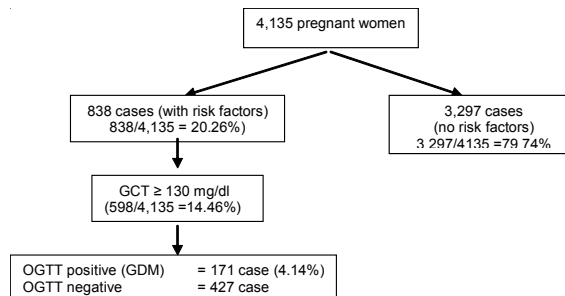
From the 4,135 pregnant women, 838 women had at least one of the risk indicators, and of these 838 women, 598 were recruited as they had positive results of GCT using cut-off value at 130 mg/dl.

Normal GCT results (threshold less than 130 mg/dl) were obtained in 3,537 of 4,135 women (85.54%). Of the 598 positive GCT, 171 pregnant women had a positive result of OGTT.

The present study shows that the prevalence of GDM is increasing with maternal age, especially after 35 years. However, there were 35 cases, under 30 years old, which is under the age that the authors used to identify risk in the present study. This is quite a large number as shown in Table 2.

In Table 3, if the value shifts from 130 to 140

Table 1. Variation in the cut off value of GCT

Reference	Threshold mg/dl	Sensitivity %	Specificity %
O'Sullivan, 1973[15]	140	79	87
Marshall, 1982[16]	135	99	95
Jirapinyo M, 2003[17]	140	86	65
Miyakoshi K, 2003[18]	140	96	76
Yogev Y, 2004[19]	130	97	63

Table 2. Prevalence of GDM with relation to age

Age (yr)	GCT (case)	GDM (case)	Prevalence (%)
≤ 19	22	4	18.18
20-24	70	11	15.71
25-29	157	20	12.72
30-34	238	38	15.97
35-39	251	66	26.29
≥ 40	100	32	32.00
Total	838	171	20.41

Table 3. The number of GDM in group with different GCT results

GCT value (mg/dl)	GCT (case)	GDM (case)	Percentage (%)
130-134	50	2	4.00
135-139	59	0	0.00
140-144	77	11	14.28
145-149	91	15	16.48
150-154	59	6	10.16
155-159	49	4	8.16
160-164	59	2	3.38
165-169	39	12	30.76
170-174	39	9	23.07
175-179	16	4	25.00
≥ 180	300	106	35.53
Total	838	171	20.41

mg/dl, there would be only two cases missed (2/838 = 0.24%). However, the numbers of OGTT to be performed could be reduced to 109 cases.

Considering the sensitivity and specificity, if the cut-off value was 130 or 135 mg/dl, it slightly increased sensitivity but greatly reduced specificity of the test, compared with 140 mg/dl. In addition, the prevalence of GDM is slightly decreased when 140 mg/dl was used as the cut-off value compared to 130 and 135 mg/dl as shown in Table 4

When 140 mg/dl was used as the cut-off value,

the prevalence of GDM in high-risk group was 20.17% (169/838) and estimated prevalence of the whole population was 4.09% (169/4,135).

In the ROC curve, at the level of 150mg/dl, the sensitivity and specificity were 80.1% and 62.7% respectively. However, in high-risk group, the screening must have high sensitivity that was more efficient in identifying almost all cases of GDM. If the authors used 140 mg/dl as the cut-off value, the sensitivity was increased to 95.3% with the specificity of 48.6%. Therefore, in the present study, the authors recommend a

Table 4. The number of GDM, sensitivity, specificity and prevalence in different GCT threshold

GCT Threshold (mg/dl)	GCT (case)	GDM (case)	Sensitivity (%)	Specificity (%)	Prevalence (%)
≥ 130	838	171	100.0	38.2	20.41
≥ 135	788	169	98.8	41.8	20.17
≥ 140	729	169	95.3	48.6	20.17
≥ 145	652	158	87.1	44.2	18.85
≥ 150	561	143	80.1	62.7	17.06
≥ 155	502	137	77.8	67.3	16.34
≥ 160	453	133	76.6	72.3	15.87
≥ 165	394	131	75.4	77.9	15.63
≥ 170	355	119	66.1	80.9	14.2
≥ 175	316	110	62.6	83.3	13.12
≥ 180	300	106	60.2	86.2	12.64

Table 5. The frequency of GDM with respective to the presence of risk factors

| Risk factors	No. of risk count	No. of GDM	Percentage
Family history of DM	354	66	18.64
Previous history of GDM	4	0	0.00
Previous infant of macrosomia	12	4	33.33
Previous infant of congenital anomalies	6	0	0.00
Unexplained fetal loss	14	3	21.43
Age ≥ 30 years	510	87	17.06
Obesity BMI > 27kg/m^2	96	9	9.38
Chronic hypertension	4	2	50.00
Pregnancy induce hypertension	6	2	33.33
Hydramnios	0	0	0.00
Glucosuria ≥ trace	120	20	16.67
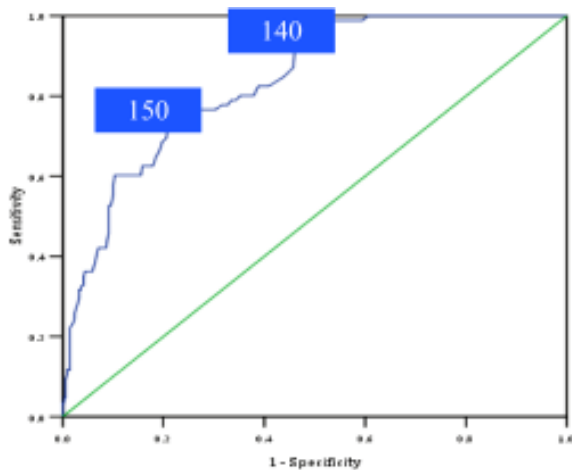
Fig. 1 The Receiver' Operator Characteristic Curve (ROC curve)

cut-off value for the GCT of 140mg/dl when screening GDM in high-risk pregnancy.

When looking at the risk factors in Table 5, the two highest risks detected were family history of DM and age ≥ 30years. These risks were also associated with the highest number of GDM. Previous history of GDM, previous infant of congenital anomalies, and hydramnios were three factors not associated with GDM. However, this was possibly due to the very low number of cases.

Discussion

From the present study, the authors recommend the use of GCT level at 140mg/dl for screening of GDM in high-risk pregnancy. This has a sensitivity and specificity of 95.3% and 48.6% respectively. Only two cases (0.24%) were missed diagnosis with these values. Using 130 or 135 mg/dl as the cutoff, only slightly

increased the sensitivity but greatly reduced the specificity of the test. This leads to unnecessarily performing unnecessarily OGTT in 109 cases. Furthermore, this recommended GCT level is approximately the same level as described in the previous studies when the specificity and the sensitivity were comparable[15,17,18].

In the present study, the authors reported the prevalence of GDM in high-risk pregnancy at Bhumibol Adulyadej Hospital at 20.17% (169/838). It is higher than previous studies, 12.3% in the study of Di cianni et al[20], 6.2% in the study of Sunsanee vithayakul et al[11], and 7.05% in the study of Chanpra paph et al[21]. The authors proposed that the difference of GDM among studies might be due, in part, to the criteria used for screening.

As mentioned earlier, the previous prevalence of GDM in the whole population at Bhumibol Adulyadej Hospital (0.97%) was lower than the prevalence reported by Sirirat et al (2.2%)[10] and Sunsanee Vithayakul et al (2.5%)[11]. This may be due to incomplete screening of the high-risk pregnancy population, rather than the inappropriate cut-off value of GCT. In the present study, when all pregnant women were screened first with the risk factors criteria and GCT, the prevalence of GDM of all pregnant women surged up to 4.14%, higher prevalence when comparable to Sunsaneevithayakul et al[11]. Also, the authors found that using risk indicators, together with the GCT for screening of GDM can reduce the number of OGTT cases to be performed at approximately 85.54% (3537/4135 cases). Therefore, from this result, the authors suggested these two parameters, risk indicators together with the GCT, for screening of GDM.

From to the present study, the prevalence of GDM increases with maternal age especially after 35 years. However, at present, one of the criteria the authors used to screen for GDM was the age of 30 years or older. Using these criteria, 35 cases (20.47%) of GDM might not have been detected (35/171). Therefore, the proper age of the patient in the screening criteria needs to be studied further.

Although the authors recommend the cut-off GCT level $\geq$ 140 mg/dl for screening of GDM in high-risk pregnancy, the association between GCT level and the pregnancy outcome has not yet been identified. Therefore, the associations of GCT level and pregnancy outcome need to be studied further.

Conclusion
1. Recommended threshold of 140 mg/dl use as the cut-off value of 1-hr, 50-grams glucose challenge test for screening of gestational diabetes mellitus in high-risk pregnancy.

2. Prevalence of gestational diabetes mellitus in high-risk pregnancy at Bhumibol Adulyadej Hospital is 20.41% (171/838).

3. Using risk indicators, together with the 1-hr, 50-grams glucose challenge test for screening of gestational diabetes mellitus is a highly effective strategy.

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การตรวจคัดกรองโรคเบาหวานระหว่างตั้งครรภ์โดยใช้ 50 gram glucose challenge test ในสตรีตั้งครรภ์ที่มีความเสี่ยง

วราภรณ์ จันทรัตน์, วิบูลย์ เรืองชัยนิคม, สินาท พรหมมาศ

วัตถุประสงค์: เพื่อหาค่าที่เหมาะสมในการตรวจคัดกรองโรคเบาหวานระหว่างตั้งครรภ์โดยใช้ 1 hr, 50 gram glucose challenge test (GCT) และเพื่อหาความชุกของโรคเบาหวานระหว่างตั้งครรภ์ในสตรีตั้งครรภ์ที่มีความเสี่ยง

ประเภทงานวิจัย: Descriptive study (Diagnostic test)

สถานที่ทำการวิจัย: กองสูตินรีเวชกรรมโรงพยาบาลภูมิพลอดุลยเดช กรมแพทย์ทหารอากาศ

กลุ่มตัวอย่าง: สตรีตั้งครรภ์ที่มาฝากครรภ์ช่วงระหว่างเดือน มกราคม ถึง ตุลาคม พ.ศ. 2547 ที่มีอายุครรภ์ระหว่าง 24-28 สัปดาห์และมีความเสี่ยงต่อการเกิดโรคเบาหวานระหว่างตั้งครรภ์ตามเกณฑ์ที่กำหนด จำนวน 838 คน

วัสดุและวิธีการ: สตรีตั้งครรภ์ที่ถูกคัดเลือกทั้งหมดได้รับการตรวจ GCT และสตรีตั้งครรภ์ที่มีระดับน้ำตาลมากกว่าหรือเท่ากับ 130 mg/dl จะได้รับการตรวจ 3 hr, 100 gram glucose tolerance test (OGTT) การวินิจฉัยโรคเบาหวานระหว่างตั้งครรภ์ใช้ Carpenter and Coustan diagnostic criteria และใช้ Receiver-operator characteristic (ROC) curve เพื่อหาจุดตัดที่เหมาะสมของ GCT

ตัววัดที่สำคัญ: จุดตัดที่เหมาะสมของ GCT จาก ROC curve และ sensitivity, specificity ของแต่ละค่าของ GCT และความชุกของโรคเบาหวานระหว่างตั้งครรภ์

ผลการศึกษา: จุดตัดที่เหมาะสมของ GCT จาก ROC curve เท่ากับ 140 mg/dl โดยมี sensitivity และ specificity เท่ากับ 95.3% และ 48.6% ตามลำดับ พบความชุกของโรคเบาหวานระหว่างตั้งครรภ์ในสตรีตั้งครรภ์ที่มีความเสี่ยงเท่ากับ 20.17% (169/838)

สรุป: จุดตัดที่เหมาะสมของ GCT ในการตรวจคัดกรองโรคเบาหวานระหว่างตั้งครรภ์ในสตรีตั้งครรภ์ที่มีความเสี่ยงสูงเท่ากับ 140 mg/dl และพบความชุกในสตรีกลุ่มนี้เท่ากับ 20.17%