No. 393, December 2019 (replaces No. 334, July 2016)

# Guideline No. 393-Diabetes in Pregnancy

This Clinical Practice Guideline has been prepared by the Maternal Fetal Medicine committee, reviewed by the Family Physicians Advisory, Aboriginal Health Initiative and Clinical Practice – Obstetrics guideline committees and the Canadian Diabetes Association, endorsed by the Canadian Diabetes Association and approved by the Board of the Society of Obstetricians and Gynaecologists of Canada.

Howard Berger, MD, Toronto, ON

Robert Gagnon, MD, Montréal, QC

Mathew Sermer, MD, Toronto, ON

**Maternal Fetal Medicine Committee (2019):** James Andrews, MD, Surrey, BC; Hayley Bos, MD, Victoria, BC (co-chair); Sheryl Choo, London, ON; Elisabeth Codsi, MD, Montreal, QC; Venu Jain, Edmonton, AB; Lisa Kuechler, RN, Victoria, BC; Noor Ladhani, MD, Toronto, ON; Heather Martin, RM, Edmonton, AB; N. Lynne McLeod, MD, Halifax, NS; William Mundle, MD, Windsor, ON (co-chair); Kirsten Niles, Toronto, ON; Christy Pylypjuk, MD, Winnipeg, MB; Jennifer Walsh, MD, Calgary, AB

**Special Contributor:** Venu Jain, MD, Edmonton, AB

The disclosure statements have been received from all authors and no conflicts of interest were declared.

**Key Words:** Diabetes, pregnancy, stillbirth

Corresponding author: Dr. Howard Berger

## CHANGES IN PRACTICE

1. Universal screening for gestational diabetes is recommended.
2. Serial ultrasounds to assess fetal growth velocity and amniotic fluid volume provides objective endpoints to assess the effectiveness of glycemic control in pregnancy with diabetes.
3. When betamethasone is administered for lung maturation, close maternal glycemic surveillance is recommended. Screening for gestational diabetes should be postponed for at least 7 days after the administration of betamethasone.
4. Pregnant women with either gestational or pre-gestational diabetes should be offered induction between 38 to 40 weeks gestation depending on their glycemic control and other comorbidity factors.

## KEY MESSAGES

1. Multidisciplinary management to achieve optimal glycemic control improves perinatal outcome.
2. There is an increased risk of stillbirth in women with diabetes in pregnancy, particularly near term.
3. Optimizing glycemic control in pregnancies complicated with diabetes reduces the risk of preeclampsia, shoulder dystocia, and a large for gestational age fetus.
4. The occurrence of gestational diabetes increases the risk of developing type 2 diabetes in the future.

J Obstet Gynaecol Can 2019;41(12):1814–1825

https://doi.org/10.1016/j.jogc.2019.03.008

## Abstract

**Objectives:** This guideline reviews the evidence relating to the diagnosis and obstetrical management of diabetes in pregnancy.

**Outcomes:** The outcomes evaluated were short and long-term maternal outcomes including pre-eclampsia, Caesarean section, future diabetes and other cardiovascular complications; and fetal outcomes including congenital anomalies, stillbirth, macrosomia, birth trauma, hypoglycemia and long-term effects.

**Evidence:** Published literature was retrieved through searches of PubMed and The Cochrane Library using appropriate controlled vocabulary (MeSH terms "diabetes" and "pregnancy"). Where appropriate, results were restricted to systematic reviews, randomized control trials/controlled clinical trials, and observational studies. There were no date limits but results were limited to English or French language materials.

**Values:** The quality of evidence was rated using the criteria described in the Report of the Canadian Task Force on Preventive Health Care.

**Summary Statements:**

1. The adverse outcomes associated with diabetes in pregnancy are substantially associated with hyperglycemia as well as the co-existing metabolic environment. Women with pre-existing diabetes should receive preconception care to optimize blood sugar control and other co-morbidities. Outcomes for the fetus/neonate and the mother in both pre-gestational diabetes mellitus and gestational diabetes mellitus pregnancies are improved by multidisciplinary management whose goal is achieving optimal blood sugar control and appropriate fetal surveillance (II-2).
2. Retrospective studies indicate that women with pre-gestational diabetes mellitus have an increased risk of stillbirth before 40 weeks of gestation when compared with the general obstetrical population. Similarly, large recent cohort and simulation studies of women with gestational diabetes mellitus pregnancies also indicate a higher risk of stillbirth between 36-39 weeks gestation (II-2).
3. Women with gestational diabetes mellitus have a higher risk of pre-eclampsia, shoulder dystocia, Caesarean section and large for gestational age infants (II-2).
4. Treatment of women with gestational diabetes mellitus and optimization of glycemic control reduces the risk of pre-eclampsia, shoulder dystocia, and large for gestational age infants (I).
5. The occurrence of gestational diabetes mellitus increases the risk of developing type 2 diabetes in the future for the mother (II-2).

**Recommendations:**

1. The "preferred screening and diagnostic 2-step" approach for gestational diabetes mellitus of the Canadian Diabetes Association 2013 guidelines is endorsed. All pregnant women should be offered screening between 24-28 weeks using a standardized non-fasting 50-g glucose challenge screening test (GCT) with plasma glucose (PG) measured 1 hour later (III-B).

   1.1. If the value is <7.8 mmol/L, no further testing is required.

   1.2. If the value of the GCT is 7.8–11.0, a 2-hour 75-g oral glucose tolerance test with fasting PG (FPG), 1-hour PG, 2-hour PG should be performed.

   Gestational diabetes mellitus is diagnosed if 1 value is met or exceeded:

   i. FPG ≥5.3 mmol/L 95 mg/dl
   ii. 1-h PG ≥10.6 mmol/L 190 mg/dl
   iii. 2-h PG ≥9.0 mmol/L 162 mg/dl

   1.3. If the value of the GCT is ≥11.1 mmol/L, gestational diabetes mellitus is diagnosed

2. The "alternative 1-step diagnostic" approach of the Canadian Diabetes Association 2013 guidelines is acceptable. In this strategy pregnant women should be offered testing between 24-28 weeks using a standardized 2-hour 75-g oral glucose tolerance test with fasting plasma glucose (FPG), 1-hour plasma glucose (PG), 2-hour PG (III-B).

   Gestational diabetes mellitus is diagnosed if 1 value is met or exceeded:

   i. FPG ≥5.1 mmol/L
   ii. 1-h PG ≥10.0 mmol/L
   iii. 2-h PG ≥8.5 mmol/L

   It is recognized that the use of different diagnostic thresholds for the "preferred" and "alternate" strategies could cause confusion in certain settings. Despite this the committee has identified the importance of remaining aligned with the current CDA 2013 guidelines as being a priority. It is thus recommended that each care centre strategically align with one of the two strategies and implement protocols to ensure consistent and uniform reporting of test results.
3. If there is a high risk of gestational diabetes mellitus based on multiple risk factors, screening or testing should be offered during the first half of the pregnancy and repeated at 24-28 weeks gestation if initially normal. If for any reason it was missed or if there is a clinical suspicion of later onset gestational diabetes, a screening or diagnostic test should be performed (II-2B).
4. Women with pre-existing or gestational diabetes mellitus should be provided with care by a multidisciplinary team aimed at attaining and then maintaining euglycemia (II-2B).
5. For patients with pre-gestational diabetes mellitus or gestational diabetes mellitus, starting at 28 weeks as a baseline, with subsequent serial assessment of fetal growth every 3-4 weeks is suggested to assess the effect of maternal glycemic control on fetal growth rate and amniotic fluid volume (II-2B).
6. Initiation of weekly assessment of fetal well-being at 36 weeks is recommended in pre-gestational diabetes mellitus and in gestational diabetes mellitus. It is also reasonable to consider weekly fetal assessment for women with diet controlled gestational diabetes mellitus beginning at 36 weeks. Acceptable methods of assessment of fetal well-being near term can include the non-stress test, non-stress test + amniotic fluid index, biophysical profile or a combination of the above (III-A).
7. If co-morbid factors are present such as obesity, evidence of suboptimal glycemic control, large for gestational age (>90%), previous stillbirth, hypertension or small for gestational age (<10%) are present, earlier onset and/or more frequent fetal health surveillance is recommended. In specific cases where fetal growth restriction is suspected, the addition of umbilical artery and fetal middle cerebral artery Doppler assessment may be helpful (II-2A).
8. Pregnant women with gestational diabetes mellitus or with pre-gestational diabetes mellitus should be offered induction between 38-40 weeks of gestation depending on their glycemic control and other co-morbidity factors (II2-B).
9. Antenatal corticosteroid therapy should be administered to women with insulin-treated gestational diabetes mellitus and pregestational diabetic women at the same dosage, according to the same indications, and in the same gestational age range as that recommended for non-diabetic women (Skoll A, et al. No. 364-Antenatal Corticosteroid Therapy for Improving Neonatal Outcomes. J Obstet Gynaecol Can 2018;40:1219-39). When administered to women with preexisting or poorly controlled diabetes, close maternal

glycemic surveillance is recommended (III-B). Following the first dose of betamethasone, the following insulin adjustments are recommended as per CDA guidelines (Diabetes Canada Clinical Practice Guidelines Expert C, et al. Diabetes and Pregnancy. Can J Diabetes 2018;42 Suppl 1:S255-S82):

- Day 1: Increase the night insulin dose by 25%
- Days 2 and 3: Increase all insulin doses by 40%
- Day 4: Increase all insulin doses by 20%
- Day 5: Increase all insulin doses by 10% to 20%
- Days 6 and 7: Gradually taper insulin doses to pre-betamethasone doses

10. If not previously done, in women with threatened preterm labour requiring betamethasone, a screening and diagnostic test for gestational diabetes mellitus should be performed either before or at least 7 days after the administration of betamethasone (III-B).
11. Women with GDM should be offered testing with a 75-g oral glucose tolerance test between 6 weeks and 6 months postpartum to detect prediabetes and diabetes (Thompson D, et al. Diabetes and pregnancy. Can J Diabetes 2013;37 Suppl 1:S168–83) (II-2A).

    11.1 Normal
        i. Fasting plasma glucose (FPG) <6.1 mmol/L
        ii. 2h <7.8 mmol/L
        iii. $HbA_{1C}$ <6.0%

    11.2 Pre-diabetic
        i. FPG 6.1-6.9 mmol/L or
        ii. 2h plasma glucose (PG) 7.8-11.0 mmol/L or
        iii. $HbA_{1C}$ 6.0-6.4%

    11.3 Type 2 Diabetes mellitus
        i. FPG $\geq$ 7.0 mmol/L
        ii. Random PG or 2h PG $\geq$11.1 mmol/L
        iii. $HbA_{1C}$ $\geq$6.5%

12. Breastfeeding is strongly recommended after delivery for all women with pre-gestational diabetes mellitus or gestational diabetes mellitus (II-2A).

## INTRODUCTION

A large population-based study in Ontario demonstrated that between 1996-2010 the incidence of both gestational diabetes mellitus (GDM) and pre-gestational diabetes mellitus (PGDM) which includes both type 1 and type 2 DM, has doubled from 2.7% to 5.6% for GDM and from 0.7 to 1.5% for PGDM.[1] When compared with nondiabetic pregnant women, the risk of both congenital anomalies, odds ratio (OR) of 1.86 (95% confidence interval [CI] 1.49−2.33) and perinatal mortality, OR 2.33 (95% CI 1.59-3.43) remained higher in PGDM pregnant women.[1] Similarly, in a Swedish population-based cohort of over 1.2 M pregnancies with singleton gestations, women with GDM had a higher risk of adverse maternal outcomes with adjusted OR of 1.81 (95% CI 1.64-2.00); for shoulder dystocia of 2.74 (95% CI 2.04-3.68); and for Caesarean section, 1.46 (95% CI 1.38-1.54).[2] In addition, with GDM, a higher risk of adverse neonatal outcomes including large-for-gestational age, OR 3.43 (95% CI 3.21-3.67), Erb's palsy, OR 2.56 (95% CI 1.96-3.32), prematurity, OR 1.71 (95% CI 1.58-1.86), and major malformations, OR 1.19 (95% CI 1.02-1.39) has been reported.[2] It is of interest that no statistically significant improvement in maternal and neonatal outcome was seen over time in either study with the exception of a decline in the rate of congenital anomalies by 23%.[1,2]

While the benefits of specialized management of pregnancies complicated by PGDM is well known, we now have data from randomized controlled trials (RCTs) that document a reduction in certain perinatal morbidities after diagnosis and management of GDM.[3,4] The primary goal of this management is to attain and then maintain euglycemia. This is best done by a multidisciplinary team with attention to diet and exercise, and glucose monitoring, and, as appropriate, medical management with insulin and/or oral hypoglycemic agents.

The purpose of these guidelines is to review the diagnostic criteria and issues related to the obstetrical management of GDM and PGDM. Specific recommendations regarding glycemic control are beyond the scope of this document but can be found in the 2013 CDA Clinical Practice Guidelines http://guidelines.diabetes.ca/browse/chapter36. The quality of evidence was rated using the criteria described in the Report of the Canadian Task Force on Preventive Health Care (Table 1).

## ABBREVIATIONS

| | |
|---|---|
| ACOG | American College of Obstetricians and Gynecologists |
| CDA | Canadian Diabetes Association |
| FPG | fasting plasma glucose |
| GCT | glucose challenge screening test |
| GDM | gestational diabetes mellitus |
| HAPO | Hyperglycemia and Adverse Pregnancy Outcome study |
| IADPSG | International Association of Diabetes and Pregnancy Study Groups |
| NND | number needed to deliver |
| OGTT | oral glucose tolerance test |
| PG | plasma glucose |
| PGDM | pre-gestational diabetes mellitus |
| RCT | randomized controlled trial |
| RPG | random plasma glucose |
| SMBG | self-monitored blood glucose |

## IMPACT OF DIABETES MELLITUS ON PERINATAL MORTALITY

Table 2 summarizes the relative risk or OR for stillbirth in different populations studied in pregnancies with GDM compared with non-GDM pregnancies. A wide range of absolute stillbirth rates (per 1000 pregnancies) have been reported from as low as 0.32 up to 4.2 per 1000 pregnancies depending on the population studied and the gestational age cut-off used to define stillbirth (Table 2). Some studies[5] have confirmed that GDM may be diagnosed before 24 weeks gestation approximately 22%−27% of the time. Almost one-third of these patients (or 8% of the total diagnosed with GDM) will have type 2 diabetes when tested postpartum.[6] This is particularly true in the presence of the following risk factors: maternal age > 35 years, obesity (BMI >30), ethnicity (Aboriginal, African, Asian, Hispanic, South Asian), family history of diabetes, polycystic ovary syndrome, acanthosis nigricans, corticosteroid use, previous pregnancy complicated with GDM, or previous macrosomic infant.[7] Hutcheon et al.[8] have suggested that only stillbirths above 28 weeks gestation should be included to determine the risk of stillbirth associated with GDM. Including women with an earlier diagnosis may not represent the risk associated with GDM but rather a mix of GDM and other causes of stillbirths leading to the introduction of a bias by including a period of follow-up during which, by design, death or the study outcome cannot occur. Since GDM is usually diagnosed after 24-28 weeks gestation, it would be more appropriate to include only late stillbirth occurring after 28 weeks. Table 2 illustrates this phenomenon. When defining stillbirth occurring at >20 weeks, the risk of stillbirth attributable to GDM is reduced or insignificant.[8−11] This is because more than 30% of stillbirths occur at 20-23 weeks before GDM is usually diagnosed.[12] When including only stillbirths

**Table 1. Key to evidence statements and grading of recommendations, using the ranking of the Canadian Task Force on Preventive Health Care**

| Quality of Evidence Assessment* | Classification of Recommendations† |
|---|---|
| I: Evidence obtained from at least one properly randomized controlled trial | A. There is good evidence to recommend the clinical preventive action |
| II-1: Evidence from well-designed controlled trials without randomization | B. There is fair evidence to recommend the clinical preventive action |
| II-2: Evidence from well-designed cohort (prospective or retrospective) or case-control studies, preferably from more than one centre or research group | C. The existing evidence is conflicting and does not allow to make a recommendation for or against use of the clinical preventive action; however, other factors may influence decision-making |
| II-3: Evidence obtained from comparisons between times or places with or without the intervention. Dramatic results in uncontrolled experiments (such as the results of treatment with penicillin in the 1940s) could also be included in the category | D. There is fair evidence to recommend against the clinical preventive action |
| III: Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees | E. There is good evidence to recommend against the clinical preventive action |
| | L. There is insufficient evidence (in quantity or quality) to make a recommendation; however, other factors may influence decision-making |

* The quality of evidence reported in these guidelines has been adapted from The Evaluation of Evidence criteria described in the Canadian Task Force on Preventive Health Care.

† Recommendations included in these guidelines have been adapted from the Classification of recommendations criteria described in The Canadian Task Force on Preventive Health Care.

Taken from: Woolf SH, Battista RN, Angerson GM, Logan AG, Eel W. Canadian Task Force on Preventive Health Care. New grades for recommendations from the Canadian Task Force on Preventive Health Care. CMAJ 2003;169:207e8.

**Table 2. Risk of stillbirth; GDM versus no GDM**

| Author | Gestational age cut-off | Population (n) | Absolute stillbirth rate in GDM (per 1000 pregnancies) | Relative risk or odds ratio (95% CI) | Policy management |
|---|---|---|---|---|---|
| Hutcheon et al.[8] | ≥20 weeks | 2 001 749 | 4.2 | 0.88 (0.79-0.99) | Not available |
| Peticca et al.[11] | ≥20 weeks | 120 604 | 2.0 | 0.31 (0.11-0.67) | Induction rate: 38% vs 24% |
| Karmon et al.[9] | ≥20 weeks | 184 256 | 4.0 | 0.5 (0.4-0.7) | Routine induction at 40 weeks |
| Ohana et al.[10] | ≥20 weeks | 228 293 | 0.32 | 0.7 (0.5-0.8) | Not available |
| Fadl et al.[2] | >28 weeks | 1 260 297 | 4.0 | 1.18 (0.87-1.60) | Not available |
| Hutcheon et al.[8] | >28 weeks | 1 988 320 | 3.5 | 1.25 (1.11-1.41) | Not available |
| Rosenstein et al.[13] | ≥36 weeks | 4 190 953 | 1.71 | 1.34 (1.2-1.5) | At >39 weeks risk higher if expectant management |

GDM: gestational diabetes mellitus.

occurring after 28 weeks, many studies to date have shown a trend or a statistically significant increased risk of stillbirth attributable to GDM.[2,8,13] The specific excess risk of stillbirth in relation to week of gestation has recently been shown in a cohort[13] and simulation study derived from this cohort.[14] This retrospective analysis of population-based data from California, showed that the overall risk of stillbirth from 36-42 weeks was higher in women with GDM when compared with women without GDM (17.1 vs. 12.7/10,000 deliveries; relative risk (RR) 1.34 (95% CI 1.2−1.5).[14] Stillbirth rates were also examined at each gestational age, and from 36 to 39 weeks, women with GDM had a statistically significant elevated RR of stillbirth compared with women without GDM, ranging from RR, 1.45 (95% CI 1.1−1.9) at 38 weeks to RR 1.84 (95% CI 1.5−2.3) at 37 weeks.[14] This increased risk of stillbirth remained statistically significant at 39 weeks with an RR of 1.56 (95% CI 1.2−2.0) but not at 40 and 41 weeks gestation. The loss of significance at 40−41 weeks was either due to the increase in stillbirths in non-GDM pregnancies[15] or due to the relatively low number of patients after 39 weeks in GDM pregnancies compared to non-GDM pregnancies. In addition, the risk of expectant management in women with GDM carried a higher risk of perinatal mortality than the risk of delivery at 39 and 40 weeks gestation.[13,14] The number of women with GDM needed to deliver (NND) at 39 and 40 weeks to prevent 1 excess death was 1518 and 1311, respectively.[13] This is comparable to an NND of 1299 at 40 weeks for women without GDM and ≥40 years of age at the time of delivery.[15] The retrospective nature of this study and the inability to control for glycemic control and insulin treatment are limitations. A retrospective cohort study from a centre with a

policy of induction by 40 weeks for all pregnant women with diet-controlled GDM suggested that it is protective against stillbirth when compared with the general obstetrical population, OR 0.5 (95% CI 0.4-0.7).[9] The impact of this policy of induction on Caesarean section rates and neonatal morbidity is controversial. However, a small randomized clinical trial in mainly non-diabetic women by Nicholson et al.[16] demonstrated a lower neonatal intensive care unit admission rate, a higher uncomplicated vaginal birth rate and a lower mean adverse outcome index score (better pregnancy outcomes) among women who were actively managed through elective labour induction based on a unique management of risk scoring system.

There is good evidence that PGDM is associated with a 3-5-fold increase in stillbirths when compared with non-diabetic pregnant women.[17] Further prospective research is needed on the optimization of timing of delivery in both GDM and PGDM pregnancies with specific attention to stratification by adequacy of glycemic control; the impact on maternal, fetal and neonatal outcomes; as well as economic analysis of different management strategies.

**REFERS TO SUMMARY STATEMENTS 1 & 2**

## SCREENING FOR GESTATIONAL DIABETES MELLITUS (GDM) – APPENDIX A

Despite not meeting many of the criteria for a program of population-based screening,[18] screening for GDM has been accepted widely and is almost universally practised among health care professionals in North America.[19,20] Methods for screening for GDM include:

1. Screening with a 1-hour 50-g glucose load (or alternative)
2. Risk factor based screening
3. One step testing with a diagnostic 2-hour 75 gram oral glucose tolerance test (OGTT). This does not in fact constitute a screening test but rather universal testing
4. Screening with alternative biochemical tests: Fasting plasma glucose (FPG); $HbA_{1C}$, random plasma glucose (RPG)

There have been no RCTs comparing screening for GDM with no screening[20] thus the decision to perform screening is based on the recent RCTs that have shown certain health benefits for treatment of GDM.[3,4] As GDM is an asymptomatic condition, logic dictates that some form of screening would need to be performed in order to diagnose cases that might benefit from treatment and management of GDM. The Toronto Tri Hospital study established that adverse outcomes associated with GDM increase along a continuum of increasing glucose thresholds.[21] More recently, the Hyperglycemia and Adverse Pregnancy Outcome (HAPO) study[22] confirmed these findings in a large prospective observational study but were unable to define outcome based thresholds for the diagnosis of GDM. Despite this, the International Association of Diabetes and Pregnancy Study Groups (IADPSG) published recommendations for new thresholds for the diagnosis of GDM based on statistical re-analysis of the HAPO data.[23] The thresholds for the 2-hour 75-g OGTT used were calculated by defining glucose concentrations at which the OR of the 4 HAPO primary outcomes (birthweight >90%; primary Caesarean section rate; neonatal hypoglycemia and cord C-peptide levels >90%) reached 1.75. These thresholds, when applied to the HAPO cohort, led to an average GDM incidence of 17% across all HAPO sites. In addition the IADPSG recommended abandoning the 1-hour 50-g glucose load in favour of a 1-step testing strategy. Table 3 provides a summary of the glucose thresholds, screening, and diagnostic strategies used worldwide. In North America, either a 2-step or a 1-step approach is felt to be acceptable since there is no demonstrated difference in outcome using either strategy.[7,24,25]

The Canadian Diabetes Association (CDA) guidelines in which the Society of Obstetricians and Gynaecologists of Canada (SOGC) was represented in an attempt to achieve consensus between obstetricians and endocrinologists were updated in 2013.[7] Guiding the decisions of the committee were the realization that: (1) women with one abnormal value on the OGTT (previously classified as intolerance to glucose of pregnancy or IGT) have similar outcomes to women with two abnormal values and are routinely managed in the same manner[6,26–30]; (2) the HAPO trial[22] provided data that could be used to help formulate outcome based diagnostic thresholds for GDM and; (3) there is a need to achieve some degree of uniformity with regards to screening methodology and diagnostic criteria in Canada. The CDA 2013 guidelines recommends a universal screening for GDM for all pregnant women between 24 and 28 weeks gestation followed with a 2-hour 75-g oral glucose tolerance test if the 1-hour plasma glucose (PG) post 50 g glucose load value is ≥7.8 mmol.[7] This is referred to as the "preferred 2-step" approach with diagnostic criteria thresholds corresponding to an OR of 2.0 for the four main HAPO outcomes.[22] An "alternative 1-step" approach with diagnostic criteria thresholds with an OR of 1.75[22] for adverse perinatal outcome is also acceptable.[7] The 2014 American Diabetes Association guidelines[24] endorsed an approach similar to the CDA 2013 although the second step differs with the diagnostic test remaining the 100 gram OGTT.[24] These guidelines are also more in line with

**Table 3. Universal Screening and Diagnostic criteria for GDM (mmol/L)**

| | ACOG 2013[25] ADA 2014[24] Carpenter and Coustan | ACOG 2013[25] ADA 2014[24] National Diabetes Data Group | CDA 2013[7] "preferred approach" | CDA 2013[7] "alternative approach", IADPSG 2010,[86] ADIPS 2014[31], ADA 2014[24] | WHO 2013[32] |
|---|---|---|---|---|---|
| Gestational age at screening[a] | 24-28 weeks | 24-28 weeks | 24-28 weeks | 24-28 weeks | Any time |
| Steps | 2-step | 2-step | 2-step | 1-step | 1-step |
| Step 1 Screening 1-h 50 g glucose challenge | Step 2 if value ≥7.8 No diagnostic cut-off for GDM | Step 2 if value ≥7.8 No diagnostic cut-off for GDM | GDM if ≥11.1 Step 2 if value 7.8-11.0 | | |
| Step 2 | | | | | |
| Loading dose | 100 g | 100 g | 75 g | 75 g | 75 g |
| Fasting | ≥5.3 | ≥5.8 | ≥5.3[b] | ≥5.1[c] | ≥5.1[c] |
| 1 hour | ≥10.0 | ≥10.6 | ≥10.6[b] | ≥10.0[c] | ≥10.0[c] |
| 2 hours | ≥8.6 | ≥9.2 | ≥9.0[b] | ≥8.5[c] | ≥8.5[c] |
| 3 hours | ≥7.8 | ≥8.0 | Not needed | Not needed | Not needed |
| GDM if | ≥2 abnormal values | ≥2 abnormal values | ≥1 abnormal value | ≥1 abnormal value | ≥1 abnormal value |
| Prevalence of GDM (%) | 4.8 | 3.2 | 7.0 | 16.1 | 16.1 |

ACOG: American College of Obstetrics and Gynecology; ADA: American Diabetes Association; ADIPS: Australasian Diabetes in Pregnancy Society; CDA: Canadian Diabetes Association; IADPSG: International Association of Diabetes in Pregnancy Group; GDM: gestational diabetes mellitus; WHO: World Health Organization.

[a] Screening offered at any stage in the pregnancy if multiple risk factors

[b] OR of 2.00 for adverse perinatal outcome based on HAPO study

[c] OR of 1.75.

the American College of Obstetricians and Gynecologists (ACOG) 2013 guidelines.[25] It is of note that the Australasian Diabetes in Pregnancy Society and the World Health Organization have both adopted the IADPSG criteria in their 2013 guidelines.[31,32] The incidence of GDM will vary between 3.2% and 17.8% depending of the thresholds used and the composition of the screened population. Table 3 summarizes the different screening and diagnostic criteria used for GDM.

## THE 1-HOUR 50-g GLUCOSE CHALLENGE SCREENING TEST

It is recognized that there is controversy regarding the use of a 1-hour 50-g non-fasting GCT as a screening test for GDM. Criticism is focused on the following issues: (1) the inability to identify women with isolated elevated FPG; (2) limited reproducibility; (3) incomplete uptake of the diagnostic test in those that screen positive; (4) delay in diagnosis of GDM; and (5) Sensitivity of the test is only 76.6%.[33] In contrast, this test is widely practised in North America and has high acceptance in both patients and caregivers. Until data emerges that support significant superior outcomes with a one-step diagnostic test, the SOGC has decided to recommend the continued use of the 50-g OGTT as the primary screening tool in women without high-risk characteristics.

There are no established criteria for the diagnosis of GDM based on the 1-hour 50-g post-load value but it is recognized that there are results of this test that indicate a very high chance of diagnosing GDM on the confirmatory test. Cheng et al.,[34] in a cohort of 14 771 pregnancies with GDM have shown that there is an increase in Caesarean section, OR 4.18 (95% CI 1.15-15.2), and an increase in shoulder dystocia, OR 15.14 (95% CI 1.64-140) in women who had a screening 1-hour post 50-g glucose load value above 11.1 mmol/L. When the outcome post 1-hour 50-g glucose load is defined by an abnormal oral glucose tolerance test only, the cutoff values that can reliably diagnose GDM is probably >12.2 mmol/L.[34,35]

For these reasons, the joint CDA-SOGC 2013 committee on diabetes in pregnancy decided that if a value of ≥11.1 mmol/L after a 1-hour 50-g glucose load is obtained, a 2-hour 75-g OGTT is unnecessary.

When the a priori risk of diagnosing GDM or overt DM is high based on clinical, demographic, or historical risk factors it will be prudent to offer either screening or testing earlier in gestation. This is mainly to facilitate the diagnosis of unrecognized type 2 DM that will benefit from earlier interventions to ensure adequate glycemic control. In the presence of the following risk factors: maternal age >35 years, obesity

(pre-pregnancy body mass index >30 kg/m$^2$), ethnicity (Aboriginal, African, Asian, Hispanic, South Asian), family history of diabetes, polycystic ovary syndrome, acanthosis nigricans, corticosteroid use, previous pregnancy complicated with GDM, or previous macrosomic infant, either 1-hour 50-g glucose challenge screening test or a diagnostic 75-g GTT can be offered in the first half of the pregnancy and repeated at 24−28 weeks if negative.[7] Until there is evidence to support alternate thresholds for the early 50-g GCT or 75-g GTT we suggest using the same criteria that is used for the standard 24−28 week test.

Pregnancy after bariatric surgery is becoming more common. GDM diagnostic testing, when applied to women who have undergone Roux-en-Y gastric bypass, increases the GDM diagnosis without changing pregnancy outcome.[36] In addition, a high incidence of 58% of reactive hypoglycemia is encountered during OGTT. Therefore, studies are needed to provide alternative screening and diagnostic criteria for GDM in post bariatric surgery women. Due to lack of evidence supporting different thresholds for screening for GDM, it is not possible to define alternate thresholds. Until then, it is reasonable to order fasting and 1-hour postprandial blood glucose in addition to $HbA_{1C}$ level in these women to rule out abnormalities in carbohydrate metabolism.

**REFERS TO RECOMMENDATIONS 1, 2 & 3**

## ANTEPARTUM MANAGEMENT OF GESTATIONAL DIABETES MELLITUS

The benefits of treating GDM are now generally accepted.[3,4] There is also an association between the presence of GDM and hypertensive disorders of pregnancy.[22,37] The goals of treatment are: (1) optimizing fetal growth and preventing macrosomia, (2) reducing the risk of intrauterine fetal death, (3) reducing the risk of pre-eclampsia,[38] (4) reducing the risks of Caesarean section, and (5) reducing the risk of neonatal complications including shoulder dystocia, birth trauma and neonatal hypoglycemia.

**REFERS TO SUMMARY STATEMENTS 3, 4 & 5**

### Optimizing Fetal Growth and Preventing Macrosomia

Fetal macrosomia may occur without gestational diabetes. However, the incidence of macrosomia in pregnancies complicated with maternal hyperglycemia is a function of maternal glycemic control.[22,29,30,37,39−41] There is an association between excessive fetal weight and certain perinatal complications including shoulder dystocia and birth trauma,[42,43] perinatal mortality,[44] and Caesarean delivery.[21,45−48] Landon et al.[4] have shown that the treatment of mild gestational diabetes results in a significant reduction with treatment as compared with usual care in several pre-specified secondary outcomes, including mean birth weight (3302 vs. 3408 g), neonatal fat mass (427 vs. 464 g), the frequency of large-for-gestational-age infants (7.1% vs. 14.5%), birth weight greater than 4000 g (5.9% vs. 14.3%), shoulder dystocia (1.5% vs. 4.0%), and Caesarean delivery (26.9% vs. 33.8%). In a secondary analysis the Maternal Fetal Medicine Network RCT for the treatment of mild GDM demonstrated that induction of labour between 37 and 40 weeks of gestation in women did not increase the rate of Caesarean delivery.[49] Treatment of GDM, as compared with usual care, was also associated with reduced rates of preeclampsia and gestational hypertension (combined rates for the two conditions, 8.6% vs. 13.6%; $P = 0.01$).

Current CDA 2013 guidelines for maternal glycemic control suggest striving for the following targets on self-monitored blood glucose (SMBG): fasting SMBG <5.3 mmol/L; 1-hour postprandial of <7.8 mmol/L or 2 hours postprandial <6.7 mmol/L. This often can be achieved by nutritional counselling and modification of physical activity level. When unsuccessful after 1−2 weeks of non-medical interventions, medical therapy should be initiated.[7] Optimizing maternal glycemic control in women with GDM decreases the risk of pre-eclampsia, decreases the risk of fetal macrosomia, shoulder dystocia, and Caesarean section.[4]

A small-for-gestational-age fetus can also be a complication of overtreatment of GDM or a complication of associated risk factors.[49] An RCT comparing insulin therapy based on "tight" maternal glycemic control (keeping fasting SMBG <5.0 mmol/L and 2 hours postprandial at <6.7 mmol/L) alone versus ultrasound-based measurement of fetal abdominal circumference percentile and more "relaxed" maternal glycemic control (fasting SMGC <6.6 mmol/L and 2 hours postprandial <11.1 mmol/L) has demonstrated that both methods resulted in equivalent perinatal outcome.[50] The addition of measuring the abdominal circumference every 3−4 weeks helped guide the decision to treat some pregnant women more aggressively with tighter glycemic control to prevent macrosomia while using a more "relaxed" control if the abdominal circumference was low to prevent the development of a small-for-gestational-age fetus.[50−52] If a small-for-gestational-age fetus is suspected, umbilical artery and middle cerebral artery Doppler (if available) should be done as part of the assessment of placental function and fetal well

being. In the presence of fetal macrosomia or poor glycemic control, polyhydramnios may also develop. Therefore, the measurement of the amniotic fluid volume can be another tool used to assess maternal glycemic control in the context of GDM.[53]

### Reducing the Risk of Intrauterine Fetal Death

The most important factor to minimize fetal death is optimizing maternal glycemic control in order to optimize fetal growth. The 2007 SOGC guidelines on antenatal fetal surveillance[54] lists pre-pregnancy diabetes and insulin-requiring GDM as conditions associated with increased perinatal morbidity/mortality where antenatal fetal surveillance may be beneficial. In light of more recent evidence that diet-controlled GDM might also be associated with an increase in perinatal mortality [8,13,14] particularly after 38 weeks gestation, these patients should not be excluded from a protocol for antenatal fetal surveillance applicable to high-risk pregnancies. Landon and Vickers[55] previously questioned if patients with diet-controlled GDM should have any fetal health surveillance prior to 40 weeks gestation since the risk of fetal death is low. In contrast, they advocated twice per week fetal health surveillance starting at 32 weeks for all insulin-treated GDM patients. Most published protocols for antenatal fetal surveillance for diet-controlled GDM include ultrasound for fetal growth every 3-4 weeks starting at 28 weeks gestation and delivery no later than 40 weeks gestation.[9,50,52,56] The ACOG 2013 guidelines[25] states that for women with GDM and poor glycemic control, fetal surveillance may be beneficial. A retrospective study of 2134 women with pregnancies complicated by diabetes reported that an antepartum fetal surveillance program using twice-weekly non-stress test and fluid index assessment in pregnancies complicated by diabetes was successful in preventing stillbirth.[57] The role of the biophysical profile (BPP) in antenatal surveillance of diabetic pregnancies has not been studied in a large population, but one can logically extrapolate from the known value of the BPP in non diabetic pregnancies[58,59] to a diabetic pregnancy surveillance protocol.

The use of pre-delivery weight estimation to detect the presence of fetal macrosomia is problematic due to the poor performance of all methods of pre-delivery fetal weight estimation.[60–62] Previous evidence has suggested that in the context of suspected fetal macrosomia there is no proven benefit of induction of labour compared with expectant management.[63] However, more recently, Boulvain et al.[64] demonstrated in a large randomized clinical trial that induction of labour for suspected large-for-date fetuses is associated with a reduced risk of shoulder dystocia and associated morbidity compared with expectant management. Induction of labour did not increase the risk of Caesarean delivery and improved the likelihood of spontaneous vaginal delivery. There is only one randomized clinical trial comparing elective induction with expectant management in GDM pregnancies.[65] In a mixed group of women with uncomplicated insulin-requiring GDM or PGDM, expectant management of pregnancy after 38 weeks gestation did not reduce or increase the incidence of Caesarean delivery. However, there was an increased prevalence of large-for-gestational-age infants (23% vs. 10%) and shoulder dystocia (3% vs. 0% NS) in the expectant group.

**REFERS TO RECOMMENDATIONS 4, 5, 6 & 7**

## TIMING OF DELIVERY

A recent systematic review demonstrated a reduction in the rate of fetal macrosomia with active rather than expectant management.[66] Due to the significant heterogeneity in the studies analyzed the authors were limited in their ability to draw conclusions and provide recommendations for management. Due to the small number of patients, these studies were not powered to address the impact of induction or expectant management on perinatal mortality. In the view that the risk of intrauterine fetal death appears to outweigh the risk of infant death after 39 weeks,[13] induction of labour at 39 weeks could be considered in insulin-treated GDM patients. Since retrospective studies suggest that a policy of induction by no later than 40 weeks is associated with a decreased rate of stillbirth in women with diet-controlled GDM when compared with the general obstetrical population (OR 0.5 (95% CI 0.4-0.7),[9] induction by 40 weeks maybe beneficial in this population. It is also reassuring that a recent study including all randomized clinical trials comparing induction of labour at term or post-term with expectant management for high-and low risk pregnancies showed a reduced risk of fetal death (RR 0.50; 95% CI 0.25−0.99), reduced risk of neonatal intensive care unit admission (RR 0.86; 95% CI 0.79−0.94) and no increase in Caesarean section rate with labour induction,[67] findings that have been replicated in other studies.[68,69]

**REFERS TO RECOMMENDATION 8**

## SPECIAL CONSIDERATIONS

### Diabetes and the Use of Antenatal Corticosteroids

The widespread use of corticosteroids in patients at risk of preterm delivery, often administered at the same

gestational age where screening and diagnosis of GDM is usually performed, can make interpretation of screening of GDM difficult. Fisher et al.[70] has demonstrated that abnormal screening tests can be present for more than 1 week after the administration of betamethasone in 48% of patients. For this reason, they suggested that a 1-step diagnostic procedure is more appropriate. The overall incidence of GDM was 14% in women who received betamethasone compared with 4% in controls using a 3-hour 100-g OGTT using the National Diabetes Data Group criteria (see Table 3).[70] Therefore, a 2-hour OGTT should be performed no less than 7 days post administration of the last dose of betamethasone. Since ketoacidosis in the pregnant diabetic patient is a potential cause of fetal demise,[71–73] it is also recommended to closely monitor maternal glycemia after betamethasone administration in women with poorly controlled diabetes. Studies evaluating the safety and efficacy of antenatal corticosteroids in women with diabetes or gestational diabetes at high risk of preterm birth are lacking.[74] In absence of these data, utilization of the same criteria for administration of antenatal corticosteroids as in women without diabetes appears reasonable.[75]

**REFERS TO RECOMMENDATIONS 9 & 10**

## COUNSELLING POSTPARTUM–APPENDIX B

Women should be encouraged to breastfeed immediately after delivery in order to avoid neonatal hypoglycemia and to continue for at least 6 months postpartum in order to reduce the risk of childhood obesity and reduce the risk of maternal hyperglycemia.[76–79] Up to one-third of affected women will have diabetes or impaired glucose tolerance at postpartum screening. It has also been estimated that 15%–50% will develop type 2 diabetes later in life.[24,25,80–84] Recent data from a prospective observational study has shown that after a pregnancy complicated by GDM, higher lactation intensity and longer duration are independently associated with lower 2-year incidences of type 2 diabetes.[42,85]

**REFERS TO RECOMMENDATIONS 11 & 12**

## SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jogc.2019.03.008.

## REFERENCES


1. Feig DS, Hwee J, Shah BR, et al. Trends in incidence of diabetes in pregnancy and serious perinatal outcomes: a large, population-based study in Ontario, Canada, 1996-2010. Diabetes Care 2014;37:1590–6.
2. Fadl HE, Ostlund IK, Magnuson AF, et al. Maternal and neonatal outcomes and time trends of gestational diabetes mellitus in Sweden from 1991 to 2003. Diabet Med 2010;27:436–41.
3. Crowther CA, Hiller JE, Moss JR, et al. Effect of treatment of gestational diabetes mellitus on pregnancy outcomes. N Engl J Med 2005;352:2477–86.
4. Landon MB, Spong CY, Thom E, et al. A multicenter, randomized trial of treatment for mild gestational diabetes. N Engl J Med 2009;361:1339–48.
5. Hawkins JS, Lo JY, Casey BM, et al. Diet-treated gestational diabetes mellitus: comparison of early vs routine diagnosis. Am J Obstet Gynecol 2008;198:287. e1-6.
6. Retnakaran R, Zinman B, Connelly PW, et al. Impaired glucose tolerance of pregnancy is a heterogeneous metabolic disorder as defined by the glycemic response to the oral glucose tolerance test. Diabetes Care 2006;29:57–62.
7. Thompson D, Berger H, Feig D, et al. Diabetes and pregnancy. Can J Diabetes 2013;37 Suppl 1:S168–83.
8. Hutcheon JA, Kuret V, Joseph KS, et al. Immortal time bias in the study of stillbirth risk factors: the example of gestational diabetes. Epidemiology 2013;24:787–90.
9. Karmon A, Levy A, Holcberg G, et al. Decreased perinatal mortality among women with diet-controlled gestational diabetes mellitus. Int J Gynaecol Obstet 2009;104:199–202.
10. Ohana O, Holcberg G, Sergienko R, et al. Risk factors for intrauterine fetal death (1988-2009). J Matern Fetal Neonatal Med 2011;24:1079–83.
11. Peticca P, Keely EJ, Walker MC, et al. Pregnancy outcomes in diabetes subtypes: how do they compare? A province-based study of Ontario, 2005-2006. J Obstet Gynaecol Can 2009;31:487–96.
12. Liu S, Joseph KS, Hutcheon JA, et al. Gestational age-specific severe maternal morbidity associated with labor induction. Am J Obstet Gynecol 2013;209:209. e1-8.
13. Rosenstein MG, Cheng YW, Snowden JM, et al. The risk of stillbirth and infant death stratified by gestational age in women with gestational diabetes. Am J Obstet Gynecol 2012;206:309. e1-7.
14. Niu B, Lee VR, Cheng YW, et al. What is the optimal gestational age for women with gestational diabetes type A1 to deliver? Am J Obstet Gynecol 2014;211:418. e1-6.
15. Page JM, Snowden JM, Cheng YW, et al. The risk of stillbirth and infant death by each additional week of expectant management stratified by maternal age. Am J Obstet Gynecol 2013;209:375. e1-7.
16. Nicholson JM, Parry S, Caughey AB, et al. The impact of the active management of risk in pregnancy at term on birth outcomes: a randomized clinical trial. Am J Obstet Gynecol 2008;198:511. e1-15.
17. Mathiesen ER, Ringholm L, Damm P. Stillbirth in diabetic pregnancies. Best Pract Res Clin Obstet Gynaecol 2011;25:105–11.
18. Grimes DA, Schulz KF. Uses and abuses of screening tests. Lancet 2002;359:881–4.
19. Hillier TA, Vesco KK, Pedula KL, et al. Screening for gestational diabetes mellitus: a systematic review for the U.S. Preventive Services Task Force. Ann Intern Med. 2008;148:766–75.
20. Ogunyemi DA, Fong A, Rad S, et al. Attitudes and practices of healthcare providers regarding gestational diabetes: results of a survey conducted at

the 2010 meeting of the International Association of Diabetes in Pregnancy Study Group (IADPSG). Diabet Med 2011;28:976–86.

21. Sermer M, Naylor CD, Gare DJ, et al. Impact of increasing carbohydrate intolerance on maternal-fetal outcomes in 3637 women without gestational diabetes. The Toronto Tri-Hospital Gestational Diabetes Project. Am J Obstet Gynecol. 1995;173:146–56.

22. Metzger BE, Lowe LP, Dyer AR, et al. Hyperglycemia and adverse pregnancy outcomes. N Engl J Med 2008;358:1991–2002.

23. American Diabetes Association. Standards of medical care in diabetes −2012. Diabetes Care 2012;35:S11.

24. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes care 2014;37:S81.

25. Committee on Obstetric Practice. Practice bulletin no. 137: gestational diabetes mellitus. Obstet Gynecol 2013;122:406–16.

26. Berger H, Crane J, Farine D, et al. Screening for gestational diabetes mellitus. J Obstet Gynaecol Can 2002;24:894–912.

27. Ergin T, Lembet A, Duran H, et al. Does insulin secretion in patients with one abnormal glucose tolerance test value mimic gestational diabetes mellitus? Am J Obstet Gynecol 2002;186:204–9.

28. Landon MB, Gabbe SG. Gestational diabetes mellitus. Obstet Gynecol 2011;118:1379–93.

29. Landon MB, Mele L, Spong CY, et al. The relationship between maternal glycemia and perinatal outcome. Obstet Gynecol 2011;117:218–24.

30. Langer O, Brustman L, Anyaegbunam A, et al. The significance of one abnormal glucose tolerance test value on adverse outcome in pregnancy. Am J Obstet Gynecol 1987;157:758–63.

31. Nankervis A, McIntyre HD, Moses R, et al., Australasian Diabetes in Pregnancy Society. ADIPS Consensus Guidelines for the Testing and Diagnosis of Gestational Diabetes Mellitus in Australia. Australasian Diabetes in Pregnancy Society; 2014. Available at: http://adips.org/downloads/ADIPSConsensusGuidelinesGDM-03.05.13VersionACCEPTEDFINAL.pdf. Accessed on March 22, 2019.

32. World Health Organization. Diagnostic criteria and classification of hyperglycaemia first detected in pregnancy. 2013.

33. Simmons D, Moses RG. Gestational diabetes mellitus: to screen or not to screen?: Is this really still a question? Diabetes Care 2013;36:2877–8.

34. Cheng YW, Esakoff TF, Block-Kurbisch I, et al. Screening or diagnostic: markedly elevated glucose loading test and perinatal outcomes. J Matern Fetal Neonatal Med 2006;19:729–34.

35. Cheng YW, Block-Kurbisch I, Caughey AB. Carpenter-Coustan criteria compared with the national diabetes data group thresholds for gestational diabetes mellitus. Obstet Gynecol 2009;114:326–32.

36. Freitas C, Araujo C, Caldas R, et al. Effect of new criteria on the diagnosis of gestational diabetes in women submitted to gastric bypass. Surg Obes Relat Dis 2014;10:1041–6.

37. Bauman WA, Maimen M, Langer O. An association between hyperinsulinemia and hypertension during the third trimester of pregnancy. Am J Obstet Gynecol 1988;159:446–50.

38. Magee LA, Pels A, Helewa M, et al. Canadian Hypertensive Disorders of Pregnancy Working G. Diagnosis, evaluation, and management of the hypertensive disorders of pregnancy: executive summary. J Obstet Gynaecol Can 2014;36:416–41.

39. Berkus MD, Langer O. Glucose tolerance test: degree of glucose abnormality correlates with neonatal outcome. Obstet Gynecol 1993;81:344–8.

40. Landon MB, Langer O, Gabbe SG, et al. Fetal surveillance in pregnancies complicated by insulin-dependent diabetes mellitus. Am J Obstet Gynecol 1992;167:617–21.

41. Langer O, Kozlowski S, Brustman L. Abnormal growth patterns in diabetes in pregnancy: a longitudinal study. Isr J Med Sci 1991;27:516–23.

42. Gilbert WM, Nesbitt TS, Danielsen B. Associated factors in 1611 cases of brachial plexus injury. Obstet Gynecol 1999;93:536–40.

43. Nesbitt TS, Gilbert WM, Herrchen B. Shoulder dystocia and associated risk factors with macrosomic infants born in California. Am J Obstet Gynecol 1998;179:476–80.

44. Mondestin MA, Ananth CV, Smulian JC, et al. Birth weight and fetal death in the United States: the effect of maternal diabetes during pregnancy. Am J Obstet Gynecol 2002;187:922–6.

45. Boulet SL, Alexander GR, Salihu HM, et al. Macrosomic births in the united states: determinants, outcomes, and proposed grades of risk. Am J Obstet Gynecol 2003;188:1372–8.

46. Gregory KD, Henry OA, Ramicone E, et al. Maternal and infant complications in high and normal weight infants by method of delivery. Obstet Gynecol 1998;92:507–13.

47. Lepercq J, Le Meaux JP, Agman A, et al. Factors associated with cesarean delivery in nulliparous women with type 1 diabetes. Obstet Gynecol 2010;115:1014–20.

48. Naylor CD, Sermer M, Chen E, et al. Cesarean delivery in relation to birth weight and gestational glucose tolerance: pathophysiology or practice style? Toronto Trihospital Gestational Diabetes Investigators. JAMA 1996;275:1165–70.

49. Sutton AL, Mele L, Landon MB, et al. Delivery timing and cesarean delivery risk in women with mild gestational diabetes mellitus. Am J Obstet Gynecol 2014;211:244. e1-7.

50. Schaefer-Graf UM, Kjos SL, Fauzan OH, et al. A randomized trial evaluating a predominantly fetal growth-based strategy to guide management of gestational diabetes in Caucasian women. Diabetes Care 2004;27:297–302.

51. Bonomo M, Cetin I, Pisoni MP, et al. Flexible treatment of gestational diabetes modulated on ultrasound evaluation of intrauterine growth: a controlled randomized clinical trial. Diabetes Metab 2004;30:237–44.

52. Kjos SL, Schaefer-Graf UM. Modified therapy for gestational diabetes using high-risk and low-risk fetal abdominal circumference growth to select strict versus relaxed maternal glycemic targets. Diabetes Care 2007;30 Suppl 2: S200–5.

53. Karcaaltincaba D, Yalvac S, Kandemir O, et al. Glycosylated hemoglobin level in the second trimester predicts birth weight and amniotic fluid volume in non-diabetic pregnancies with abnormal screening test. J Matern Fetal Neonatal Med 2010;23:1193–9.

54. Liston R, Sawchuck D, Young D. Society of Obstetricians and Gynaecologists of Canada. British Columbia Perinatal Health P. Fetal health surveillance: antepartum and intrapartum consensus guideline. J Obstet Gynaecol Can 2007;29:S3–56.

55. Landon MB, Vickers S. Fetal surveillance in pregnancy complicated by diabetes mellitus: is it necessary? J Matern Fetal Neonatal Med 2002;12:413–6.

56. Graves CR. Antepartum fetal surveillance and timing of delivery in the pregnancy complicated by diabetes mellitus. Clin Obstet Gynecol 2007;50:1007–13.

57. Johnson JM, Lange IR, Harman CR, et al. Biophysical profile scoring in the management of the diabetic pregnancy. Obstet Gynecol 1988;72: 841–6.

58. Manning FA, Bondagji N, Harman CR, et al. Fetal assessment based on the fetal biophysical profile score: relationship of last BPS result to subsequent cerebral palsy. J Gynecol Obstet Biol Reprod (Paris) 1997;26:720–9.

59. Manning FA, Bondaji N, Harman CR, et al. Fetal assessment based on fetal biophysical profile scoring. VIII. The incidence of cerebral palsy in tested and untested perinates. Am J Obstet Gynecol. 1998;178:696–706.

60. Melamed N, Yogev Y, Meizner I, et al. Sonographic fetal weight estimation: which model should be used? J Ultrasound Med 2009;28:617–29.

61. Melamed N, Yogev Y, Meizner I, et al. Sonographic prediction of fetal macrosomia: the consequences of false diagnosis. J Ultrasound Med 2010;29:225–30.

62. Melamed N, Yogev Y, Meizner I, et al. Prediction of fetal macrosomia: effect of sonographic fetal weight-estimation model and threshold used. Ultrasound Obstet Gynecol 2011;38:74–81.

63. Vendittelli F, Riviere O, Neveu B, et al. Does induction of labor for constitutionally large-for-gestational-age fetuses identified in utero reduce maternal morbidity? BMC Pregnancy Childbirth 2014;14:156.

64. Boulvain M, Senat MV, Perrotin F, et al. Induction of labour versus expectant management for large-for-date fetuses: a randomised controlled trial. Lancet 2015;385:2600–5.

65. Kjos SL, Henry OA, Montoro M, et al. Insulin-requiring diabetes in pregnancy: a randomized trial of active induction of labor and expectant management. Am J Obstet Gynecol 1993;169:611–5.

66. Witkop CT, Neale D, Wilson LM, et al. Active compared with expectant delivery management in women with gestational diabetes: a systematic review. Obstet Gynecol 2009;113:206–17.

67. Mishanina E, Rogozinska E, Thatthi T, et al. Use of labour induction and risk of cesarean delivery: a systematic review and meta-analysis. CMAJ 2014;186:665–73.

68. Gulmezoglu AM, Crowther CA, Middleton P, et al. Induction of labour for improving birth outcomes for women at or beyond term. Cochrane Database Syst Rev 2012;6:CD004945.

69. Melamed N, Ray JG, Geary M, et al. Induction of labor before 40 weeks is associated with lower rate of cesarean delivery in women with gestational diabetes mellitus. Am J Obstet Gynecol 2016;214:364. e1-8.

70. Fisher JE, Smith RS, Lagrandeur R, et al. Gestational diabetes mellitus in women receiving beta-adrenergics and corticosteroids for threatened preterm delivery. Obstet Gynecol 1997;90:880–3.

71. Bhagwanjee S, Muckart DJ, Hodgson RE, et al. Fatal foetal outcome from diabetic ketoacidosis in pregnancy. Anaesth Intensive Care 1995;23:234–7.

72. Montoro MN, Myers VP, Mestman JH, et al. Outcome of pregnancy in diabetic ketoacidosis. Am J Perinatol 1993;10:17–20.

73. Sinha N, Venkatram S, Diaz-Fuentes G. Starvation ketoacidosis: a cause of severe anion gap metabolic acidosis in pregnancy. Case Rep Crit Care 2014;2014:906283.

74. Gyamfi-Bannerman C, Thom EA, Blackwell SC, et al. Antenatal Betamethasone for Women at Risk for Late Preterm Delivery. N Engl J Med 2016.

75. Sotiriadis A, Makrydimas G, Papatheodorou S, et al. Corticosteroids for preventing neonatal respiratory morbidity after elective caesarean section at term. Cochrane Database Syst Rev 2009:CD006614.

76. Chertok IR, Raz I, Shoham I, et al. Effects of early breastfeeding on neonatal glucose levels of term infants born to women with gestational diabetes. J Hum Nutr Diet 2009;22:166–9.

77. Critch JN. Canadian Paediatric Society N. Gastroenterology C. Nutrition for healthy term infants, birth to six months: An overview. Paediatr Child Health 2013;18:206–9.

78. Gunderson EP, Hedderson MM, Chiang V, et al. Lactation intensity and postpartum maternal glucose tolerance and insulin resistance in women with recent GDM: the SWIFT cohort. Diabetes Care 2012;35:50–6.

79. Schaefer-Graf UM, Hartmann R, Pawliczak J, et al. Association of breast-feeding and early childhood overweight in children from mothers with gestational diabetes mellitus. Diabetes Care 2006;29:1105–7.

80. Buchanan TA, Xiang AH. Gestational diabetes mellitus. J Clin Invest 2005;115:485–91.

81. Chodick G, Elchalal U, Sella T, et al. The risk of overt diabetes mellitus among women with gestational diabetes: a population-based study. Diabet Med 2010;27:779–85.

82. Kaaja RJ, Greer IA. Manifestations of chronic disease during pregnancy. JAMA 2005;294:2751–7.

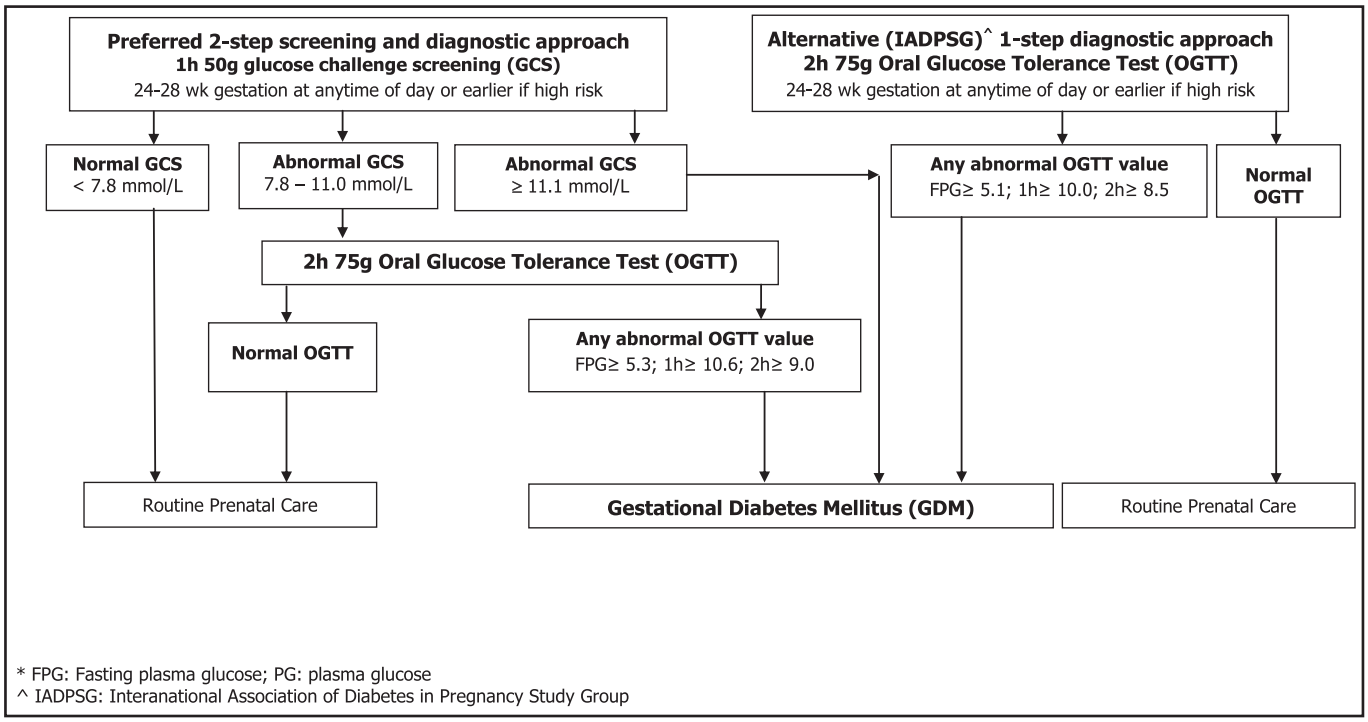
83. Kim C, Newton KM, Knopp RH. Gestational diabetes and the incidence of type 2 diabetes: a systematic review. Diabetes Care 2002;25:1862–8.

84. Russell MA, Phipps MG, Olson CL, et al. Rates of postpartum glucose testing after gestational diabetes mellitus. Obstet Gynecol 2006;108:1456–62.

85. Gunderson EP, Hurston SR, Ning X, et al. Lactation and Progression to Type 2 Diabetes Mellitus After Gestational Diabetes Mellitus: A Prospective Cohort Study. Ann Intern Med 2015;163:889–98.

86. International Association of Diabetes, Pregnancy Study Groups Consensus Panel; Metzger BE, Gabbe SG, Persson B, Buchanan TA, et al. International association of diabetes and pregnancy study groups recommendations on the diagnosis and classification of hyperglycemia in pregnancy. Diabetes Care 2010;33:676–82.

## Appendix A. Gestational Diabetes Mellitus Screening and Diagnosis




## Appendix B. Gestational Diabetes Mellitus Postpartum Testing