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Pregestational Diabetes Mellitus

Pregestational diabetes mellitus represents one of the most challenging medical complications of pregnancy. This document provides an overview of the current understanding of pregestational diabetes mellitus and suggests management guidelines during pregnancy. Because few well-designed studies have been performed, many of the guidelines are based on expert and consensus opinion.

This Practice Bulletin was developed by the ACOG Committee on Practice Bulletins—Obstetrics with the assistance of Steven G. Gabbe, MD. The information is designed to aid practitioners in making decisions about appropriate obstetric and gynecologic care. These guidelines should not be construed as dictating an exclusive course of treatment or procedure. Variations in practice may be warranted based on the needs of the individual patient, resources, and limitations unique to the institution or type of practice.

Background

Definition and Prevalence

More than 8 million women in the United States have pregestational diabetes mellitus, and it is observed in 1% of all pregnancies (1, 2). Type 2 pregestational diabetes mellitus is most common and is characterized by onset later in life; peripheral insulin resistance; relative insulin deficiency; obesity; and the development of vascular, renal, and neuropathic complications. The rapidly increasing incidence of type 2 pregestational diabetes mellitus is caused, in part, by increasing obesity in the United States (3). Although 90% of diabetes cases encountered during pregnancy are gestational diabetes mellitus (GDM), more than one half of these women eventually develop type 2 pregestational diabetes mellitus later in life. Type 1 diabetes mellitus tends to occur early in life. In contrast to type 2 pregestational diabetes mellitus, type 1 pregestational diabetes mellitus is characterized by an autoimmune process that destroys the pancreatic β cells, leading to the need for insulin therapy.

Management of Diabetes During Pregnancy

Pregnancy is characterized by increased insulin resistance and reduced sensitivity to insulin action. Late in the first trimester, relatively higher levels of estrogen enhance insulin sensitivity and, when associated with nausea and vomiting, increase the risk for maternal hypoglycemia. The increase in insulin resistance is largely the result of a mixture of placental hormones, including

human placental lactogen, progesterone, prolactin, placental growth hormone, and cortisol. More recently, tumor necrosis factor α and leptin have been implicated as contributors to the insulin resistant state of pregnancy (4). Insulin resistance is greatest in the third trimester.

The management of diabetes in pregnancy must focus on excellent glucose control achieved using a careful combination of diet, exercise, and insulin therapy (5–8). Patients may need to be seen every 1–2 weeks during the first two trimesters and weekly after 28–30 weeks of gestation. During pregnancy, caloric requirements are increased approximately 300 kcal higher than basal needs in patients with a singleton fetus (9, 10). Carbohydrate counting increases dietary flexibility and is extremely useful as long as the total daily caloric intake is considered to avoid excessive weight gain. A registered dietitian may be of value in providing an individualized nutrition program. Women with normal body weights usually require 30–35 kcal/kg/d. Women who are less than 90% of desirable body weight may need to increase their caloric requirements to 30–40 kcal/kg, whereas those who are more than 120% of desirable body weight should decrease their caloric intake to 24 kcal/kg/d. Caloric composition includes 40–50% from complex, high-fiber carbohydrates; 20% from protein; and 30–40% from primarily unsaturated fats. The calories may be distributed as follows: 10–20% at breakfast; 20–30% at lunch; 30–40% at dinner; and up to 30% for snacks, especially a bedtime snack to reduce nocturnal hypoglycemia (9). Artificial sweeteners, including saccharin, aspartame, and acesulfame-k, may be safely used in moderate amounts. Patients should be encouraged to keep a log of food intake several days each week so that this information can be correlated with insulin dosages, exercise, and glucose values.

Most insulin used in the treatment of pregestational diabetes mellitus is biosynthetic human insulin. Insulin requirements will increase throughout pregnancy, most markedly in the period between 28–32 weeks of gestation (11). On average, insulin needs increase from a range of 0.7–0.8 U/kg/d in the first trimester, to 0.8–1 U/kg/d in the second trimester, to 0.9–1.2 U/kg/d in the third trimester (7, 12). The goal of therapy is to maintain capillary glucose levels as close to normal as possible, including a fasting glucose level of 95 mg/dL or less, premeal values of 100 mg/dL or less, 1-hour postprandial levels of 140 mg/dL or less, and 2-hour postprandial values of 120 mg/dL or less. During the night, glucose levels should not decrease to less than 60 mg/dL. Mean capillary glucose levels should be maintained at an average of 100 mg/dL with a glycosylated hemoglobin A_{1C} ($Hb\ A_{1C}$) concentration no higher than 6% (13, 14).

Short- or rapid-acting insulins (short-acting regular insulin, insulin lispro, and insulin aspart) are administered before meals to reduce glucose elevations associated with eating (15, 16) (Table 1). Although insulin lispro may be used in place of regular insulin, the two are not interchangeable. Regular insulin should be given approximately 30 minutes before eating. Insulin lispro should be given immediately before eating (17). Although its rapid onset of action improves compliance and patient satisfaction, insulin lispro can cause significant hypoglycemia in the unprepared patient.

Longer acting insulins are used to restrain hepatic glucose production between meals and in the fasting state (see Table 1). Intermediate-acting insulin (15, 16) usually is given before breakfast with a rapid- or short-acting insulin and before the evening meal or at bedtime. Bedtime dosing is preferred because an injection given with the evening meal may increase the risks of nocturnal hypoglycemia. Extended insulin zinc suspension has a prolonged duration of action that may make it difficult to determine the timing of its effect, especially if it is given twice daily. Glargine is a recently developed human insulin analog produced with recombinant DNA (18). The absorption of this insulin analog is delayed, creating a steady basal insulin state with no peak and a 24-hour duration. Glargine cannot be mixed in the same syringe with other insulins. Experience with glargine in pregnancy has been limited. In patients who are highly insulin resistant, regular U500 (concentrated) insulin may be valuable (14).

Frequent self-monitoring of blood glucose is essential to achieve euglycemia without significant hypoglycemia during pregnancy (19). Capillary glucose levels should be checked using a glucose meter and recorded in the fasting state, before and 1 or 2 hours after each meal,

Table 1. Action Profile of Commonly Used Insulins

Type	Onset of Action	Peak of Action (hours)	Duration of Action (hours)
Insulin lispro	1–15 minutes	1–2	4–5
Insulin aspart	1–15 minutes	1–2	4–5
Regular insulin	30–60 minutes	2–4	6–8
Isophane insulin suspension	1–3 hours	5–7	13–18
Insulin zinc suspension	1–3 hours	4–8	13–20
Extended insulin zinc suspension	2–4 hours	8–14	18–30
Insulin glargine	1 hour	No peak	24

Modified from Gabbe SG, Graves CR. Management of diabetes mellitus complicating pregnancy. Obstet Gynecol 2003;102:857–68.

and before bed. Results may differ depending on whether the meter tests whole blood, serum, or plasma. Fasting glucose levels reflect the action of overnight basal insulin, whereas glucose concentrations before meals indicate daytime basal insulin activity (15). Levels after meals reveal the effect of the meal and recent insulin doses. In selected patients, especially those on insulin pumps, glucose determinations at 2–3 AM may help detect nocturnal hypoglycemia caused by excessive basal insulin or an inadequate bedtime snack or nocturnal hyperglycemia caused by insufficient basal insulin or pump failure. Generally, insulin doses are changed by 20% in response to hyperglycemia or hypoglycemia. A Hb A_{1C} measurement provides an indication of glycemic control over the past 2–3 months and should be performed during each trimester. An Hb A_{1C} value of 8% reflects a mean glucose level of 180 mg/dL, with each 1% higher or lower than 8% equal to a change of 30 mg/dL (13). Patients should check urine ketones when their glucose levels exceed 200 mg/dL and immediately report positive results to their health care teams.

Even with meticulous monitoring, hypoglycemia is more frequent in pregnancy than at other times, particularly in patients with type 1 pregestational diabetes mellitus. Patients should be questioned to determine if they can recognize when their glucose levels decrease to less than 60 mg/dL. Patients and their families should be taught how to respond quickly and appropriately to hypoglycemia. A glass of milk is preferable to fruit juices containing high levels of glucose. In addition, patients should have glucagon on hand for severe hypoglycemia and loss of consciousness.

Maternal Morbidity

Pregnancy has been associated with exacerbation of many diabetes-related complications. Poorly controlled pregestational diabetes mellitus leads to serious end-organ damage that may eventually become life threatening. In turn, preexisting diabetes-related end-organ disease may have deleterious effects on obstetric outcomes.

Diabetic retinopathy, the leading cause of blindness between ages 24 and 64 years, is classified as 1) background retinopathy, characterized by retinal microaneurysms and dot-blot hemorrhages; and 2) proliferative retinopathy, marked by neovascularization (20). The rapid institution of strict glycemic control in women with diabetes during pregnancy has been associated with acute progression of retinopathy, particularly in women with hypertensive disorders, including preeclampsia (21). Proliferative retinopathy is best treated with laser therapy, ideally before conception (22). Women with diabetes who become pregnant should have a comprehensive eye examination in the first trimester and be monitored closely throughout pregnancy (23).

Diabetic nephropathy is estimated to occur in 5–10% of pregnancies (24, 25). Most studies have failed to demonstrate permanent deterioration in renal function associated with pregnancy in women with mild-to-moderate diabetic nephropathy. However, progression to end-stage renal disease has been reported in women with serum creatinine levels exceeding 1.5 mg/dL or severe proteinuria (>3 g per 24 hours) (26). Women with preexisting diabetic nephropathy are at significantly higher risk for several adverse obstetric complications, including hypertensive disorders, uteroplacental insufficiency, and iatrogenic preterm birth, because of worsening renal function (27, 28). Before conception, a baseline evaluation of renal function by serum creatinine and assessment of urinary protein excretion (urine albumin-to-creatinine ratio or 24-hour albumin excretion) is recommended with follow-up measurements at regular intervals throughout pregnancy (29).

Chronic hypertension is observed in approximately 5–10% of pregnant patients with pregestational diabetes mellitus (30). Hypertension, especially in the presence of nephropathy, increases the risk of preeclampsia, uteroplacental insufficiency, and stillbirth (31). Ideally, hypertension should be controlled before conception. In nonpregnant patients, treatment is likely to include an angiotensin-converting enzyme inhibitor or an angiotension II receptor blocker. Because of their adverse fetal effects, these medications should be discontinued before conception and should not be used during pregnancy.

Symptomatic coronary artery disease in women with pregestational diabetes mellitus is most commonly seen in those with long-standing disease, nephropathy, and hypertension (32). Preexisting symptomatic coronary artery disease may be a potential contraindication to pregnancy because of the pregnancy-associated hemodynamic changes that may result in myocardial infarction and death (9). Diabetic neuropathy is not well-studied in pregnancy but may manifest as recalcitrant nausea and vomiting secondary to gastroparesis (33).

Diabetic Ketoacidosis

Diabetic ketoacidosis is a life-threatening emergency observed in 5–10% of all pregnancies complicated by pregestational diabetes mellitus (34, 35). Because diabetic ketoacidosis is caused by an absolute or relative insulin deficiency, it is most commonly observed in women with type 1 pregestational diabetes mellitus. Enhanced insulin resistance probably plays a role in the higher incidence of diabetic ketoacidosis observed during pregnancy, as well as the propensity for diabetic ketoacidosis to develop more rapidly and at less severe

levels of hyperglycemia and even normal glucose levels. Common risk factors for diabetic ketoacidosis during pregnancy include new onset diabetes; infections, such as influenza and urinary tract infection; poor patient compliance; insulin pump failure; and treatment with β-mimetic tocolytic medications and antenatal corticosteroids (36).

Typical clinical presentation of diabetic ketoacidosis in pregnancy includes abdominal pain, nausea and vomiting, and altered sensorium. Abnormal laboratory findings commonly include a low arterial pH (<7.3), a low serum bicarbonate level (<15 mEq/L), an elevated anion gap, and positive serum ketones (36). Continuous fetal heart rate monitoring commonly demonstrates recurrent late decelerations. However, this pattern usually resolves as the maternal condition improves, and delivery is rarely indicated.

Treatment regimens are based on aggressive hydration and intravenous insulin (see box). Because hypoglycemia and hypokalemia are frequent complications of diabetic ketoacidosis therapy, glucose and potassium concentrations should be monitored closely. Although maternal mortality is rare, fetal mortality has ranged from 35% of cases to, more recently, 10% of cases (35, 37).

Management of Diabetic Ketoacidosis During Pregnancy

1. Laboratory assessment
   - Obtain arterial blood gases to document degree of acidosis present; measure glucose, ketones, and electrolyte levels at 1- to 2-hour intervals
2. Insulin
   - Low-dose, intravenous
   - Loading dose: 0.2–0.4 U/kg
   - Maintenance: 2–10 U/h
3. Fluids
   - Isotonic sodium chloride
   - Total replacement in first 12 hours equals 4–6 L
   - 1 L in first hour
   - 500–1,000 mL/h for 2–4 hours
   - 250 mL/h until 80% replaced
4. Glucose
   - Begin 5% dextrose in normal saline when plasma level reaches 250 mg/dL (14 mmol/L)
5. Potassium
   - If initially normal or reduced, an infusion rate up to 15–20 mEq/h may be required; if elevated, wait until levels decrease into the normal range, then add to intravenous solution in a concentration of 20–30 mEq/L
6. Bicarbonate
   - Add one ampule (44 mEq) to 1 L of 0.45 normal saline if pH is <7.1

Reprinted with permission from Elsevier. Landon MB, Catalano PM, Gabbe SG. Diabetes mellitus. In: Gabbe SG, Niebyl JR, Simpson JL, editors. Obstetrics: normal and problem pregnancies. 4th edition. New York (NY): Churchill Livingstone; 2002. p. 1102.

Perinatal Morbidity and Mortality

The perinatal mortality rate in pregnancies complicated by pregestational diabetes mellitus has decreased markedly in recent years. Overall perinatal outcome is best when glucose control is achieved before conception and in the absence of maternal vascular disease (7, 38). The relationship between maternal end-organ disease and adverse pregnancy outcome was first illustrated by Priscilla White, whose classification system attempted to predict perinatal risk according to the age at onset of diabetes; duration of diabetes; and the presence of renal (class F), proliferative retinal (class R), and cardiac (class H) complications (39).

Major congenital anomalies are the leading cause of perinatal mortality in pregnancies complicated by pregestational diabetes mellitus, occurring in 6–12% of infants of women with diabetes (40). Studies have linked the increased rate of congenital malformations, as well as spontaneous abortion, to poor preconceptional glucose control (41, 42). Hyperglycemia during organogenesis (5–8 weeks after the last menstrual period) is thought to play a critical role in abnormal development (43); however, hypoglycemia has not been associated with adverse fetal outcome (44). Glycosylated hemoglobin levels correlate directly with the frequency of anomalies. A level less than 1% higher than the upper limit of normal, or approximately 5–6%, is associated with a fetal malformation rate close to that observed in normal pregnancies (2–3%), whereas an Hb A_{1C} concentration near 10% is associated with a fetal anomaly rate of 20–25% (40, 45). Complex cardiac defects; central nervous system anomalies, such as anencephaly and spina bifida; and skeletal malformations, including sacral agenesis are most common (14, 46, 47).

Adverse perinatal outcomes later in pregnancy also are increased in women with pregestational diabetes mellitus (14). Facilitated diffusion of glucose across the placenta leads to transient fetal hyperglycemia. Subsequent stimulation of the fetal pancreatic β cells results in fetal hyperinsulinemia with several fetal and neonatal consequences. Because insulin is a potent growth hormone,

excessive fetal growth occurs, particularly in adipose tissue (48). The fetus of a woman with poorly controlled diabetes is at increased risk of intrauterine fetal death and is more likely to weigh more than 4,000 g with a disproportionate concentration of fat around the shoulders and chest, which more than doubles the risk of shoulder dystocia at vaginal delivery (14). Elevated postprandial values may be most closely related to the risk for macrosomia (49, 50).

The neonatal consequences of poorly controlled pregestational diabetes mellitus during pregnancy include profound hypoglycemia, a higher rate of respiratory distress syndrome, polycythemia, organomegaly, electrolyte disturbances, and hyperbilirubinemia. Long-term outcomes for type 1 diabetes mellitus include obesity and carbohydrate intolerance (51–54).

Obstetric Complications

Spontaneous preterm labor appears to be more common in women with pregestational diabetes mellitus (55). The increased incidence of hydramnios may be a cause of preterm labor in some patients with pregestational diabetes mellitus, particularly those with poor glycemic control (56).

Preeclampsia is observed in 15–20% of pregnancies complicated by type 1 diabetes mellitus without nephropathy and approximately 50% in the presence of nephropathy (55, 57). Preeclampsia also is more likely in women with hypertension and poor glucose control (24, 25, 27). In the setting of hypertension and nephropathy, the risk of fetal intrauterine growth restriction is more than doubled. The rate of primary cesarean delivery is increased in women with pregestational diabetes mellitus (56, 58).

Clinical Considerations and Recommendations

▶ *Is there a role for preconceptional counseling?*

Preconceptional counseling for women with pregestational diabetes mellitus has been reported to be beneficial and cost-effective and should be encouraged (59). Because fewer than one third of women with diabetes mellitus seek preconceptional counseling (60), any visit to a health care provider should be used as an opportunity to review the aspects of diabetes management during pregnancy. Preconceptional counseling should focus on the importance of euglycemic control before pregnancy, as well as the adverse obstetric and maternal outcomes that can result from poorly controlled diabetes. A search for underlying vasculopathy is advisable and, in selected patients, may include a retinal examination by an ophthalmologist, a 24-hour urine collection for protein excretion and creatinine clearance, and electrocardiography. Because up to 40% of young women with type 1 diabetes mellitus also may have thyroid dysfunction, thyroid function studies also should be obtained (61). Multivitamins containing at least 400 μg of folic acid should be prescribed to all women contemplating pregnancy. This is particularly important in women with diabetes given their increased risk of neural tube defects. Higher doses of folic acid may be beneficial in some cases, especially in the presence of other risk factors for neural tube defects.

▶ *Is there a role for continuous subcutaneous insulin infusion during pregnancy?*

With continuous subcutaneous insulin infusion therapy (the insulin pump), insulin can be delivered in a pattern that closely resembles physiologic insulin secretion (62–64). A rapid-acting insulin, such as insulin lispro, is most appropriate for infusion pumps (65). Usually 50–60% of the total daily dose is administered at a continuous basal rate, with boluses before meals and snacks comprising 40–50% of the total daily dose (64). Patients who use continuous subcutaneous insulin infusion must be highly motivated and compliant. The advantages of the pump include improved patient satisfaction, a decrease in severe hypoglycemia, and better control of hyperglycemia. Major disadvantages include the increased cost of the pump and pump supplies. In addition, if the delivery of insulin is interrupted or impaired by battery failure or infection at the infusion site, diabetic ketoacidosis may develop rapidly (66).

▶ *Is there a role for oral hypoglycemic agents in pregnancy?*

Oral hypoglycemic agents, used widely in the treatment of nonpregnant patients, have not been well studied in pregnancy (67). However, glyburide, a second-generation sulfonylurea, does not cross the placenta and has been used to treat GDM. Its onset of action is approximately 4 hours and its duration of action is approximately 10 hours. In a study of 404 pregnant women with treatment initiated between 11 and 33 weeks of gestation, glyburide was found to be comparable to insulin in improving glucose control without evidence of adverse maternal and neonatal complications. Metformin has been used as a treatment for infertility in polycystic ovary syndrome (68). Metformin is a category B drug, and although there are more reports of its use during pregnancy (69), the long-term effects of in utero exposure

have not been well studied. The use of all oral agents for control of type 2 diabetes mellitus during pregnancy should be limited and individualized until data regarding the safety and efficacy of these drugs become available.

▶ *What fetal assessment is appropriate in women with pregestational diabetes mellitus?*

An ultrasound examination early in gestation can be used not only to demonstrate fetal viability but to accurately date the pregnancy as well. Most major anomalies can be detected at 18–20 weeks of gestation by a specialized (or targeted) ultrasound examination that includes a carefully performed assessment of fetal cardiac structure, including the great vessels (70, 71). Echocardiography also may be indicated in cases of suspected cardiac defects or when the fetal heart and great vessels cannot be visualized by ultrasonography. Thereafter, periodic ultrasound examinations may be used to confirm appropriate fetal growth.

Antepartum fetal monitoring, including fetal movement counting, the nonstress test, the biophysical profile, and the contraction stress test when performed at appropriate intervals, is a valuable approach and can be used to monitor the pregnancies of women with pregestational diabetes mellitus (72–74). Initiation of testing is appropriate for most patients at 32–34 weeks of gestation. However, testing at earlier gestational ages may be warranted in some pregnancies complicated by additional high-risk conditions. In response to a report of an increased stillbirth rate in patients with a reactive nonstress test within 1 week of delivery, twice weekly testing has been widely adopted (75). Daily fetal movement counting is a simple technique for antepartum assessment that also should be considered. However, if maternal glucose control deteriorates, fetal condition may change, and repeat testing for fetal well-being may be indicated. Doppler velocimetry of the umbilical artery may be useful in monitoring pregnancies with vascular complications and poor fetal growth (76).

▶ *When and how should delivery occur?*

Optimal timing of delivery relies on balancing the risk of intrauterine fetal death with the risks of preterm birth. In poorly controlled patients, an amniocentesis for fetal lung maturity is advised for delivery before 39 weeks of gestation. If corticosteroids are administered to accelerate lung maturation, an increased insulin requirement over the next 5 days should be anticipated, and the patient's glucose levels should be closely monitored (77). Early delivery may be indicated in some patients with vasculopathy, nephropathy, poor glucose control, or a prior stillbirth. In contrast, patients with well-controlled diabetes may be allowed to progress to their expected date of delivery as long as antenatal testing remains reassuring (78). Expectant management beyond the estimated due date generally is not recommended. Although an ultrasound estimate of fetal weight may help to rule out macrosomia, ultrasonography has not proved to be more accurate than clinical assessment in determining the size of the large fetus (79–81). To prevent traumatic birth injury, cesarean delivery may be considered if the estimated fetal weight is greater than 4,500 g in women with diabetes (74). Induction of labor in pregnancies with a fetus with suspected macrosomia has not been found to reduce birth trauma and may increase the cesarean delivery rate (82).

▶ *How should glucose control be managed during labor?*

During induction of labor, maternal glycemia can be controlled with an intravenous infusion of regular insulin titrated to maintain hourly readings of blood glucose levels less than 110 mg/dL (6, 13, 83) (see box). Avoiding intrapartum maternal hyperglycemia may prevent fetal hyperglycemia and reduce the likelihood of subsequent neonatal hypoglycemia (54). During active labor, insulin may not be needed. Patients who are using an insulin pump may continue their basal infusion during labor.

Insulin Management During Labor and Delivery

- Usual dose of intermediate-acting insulin is given at bedtime.
- Morning dose of insulin is withheld.
- Intravenous infusion of normal saline is begun.
- Once active labor begins or glucose levels decrease to less than 70 mg/dL, the infusion is changed from saline to 5% dextrose and delivered at a rate of 100–150 cc/h (2.5 mg/kg/min) to achieve a glucose level of approximately 100 mg/dL.
- Glucose levels are checked hourly using a bedside meter allowing for adjustment in the insulin or glucose infusion rate.
- Regular (short-acting) insulin is administered by intravenous infusion at a rate of 1.25 U/h if glucose levels exceed 100 mg/dL.

Data from Coustan DR. Delivery: timing, mode, and management. In: Reece EA, Coustan DR, Gabbe SG, editors. Diabetes in women: adolescence, pregnancy, and menopause. 3rd ed. Philadelphia (PA): Lippincott Williams & Wilkins; 2004; and Jovanovic L, Peterson CM. Management of the pregnant, insulin-dependent diabetic woman. Diabetes Care 1980;3:63–8.

Insulin requirements decrease rapidly after delivery. One half of the predelivery dose may be reinstituted after starting regular food intake (13). For patients with cesarean delivery, rapid-acting insulin may be used to treat glucose values greater than 140–150 mg/dL after a regular meal pattern has been established.

▶ *Are special postpartum considerations necessary?*

Breastfeeding should be encouraged in women with pregestational diabetes mellitus. An additional 500 kcal/d more than the prepregnancy caloric intake is required. Small snacks before breastfeeding may reduce the risks of hypoglycemia (9).

Family planning options include low-dose combination oral contraceptives for women without vasculopathy who do not smoke, whereas progestin-only pills can be prescribed for women with vascular disease (84). Barrier methods, although less effective, will not affect glucose control or vasculopathy. Limited data suggest no increased complications for intrauterine device use in women with diabetes (85, 86). Sterilization should be considered for women with serious vasculopathy or for those who have completed their families.

Summary of Recommendations and Conclusions

The following recommendations are based on limited or inconsistent scientific evidence (Level B):

- Suspected fetal macrosomia is not an indication for induction of labor because induction does not improve maternal or fetal outcomes.
- Antepartum fetal monitoring, including fetal movement counting, the nonstress test, the biophysical profile, and the contraction stress test when performed at appropriate intervals, is a valuable approach and can be used to monitor the pregnancies of women with pregestational diabetes mellitus.
- Adequate maternal glucose control should be maintained near physiologic levels before conception and throughout pregnancy to decrease the likelihood of spontaneous abortion, fetal malformation, fetal macrosomia, intrauterine fetal death, and neonatal morbidity.
- Patients and their families should be taught how to respond quickly and appropriately to hypoglycemia.
- Preconceptional counseling for women with pregestational diabetes mellitus has been reported to be beneficial and cost-effective and should be encouraged.
- The use of oral agents for control of type 2 diabetes mellitus during pregnancy should be limited and individualized until data regarding the safety and efficacy of these drugs become available.
- To prevent traumatic birth injury, cesarean delivery may be considered if the estimated fetal weight is greater than 4,500 g in women with diabetes.

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The MEDLINE database, the Cochrane Library, and ACOG's own internal resources and documents were used to conduct a literature search to locate relevant articles published between January 1985 and October 2004. The search was restricted to articles published in the English language. Priority was given to articles reporting results of original research, although review articles and commentaries also were consulted. Abstracts of research presented at symposia and scientific conferences were not considered adequate for inclusion in this document. Guidelines published by organizations or institutions such as the National Institutes of Health and the American College of Obstetricians and Gynecologists were reviewed, and additional studies were located by reviewing bibliographies of identified articles. When reliable research was not available, expert opinions from obstetrician–gynecologists were used.

Studies were reviewed and evaluated for quality according to the method outlined by the U.S. Preventive Services Task Force:

- I Evidence obtained from at least one properly designed randomized controlled trial.
- II-1 Evidence obtained from well-designed controlled trials without randomization.
- II-2 Evidence obtained from well-designed cohort or case–control analytic studies, preferably from more than one center or research group.
- II-3 Evidence obtained from multiple time series with or without the intervention. Dramatic results in uncontrolled experiments also could be regarded as this type of evidence.
- III Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees.

Based on the highest level of evidence found in the data, recommendations are provided and graded according to the following categories:

Level A—Recommendations are based on good and consistent scientific evidence.

Level B—Recommendations are based on limited or inconsistent scientific evidence.

Level C—Recommendations are based primarily on consensus and expert opinion.

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