

CDAPP Sweet Success

Guidelines

for Care

Chapter 3

*Medical Management
and Education for
Preexisting Diabetes
During Pregnancy*



*Sweet
Success*

California Diabetes and Pregnancy Program

2015

California Diabetes and Pregnancy Program Sweet Success Guidelines for Care

**Leona Shields, PHN, MN, NP and
Guey-Shiang Tsay, RN, MSN (Editors)**
California Department of Public Health; Maternal, Child and
Adolescent Health Division.

Suggested Citation

Shields, L and Tsay, GS. Editors, California Diabetes and Pregnancy Program Sweet Success Guidelines for Care. Developed with California Department of Public Health; Maternal Child and Adolescent Health Division; revised edition, Chapter 3 updated September 2015.

Funding for the development of this toolkit was provided by:

Federal Title V Block Grant Funding through the California Department of Public Health (CDPH), Center for Family Health (CFH), Maternal, Child and Adolescent Health (MCAH) Division and was used by the Regional California Diabetes and Pregnancy Program, CDAPP Sweet Success to develop the toolkit.

The California Diabetes and Pregnancy Program (CDAPP) Toolkit “CDAPP Sweet Success Guidelines for Care” was reviewed by the California Department of Public Health; Maternal, Child and Adolescent Health Division. The toolkit is considered a resource, but does not define the standard of care in California. Readers are advised to adapt the guidelines and resources based on their local facility’s level of care and patient populations served and are also advised to not rely solely on the guidelines presented here.

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ACKNOWLEDGEMENTS

California Department of Public Health; Center for Family Health, Maternal, Child and Adolescent Health Division would like to thank the authors for their initial drafts and revisions.

Regional California Diabetes and Pregnancy Program (CDAPP) Staff
 Charlene Canger, LCSW, MFT
 Leona Dang-Kilduff, RN, MSN, CDE
 Cathy Fagen, MA, RD
 Kristi Gabel, RNC, MSN, CNS
 Maribeth Inturrisi RN, MS, CNS, CDE
 Melissa Ortiz, MA, RD, CDE
 Suzanne Sparks, RN, BSN, CDE

CDPH CFH MCAH would like to gratefully acknowledge the contribution and review from the people listed below:

Additional CDAPP members:

D. Lisa Bollman, RNC, MSN	Nancy McKee, LCSW, MSW
Sharmila Chatterjee, MSc, MS, RD	Emmy Mignano, RD, MS, CDE
Jenny Ching, RN, BSN	Jacqueline Masullo, MSW, LCSW
Sara Corder, LCSW	Lily Nichols, RD
Geetha DeSai, MS, RD, CDE	Deidre Paulson, MS, RD
Kay Goldstein, MFT	Sibylle Reinsch, PhD, MFCC
George Knapp, RN, MS	Sadie Sacks, RN, MSN
Katina Krajniak, RN	Melissa Shin, RN, BSN, PHN
Sylvia Lane, PhD, LCSW	Trudy Theiss, RD, MS, CDE
Elaine Lee, MPH, RD, CDE	Susan Yoshimura, RD, CDE
Tracy Lewis, MSW	

CDPH CFH MCAH Division Staff, Sacramento, California:

Flojaune Griffin, PhD, MPH	Sangi Rajbhandari, MPH
Suzanne Haydu, RD, MPH	Karen Ramstrom, DO, MSPH
Janet Hill, MS, RD, IBCLC	Leona Shields, PHN, MN, NP
Maria Jocson, MD, MPH, FAAP	Guey-Shiang Tsay, RN, MSN
Connie Mitchell, MD, MPH	Cheryl Terpak, MS, RDH
Susan Wallace, RN, (MPH student, UC Davis)	

Medical experts:

Kathleen Berkowitz, MD	John Kitzmiller, MD
Barry Block, MD	Siri Kjos, MD
Roger Chene DHS(c), MPH, RD	Sherrie McElvy, MD
Conrad Chao, MD	Thomas Moore, MD
Maurice Druzin, MD	David Sacks, MD
Elizabeth Harleman, MD	Kimberlee Sorem, MD
Lois Jovanovic, MD	

Program support:

Post production resource review for the revised and updated 2015 edition completed by California Diabetes and Pregnancy Program (CDAPP) Sweet Success Resource & Training Center: Tracy Esquivel, BA; Kevin Van Otterloo, MPA; D. Lisa Bollman, RNC, MSN, CPHQ. Original formatting for the 2012 edition by Cynthia Pena MPH, MSW.



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3 Medical Management and Education for Preexisting Diabetes During Pregnancy

INTRODUCTION

The management of Preexisting Diabetes Mellitus (PDM) has serious implications and impact on pregnancy.^{1,2} The progressive increase in insulin resistance caused by placental hormones, growth factors, and cytokines, necessitates intensive medical nutrition therapy and frequent adjustments of insulin to limit hyperglycemia and the worsening of diabetic complications. Tight glycemic control is challenging because insulin-induced hypoglycemia is more common. Women with preexisting diabetes have a fourfold to fivefold increase in perinatal mortality and a four to sixfold increase in stillbirth compared with the non-diabetic population.³

Glycemic control, as measured by Hemoglobin A1c (A1c), should be addressed prior to conception. Hyperglycemia at conception and during organogenesis increases the risk of spontaneous abortion and major congenital malformations (*Appendix A*). Hyperglycemia reduces fetal oxygenation, and when coupled with maternal acidosis, can lead to fetal demise. Women with type 1 diabetes are prone to diabetic ketoacidosis (DKA) at lower glucose levels.^{4,5} During pregnancy, maternal glycemic control is crucial to prevent fetal hyperinsulinemia associated with excess fetal growth and neonatal complications.

Maternal hypertension and nephropathy are associated with undergrowth of the fetus. Complications for the infant of the diabetic mother (IDM) extend into adulthood whether the infant is overgrown or undergrown.⁶ Infants of diabetic mothers have significantly increased risk for obesity, cardiovascular disease and diabetes.⁷ These challenges led to the development of multidisciplinary patient care programs such as California Diabetes and Pregnancy Program (CDAPP) Sweet Success, to improve specialized care and reduce complications. This chapter is intended to provide best practice recommendations for the medical management and health education of women with preexisting diabetes before, during and after pregnancy.

**GOALS AND
OBJECTIVES OF
PRENATAL CARE
FOR WOMEN WITH
PREEXISTING
DIABETES**

The goals and objectives in caring for women with preexisting diabetes are to reduce maternal and fetal mortality and morbidity and to approximate pregnancy outcomes experienced by the non-diabetic population.

Once pregnancy is confirmed, prenatal care begins. Women with preexisting diabetes are high-risk, and are optimally cared for by professionals experienced in the management of diabetes in pregnancy. Ideally, preexisting diabetic patients have easy access to a tertiary perinatal center, the consultation of a maternal fetal medicine physician, and a multidisciplinary team of certified diabetes educators (a registered dietitian, registered nurse, and behavioral medicine specialist).

The objective of prenatal care is to develop a diabetes treatment plan of care with the woman and team members. This is done by:

- ❖ Identifying, evaluating and treating any long-term diabetic complications
- ❖ Reviewing and achieving glycemic control of A1c $\leq 6\%$
- ❖ Identifying and evaluating self-management skills and educational needs
- ❖ Providing counsel concerning prognosis for a healthy pregnancy
- ❖ Setting expectations for patient participation

The American Association of Diabetes Educators has developed 7 Self-Care Behaviors that serve as a framework for assessment, planning, education needs and help to achieve the goals and objectives of prenatal care.⁸ The AADE 7 Self-Care Behaviors™ listed below⁸ are also addressed in *Chapter 2: Preconception and Interconception Care for Preexisting Diabetes*.

1. Healthy Eating
2. Staying Active
3. Monitoring
4. Taking Medications
5. Problem Solving
6. Reducing Risk
7. Healthy Coping and Living with Diabetes

Healthy Eating

Initial assessment and individualized meal plan by a registered dietitian and follow up each trimester. Refer to the *Chapter 7: Medical Nutrition Therapy* for specific suggestions for evaluating eating patterns and recommending a meal plan.

Staying Active

With medical clearance, women should aim for 30 to 60 minutes of brisk activity daily, such as walking or swimming. Refer to *Chapter 6: Exercise* for specific suggestions for balancing activity and insulin during pregnancy with PDM.

Monitoring

Women with preexisting diabetes should check blood glucose (BG) 8-12 times or more a day, and document food and BG daily. Documentation provides information on how food, exercise and insulin interact in order to improved BG control.^{1,2}

The staff and patient review glycemic control and establish pregnancy targets. Intensive self-monitoring of blood glucose (SMBG) is an integral part of diabetes therapy throughout pregnancy.² In preparation for visits, a food diary and blood glucose record are maintained and utilized to optimize interventions towards tight control. Kitzmiller et al explain that “Fingerstick SMBG is best in pregnancy, since alternate site testing [use of interstitial fluid glucose] may not identify rapid changes in glucose concentrations characteristic of pregnant women with diabetes.”² Daily SMBG, as described in Table 1, will provide crucial information.

Targets	Frequency	Rationale
<p>Premeal, bedtime, and overnight: 60–99 mg/dL,</p> <p>Peak postprandial glucose 100–129 mg/dL (usually 1hr from first bite of carbohydrate)</p> <p>Mean daily glucose >87 and <110 mg/dL</p> <p>These targets must be individualized to prevent persistent or severe hypoglycemia.</p>	<p>Self-monitoring of blood glucose (SMBG) should occur daily: at the start of meals, after meals, during snacks, before bed and sometimes in the middle of the night (2-4 A.M.).²</p> <p>Consider continuous glucose monitoring (CGM) for certain patients including those with asymptomatic hypoglycemia.²</p> <p>Note that glucose values from CGM (interstitial fluid) lag behind finger stick (capillary) values.</p>	<p>Maternal hyperglycemia increases fetal and maternal mortality and morbidity.</p> <ul style="list-style-type: none"> • Excess birth weight is associated with elevated postprandial glucose levels. • Infants who experience hyperinsulinemia in utero are more likely to develop obesity, HTN and diabetes later in life.¹⁰ • Extremely tight control (mean daily glucose <87 mg/dL) is associated with restricted fetal growth.¹¹ <p>Elevated glucose and rapid normalization, is related to maternal progression of existing retinopathy and nephropathy and an increased frequency of preeclampsia and preterm labor.</p>

Taking Medications

The goal is to ensure that all medications taken are safe and effective for preexisting diabetes. Refer to *Chapter 2: Preconception and Interconception Care for Preexisting Diabetes* for medication alternatives that are safe in pregnancy. Understand insulin administration, storage, expiration and availability of supplies.

Oral medications to lower glucose used by women with type 2 diabetes, such as metformin and glyburide, should not be abruptly stopped before insulin is started. These drugs do not appear to be teratogenic.¹⁴ Hyperglycemia is a teratogen.¹⁵ Some authors encourage continued use of metformin during pregnancy along with insulin, to reduce the dose of insulin, if needed.^{14,16} For women with type 2 diabetes glyburide is generally replaced by insulin. Insulin does not cross the placenta and has established efficacy in maintaining good glycemic control throughout pregnancy.

Insulin Management with Preexisting Diabetes

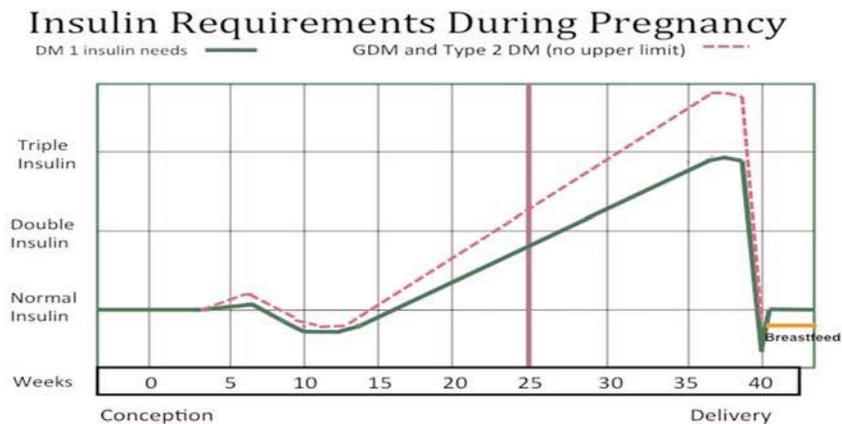
To reduce maternal and fetal mortality and morbidity and to approximate pregnancy outcomes experienced by the general non-diabetic population, tight control of maternal glycemia is essential. Although some women with type 2 diabetes may be able to sustain good control with meal planning and oral medications, most require insulin, as do all women with type 1 diabetes. This section will focus on insulin management for pregnant women with PDM.

Insulin Requirements During Pregnancy

Insulin needs vary throughout pregnancy. Women with type 1 diabetes will generally experience decreased insulin requirements towards the end of the first trimester. This may amount to a reduction of up to 30% in insulin dosage.¹⁷ From the second trimester onward, insulin requirements are expected to increase incrementally until 35 weeks of gestation.² During the second and third trimesters, “insulin requirements are expected to rise sequentially as much as 60-200%.”²

Women with type 2 diabetes may simply have improved BG from weeks 17 on. They may also notice a doubling of insulin doses by the middle of the second trimester and tripling or more, by term. Thus, optimal control of blood glucose will require frequent adjustment of insulin doses for all women either type 1 or type 2 with preexisting diabetes. Figure 1¹⁷⁻²³ is a graph of the changes that occur to the insulin requirements during pregnancy. A large copy is available in *Appendix B*.

Figure 1.



Types of Insulin

Insulin produced by a well-functioning pancreas has essentially two roles: **basal and bolus**.

Basal

The insulin produced for the "basal role" addresses the glucose that the liver is making throughout the entire day and night. This is a constant background/baseline amount and is present whether or not a person eats. Basal insulin make up about 40%-50% of the total daily dose (TDD).²⁴

The most common basal insulin used is NPH, intermediate-acting human insulin, with a peak of 4 hours and a duration of 8 hours. NPH is considered helpful for overnight basal and post absorptive needs although a risk of 3am hypoglycemia does exist. Since the action of NPH increases several hours after injecting, it would seem to be ideal. However the absorption and action of NPH is variable from day to day. Bedtime doses are more predictable when sleeping than daytime doses because activity and stress alter basal needs. Smaller doses are more effective, as larger doses prolong absorption.²⁵

Longer-acting basal insulin analogs such as glargine which lasts 18-24 hours and detemir which lasts 16-23 hours have recently appeared in the literature with small studies showing efficacy and no adverse effects in pregnancy. A large ongoing head-to-head study of detemir and NPH in pregnancy demonstrated that the long-acting insulin analogs have relatively more stable pharmacologic profiles and therefore less hypoglycemia when compared with NPH.²⁶

Bolus

The "bolus role" is the quick burst of insulin that mimics the pancreas' release of insulin in response to a meal. Ideally mealtime insulin doses are matched to carbohydrate intake, pre-meal blood glucose, and anticipated activity, again mimicking the pancreas.^{1,24}

Rapid-acting insulin analogs, lispro and aspart are the preferred “bolus” insulins for use in pregnancy.²⁷ When this insulin is compared to treatment with regular insulin, these analogues show better postprandial control, less hypoglycemia and a trend towards reduction of preterm delivery.^{28,29} Their action begins 5-15 minutes after injection and peaks at 30-90 minutes.²⁹ When taken just before the meal, the peak action of analogs is more likely to meet the peak of glucose absorbed from a meal. Regular insulin must be taken 45 minutes to an hour before eating and peaks 2 hours after injection, and most women fail to wait for the regular insulin to work, resulting in both hyperglycemia and hypoglycemia.

Insulin Regimens and Delivery Systems

Insulin is currently delivered either by Multiple Daily Injections (MDI) or by Continuous Subcutaneous Insulin Infusion (CSII) (insulin pump). Clinical trials of MDI and CSII generally show equivalent glycemic control and pregnancy outcomes.

Kitzmler and associates report that “Both MDI and CSII use the concept of basal and bolus insulin replacement to approximate physiological delivery of insulin during fasting and eating.” They go on to note that “ Tailoring of insulin doses by ‘daily pattern management’ rather than ‘after-the-fact catch up doses’ is recommended because this approach yields smoother glycemic control.”³¹ Split dosing (2/3, 1/3) and “sliding scales” should be avoided during pregnancy as they are generally insufficient for use in intensified therapy.³⁰ The insulin to carbohydrate ratio (ICR) is the grams of carbohydrates that will be metabolized for each unit of insulin. Use of this ratio allows for specific pre-meal insulin dosing based on carbohydrate load.¹ For optimum glycemic control, women with PDM should become proficient in carbohydrate counting and calculate premeal bolus insulin doses based on their ICR and blood glucose. Both methods require adjustments based on patterns, every few days to every 1-2 weeks.

Intensive Multiple Daily Injections (MDI) (pen or syringe)

Intensive MDI requires at least four injections per day: before breakfast, lunch, dinner, and at bedtime. With MDI, long-acting analog or intermediate-acting (NPH) is used for basal insulin and rapid-acting analog before meals (bolus).

Insulin Pens are another convenient method of delivering insulin. They make it possible to use the smallest and thinnest needles available. Pens are especially helpful for a patient with a history of injectable drug abuse. When using insulin syringes, it is advisable to use the 0.5cc syringe. No more than 50 units is given in one site, as more than 50 units has decreased or delayed absorption. The preferred injection site is the abdomen for the most consistent absorption during pregnancy.³¹

The recommended glucose monitoring for insulin regimen is:

- ❖ If using premeal bolus insulin, check blood glucose AM fasting, before and after meals, and at bedtime.
- ❖ If using basal insulin at bedtime, periodically check 3 AM blood glucose.

The ACOG Practice Bulletin on Pregestational Diabetes Mellitus explains that “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.”³² In practice, this often is adjusted over the course of the pregnancy.

Insulin Pump (CSII) During Pregnancy

Multiple programmable basal rates offered by pump-CSII can be especially useful for women experiencing episodes of hypoglycemia or a prominent Dawn Phenomena (increased insulin requirement between 4 and 8 AM).^{22,33} Continuous subcutaneous insulin infusion (CSII) pump therapy has been initiated during pregnancy without a deterioration of glycemic control with positive maternal and perinatal outcomes.

Insulin pumps are programmable to meet the individual’s insulin needs throughout the day. Entering the current premeal blood glucose and the anticipated carbohydrates for the meal into the pump, allows the pump to calculate the appropriate meal bolus, based on current blood glucose, insulin on board from an active bolus, and the carbohydrate content of the meal. The pump automatically corrects to target when calculating the premeal bolus dose. The pump can calculate a correction bolus when blood glucose is above target 2-3 hours after a meal. Only a rapid acting analog is used in pumps, so corrections occur shortly after a correction bolus is given.

Trouble Shooting Hyperglycemia Using the Pump - CSII

If blood glucose is >200mg/dL and a correction insulin dose does not bring it down by at least 30-60 points in two hours, urine ketones are checked. If urine ketones are moderate or severe, an insulin correction bolus is given with a syringe and the pump site and set should be changed. Blood glucose and urine ketones are monitored and the provider called if either glucose remains elevated or ketonuria persists at moderate to severe levels.²⁴

The Problem with CSII

Unfortunately for some women, pumps make insulin dosing so convenient that they may become careless about diet and exercise. Without healthy eating and using problem solving skills, the pump has no advantage over MDI. Malfunction resulting in no insulin delivery can occur increasing the risk for DKA. When using the pump one must attend to alarms and check BG as indicated.²⁴

Problem Solving

Hypoglycemia Prevention and Management

Hypoglycemia can be prevented or managed safely. Refer to Table 10 in *Chapter 2: Preconception and Interconception Care for Preexisting*

Diabetes.

Considerations:

- ❖ Does the patient wear a Medic-Alert® bracelet?
- ❖ Does the woman with type 1 diabetes have someone close to her who knows how and when to use glucagon, and do they have unexpired glucagon available?
- ❖ If using an insulin pump, give a subcutaneous injection correction bolus and change insertion set and insulin and reinsert pump in a new site.

Hypoglycemia is the most common maternal complication occurring in 4.4 - 41.0% of women with insulin-controlled diabetes and is an expected result of intensive glycemic control.^{34,35} The peak incidence of severe hypoglycemia in pregnancy is between 8 to 9 weeks²² and 15 to 16 weeks gestation.¹⁷ Ringholm et al found that in early pregnancy severe hypoglycemia is more common in women with type 1 diabetes. In the third trimester, they found the incidence decreased.³⁶ “Severe” hypoglycemia has been described as a hypoglycemic state which requires the assistance of another individual. This is more common and often more severe in type 1 diabetes, as compared to type 2 diabetes.³⁴

Symptoms of hypoglycemia change during pregnancy making it more difficult to sense low blood glucose levels. Maternal hypoglycemia can be life threatening and risk increases with hypoglycemic unawareness, which is the loss of warning symptoms that previously allowed the patient to recognize the onset of hypoglycemia.³⁵ Refer to Table 2 for indications of hypoglycemia.

Systems affected	Symptoms
Neurogenic (sympathetic nervous system stimulation)	Increased heart rate, sweating, tremors, hunger, tingling in the hands, feet, lips, or tongue
Neuroglycopenic (Deficient brain glucose)	Difficulty thinking, confusion, irritability, seizure, coma, death

Hypoglycemia is not associated with adverse effects on fetal blood flow, heart rate or breathing or measures of intellectual development after birth.^{38,39}

Women and their family and friends that are closest to them are taught strategies to prevent and treat hypoglycemia during pregnancy, including the use of glucagon for the most severe hypoglycemic reactions (loss of consciousness and inability to swallow).³⁷ For information about the administration of Glucagon, refer to the website:

- ✓ <http://pi.lilly.com/us/rglucagon-ppi.pdf>

Hyperglycemia Management

Hyperglycemia is managed safely by the pregnant woman who:

- ❖ Recognizes when BG is above 200 x 2-hours after correction a bolus.
- ❖ When hyperglycemic as above, checks urine ketones and if moderate or large, calls provider.
- ❖ If using an insulin pump, gives a subcutaneous injection correction bolus and changes insertion set and insulin and reinserts pump in a new site.

Conditions that Increase Insulin Needs

Insulin doses must be increased to overcome a reduction in sensitivity for the following conditions:

- ❖ Advanced pregnancy >24 weeks gestation (placental mediated insulin resistance)
- ❖ Obesity BMI ≥ 30 (increased insulin resistance)
- ❖ Stress such as illness (preterm labor, preeclampsia), surgery (Cesarean), psychosocial issues
- ❖ Infection, especially when accompanied by fever, i.e. UTI, pyelonephritis
- ❖ Medications such as betamimetics (terbutaline, ephedrine, epinephrine) or steroids (progesterone, betamethasone, prednisone)

These conditions place a woman with preexisting diabetes at risk for hyperglycemia and potential for ketoacidosis.⁴⁰

Sick Days

The goals of sick day care are to:

- ❖ maintain normal glycemia
- ❖ replace carbohydrate
- ❖ provide adequate hydration
- ❖ prevent diabetic ketoacidosis
- ❖ treat the cause of illness so that sick days are reduced

Sick day management is covered in *Chapter 7: Medical Nutrition Therapy*.

Diabetic Ketoacidosis (DKA) Prevention

The incidence of DKA in pregnancy occurs in 1-3% of patients with preexisting diabetes. The fetal mortality rate during this condition is approximately 9-35%; and the risk of maternal death has been estimated at 5-15%.^{4,5} Although more prevalent in patients with type 1 diabetes, there are case reports of DKA in patients with type 2 diabetes and gestational diabetes. The majority of cases of DKA develop in the second and third trimester and can occur with blood glucose less than 200mg/dL. This condition requires prompt recognition and treatment.⁴ Predisposing and precipitating factors for DKA are listed in Table 3 below.

Table 3. DIABETIC KETOACIDOSIS (DKA)^{1,4,5}	
Predisposing Factors	<ul style="list-style-type: none"> • Decreased buffering capacity (respiratory alkalosis of pregnancy) • Vomiting and dehydration (hyperemesis, gastrointestinal disorder) • “Accelerated starvation” of pregnancy • Increased insulin antagonists (Human Placental Lactogen, prolactin, cortisol) • Stress
Precipitating Events	<ul style="list-style-type: none"> • Poor blood glucose control • Infection • Use of steroids or betamimetics • Omission of insulin doses or CSII failure not recognized and treated • Omission of doses of oral glucose lowering agents • Diabetic gastroparesis • Newly diagnosed type 1 diabetes during pregnancy

Nausea, vomiting, and decreased caloric intake in an otherwise normal pregnant, diabetic woman, require evaluation to identify the cause and exclude ketosis. On rare occasion, DKA has resulted in women with type 1 diabetes when health care providers have withheld insulin due to seemingly normal blood glucose. Insulin should not be withheld for more than a few hours in a patient with type 1 diabetes, even in the presence of normal blood glucose.^{4,5}

DKA profoundly affects both the mother and the fetus. Maternal volume depletion and acidosis leading to decreased uterine blood flow may cause a relative fetal hypoxemia. Glucose and ketones readily cross the placenta, parallel to maternal levels. In the presence of maternal DKA, fetal heart rate changes may occur on a non-stress test such as absence of baseline variability and the presence of late decelerations.⁵

Maternal hypokalemia can cause fetal and maternal cardiac arrhythmias. While carefully monitoring both fetus and mother, the underlying DKA must be corrected. These abnormalities are generally reversible with appropriate aggressive treatment to improve the maternal condition and stabilize the fetal heart rate patterns.

Recommendations for prevention, early identification, and treatment of DKA include the following:

- ❖ Suspect possible DKA when type 1 diabetes women report GI upset such as nausea, vomiting, poor oral intake, or flu-like symptoms.
- ❖ Teach diabetic women to recognize and report these symptoms.
- ❖ Measure urine ketones in the presence of persistent hyperglycemia > 200 mg/dL. If moderate to large urine ketones are present, the woman should notify her provider. The presence of urinary ketones may trigger the need to obtain serum ketone levels as there is a delay of several hours until ketones from the blood appear in the urine. Chronic elevated blood ketones have been implicated in effecting fetal neuropsychomotor

development.

- ❖ Identify and correct the underlying cause of the DKA.⁵

Diabetic ketoacidosis is a critical condition in pregnancy with significant risk of maternal and fetal morbidity and mortality. The patient should be cared for in an acute care unit and in a multidisciplinary fashion including both medicine and obstetric teams as well as neonatology and anesthesia.⁴¹

Reducing Risk

Identify, Evaluate and Treat any Diabetic Complications.

The initial medical evaluation is focused on establishing baseline health status and identifying complications. Table 4 lists the diagnostic tests, the trimesters during which they are obtained, and their rationale.

Table 4. PRENATAL TESTS, EVALUATION AND RATIONALE FOR PREEXISTING DIABETES^{1,2,19}				
Test/Evaluation and Targets	Target 1st Trimester	Target 2nd Trimester	Target 3rd Trimester	Rationale/Risks
Glycemic Control				
Glycemic Control Hemoglobin A1c	A1c ≤6.3%	A1c ≤6%	A1c ≤6%	<ul style="list-style-type: none"> ❖ Turnover of red cells in pregnancy is shortened to <90 days. ❖ An A1c ≤6.3% during organogenesis is associated with decreased risk of birth defects and spontaneous abortion (SAB) to the non-diabetic population incidence rate (1-3%).
Thyroid				
Thyroid Stimulating Hormones (TSH) Thyroid Peroxidase Antibodies (TPO)	<ul style="list-style-type: none"> ❖ TSH >0.03 ≤2.5 mIU/mL ❖ If normal <u>and</u> not being treated, no further testing 	<ul style="list-style-type: none"> ❖ TSH ≤3 mIU/mL ❖ If normal do not retest ❖ Retest if abnormal or being treated 	<ul style="list-style-type: none"> ❖ TSH ≤3 mIU/mL ❖ If normal do not retest ❖ Retest if abnormal or being treated 	<ul style="list-style-type: none"> ❖ TPO antibodies cross the placenta. ❖ Autoimmune thyroid disease is common with type 1 diabetes (35-40%). ❖ Abnormal thyroid function can affect fertility and increase risk of spontaneous abortion.⁴² ❖ Hypothyroid can effect fetal brain development and reduce IQ.
Lipids				
If insulin resistance, obesity and type 2 diabetes a Fasting Lipid Panel is indicated	<ul style="list-style-type: none"> ❖ If indicated LDL ≤100 HDL ≥50 TGs ≤150 	<ul style="list-style-type: none"> ❖ If indicated 	<ul style="list-style-type: none"> ❖ If indicated 	<ul style="list-style-type: none"> ❖ Lipid abnormalities are associated with insulin resistance, obesity and type 2 diabetes. ❖ Statin therapy is contraindicated during pregnancy. ❖ Triglycerides >500mg. increase risk for pancreatitis and fatty liver disease.

Table 4. PRENATAL TESTS, EVALUATION AND RATIONALE FOR PREEXISTING DIABETES , Continued^{1,2,19}				
Test/Evaluation and Targets	Target 1st Trimester	Target 2nd Trimester	Target 3rd Trimester	Rationale/Risks
Liver Function				
<p>Aspartate Aminotransferase (AST) Alanine Aminotransferase (ALT)</p> <p>Assess for history of fatty liver disease with high BMI and poor glucose control.</p> <p>If liver function tests (LFT) are abnormal consider a liver ultrasound</p>	<p>If indicated</p> <p>Use lab normal</p>	<p>As indicated</p> <p>Use lab normal</p>	<p>As indicated</p> <p>Use lab normal</p>	<ul style="list-style-type: none"> ❖ Fatty liver disease has been associated with late term fetal loss. ❖ During pregnancy, fatty liver disease is treated with dietary and lifestyle change to improve glycemic control. ❖ If LFT is abnormal, consider referral to hepatologist.
Kidney Function (evaluate for potential Nephropathy)				
Serum Creatinine	<1	Repeat if abnormal	Repeat if abnormal	
<p>Nephropathy: Random urine dip for Microalbumin</p> <p>Albumin-to-Creatinine Ratio</p> <p>If at the upper end of normal (25–29 mg) or +1 protein on urine dipstick, obtain a 24-hour urine collection for total protein, creatinine clearance with a serum creatinine</p> <p>Urine C&S if symptomatic for infection</p>	<p>Microalbumin, (≤30 mg is normal)</p> <p>ACR (<9 mg/mmol)</p> <p>Urine dipstick for protein at each OB visit</p> <p>Total protein <300 mg/24 hrs.</p> <p>Perform as indicated</p>	<p>Urine dipstick for protein at each OB visit</p> <p>Repeat 24 hour urine collection if abnormal</p> <p>Perform as needed</p>	<p>Urine dipstick for protein at each OB visit</p> <p>Repeat 24 hour urine collection if abnormal</p> <p>Perform as needed</p>	<ul style="list-style-type: none"> ❖ Nephropathy is associated with increased risk for early preeclampsia and intra-uterine growth restriction (IUGR). ❖ Nephropathy may worsen during pregnancy. ❖ Establish baseline renal function. ❖ Consider Antibiotic Suppression treatment after one infection.

Table 4. PRENATAL TESTS, EVALUATION AND RATIONALE FOR PREEXISTING DIABETES , Continued ^{1,2,19}				
Test/Evaluation and Targets	Target 1st Trimester	Target 2nd Trimester	Target 3rd Trimester	Rationale/Risks
Hypertension				
Blood Pressure (BP) Evaluation Diabetes is associated with increased incidence of gestational hypertension, preeclampsia, and IUGR Consider pharmacologic therapy if SBP>140 or DBP>90	Test BP at each office visit	Test BP at each office visit	Test BP at each office visit	<ul style="list-style-type: none"> ❖ Uncontrolled hypertension is associated with progression of existing retinopathy, nephropathy, preeclampsia and poor fetal growth -intrauterine growth restriction - (IUGR). ❖ Evaluate medications for utilization in pregnancy (refer to <i>Chapter 2: Preconception and Interconception Care for Preexisting Diabetes</i>).
Retinopathy				
Retinal exam by ophthalmologist (dilated retinal exam)	Test	Repeat if abnormal	Repeat if abnormal	<ul style="list-style-type: none"> ❖ Poor glycemic control, rapid change in blood glucoses and hypertension are associated with progression of retinopathy. ❖ Lasertreatment is suggested for pregnant patients ❖ If retinopathy is unstable, an assisted delivery with no valsalva maneuvers may be indicated.
Cardiovascular Disease				
Electrocardiogram (EKG) recommended for: All women with symptoms or significant history; type 2 diabetes; or type1 diabetes for ≥10 years who have not an EKG within the past year	Test and follow-up as indicated			<ul style="list-style-type: none"> ❖ Risk of coronary heart disease (CHD) is more common in type 2 diabetes, and women with longer history of type 1 diabetes and associated with maternal age ≥35 years. ❖ If cardiovascular disease suspected or identified, refer to cardiologist. ❖ Associated with both maternal and fetal morbidity and mortality, including poor fetal growth, and preterm and assisted deliveries.

Table 4. PRENATAL TESTS, EVALUATION AND RATIONALE FOR PREEXISTING DIABETES , Continued^{1,2,19}				
Test/Evaluation and Targets	Target 1st Trimester	Target 2nd Trimester	Target 3rd Trimester	Rationale/Risks
Neuropathies				
Neuropathy Assessment and treatment is based on symptoms <ul style="list-style-type: none"> ❖ Hypoglycemia awareness ❖ Assess foot care 	Check for history of: <ul style="list-style-type: none"> ❖ Gastroparesis ❖ Orthostatic B/P changes ❖ Hypoglycemia unawareness ❖ Peripheral pain, burning, weakness 			<ul style="list-style-type: none"> ❖ Assess for sensory and autonomic neuropathy as indicated using standard tests. ❖ If hypoglycemia unawareness is identified-modified glucose targets may be indicated. ❖ Gastroparesis, pain, and infection will effect blood glucose control.
Other				
Urine dipstick for Ketones Women are instructed to check urine ketones when BG is >180 for more than 2 hours Ketonuria with hyperglycemia should warrant a call to the provider	Dip urine at each office visit and as indicated			<ul style="list-style-type: none"> ❖ Diagnosis of diabetic ketoacidosis (DKA) is not made on the basis of ketonuria but on the basis of hyperglycemia, ketonemia and low bicarbonate level which is a medical emergency. ❖ Ketoacidosis can develop at lower BG during pregnancy due to accelerated metabolic “starvation.”
Oral health Any woman that has not had regular dental care or shows signs of oral disease or trauma should be referred for a dental examination.	Twice yearly, or as often as recommended by her dentist for examinations, cleaning and protective treatments, such as fluoride and dental sealants.			<ul style="list-style-type: none"> ❖ Periodontal disease is a chronic oral infection associated with difficult glycemic control, inflammation and pregnancy complications such as preterm labor. ❖ Dental treatment is safe during pregnancy.
Celiac Disease: Antibodies to Tissue Serum IgA Endomysial Antibody (IgA EMA) IgA Tissue Transglutaminase Antibody (IgA tTG) If not previously screened-screen all type 1 diabetics, regardless of symptoms	No antibodies is a normal test result If abnormal: <ul style="list-style-type: none"> ❖ Refer to RD for specialized meal plan ❖ Do not biopsy 			<ul style="list-style-type: none"> ❖ Type 1 diabetes has a 4-12% prevalence of celiac disease compared to 1% in the general population. ❖ Celiac disease is an autoimmune disease associated with type 1 diabetes which presents with erratic blood glucose control and mal-absorptive symptoms.

Reduce Fetal Morbidity and Mortality

The fetus in a hyperglycemic environment is at risk for malformations, macrosomia, lung maturity delays, birth trauma (shoulder dystocia, brachial plexus palsy), polyhydramnios and origination of adult metabolic disorders such as obesity, cardiovascular disease and type 2 diabetes.^{20,22} Refer to *Chapter 5: Impact of Maternal Diabetes on Fetal Development and Neonatal Care*.

Maternal tests to determine fetal well-being are described in Table 5.

Weeks Gestation	Test of Fetal Well-Being	Rationale
7-13	Ultrasound	The most accurate measurement for dating is the crown-rump length of the fetus. Ultrasound for dates: crown-rump length (CRL) and for fetal heart activity to confirm viable pregnancy.
18	Ultrasound Anatomy Scan (level 2 ultrasound)	An ultrasound anatomy scan, or level 2 ultrasound, is used to identify birth defects and track growth.
18-before 24	Fetal Echo Cardiogram	Women with PDM should undergo a fetal echo cardiogram at 18-24 weeks gestation because cardiac defects are the most common birth defect related to hyperglycemia. Early detection of abnormalities can ensure adequate preparation for swift treatment of a cardiac defect.
26	If vasculopathy or poor glycemic control, start weekly or twice weekly Non-Stress Testing (NST)/ Amniotic Fluid Index (AFI)	Women with poor glycemic control, high blood pressure, retinopathy, nephropathy or IUGR are at greater risk for poor outcomes and preterm birth, which warrants early antenatal testing by non-stress testing and amniotic fluid index (NST/AFI). If NST is nonreactive BPP (biophysical profile) and Doppler flow studies of umbilical arteries may be warranted. ⁴³
26	Start kick counts	Kick counts are a simple, effective way for the mother to monitor fetal well-being due to an increased risk for fetal death (4-5 fold), particularly in the third trimester. Counting kicks after a meal or in the evening yields the best results. Teach women to report decreased or absent movements ASAP to her provider.
28	Ultrasound for growth	Fetal measurements to estimate size and to evaluate velocity of growth are matched to earlier ultrasounds. An ultrasound done between 28 and 32 weeks gestation showing fetal growth >75%, predicts LGA at term. ⁴⁴ Repeat if indicated.
28	Umbilical artery Doppler studies	Doppler should be performed in women with Intrauterine Growth Restriction (IUGR), hypertension as well as oligohydramnios. ⁴³
32	Antenatal testing (NST/AFI)	Twice weekly or as prescribed for all preexisting diabetes. ⁴⁰
36-38	Ultrasound for estimated fetal weight	This ultrasound can provide information to assess the timing and method of delivery (See Intrapartum section).
<39 weeks planned delivery	Amniocentesis for lung maturity	The hyperglycemic and hyperinsulinemic fetal environment delays surfactant production leading to an increased risk for respiratory distress after 35 weeks. No delay was found if well-controlled. When deliver is <34-35 weeks gestation, betamethasone treatment is used to enhance fetal lung maturity. If an emergent delivery is indicated at <39 weeks, forgo amniocentesis. Poor glycemic control is another indication for delivery prior to 39 weeks.

Healthy Coping and Living with Diabetes

Support women's coping with diabetes and adapting to parenthood by:

- ❖ Developing a plan of care with team members based upon the woman's pregnancy goals
- ❖ Encouraging adequate support systems
- ❖ Assisting her to recognize stress and take steps to reduce it
- ❖ Developing a working relationship with health care team with an emphasis on team dynamics, supportive engagement, good listening skills and motivational interviewing

Develop a plan of care with team members. Kitzmiller et al elaborate further by explaining, "For women with PDM [preexisting diabetes mellitus], feelings of anxiety, guilt, and responsibility are heightened." They go on to say, "Acknowledging steps to make positive changes while encouraging more intensive self-management is vital to establishing a strong patient-clinician relationship."¹

Anticipatory counseling is encouraged during pregnancy so women and their partners are aware of expected changes and issues. Attention should be paid to what the individual feels she can accomplish.

Set expectations for patient participation. Women with preexisting diabetes enter pregnancy with individual approaches to their care. Taking the approach that pregnancy will present unique challenges, (i.e. morning sickness and tight glucose control) may encourage the woman to try some new strategies. Starting with woman's strengths, the provider should maintain a balance supporting autonomy and safety. The behavioral medicine specialist can be pivotal in moving women through barriers to active participation. Refer to *Chapter 9: Behavioral and Psychosocial Components of Care* for more details.

Planning for Labor and Delivery

A delivery plan should be discussed and prepared by the 36th week gestation. This plan is developed with the patient and her partner, and is clearly communicated to the inpatient providers. Delivery should be planned in a facility that can manage the anticipated complexities of diabetes care.

The following information is discussed when formulating the plan⁴⁵:

- ❖ Timing of delivery
- ❖ Method of delivery
- ❖ Pain management
- ❖ When to call OB
- ❖ Blood glucose control and insulin use during labor
- ❖ Management of maternal and fetal intrapartum complications (i.e. shoulder dystocia, labor dystocia, and cesarean delivery)

- ❖ Benefits of breastfeeding to both mother and infant
- ❖ Postpartum follow-up

Intrapartum Management

The goals of intrapartum insulin management are to maintain maternal normoglycemia at 70-110 mg/dL in order to optimize fetal tolerance of labor and prevent neonatal hypoglycemia.

Timing of Delivery

Due to the limited amount of adequate prospective studies, timing of delivery remains disputed. The American College of Obstetricians and Gynecologists (ACOG) and the American Diabetes Association (ADA) do not recommend elective delivery before 39 weeks unless a woman has a clinical indication for preterm delivery.^{1,32,46,47}

Method of Delivery

The method of delivery for women with preexisting diabetes is influenced by clinical and non-clinical factors. Clinically, infants of these mothers weigh more and have greater fat distribution in the trunk and shoulders, which increases the incidence of shoulder dystocia (4.7-11.4%) in vaginal deliveries.¹ However, shoulder dystocia is difficult to predict and preventive cesarean delivery is not an acceptable clinical practice. With large babies, preeclampsia or labor abnormalities, such as active phase arrest, are more common. Fetal hypoxia and acidosis are more common with preeclampsia, vasculopathy and maternal hyperglycemia.¹ Continuous fetal heart rate monitoring is recommended.^{1,32} Morbid obesity in the mother may preclude monitoring the fetus during labor.⁴⁵ ACOG states that "cesarean section may be considered for suspected fetal macrosomia with estimated fetal weights greater than 5,000g in women without diabetes and greater than 4,500g in women with diabetes."⁴⁸ While preexisting diabetes alone is not an indication for cesarean delivery, 30-60 % of these women have cesarean births.¹

Labor and Management of Pain

Ripening the cervix with dinoprostone or misoprostol does not have specific untoward effects with diabetes, however the usual considerations for induction of labor apply.⁴⁷ Pain can cause elevation in stress hormones and an increase in blood glucose. There are no contraindications to epidural anesthesia which is considered the same as it is for nondiabetic women. Epidural anesthesia attenuates catecholamine release during painful labor and may actually improve insulin action to lower blood glucose.⁴⁹ Ephedrine administration to maintain maternal blood pressure may cause a temporary increase in blood glucose for several hours.

There is an association between operative vaginal delivery and an increased risk of shoulder dystocia.⁵⁰ Therefore, before the rare consideration of operative vaginal delivery, proper steps should be taken in anticipation of shoulder dystocia. An anesthesiologist, pediatrician, and well-trained nurses, familiar with the management of shoulder dystocia, should be immediately available. It is important to note that with the increase in obesity, the incidence of shoulder dystocia has increased.

The woman's relationship with her providers and her partner plays a large part in the quality of her coping.

Glycemic Control During Labor

Labor is exercise so blood glucose and insulin requirements may decrease. The target blood glucose range is 70-110 mg/dL with optimum maintenance of blood glucose at about 100 mg/dL.^{32,51,52} The single most important action to maintain euglycemia during labor is to check the blood glucose frequently. General guidelines to optimize glucose control using Continuous Intravenous Insulin Infusion (CIII) Drip are found below in Tables 6 and 7.

Table 6. CLINICAL ACTIONS TO MAINTAIN MATERNAL EUGLYCEMIA USING CONTINUOUS INTRAVENOUS INSULIN INFUSION (CIII) - DRIP FOR WOMEN WITH PREEXISTING DIABETES^{52,53}
NOTE: For induction of labor in the morning, the usual dose of NPH insulin is given at bedtime the night before but the morning dose of NPH insulin is withheld.
❖ Obtain baseline blood glucose to confirm blood glucose is >70 mg/dL or <110 mg/dL.
❖ In early labor, clear NON CALORIC liquids maybe taken. If carbohydrates are needed, use intravenous dextrose (D5 1/2 NS) as a carbohydrate source, controlled by an infusion device. This equals 5 grams dextrose per 100 mL of 1/2 normal saline. Women with gastroparesis must be NPO throughout labor.
❖ Start main IV with 1000 ml LR at a rate of 50 ml/hr (or 100 ml/hr if not infusing glucose).
❖ Initiate insulin infusion when blood glucose is >70 mg/dL for type 1 diabetes; or blood glucose is 91-110 mg/dL for type 2 diabetes. NOTE: Insulin sticks to the IV tubing therefore, 10-20 ml of the insulin solution must be flushed through the tubing prior to beginning the insulin infusion.
❖ Check blood glucose every 30 minutes until close to 100 mg/dL. Adjust drip dose according to algorithm depicted in Table 7. When blood glucose is stable at 100 mg/dL, BG checks can be done once per hour. Anytime blood glucose is out of the target range it is checked every 15 to 30 minutes.
❖ If blood glucose is <100 mg/dL, begin infusion with 1000 ml D5LR (or D5NS) at 100 ml/hr using an intravenous infusion controller device.
❖ Observe for signs of hypoglycemia and if present, check blood glucose levels immediately. If blood glucose is <70 mg/dL, stop insulin infusion and treat for hypoglycemia (refer to Table 9).
❖ The insulin drip and blood glucose monitoring is continued while the patient is in labor, delivery or undergoing cesarean section.
❖ Following delivery of the infant and placenta, insulin requirements are cut in half. If insulin drip is to be continued postpartum, the algorithm must be cut in half and blood glucose is checked every hour until insulin drip is discontinued.

Table 7 consists of an algorithm for insulin doses during intrapartum and postpartum.

Table 7. CONTINUOUS INTRAVENOUS INSULIN INFUSION (CIII) - DRIP DURING INTRAPARTUM AND POSTPARTUM ALGORITHM FOR WOMEN WITH PREEXISTING DIABETES⁵³		
	INTRAPARTUM	POSTPARTUM
Blood glucose (mg/dL)	Units of insulin in ml/hr	Units of Insulin in ml/hr
	100 units Regular human insulin in 100 ml NS (1ml = 1unit insulin)	
<70 (treat for hypoglycemia)	0	0
71-90	0.5 ml/hr - Start for type 1 diabetes	0
91-110	1 ml/hr - Start for type 2 diabetes	0.5 ml/hr
111-130	2 ml/hr	1 ml/hr
131-150	3 ml/hr	1.5 ml/hr
151-170	4 ml/hr	2 ml/hr
171-190	5 ml/hr	2.5 ml/hr
>190	Assess urine for ketones, Call MD for insulin dose	

With the recommendation of the health care provider, a woman can use her Continuous Subcutaneous Insulin Infusion (CSII) Pump during labor in place of IV drip insulin.⁵⁴ Table 8 lists the general principals of managing CSII-Pump in labor.

Table 8. GENERAL PRINCIPALS OF CONTINUOUS SUBCUTANEOUS INSULIN INFUSION (CSII) - PUMP⁵⁵
❖ For women using the CSII - Pump, basal rates remain the same until uterine activity is regular. When contractions are regular and patient is having clear non-caloric fluids, cut basal insulin rates by 30% of the last pregnancy setting.
❖ Check BG at least every hour and when not in target range, check BG every 30 minutes.
❖ Cut basal rate by 50% of last pregnancy setting, when in active labor.
❖ If Correction Bolus is needed for BG >110 mg/dL, use half the dose and check BG in 30 minutes.

Table 9 addresses treatment of hyperglycemia and hypoglycemia when NPO.

Table 9. TREATING HYPERGLYCEMIA AND HYPOGLYCEMIA WHEN NPO FOR WOMEN WITH PREEXISTING DIABETES^{51,53,56}
Note: Hyperglycemia and Hypoglycemia can be avoided by frequent (no less than hourly) blood glucose checks.
<p>Treating Hyperglycemia Consider source of elevated blood glucose: fever, infection, betamimetics (ephedrine or terbutaline), pain or anxiety, and treat the source. If blood glucose target of 70-110 are not achieved within 2 hours of insulin adjustments, modify IV insulin per the algorithm in Table 7.</p>
<p>Treating Hypoglycemia (Notify physician)⁵³ For blood glucose > 50 to < 70 mg/dL:</p> <ul style="list-style-type: none"> ❖ Stop insulin infusion ❖ Check blood glucose every 15 min until >70 mg/dL x 2; then restart insulin infusion per modified algorithm. <p>For blood glucose < 50mg/dL and patient is conscious:</p> <ul style="list-style-type: none"> ❖ Stop insulin infusion ❖ Increase IV D5 solution to 200 ml/hr until blood glucose is > 70 ❖ Check fingerstick every 15 minutes until blood glucose > 70 times 2; then restart insulin infusion per modified algorithm. <p>For blood glucose < 50 mg/dL and the patient is unconscious:</p> <ul style="list-style-type: none"> ❖ Stop insulin infusion ❖ Carefully consider 50 ml of D50 IV push ❖ Increase D5 solution to 200 ml/hr until blood glucose >70 mg/dL; then restart insulin per modified algorithm. <p>Avoid Glucagon unless the patient is losing consciousness and IV access is lost. Glucagon can cause nausea and vomiting, and it will block insulin for hours allowing the blood glucose to surge above 200 mg/dL. Turn woman on her side.⁵⁶</p>

Cesarean Delivery

When cesarean birth is planned, it is advisable to schedule it in the early morning, avoiding a prolonged fasting period from food and fluid, which complicates insulin management. Women are advised to take their full dose of NPH insulin at bedtime the night before.⁵⁵ The blood glucose is checked upon arrival at the hospital, the fasting target is 80-100 mg/dL.

All women with type 1 diabetes require insulin. Many providers will begin the D5 ½ NS solution when the blood glucose is <130 mg/dL and provide the insulin drip to maintain ~100 mg/dL blood glucose. If the blood glucose goes above 130 mg/dL the glucose infusion can be stopped or reduced to 50 ml/hr and the insulin continued per the algorithm in Table 7 in the postpartum column.^{45,51}

For women with type 2 diabetes, if blood glucose is <100 mg/dL then a glucose-containing IV fluid infusion should be started. One option is D5LR at a rate of 125 m/hr. Some women with type 2 diabetes will need no insulin if their fasting BG is within target and they are not fed or do not require the D5 IV solution.⁴⁵

Continuous Subcutaneous Insulin Infusion (CSII)

Women using an insulin pump who are scheduled for a cesarean birth should maintain the same overnight basal insulin that brings their fasting level to 80-100 mg/dL. Upon arrival at the hospital glucose-containing IV solution should be started, therefore she may not need an adjustment of her basal insulin until after delivery. Initially postpartum there may be an increase in blood glucose due to the stress hormones released in response to surgery, which can last through the two hour recovery period. Blood glucose may be checked every 30 minutes perioperatively due to these rapid changes. It is not necessary to remove the pump for surgery if blood glucose is within target range. If blood glucose is below 80 mg/dL, the pump can be suspended for an hour without adverse effects.

Impact of Cesarean Birth for Women with Preexisting Diabetes

The most common complication related to cesarean birth in women with preexisting diabetes is separation from the baby and delayed breastfeeding. Although some hospitals encourage breastfeeding in the operating room, most do not. This can result in the baby being in the nursery for several hours while the mother is in the recovery room. The delay can be prolonged if the baby has complications. The first hour after birth is the newborns' most alert awake time and this time may pass before breastfeeding is initiated. This can contribute to delayed lactogenesis and newborn hypoglycemia. Every effort should be made to get the couplet together as soon as possible after delivery.

Infection (endometritis and wound break down) is more common in uncontrolled diabetes.⁵⁷ Perioperative antibiotic prophylaxis is effective in reducing the incidence of postoperative fever, endometritis, and wound infections.^{58,59}

Cesarean birth carries a fivefold higher risk of thrombosis compared with vaginal birth in non-diabetic women. There are no controlled studies for women with preexisting diabetes. Thirty-six percent of all Deep Vein Thrombosis (DVT) occurred within the first 6 weeks postpartum. Obesity increases this risk. Studies in non-diabetic women suggest postoperative compression devices provide some preventative benefit.⁶⁰ Heparin prophylaxis may cause heparin induced thrombocytopenia and major bleeding, therefore it is not recommended.⁶¹

**POSTPARTUM
MANAGEMENT OF
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PREEXISTING
DIABETES**

Postpartum insulin needs are reduced with the delivery of the placenta.⁶² Appropriate adjustments are made as soon as possible to avoid hypoglycemia. To enhance healing and reduce post-surgical complications, hyperglycemia (blood glucose >160 mg/dL) should be avoided.

Glycemic Control after Vaginal Birth

These are the target blood glucose levels following a vaginal birth: premeal and fasting 100-110 mg/dL, and 2 hour postmeal >100, <150-160 mg/dL.⁶²

If women with preexisting diabetes were given insulin IV or by insulin pump during a vaginal birth:

1. Discontinue the insulin drip (CIII) when blood glucose is <140 mg/dL or reset all pump parameters to one-third of the pregnancy dose.
2. Discontinue the dextrose infusion when blood glucose is >80 mg/dL.
3. Provide a meal and give one-half the premeal insulin dose (from pregnancy) for type 2 diabetes and one-third the premeal insulin dose for type 1 diabetes.^{55,62}
4. Alternately, the woman with type 2 diabetes may use metformin and /or glyburide for blood glucose control at their prepregnant doses.^{62,63} Some women with type 2 diabetes may need no medication for a few days to a week after delivery.
5. Women with type 1 diabetes may need smaller insulin doses than before pregnancy and may need no insulin for a short time (24-48 hours).⁶²
6. Blood glucose is checked frequently in the first few days postpartum as insulin needs rapidly change especially with breastfeeding (refer to *Chapter 8: Breastfeeding*).
 - Check blood glucose with vital signs during recovery and on admission to the Postpartum unit.
 - Check blood glucose before breastfeeding and following breastfeeding at night or any time the mother plans a nap after breastfeeding for the first few days. Refer to *Chapter 8: Breastfeeding*.
 - Check blood glucose during fasting, before meals, two hours after meals, at bedtime, and at 3 AM.

Glycemic Control in the Early Postpartum Period^{20,64}

If women with preexisting diabetes were given insulin by IV or insulin pump during a cesarean birth:

- ❖ For type 1 diabetes, continue IV insulin infusion (drip-CIII) at half the algorithm (Table 7) after the delivery of the placenta.
- ❖ For women using an insulin pump (CSII), reset all pump parameters to one third the pregnancy dose when blood glucose is <140 mg/dL.

1. Continue dextrose infusion @ 100 ml/hr or a rate to keep blood glucose <140 mg/dL.
2. Check blood glucose every 1-2 hours while on IV insulin infusion and continue to adjust the dose according to half the labor algorithm.
3. When able to take liquids provide NON-caloric NO-carbohydrate clear liquids such as broth, tea, water and transition to meals as soon as possible.
4. When able to have a meal, discontinue IV dextrose, discontinue IV insulin and give one-half the pregnancy premeal insulin dose for type 2 diabetes and one-third the pregnancy premeal insulin dose for type 1 diabetes.
5. Alternately, the woman with type 2 diabetes may use metformin and /or glyburide for blood glucose control at their pre-pregnant doses. Some women with type 2 diabetes may need no medication for a few days to a week after delivery.
6. Women with type 1 diabetes may need smaller insulin doses than before pregnancy or may need no insulin for a short time (24-48 hours).
7. Blood glucose is checked frequently in the first few days postpartum as insulin needs rapidly change especially with breastfeeding (refer to *Chapter 8: Breastfeeding*).
 - Check blood glucose with vital signs during recovery and on admission to the postpartum unit.
 - Check blood glucose before breastfeeding and following breastfeeding at night or any time the mother plans a nap after breastfeeding for the first few days (refer to *Chapter 8: Breastfeeding*).
 - Check blood glucose during fasting, before meals, one to two hours after meals, at bedtime, and at 3 AM.

**PREEXISTING
DIABETES:
POSTPARTUM SELF
CARE AND
MEDICAL
FOLLOW-UP**

Plans for postpartum and interconception care should begin during pregnancy. Medical follow-up is scheduled two and six weeks postpartum to address early postpartum needs. The postpartum period offers an opportunity for the woman and her healthcare providers to establish an individualized health care plan.⁶² Maximizing BG control during the interconception period is a priority. Delaying pregnancy more than 18 months during this transition period is recommended. Conde-Agudelo et al conducted a meta-analysis between the relationship of birth spacing and negative perinatal outcomes. They concluded that “Interpregnancy intervals shorter than 18 months and longer than 59 months are significantly associated with increased risk of adverse perinatal outcomes.”⁶⁵ With this in mind, select the most effective method of birth control with the least adverse effect on carbohydrate metabolism.

Table 10 addresses recommendations for postpartum self-care and follow-up for women with preexisting diabetes.

Table 10. POSTPARTUM SELF-CARE AND FOLLOW-UP FOR WOMEN WITH PREEXISTING DIABETES^{1,62,66-68}		
Self-Management Behavior	Goal	Rationale
Healthy Eating	<ul style="list-style-type: none"> • Postpartum follow up at 2-6 weeks with RD to reinforce a meal plan that incorporates principals of healthy meal and lifestyle. • Encourage attainment of a healthy BMI. • Adjust meal plan as needed to accommodate breastfeeding needs and weight goals. • Women with celiac disease can be deficient in iron, fat soluble vitamins, B12 and folate. 	<p>Refer to <i>Chapter 7: Medical Nutrition Therapy</i> for specific suggestions for postpartum meal plan recommendations.</p> <p>Refer to <i>Chapter 8: Breastfeeding</i></p>
Staying Active	<ul style="list-style-type: none"> • With medical approval, encourage 30-60 minutes per day of brisk activity, such as walking, swimming, stationary cycling etc. Find an ongoing, long term, enjoyable activity program. 	Refer to <i>Chapter 6: Exercise</i> . Exercise increases insulin sensitivity and may decrease postpartum mood disorders.
Monitoring Blood Glucose	<ul style="list-style-type: none"> • Maintain blood glucose within these targets for postpartum and if breastfeeding: <ul style="list-style-type: none"> ◦ Fasting/premeal <110mg/dL ◦ 2 hour postmeal <150 -170mg/dL • Once blood glucose and medication management are stabilized, check blood glucose fasting, before meals and at bedtime. Post meal testing as indicated. 	Checking blood glucose 3-7 times per day is associated with improved glucose control and fewer complications of diabetes. Strive for A1c of <6% at 3 months postpartum.
Taking Medications	<ul style="list-style-type: none"> • Maintain contact with provider throughout the first 6 weeks postpartum as insulin or oral hypoglycemic medication needs drop or change frequently. • Metformin and glyburide are considered safe for breastfeeding. • Women who utilized antihypertensive therapy or lipid lowering medication, should consult with their physician regarding the medication and breastfeeding. 	Refer to <i>Chapter 8: Breastfeeding</i> .
Problem Solving	<ul style="list-style-type: none"> • Advise the woman to notify the primary physician who provides her diabetes care outside of pregnancy regarding the outcome of her pregnancy and schedule a follow up appointment. 	<p>Inadequate glycemic control in the postpartum period can have immediate and serious consequences such as poor healing, infections or DKA.</p> <p>Prior to delivery advise women with diabetes to see health care providers at 2-6 weeks for postpartum follow up.</p>

Table 10. POSTPARTUM SELF-CARE AND FOLLOW-UP FOR WOMEN WITH PREEXISTING DIABETES Continued^{1,62,66-68}		
Self-Management Behavior	Goal	Rationale
Reducing Risks	<ul style="list-style-type: none"> • Continue normal diabetic care. Obtain A1c, lipids and TSH at 6 months postpartum or sooner if indicated. • Target values^{1,68}: <ul style="list-style-type: none"> ○ A1c <6% ○ LDL <100mg/dL ○ HDL >50 mg/dL ○ TGs <150mg/dL • Breastfeed for at least 6 months, preferably for 1 year. • Plan future pregnancies: <ul style="list-style-type: none"> ○ Postpartum begins preconception for future pregnancies. • Plan for adequate birth control. 	<p>Postpartum thyroiditis occurs in 10-23% of women with preexisting diabetes and risk increases for the next year. It is associated with postpartum depression and poor glycemic control, especially with type 1 diabetes.</p> <p>Two years between pregnancies is recommended due to stress on the health status of women from insulin resistance of pregnancy.</p> <p>Most methods of birth control are compatible with uncomplicated preexisting diabetes. Refer to <i>Appendix A</i> in the <i>Chapter 2: Preconception and Interconception Care for Preexisting Diabetes</i>.</p>
Healthy coping	<ul style="list-style-type: none"> • Encourage use of family and social support system (mothers groups etc.). • Assess ability to provide care for self and infant. • Assess with Edinburgh Postnatal Depression Scale at 6 weeks postpartum and again at 3 months postpartum.^{1,66} 	<p>The nature of perinatal mood and anxiety disorders (PMAD) require providers to be able to identify, educate the family, and make appropriate referrals. Refer to <i>Chapter 9: Behavioral and Psychosocial Components to Care</i>.</p>

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Appendices

- A Risk for Major or Minor Congenital Anomaly Based on Periconceptional A1c & Factors That Impact Blood Glucose Levels and A1c Before and During Pregnancy
- B Changes in Insulin Requirements During Pregnancy
- C Suggested Premeal Insulin Correction Algorithm for patients using MDI only – not for pump use

Appendix A**RISK FOR MAJOR OR MINOR CONGENITAL ANOMALY
BASED ON PERICONCEPTIONAL A1c**

The Congenital Anomaly Chart below illustrates that A1c at approximately 2 standard deviations above normal increases the risk for congenital malformations.

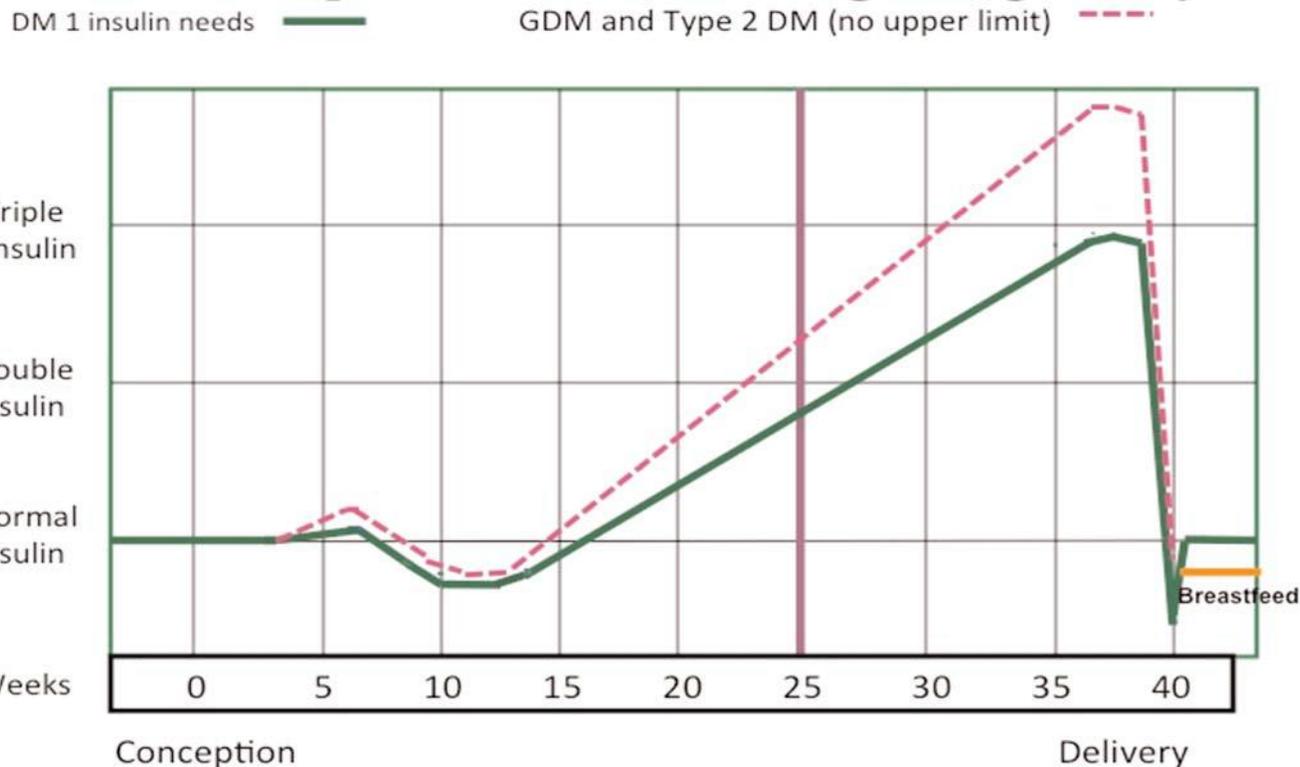
RISK FOR MAJOR OR MINOR CONGENITAL ANOMALY BASED ON PERICONCEPTIONAL A1c⁶⁹													
Standard deviation from mean	0	1	2	3	4	5	6	7	8	9	10	11	≥ 12
Estimated A1c (%)	5.5	6.2	6.9	7.6	8.3	9.0	9.7	10.4	11.1	11.8	12.5	13.2	≥ 13.9
Abnormality risk (%)	2	3	3	4	5	6	7	8	10	12	14	17	20

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Multiple factors can change the A1c results. The table below is a partial list of factors that are often encountered.

FACTORS THAT IMPACT BLOOD GLUCOSE LEVELS AND A1c BEFORE AND DURING PREGNANCY²		
FACTOR	Increased BG/A1c	Decreased BG/A1c
Nausea and vomiting /early pregnancy	X	
Late pregnancy due to increasing insulin resistance	X	
Stress/Sepsis	X	
Timing of BG check in relationship to last meal	X	X
Individual post meal peaks	X	X
Exercise		X Generally
Carbohydrate intake	X	X if restricted severely
↑↑Fat and protein content in meal		X until after time of usual peak BG
Medication (betamethasone, betamimetics) herbs	X Mostly	
Anemia		X
Inappropriate self-care (e.g. over treatment of hypoglycemia)	X	

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Appendix B**Changes in Insulin Requirements During Pregnancy****Insulin Requirements During Pregnancy**

17. Garcia-Patterson A, Gich I, Amiri SB, Catalano PM, de Leiva A, Corcoy R. Insulin requirements throughout pregnancy in women with type 1 diabetes mellitus: three changes of direction. *Diabetologia*. 2010;53(3):446-451.
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Appendix C

**Suggested Premeal Insulin Correction Algorithm
for patients using MDI only – not for pump use**

SUGGESTED PREMEAL INSULIN CORRECTION ALGORITHM - MDI		
If BG before meals (breakfast , lunch and dinner) is:	Supplement the dose of premeal rapid acting analog by taking:	And
< 70 mg/dL	2 units less	Eat right away, inject insulin after the meal.
71 - 80 mg/dL	1 unit less	Eat carbohydrate right away.
81 - 99 mg/dL	Take usual/basic dose	Eat right away.
100 - 129 mg/dL	1 unit more	Eat right away.
130 - 159 mg/dL	2 units more	Recheck in 15 min, eat when < 110 mg/dL.
160 - 189 mg/dL	3 units more	Wait 30 minutes to eat if still > 110 mg/dL*.
≥ 190 mg/dL	4 units more	Check CBG every 30 - 60 minutes, eat when near 110*. Check urine ketones.
If BG >200mg/dL, check urine ketones and call provider.		
* Although it is best to wait until BG is in a “normal” range to eat, many pregnant women report this to be difficult. In that case, we recommend eating the non-carbohydrate portion of the meal first.		
This algorithm should be adjusted to make it effective for the individual. This algorithm uses ~30mg/dL correction above a target of a premeal BG of 100mg/dL. Below 80mg/dL insulin sensitivity may increase, therefore, less than the usual dose should be taken.		

Your basic dose of rapid acting premeal insulin is based on your ratio of units of insulin to grams of carbohydrate at each meal. If you have a high or low blood sugar before a meal you need to correct your insulin dose based on your premeal sugar as described above. Insulin works better when your sugar is low or normal; therefore the timing of your insulin dose is also important when trying to achieve good control. Adjust your premeal basic dose based on the correction algorithm.

THIS IS NOT A SLIDING SCALE

For more information:

California Department of Public Health, Center for Family Health,
Maternal Child and Adolescent Health Division,
California Diabetes and Pregnancy Program (CDAPP) Sweet Success
(916) 650-0300

<http://www.cdph.ca.gov/programs/CDAPP>

or

California Diabetes and Pregnancy Program (CDAPP) Sweet Success
Resource and Training Center
Tracy Esquivel, BA
(714) 921-9755

<http://www.CDAPPSweetSuccess.org>

