Monitoring and Medical Nutrition Therapy of Gestational Diabetes Mellitus

V Seshiah

Pre-gestational diabetes (either type 1 or type 2) has the potential to subject the developing fetus to abnormal maternal glucose levels resulting in problems with organogenesis, resulting in congenital anomalies or spontaneous abortion. Whereas in, Gestational Diabetes Mellitus (GDM) which manifests after organogenesis in the second part of pregnancy, therefore the major risk for the fetus is macrosomia. Although the goal for Medical Nutrition Therapy (MNT) for each of these disorders is the same which is euglycemia, the means to achieve it are very different and somewhat controversial1.

MATERNAL AND FETAL ADAPTATIONS IN PREGNANCY
A new structure arises De novo during pregnancy, develops and matures till it is expelled at the completion of the gestational period. The metabolic adaptations that occur during pregnancy are to accommodate a rapidly growing tissue transplant, the conceptus. For its own normal growth and development, the conceptus brings about alterations in maternal fuel metabolism and hormones. The placenta facilitates embryogenesis, growth, maturation and survival of the fetus. It has the capacity to synthesize steroid and peptide hormones and to modulate and transport maternal fuel to the fetus.

FUEL METABOLISM IN NORMAL PREGNANCY
The fuel metabolism during normal (non-diabetic) pregnancy is characterized by,
- Facilitated insulin action during the first half of pregnancy
- Diabetogenic stress during the second half of pregnancy

Early Weeks of Gestation
In the early weeks of gestation certain hormonal changes occur,
- Increase in fasting insulin concentration
- Increase in glucose stimulated insulin release (which reaches a peak at the 18th - 20th week)
- Increase in serum levels of estrogen and progesterone which induces beta cell hyperplasia

These hormonal changes result in an increased elaboration of insulin (hyperinsulinemia) and heightened sensitivity to insulin. Insulin, being an anabolic and anti-catabolic hormone favors the following,
- Tissue glycogen storage,
- Prevents production of glucose from the liver
- Increases peripheral glucose utilization

The net effect of these anabolic changes is a decrease in fasting blood glucose by 10% compared to non-pregnancy fasting level. The other reason for the decrease in the fasting plasma glucose (FPG) is due to increase in plasma volume in early gestation and increase in feto placental glucose utilization.

Later Weeks of Gestation
During the later half of pregnancy, the facilitated insulin action continues and at the same time, there is an increased elaboration of placental chorionic somato - mammotrophin (Human Placental Lactogen, HPL), prolactin and cortisol. These surges in counter hormones result in insulin resistance and stress on the carbohydrate metabolism (diabetogenic stress) and due to this, maternal insulin sensitivity is reduced
approximately by 50%. Extra insulin compensates for the 50% reduction in the responsiveness of peripheral tissues to insulin action due to placental hormones. In a normal pregnant woman, first and second phase insulin response increases approximately three fold by the third trimester and is associated with maternal B cell hypertrophy and hyperplasia.

**METABOLIC CHANGES IN NORMAL PREGNANCY**

During pregnancy, metabolism increases by 15-26% to support both mother and developing fetus. Early pregnancy is characterized by normal glucose tolerance, normal hepatic gluconeogenesis, and normal or improved insulin sensitivity. As pregnancy progresses, carbohydrate metabolism becomes altered due to an increase in insulin secretion and decreased insulin sensitivity. Thus, some insulin resistance occurs, by late pregnancy overall insulin action is decreased 50-70% as compared to a nonpregnant woman.

**MEDICAL NUTRITION THERAPY**

All women with GDM should receive nutritional counseling. The meal pattern should provide adequate calories and nutrients to meet the needs of pregnancy. The expected weight gain during pregnancy is 300 to 400 gm/week and total weight is 10-12 kg by term. Hence the meal plan aims to provide sufficient calories to sustain adequate nutrition for the mother and fetus and to avoid excess weight gain and postprandial hyperglycemia.

**GENERAL NUTRITION GUIDELINES FOR PREGNANCY**

- Normal pregnancy nutritional guidelines focus on several dietary elements like calorie intake, macronutrient proportion, vitamins and minerals.
- Calorie requirement depends on age, activity, pre pregnancy weight and stage of pregnancy. Approximately 30 to 40 Kcal/kg ideal body weight or an increment of 300 kcal/day above the basal requirement is needed in 2nd and 3rd trimesters.
- Eating 3-4 servings of fruits and vegetables, 9 servings of whole grains for energy, 3 servings of dairy for calcium, and 3 servings of meat to reach daily protein requirements.
- There are certain foods that are to be avoided in pregnancy due to fetal developmental harm. Those foods are: smoked fish, soft cheeses, unpasteurized milk, raw meat and eggs which have been associated with bacterial infections. Fish containing mercury and raw shellfish should be avoided.
- Caffeine has been associated with miscarriage, premature birth, low birth weight and withdrawal symptoms in the neonate when consumed in large amounts in pregnancy.
- Alcohol should not be used.

**CALORIE RESTRICTION**

When women who are classified as obese or overweight prior to pregnancy, the amount of weight gain in pregnancy differs from those who are not at a normal or underweight prior to pregnancy. Women greater than 150% of ideal body weight, no more than 15 pounds should be gained with pregnancy. Optimal infant birth weight was achieved when less than 3 kg or no weight was gained in these women.

The standards for energy requirements for pregnant women with GDM, as supported by the American College of Obstetrics and Gynecology, determine the amount of energy needed to maintain pregnancy based upon the pre-gravid weight. For GDM women, who are 1.5 times their ideal body weight the caloric intake is 12-15 kcal/kg of the current pregnant weight, while those at less than 0.8 of their ideal body weight are to increase their caloric intake to 35-40 kcal/kg current pregnant weight. For those at 0.8 to 1.2 times their ideal body weight, 30 kcal/kg and those at 1.2-1.5 times ideal body weight, 24 kcal/kg current pregnant weight is the standard.

Pregnancy is not the ideal time for obesity correction. In an obese pregnant woman, a lower weight gain of 5-6 kg may be optimal. Underweight subjects or those not gaining weight as expected, particularly in the third trimester, require admission to ensure adequate nutrition to prevent low birth weight infants.

**CALORIE COUNTING**

When postprandial glucose (PPG) levels increases there is an increased risk of macrosomia. The threshold for the marked increase was seen when PPG levels increases from 120 mg/dl. Thus a dietary therapy, ‘the euglycemic diet’ was developed. The euglycemic diet takes into account the metabolic changes that occur within the pregnant woman as she goes throughout her day.

As a part of the MNT, pregnant diabetic woman are advised to wisely distribute their calorie consumption especially the breakfast. This implies splitting the usual breakfast portion into two equal halves and consuming the portions with a 2-hr gap in between. By this the undue peak in plasma glucose levels after ingestion of the total quantity of breakfast at one time is avoided. For e.g. If 4 slices of bread (applies to
all types of breakfast menu) is taken for breakfast at 8 am and 2 hr PG at 10 am is 140mg, the same quantity divided into two portions ie., two slices at 8 am and the remaining two slices after 10 am, the 2-hr PPG at 10.00 am falls by 20-30 mg/ dL. This recommendation is based on scientific information. In the morning a surge of cortisol is seen (‘the dawn phenomenon’), which causes the release of glucose from stored sources and hepatic gluconeogenesis, thus the blood glucose is higher to begin with. Therefore, a decreased amount of carbohydrate is needed in the breakfast meal.

The carbohydrate parameters of the diet are: 12.5% of the total daily carbohydrate at breakfast, 28 % at lunch and dinner, with the remainder in three snacks distributed throughout the day. The postprandial glucoses recorded by the women correlated to the carbohydrate intake.

ROLE OF FATS
Fat content in the American Diabetic Association (ADA) diet consists of less than 25 % of the total caloric intake. The role of saturated and mono-unsaturated fats in GDM women is different with respect to the uptake of glucose postprandially. The saturated fatty acid is able to release better insulin during pregnancy. Though in non-pregnant state, the saturated fats are correlated with the heart diseases, was not found to be that harmful during pregnancy.

ROLE OF PROTEIN
Protein content in the ADA diet and euglycemic diet makes up 20 % of the total daily caloric intake. Increased satiety has also been correlated with meals that are high in protein content. Thus, this aspect could help morbidly obese patients to manage overall caloric intake especially when moderate calorie restriction therapy is being used.

MONITORING GLYCEMIC CONTROL
The success of the treatment for a woman with GDM depends on the glycemic control maintained with meal plan or pharmacological intervention. Studies suggest 1, 1 ½ and 2- hr postmeal for monitoring glycemic control. Two- hour postmeal monitoring is preferred as the diagnosis of GDM is also based on 2- h plasma glucose. It is easier to remember this timing, as the time for diagnosis and also for monitoring is the same ie, 2 hours. However, whichever timing is targeted for monitoring glycemic control and adjusting insulin dose, blood tests must be performed at the same time at each visit.

- Women with type 1 or type 2 diabetes need pre-pregnancy counseling to maintain blood glucose levels (FPG < 90 mg/dl and 2 hr PG < 120 mg/dl) and A1c level at an acceptable level (A1c < 6%) to conceive.
- For GDM, once diagnosis is made, meal plan is advised initially for two weeks. If MNT fails to achieve control i.e., FPG < 90 mg/ dl and/ or 2 hr PG < 120 mg/ dl, insulin may be initiated.
- For women with type 1 and type 2 diabetes who are already on treatment, intensive monitoring is required from the day 1 of conception. They will have to do self monitoring of blood glucose (SMBG) or get the levels checked at a laboratory atleast once a week to adjust the dosage of insulin.

- Once target blood glucose is achieved, woman with GDM till the 28th week of gestation require monitoring of both fasting and 2 hr post breakfast once a month and at other time of the day as the clinician decides.
- After the 28th week of gestation, the monitoring should be more frequent atleast once in 2 weeks, if need be more frequently.
- After 32 weeks of gestation, monitoring should be done once a week till delivery.
- Continuous glucose monitoring devices are available but these equipments need special training and further are expensive. These devices may be useful in high risk pregnancies to know the glycemic fluctuations and to plan proper insulin dosage.

Pregnant women should be advised to perform SMBG on a daily basis, failing which, at least weekly monitoring should be encouraged. If self-monitoring is not possible, laboratory venous plasma glucose has to be estimated for adjusting the dose of insulin.

Explanatory note: GDM women usually have high post breakfast plasma glucose level compared to post lunch and post dinner. The period between breakfast and lunch is often problematical because of the physiological tendency to hyperglycemia at this time, and may necessitate substantial increases in the morning dose of short-acting insulin, together with careful adjustment of meal timing and snacks to avoid hypoglycemia. A few GDM women may have high post lunch and dinner plasma glucose. Insulin dose has to be adjusted by frequent monitoring of postprandial blood glucose.

MEASURING OTHER PARAMETERS
It is rewarding if blood pressure is monitored during every visit along with examination of the fundus and estimation
of Microalbuminuria, every trimester.

**A1c LEVELS**

Hemoglobin A1c is an effective clinical tool for accessing glycemic control and can be performed every 2 weeks to chart management because the turnover rate of the red blood cells during pregnancy is only 90 days as compared with 120 days in the nonpregnant state.

If the glucose intolerance is detected in the early pregnancy, A1c level will be helpful to differentiate between a pre GDM and GDM. If the A1c level is more than 6%, she is likely to be a pre GDM. A1c is useful in monitoring the glucose control during pregnancy, but not for the day to day management. A1c level may serve as a prognostic value.

Estimation of fructosamine during pregnancy is less frequently used.

**URINE ALBUMIN**

A urine test, which should include a culture, should be done fortnightly, and serum creatinine, microalbuminuria, and proteinuria every trimester.

**BLOOD PRESSURE (BP)**

The BP has to be monitored during every visit. If BP is found to be more than 130/80 mmHg, advise alpha- methyldopa 125 mg and dose to be adjusted on follow-up.

**FUNDUS EXAMINATION**

Pregnant women with diabetes should be given a thorough explanation on the risk of development or progression of diabetic retinopathy. Fundus Fluorescein angiography is a sensitive tool to assess the extent of capillary nonperfusion and early neovascularization, may aid in guiding treatment of macular edema, although ophthalmoscopic examination is satisfactory in most of the cases for the diagnosis of proliferative retinopathy. In addition, no detrimental effects of fluorescein dye on the fetus have been documented. Eyes must be examined at the first trimester and successively as the need arises.

**FETAL EVALUATION**

An ultrasound scan has to be performed around 18-20 weeks of gestation focusing on structures namely the sive, skull, kidney and heart. Fetal echocardiography has to be done around 20-24 weeks which allows to view all the four chambers of the heart. From 26th week onwards, fetal growth and liquor volume has to be monitored every - 3 weeks. Fetal abdominal circumference provides baseline for further serial measurements which gives growth acceleration or restriction. Fetal movements are monitored from 20 weeks onwards. Screening for chromosomal anomalies is necessary in pre GDM. Screening should be done for Down's syndrome, alpha fetoprotein for neural defects and human chorionic gonadotrophin to identify any chromosomal abnormalities.

**MID PREGNANCY (16-20 WK) to detect fetal anomalies**

- Maternal serum alpha fetoprotein
- Screening for chromosomal anomalies
- Ultrasonography
- Fetal echocardiography

**LATE PREGNANCY (28 wk to delivery) to assess fetal well being**

- Maternal assessment of fetal activity (< 4/hr indicate fetal jeopardy)
- Non stress test
- Contraction stress test
- Fetal biophysical profile
- Ultrasonography
- Lecithin to sphingomyelin (L/S) ratio (>3.0), lung profile

**CONCLUSION**

Due to increased glucose and insulin levels, a multitude of fetal and maternal complications are manifesting, the most prevalent being macrosomia. Multiple studies have correlated fetal complications such as macrosomia to peak postprandial glucose levels. By restricting carbohydrate concentration in the euglycemic diet and modifying the caloric intake based on pre-gravid weight, success has been achieved in reducing large for gestational age and macrosomic infants. The euglycemic diet targets a pre-prandial glucose of 90 mg/dl or less and a peak postprandial of 120 mg/dl. However, research has shown that normal pregnant women in the third trimester have lower preprandial and postprandial glucose concentrations than nonpregnant women. This would support advocating euglycemic standards of ≤ 90 mg/dl preprandially for women with gestational diabetes.

Poor gestational metabolic management can be directly linked to the level of neurological functioning of the child and these children are more prone to develop metabolic syndromes. The management of GDM is based upon the synergistic effects of MNT, exercise and an insulin regimen when necessary. Regardless, MNT remains the cornerstone
of treatment for GDM. Food plans should be culturally appropriate and individualized to take into account the patient’s body habitus, weight gain and physical activity and be modifies as needed throughout pregnancy to achieve treatment goals.

Women with GDM are at increased risk for developing type 2 diabetes. Nutrition interventions for GDM should emphasize overall healthy food choices, food portion, and cooking practices that can be continued postpartum and may help to prevent later diabetes, obesity, cardiovascular disease, and cancer16.

REFERENCES