

# Gestational Diabetes Mellitus (GDM) Diagnosis, Therapy and Follow-Up Care

## Practice Guideline of the German Diabetes Association (DDG)<sup>1</sup> and the German Association for Gynaecology and Obstetrics (DGGG)<sup>2</sup>

### Authors

H. Kleinwechter<sup>1</sup>, U. Schäfer-Graf<sup>2</sup>, C. Bühner<sup>3</sup>, I. Hoesli<sup>4</sup>, F. Kainer<sup>5</sup>, A. Kautzky-Willer<sup>6</sup>, B. Pawlowski<sup>7</sup>, K. Schunck<sup>8</sup>, T. Somville<sup>9</sup>, M. Sorger<sup>10</sup>

### Affiliations

Affiliation addresses are listed at the end of the article.

### Preliminary Remark



This practice guideline on gestational diabetes is a treatment oriented short version of the evidence based guideline that can be viewed in the internet. It replaces the DDG and DGGG recommendations of 2001 for diagnostic and therapy of gestational diabetes. A complete rework had become necessary in view of epidemiologically based diagnostic criteria, which had been derived from the Hyperglycaemia and Adverse Pregnancy Outcome study (HAPO) by international consensus, and in view of randomised therapy and observation studies published after 2001. With this, Germany has adopted the international standard. Screening and diagnosing gestational diabetes by means of blood glucose are part of the legally binding maternity guidelines in Germany since March 3, 2012.

### Definition



Gestational diabetes mellitus (GDM, ICD-10: O24.4G) is defined as a glucose tolerance disorder which is first diagnosed in pregnancy with a 75 g oral glucose tolerance test (OGTT) under standardised conditions with a quality controlled measurement of venous plasma glucose. Diagnosis is possible with a *single* elevated glucose level.

One the other hand, the definition of manifest diabetes during pregnancy is based on criteria that applies outside of pregnancy; that is, manifest diabetes during pregnancy is not classified as GDM.

### Pathophysiology, Health Objectives



GDM is usually described as a functional disorder marked by increasing insulin resistance with declining beta cell compensation. Its pathophysiology is similar to that of type 2 diabetes to a large

extent. The frequency of poor pregnancy outcomes in women with GDM can be reduced by timely diagnosis and appropriate treatment.

### Epidemiology



According to the perinatal statistics, GDM prevalence in Germany rose from 3.7% in 2010 to 4.3% in 2012 (roughly 28 200 cases in 2012).

### Consequences



#### Acute Consequences for the Mother

There are increased risks for

- ▶ urinary tract and vaginal infections with resultant increased premature birth rates,
- ▶ gingivitis,
- ▶ preeclampsia,
- ▶ inductions of labour,
- ▶ fetal macrosomias,
- ▶ cesarean sections,
- ▶ shoulder dystocias,
- ▶ perineal tears, and
- ▶ post partum bleeding requiring a blood transfusion.

#### Long-Term Consequences for the Mother Diabetes Risk in Later Life

The number of women with GDM who develop diabetes within 10 years after the pregnancy is 35-60% compared to women without GDM. This constitutes a 7 to 10-fold increase of risk. In the first year after the pregnancy, some 20% of these women develop various forms of abnormal glucose metabolism. The risk is increased with preconceptional obesity, a GDM diagnosis before

### Bibliography

**DOI** <http://dx.doi.org/10.1055/s-0034-1366412>  
Exp Clin Endocrinol Diabetes 2014; 122: 395–405 © J. A. Barth Verlag in Georg Thieme Verlag KG Stuttgart · New York · ISSN 0947-7349

### Correspondence

**Prof. Dr. med. Ute Schäfer-Graf**  
Berliner Diabeteszentrum für Schwangere, Klinik für Gynäkologie und Geburtshilfe St. Joseph Krankenhaus  
Wüsthoffstraße 15  
12101 Berlin  
Tel.: ++49/0 30/78 82 42 14/22 36  
Fax: ++49/0 30/78 82 27 66  
[ute.schaefer-graf@sjk.de](mailto:ute.schaefer-graf@sjk.de)

<sup>1</sup> Publisher DDG: M. Kellerer, S. Matthaei

<sup>2</sup> Publisher DGGG: R. Kreienberg

Week 24, insulin therapy, 1 hour glucose load level in pregnancy OGTT  $\geq 200$  mg/dL (11.1 mmol/L), or HbA1c  $\geq 5.7\%$  when GDM is diagnosed. The incidence of type 1 diabetes 5–10 years after GDM is 2.3–10% for risk groups.

### Recurrence Risk for GDM

For women of European origin, the recurrence risk of GDM in a subsequent pregnancy is 20–50%. Risk factors: obesity, number of pregnancies, GDM diagnosis before Week 24 in earlier pregnancies, insulin therapy, interval between pregnancies less than 24 months, body weight increase of more than 3 kg between pregnancies and increased fasting blood glucose two months postpartum. The recurrent risk increases to 50–84% for ethnicities with high diabetes risk (Asia, Latin America). See also **Table 1**.

### Acute Consequences for the Fetus/Child

Maternal hyperglycaemia may lead to increased fetal insulin secretion and to deposits of glycogen and fat with macrosomia, increased fetal abdominal circumference (AC) and reduced fetal pulmonary surfactant factor. The fetus's oxygen requirements are increased and the fetus may develop polyglobulia. The rate of premature birth and the risks of late intrauterine death are also increased. Postnatal problems with diabetic fetopathy include hypoglycaemia, breathing disorders, polyglobulia, hypocalcemia, and hyperbilirubinemia as well as renal vein thrombosis (very rare).

### Long-Term Consequences for the Child

The risks of children in their first 20 years of life for overweight/obesity, glucose tolerance disorder/diabetes, metabolic syndrome and elevated blood pressure (epigenetic effects) rise after intrauterine exposure to elevated glucose levels. Interventions during pregnancy for lowering elevated glucose levels should be followed by postnatal family life style changes (breast feeding, appropriate nutrition and early encouragement of physical activity) as a precaution against long-term development of obesity in later childhood and adolescence.

## Screening and Diagnosis

### Diagnosis of manifest diabetes at first visit during the pregnancy

During their first visit during early pregnancy (before Week 24), **pregnant women with elevated risk** ought to be examined for the presence of (previously unrecognised) manifest diabetes (see also **Table 2**). Either of the following two approaches may be used.

- ▶ Measurement of random venous plasma glucose during a regular visit to the gynecologist, without regard to time of day or ingestion of food. Levels of 200 mg/dL (11.1 mmol/L) or more are followed by a fasting venous plasma glucose measurement and the patient's condition is classified in one of the three groups described in **Fig. 1**.
- ▶ A random glucose level between 140 and 199 mg/dL (7.8–11.05 mmol/L) can be followed by a second blood glucose measurement or an OGTT for further clarification. An OGTT before Week 24 can be ordered in individual high risk cases (2 or more risks). On the other hand, a normal OGTT level before Week 24 does not imply that glucose tolerance will not deteriorate later on during the pregnancy.

- ▶ Alternatively, fasting glucose can be measured. A second measurement is required if the blood glucose level in venous plasma is 92 mg/dL (5.1 mmol/L) or higher.
- ▶ The blood glucose measurements must meet laboratory standards. Suspicion of manifest diabetes must be confirmed by a second measurement. The result of the second measurement is decisive. The blood specimen for the second measurement can be taken on the same day. A 75-g-OGTT during weeks 24 to 27 is carried out if blood glucose levels are normal (see also **Fig. 1**).

### Diagnosis of GDM in pregnancy weeks 24 to 27

During week 24 to 27 + 6 it is preferable to use a 75-g-OGTT as a **one-step procedure** for diagnosing GDM. GDM screening procedures such as urine glucose, fasting glucose, random glucose and HbA1c should not be performed first. Screening with a 50-g glucose challenge test (GCT) with borderline levels in venous plasma of 135 mg/dL (7.5 mmol/L) – conducted without regard to time of day or ingestion of food – can be accepted in the context of a **two-step procedure**. According to the Maternity Guideline, the 50-g test is the initial test. A result of 201 mg/dL (11.1 mmol/L) or higher is classified as GDM and there is no need for a 75-g OGTT. The OGTT is carried out in the morning under standard conditions, with the patient fasting. If the planned window of gestational age is missed, the test can also be carried out later.

The standard conditions are as follows:

- ▶ No previous surgery on the upper gastrointestinal tract such as, for example, bariatric surgery; the alternatives for these patients are intravenous GTT by the diabetologist and single blood glucose measurements, especially fasting.
- ▶ No acute illness/fever/hyperemesis/medically ordered bed rest.
- ▶ If betamethasone has been or is being used to accelerate fetal lung maturity because of impending premature birth, an OGTT cannot be conducted until at least 5 days after the last injection, and the patient must be at least partially mobile.
- ▶ Normal, individual eating and drinking habits with the usual quantities of carbohydrates during the past 3 days before the test (the patient is told not to prepare herself for the test by changing her diet, say by leaving out carbohydrates).
- ▶ Observance of a fasting period of at least 8 hours starting at 10pm on the evening before the test.
- ▶ No unusual physical activity before the test.
- ▶ No ingestion or parenteral application of medications with anti-insulin effect such as, for example, cortisol, l-thyroxine, beta-mimetics and progesterone before the test.
- ▶ The patient is not allowed to smoke either before or during the test.
- ▶ During the test, the patient should sit, preferably in the vicinity of the test laboratory.

Fasting venous plasma is measured just before the test begins. Then the patient drinks 75 g of glucose dissolved in 300 ml of water or comparable oligosaccharide mixture over a period of 3 to 5 minutes. Glucose is measured one and two hours later. If the OGTT is shortened to a duration of just one hour (measurement fasting and after one hour), then 2.1% of all cases of pregnant women with GDM will not be detected. In cases of severe morning sickness or vomiting, the test will have to be postponed for a few days.

### Assessment of the 75-g-OGTT Results

GDM is diagnosed when **at least one venous plasma** glucose level equals or exceeds the level stated in **Table 3**.

Thus it is possible for GDM to be diagnosed on the basis of a single elevated fasting level. An average of 55% (range: 26–74%) of GDM diagnoses are made on the basis of the fasting level alone. If the fasting blood glucose level equals or exceeds 126 mg/dL (7.0 mmol/L), the diagnosis is suspicion of manifest diabetes mellitus, so the test should be stopped and the glucose load not administered. Confirmation by means of a second blood glucose fasting test is called for instead. The diagnosis of manifest diabetes is confirmed by this second test.

Finally, a level of 200 mg/dL (11.1 mmol/L) or more 2 hours after administration of the glucose load establishes the diagnosis of diabetes without further tests. Pregnancy should be managed as if she had already been diagnosed with diabetes mellitus before conception.

### Blood Samples and Requirements for Quality Measurements

Blood glucose levels for GDM diagnosis must be measured in **venous plasma or venous whole blood**. Venous whole blood levels are converted to venous plasma levels either by addition of 11% (multiplication by 1.11) or by use of a plasma calibrated measurement system.

Blood glucose measurements for diagnosing GDM must meet the requirements for quality measurements laid down by the relevant guidelines of the German Medical Association. Like all other glucose measurement systems, all unit-use reagents and associated measurement systems for making an initial diagnosis of manifest diabetes during pregnancy or of gestational diabetes should, according to the manufacturer's recommendations, be specifically designed for diagnostic medical use. When used in a private practice, these systems should also be subjected to a quality assurance check in accordance with the guidelines of the German Medical Association.

### Blood Glucose Measurements: Errors and Interfering Factors

Venous whole blood and plasma measurements can be erroneous, especially due to differing pre-analytic procedures. The main problem is insufficient pre-analytic glycolysis inhibition when the specimen is shipped. When venous whole blood specimens are to be shipped, the collection tube should contain not only a blood clotting inhibitor and NaF but also citrate/citrate buffer, which is an *immediately effective* glycolysis inhibitor. The optimal procedure is to ship venous plasma that has been separated from the whole blood sample without hemolysis by centrifuging in a refrigerated centrifuge.

### Unmasking a Glucokinase Gene Mutation (MODY2)

A glucokinase mutation (MODY 2) with autosomal dominant heredity is unmasked in some 2% of all cases of glucose tolerance disorder detected during pregnancy. The signs of this are elevated fasting blood glucose levels of 99–144 mg/dL (5.5–8.8 mmol/L), a low rise of blood glucose in the OGTT from the fasting to the 2-hour level of less than 83 mg/dL (4.6 mmol/L) during or after pregnancy, normal or only slightly elevated HbA1c level, and positive family history. A suspicion of a MODY 2 mutation is established by means of a genetic analysis. The German Law on Genetic Examinations of Humans (GenDG) requires that this has to be explained to the patient and that her written consent has to be obtained.

### Initial Presentation of Type 1 Diabetes Mellitus during Pregnancy

▼ In cases of suspicion of type 1 diabetes, the diagnosis should be made following the DDG guidelines and intensive insulin substitution should be started at once.

### Therapy

#### Blood Glucose Goals

##### Target Levels

The target levels are given in ◉ **Table 4**. There are no preferences for the post prandial measurement after one or two hours. A single procedure should be established.

Blood glucose measurements: morning fasting and after the patient's meals. Median blood glucose (MBG) is computed from at least 3 preprandial and 3 postprandial measurements. One must bear in mind that the patient's experience with blood glucose measurements might be very limited at the beginning, so these values should, if possible, not serve as the sole criteria for deciding on the therapy. This applies most especially to the indications for insulin therapy. The blood glucose measurements taken by the patient must be checked regularly during the treatment process. The glucose goals given in ◉ **Table 4** should be modified in the following cases:

- ▶ Lower values for disproportional fetal growth in favour of the abdomen according to ultrasound findings (abdominal circumference above percentile 75 after Week 24).
- ▶ Higher values for fetal intrauterine growth retardation (IUGR).
- ▶ Higher values for maternal tendency to hypoglycaemia during insulin therapy.

Isolated cases of abnormal levels do not imply that there will be unfavourable effects for the children.

### Blood Glucose Monitoring

#### Individual Blood Glucose Measurements

Measurement schedule at the beginning: 4 point glucose profile – fasting in the morning and 1 or 2 hours after the beginning of each meal.

Within 2 weeks after the GDM diagnosis the measurement results and biometric data (fetal ultrasound measurements, mother's BMI) should be checked to decide whether GDM therapy should be continued with just diet therapy or also with insulin therapy. If most of the measurements (at least 50%) are elevated during two weeks, insulin therapy should be considered.

In the cases of diet controlled GDM, if all the test results lie in the target range within the first 2 weeks, then one measurement per day on a rotating schedule will be sufficient, alternative by two 4 points profiles/week.

If measurements on a rotating schedule lie within the target range, more intensive testing (a 4 or 6 point schedule) may be taken every 1 or 2 weeks. The important thing is to keep the burden on the patient as low as possible by not asking her for more data than is required to make appropriate clinical decisions.

In the cases of insulin therapy, glucose levels should be checked four or six times daily, depending on individual needs.

The blood glucose self measurements and the reliability of the home monitoring systems should be checked on a regular basis.

### HbA1c

HbA1c is measured at GDM diagnosis if a previous fairly long period of hyperglycaemia is suspected. The capillary blood glucose monitoring is more accurate than HbA1c for monitoring diabetes control.

### Ketone Bodies

If carbohydrate or calorie intake is too low, this will lead to intensified, accelerated mobilization of the mother's fat reserve so that the energy requirements of the fetus are met (hunger ketosis). Hunger ketosis can occur in cases of inadequate calorie intake or intentional reduced food intake (avoidance of insulin therapy). Pregnancy ketosis (including hunger ketosis) should be avoided because there is a possibility of unfavourable influences of ketonemia on fetal development or postnatal intellectual development. Ketone monitoring is recommended.

### Diabetes Care

Diabetes care of pregnant women with gestational diabetes should be provided only by physicians qualified as diabetologists. Counselling, education and care should be provided, preferably on an out-patient basis, in special diabetes facilities or centres for Perinatal Medicine that specialise in diabetes care.

### First Medical Consultation after GDM Diagnosis

A detailed consultation should be conducted in an atmosphere that reduces anxiety. The patient is probably being confronted with the concept of diabetes for the first time. Patients who have language difficulties, cannot read or are new to the local culture will need culturally competent translators and/or other advisors who ensure that the measures being prescribed are understood and can be implemented.

This structured medical consultation with the patient after the diagnosis of GDM has the following elements:

- ▶ Meaning of the diagnosis for mother and child.
- ▶ Time frame of the measures to be taken and the structure of the care to be provided.
- ▶ Statement of how therapy will be conducted (usually out-patient).
- ▶ Purpose of the blood glucose monitoring.
- ▶ Necessity of diet control and objective of the weight gain prescribed.
- ▶ Advantages of regular physical activity.
- ▶ Reasons for possible use of pharmacotherapy with insulin.
- ▶ Risks of active and passive cigarette smoking.
- ▶ Possibility of contacting the treatment centre at any time.

### Nutrition Counselling

Individual diet counselling should cover eating habits, daily rhythm, body weight and socio-cultural religious status to achieve the following **therapy objectives**:

- ▶ Pregnancy specific blood glucose target levels without ketosis or hyperglycaemia.
- ▶ Weight increase recommended for the mother.
- ▶ Normal growth of the fetus.

Recommended distribution of nutrients:

- ▶ Carbohydrates: 40 – 50 %
- ▶ Protein: 20 – 25 %
- ▶ Fat: 30 – 35 %

Limiting carbohydrates to 40 – 45 % of daily energy calories reduces postprandial blood glucose levels. However, the carbohydrate portion should not fall below 40%. The patient should refrain from eating quickly resorbable carbohydrates with high glycaemic index (GI). Food with roughly 30 g/day of fibre in the form of grains, fruit and vegetables is favourable. Carbohydrate intake should be spread over three meals that are not very large as well as two or three snacks because this might help the patient to avoid insulin therapy.

15 – 30 g of carbohydrates (1.5 – 3.0 KE) are recommended for breakfast (greatest increase in blood glucose). A carbohydrate rich late meal prevents an overshoot of ketone body formation during the night. Obese patients should prefer low fat food in their protein intake of up to 25 % of total daily energy.

One must also ensure sufficient intake of vitamins and minerals (folic acid, vitamin B complex, calcium, vitamin D, magnesium, iron, and iodine). Energy free sweeteners (e.g. aspartame) may be used during pregnancy within the limits of the acceptable daily doses. The recommended calorie intake is based on pre-conceptual BMI, weight gain during pregnancy and physical activity. The daily calorie requirements per kg of body weight are:

- ▶ Underweight: BMI under 18.5 ~ 35 – 40 kcal/kg
- ▶ Normal: BMI 18.5 – 24.9 ~ 30 – 34 kcal/kg
- ▶ Overweight: BMI 25.0 – 29.9 ~ 25 – 29 kcal/kg
- ▶ Obese: BMI 30.0 + at most 24 kcal/kg

In cases of obesity, calorie reduction of 30 – 33 % of daily energy requirements improves the blood glucose levels without increasing free fatty acids in plasma or inducing ketonemia. However, the level of calorie intake should not fall below 1600 – 1800 kcal/day, whereby minimum protein intake is 60 – 80 g/day. Urine monitoring is recommended if calorie intake is being reduced. Catabolic metabolism and fetal malnutrition must be avoided.

### Recommended Weight Gain

Weight gain is likewise based on pre-conceptual BMI. A weight loss of 1 – 2 kg in the first weeks after changing dietary habits can occur but is of no concern. Exceeding the stated weight limits increases the (statistical) rate of pregnancy complications, whereas falling below them increases the rate of IUGR. If the patient is obese, not achieving the minimum weight gain or even sustaining a slight loss does not have any disadvantages. The patients check their weight themselves at home once a week in the morning while naked and still fasting, and they document this.

### Education

The education for each patient depends on her therapeutic needs and individual requirements. Check that the educational materials reflect the current guidelines.

Components of education:

- ▶ Structured first consultation with information and counselling, when the diagnosis has been made.
- ▶ Introduction on blood glucose self monitoring.
- ▶ Nutrition education: preparation of an individual written BE (or KE) plan, BE (or KE) training, check of the prescribed dietary measures with possible adjustments (e.g. by means of a nutrition log).
- ▶ Education about physical activity, abstinence from nicotine and general life style.

- ▶ Weekly self measure of body weight at home, in the morning while naked and still fasting, and with documentation.
- ▶ Information on locally available exercise and physical activity programmes (e. g. clinics, sport clubs).
- ▶ Training of self administering of insulin therapy if necessary.
- ▶ Information about the follow-up care programme, beginning with an OGTT 6-12 weeks postpartum.

## Pharmacotherapy

### Insulin Therapy

If the metabolic objectives cannot be reached, insulin therapy should be initiated. Some 20% of patients with GDM need insulin. The indication for insulin is first established within 2 weeks after basic therapy begins (diet control, physical activity). This determination is based on blood glucose self monitoring, and the biometric data of the fetus and the mother. If no ultrasound measurements of the fetus are available, insulin therapy is begun if 50% or more of the levels of the 4-point schedules lie above the target levels in **Table 4** within any one week.

Proper implementation of diet control should be checked again before insulin therapy is begun. Insulin therapy might be considered at once if the fasting glucose level lies at or above 110 mg/dL (6.1 mmol/L). Insulin therapy should generally begin on an out-patient basis. The recommended insulin strategy is ICT with initial insulin daily dose of 0.5 units human insulin per kg of current body weight. NPH insulin is used as basic insulin. Insulin aspart/lispro are possible in cases of poor therapeutic response or hypoglycemia to other rapidly acting human insulins.

### Insulin Therapy and Fetal Growth (Ultrasound)

The effects of maternal hyperglycaemia on the fetus vary from case to case and are associated with different risks, depending on the fetus's growth pattern. Hence **when insulin therapy is indicated**, the growth of fetal abdominal circumference (AC) should be taken into account (modified glucose target levels concept).

Using the fetal growth pattern to modify the blood glucose target levels helps to avoid both over- and under-therapy. In cases of intrauterine fetal retardation (IUGR), the target is raised, but in cases of asymmetric macrosomia with fetal AC at or above percentile 75 the target is lowered. For this reason, the measured blood glucose levels for therapy control should be adjusted to the fetal growth parameters determined by ultrasound.

### Oral Hypoglycaemic Agents and GLP-1 Analogues

Oral hypoglycaemic agents and GLP-1 analogues should not be prescribed for pregnant women with GDM, given the lacks of official approval, experience and studies for most of these groups of preparations.

### Physical Activity, Sports

Regular physical activity/sports reduce the risk of GDM and improve the patient's resilience during pregnancy and birth. Sports can be continued during pregnancy, but individual consultation with the gynecologist is required and contraindications must be observed.

Both endurance and strength training of light to medium level may be taken up during pregnancy. The simplest type of physical activity without aids is rapid walking of at least 30 minutes duration 3 times a week or daily with an elastic band.

## Obstetric Care



### Fetal Monitoring

Fetal monitoring is dependent on the following additional risk factors and the severity of the mother's hyperglycaemia.

### Sonography

**Trimester 1** For patients with GDM in a previous pregnancy and missing postnatal glucose testing the option of an early risk assessment for congenital deformities in the context of a nuchal translucency scan during weeks 11 – 14 could be considered.

**Trimester 2** If GDM is diagnosed before Week 24 and there are additional risk factors (elevated HbA1c levels, obesity) there is an increased risk of malformations. A detailed anatomical ultrasound that meets the Stage II requirements of the German Society for Ultrasound in Medicine (DEGUM) is advisable for weeks 19 – 22.

**Trimester 3** A biometry (AC percentiles) is conducted at intervals of 3 weeks. Before delivery, it is advisable to estimate the fetus's weight and assess the relationship between its abdomen and head (fetal macrosomia is a risk factor for shoulder dystocia). Bear in mind that the accuracy of sonographically predicted weights is limited.

### Doppler Sonography

No indications in addition to the ones that apply to all pregnancies.

### Cardiotocography (CTG)

Diet controlled: CTG not indicated before the due date.

Insulin therapy: same as for pregnant women with diabetes diagnosed before conception.

### Prematurity (Induction of Fetal Lung Maturity, Tocolysis)

Betamethasone should be prescribed for inducing fetal lung maturity (before Week 34) only if strictly indicated because this will also cause the blood glucose levels to rise. When they do, adjust the insulin doses individually or, as applicable, commence insulin treatment if blood glucose levels rise to 200 mg/dL (11.1 mmol/L) or if hyperglycaemic symptoms appear.

Tocolytic therapy should preferably be applied with the oxytocin antagonist atosiban i. v. (therapy of choice) or with the oral calcium antagonist nifedipine (off label use). Beta mimetics should not be used since they may cause a rise of maternal blood glucose, which is already aggravated by bed rest.

### Birth Planning, Birth

#### Selection of hospital or clinic

Pregnant women with GDM are high-risk patients. In cases of GDM with insulin therapy, the patient should be delivered in a facility equipped with neonatal services (perinatal centre LEVEL 1 or 2) to ensure optimal primary care of the child. In cases of diet controlled GDM, the patient should be informed of the advantages of delivery in a facility with neonatal services.

### Induction of Labour (Application of prostaglandins)

Diet controlled GDM's may deliver post-dates if the fetal parameters are normal. Patients who are well controlled on insulin should probably be delivered by the due date. Poorly controlled GDM's using insulin require individual judgment. A routine, elective induction of labour in all pregnant women with GDM, say at Week 38, does not improve the outcome of the pregnancy for mother or child, nor does it change the risks.

During induction with prostaglandins, short-acting insulin should be used for better control and long-acting insulin dose should be reduced. Once labour is established, short-acting insulin is injected only after an immediately preceding blood glucose measurement.

### Cesarean Delivery

When estimated weight at birth is 4500 g or higher, there is a significant increase in the risk of shoulder dystocia, so a primary section must be considered.

When estimated weight at birth is 4000–4999 g, an informed consent about increased shoulder dystocia risk considering fetal biometry should be done, especially if there is a marked difference between head and abdomen size.

### Peripartum/Postpartum Periods

The blood glucose target in capillary plasma during birth lies between 80 and 130 mg/dL (4.4–7.2 mmol/L).

The blood glucose levels of mothers taking insulin should be measured every two hours initially, with this interval being adjusted as needed. In cases of GDM well controlled by diet, there is no need for routine maternal blood glucose checks during birth.

Insulin therapy is discontinued after birth. There should be a 4 point daily profile on day 2 after birth. If high values are repeated, inform the responsible diabetologist. Insulin is indicated after birth with blood glucose levels at 200 mg/dL (11.1 mmol/L) or higher and/or with occurrence of hyperglycaemic symptoms. Postpartal blood glucose checks are not necessary for mothers with good diet control, but the patient should still be emphatically reminded of the appointment for an OGTT 6 to 12 weeks after the birth.

### Breast Feeding

Mothers who have just had GDM tend to breast feed their babies for a shorter period of time than do mothers without diabetes. This applies most especially to obese mothers with GDM. Breast feeding for >3 month period of time might reduce overweight of the child later on. Hence mothers with GDM should be strongly encouraged to breast feed their babies. Obese women with GDM should be especially motivated and supported in breast feeding their baby. Recommendation: only breast feeding at least 3 months, followed by continued breast feeding together with introduction of food (consultation with the pediatrician).

### Follow-Up Care

#### Follow-Up Care of the Mother

##### Postpartum 75-g-OGTT

Glucose intolerance disappears after the pregnancy in most cases. Normal postpartum blood glucose levels 6–12 weeks after delivery: 75-g-OGTT, regardless of whether the baby is breast fed or not. The normal glucose levels in venous plasma are the same as for OGTT not related to pregnancy, namely:

- ▶ Normal: fasting < 100 mg/dL (5.6 mmol/L), 2 h after glucose load < 140 mg/dL (7.8 mmol/L).
- ▶ Diabetes: fasting  $\geq$  126 mg/dL (7.0 mmol/L) with second measurement required as confirmation, 2 h after glucose load  $\geq$  200 mg/dL (11.1 mmol/L), with one measurement sufficient.
- ▶ Impaired fasting glucose (IFG): 100–125 mg/dL (5.6–6.9 mmol/L).
- ▶ Impaired glucose tolerance (IGT): 140–199 mg/L (7.8–11.05 mmol/L).

Mere determination of the HbA1c value 6–12 weeks post partum is not recommended for diagnosis, nor is a fasting glucose measurement sufficient by itself.

In cases of impaired glucose tolerance, the patients must be advised to change their life style so that the risk of conversion to manifest diabetes will be reduced. Autoantibody screening is recommended for cases of increased risk for type 1 diabetes.

### Further Postpartum Checks

Since women with GDM are at increased risk to develop diabetes during the next 10 years they require continuous follow-up care. In cases of impaired glucose tolerance (IGT) and impaired fasting glucose (IFG) there should be a diabetes check-up once a year and in the other cases the checkup should be conducted every 2 or 3 years.

### Prevention of Diabetes

Modifying life style is regarded as the primary means of preventing diabetes. Women with impaired glucose tolerance after GDM benefit from life style changes for preventing diabetes and macroangiopathic complications. They are taught proper nutrition and advised to normalise body weight, stop smoking (as applicable), and engage in regular physical activity.

Moreover, women who are contemplating another pregnancy are informed of the contraindications for oral hypoglycaemic agents during the new pregnancy and of the risks in cases of unplanned pregnancy.

### Peripartum Depression

▼ The risk of postpartum depressions in women with GDM, especially in those from socially weak environments, is twice as high as this risk for all glucose tolerant pregnant women. The Edinburgh Postnatal Questionnaire is suitable as an instrument for screening for depression. Total scores of 10 or more are indicative of a depressive mood. This suspicion should be clarified by a specialist and appropriate therapy initiated. A suitable time for using this questionnaire is the OGTT appointment 6–12 weeks after the pregnancy.

### Perinatal Care and Follow-Up Care of the Child

▼ The guideline “Caring for the Newborns of Diabetic Mothers” published by the German Association of Scientific Medical Organisations (AWMF) in 2010 (No. 024/006), provides advice accordingly.

### Quality Assurance

▼ Quality assurance measures for diagnosis and therapy of gestational diabetes should be conducted (see the evidence based version of the guideline).

### List of Things to Do

▼ See ◉ **Table 6** for a summary overview of how to proceed with diagnosis, therapy and follow-on care.

## Affiliations

- <sup>1</sup> Diabetologikum Kiel, Diabetes-Schwerpunktpraxis und Schulungszentrum, Kiel
- <sup>2</sup> Berliner Diabeteszentrum für Schwangere, Klinik für Gynäkologie und Geburtshilfe, St. Joseph Krankenhaus, Berlin
- <sup>3</sup> Klinik für Neonatologie, Charité Universitätsmedizin, Berlin
- <sup>4</sup> Frauenklinik, Geburtshilfe und Schwangerschaftsmedizin, Universitätsspital Basel, Basel/CH
- <sup>5</sup> Klinik und Poliklinik für Frauenheilkunde und Geburtshilfe, Perinatalzentrum Klinikum Innenstadt LMU, München
- <sup>6</sup> Medizinische Universitätsklinik Wien, Klinik für Innere Medizin III, Abteilung für Endokrinologie u. Stoffwechsel, Gender Medicine Unit, Wien/A
- <sup>7</sup> Klinik für Stoffwechselkrankheiten, Universitätsklinikum Düsseldorf und Deutsches Diabetes-Zentrum, Düsseldorf
- <sup>8</sup> Klinik für Kinder- und Jugendmedizin, Krankenhaus im Friedrichshain, Berlin
- <sup>9</sup> Klinik für Geburtshilfe und Pränatalmedizin, Universitätsklinikum Hamburg-Eppendorf, Hamburg
- <sup>10</sup> Medizinische Poliklinik, Universitätsklinikum Bonn, Bonn

## Acknowledgments



We thank Prof. Dr. Theodor Koschinsky, Munich, for his intensive advice and appraisals of all questions respecting glucose measurements in laboratories. We also thank Dr. Heinke ADamczewski, who has a diabetes specialist practice in Köln and is a board member of the DDG study group for diabetes and pregnancy, for her design of the GDM page for inclusion in the mother “passport”.

## Annex

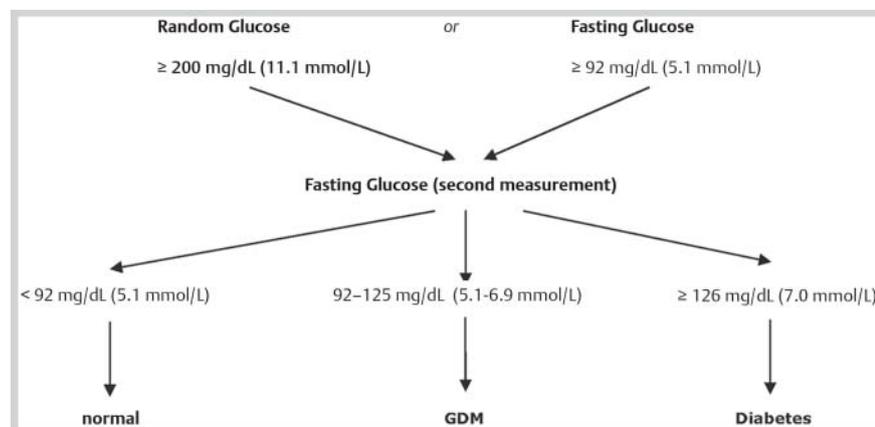


Pregnancy 1	Pregnancy 2	Pregnancy 3
GDM	40 %	-
GDM	no GDM	20 %
no GDM	GDM	~ 50 %
GDM	GDM	~ 50 %

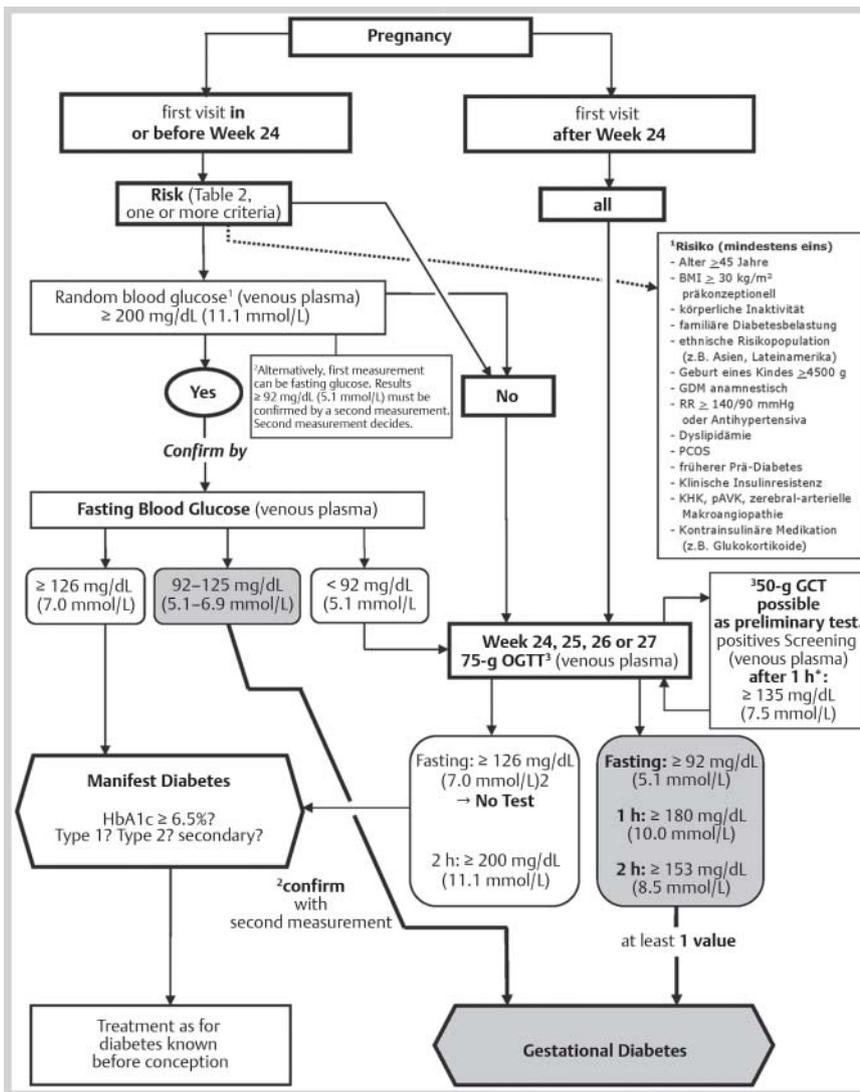
**Table 1** Risk of recurrent GDM for women of European origin in pregnancies 2 and 3 depending on the presence or absence of GDM in the previous pregnancies.

- Age  $\geq$  45 years
- BMI  $\geq$  30 kg / m<sup>2</sup> before conception
- Physical inactivity
- Parents or siblings with diabetes
- Members of an ethnic risk population (e. g. Asians, Latin Americans)
- Birth of a child  $\geq$  4500 g
- GDM in patient's history
- Arterial hypertension (blood pressure > 140 / 90 mmHg) or intake of medications for arterial hypertension
- Dyslipidemia before conc. (HDL < 35 mg/dL [0.9 mmol/L] or triglycerides > 250 mg/dL [2.82 mmol/L])
- Polycystic ovary syndrome
- Pre-diabetes (IGT/IFG/HbA1c  $\geq$  5.7 %) in an earlier test (independently of earlier GDM)
- Other clinical conditions associated with insulin resistance (e. g. acanthosis nigricans)
- History of coronary artery disease, PAOD, cerebral vascular disease
- Intake of anti-insulin medications (e. g. glucocorticoides)

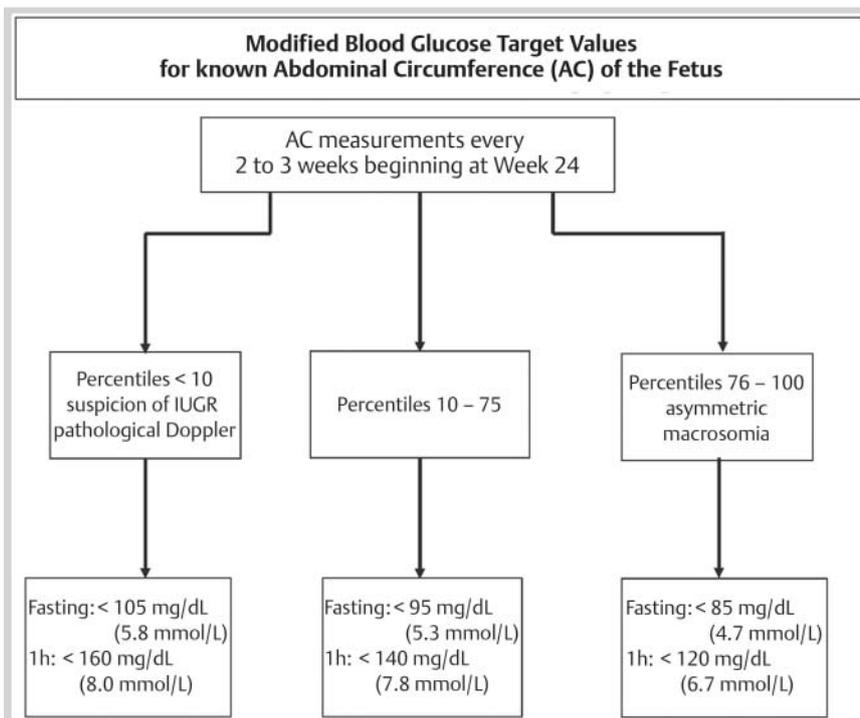
**Table 2** Risk score for manifest diabetes at first visit in pregnancy.



**Fig. 1** Diagnostic categories of plasma fasting glucose determined before 24 weeks of gestation in high risk women for diabetes when random or fasting glucose was elevated in early screening.



**Fig. 2** Screening and diagnosis algorithm for manifest and gestational diabetes. \*Preliminary test result  $\geq 201$  mg/dL (11.1 mmol/L) is assessed as GDM.



**Fig. 3** Modified target values for maternal blood glucose values during insulin therapy when fetal abdominal circumference is taken into account. Insulin therapy is indicated only if the blood glucose values lie outside the target range without insulin therapy.

Week 24, 25, 26 or 27	GDM diagnostic criteria in venous plasma	
Time	mg/dL	mmol/L
Fasting	≥ 92	≥ 5.1
After 1 hour	≥ 180	≥ 10.0
After 2 hours	≥ 153	≥ 8.5

**Table 3** Abnormal values for GDM in venous plasma (recommendations of the IADPSG Consensus Panel).

Time	Plasma equivalent	
	mg/dL	mmol/L
Fasting, preprandial	65 – 95	3.6 – 5.3
1 h postprandial	< 140	< 7.8
2 h postprandial	< 120	< 6.7
Median blood glucose, <i>measurements 1 h postprandial</i>	90 – 110	5.0 – 6.1
Median blood glucose, <i>measurements 2 h postprandial</i>	80 – 100	4.4 – 5.6

**Table 4** Blood glucose target levels for self measurements (plasma calibrated devices).

Preconception BMI kg/m <sup>2</sup> (WHO)	Total weight gain during pregnancy kg	Weight gain/week trimesters 2 and 3 <sup>1</sup> kg/wk
BMI < 18.5	12.5 – 18	0.5 – 0.6
18.5 ≤ BMI < 24.9	11.5 – 16	0.4 – 0.5
25.0 ≤ BMI < 29.9	7 – 11.5	0.2 – 0.3
30.0 ≤ BMI	5 – 9	0.2 – 0.3

**Table 5** Recommended range of weight gain during pregnancy (most recent recommendations of the Institute of Medicine (IOM)).

<sup>1</sup> assuming weight gain of 0.5 – 2 kg in Trimester 1

**Table 6** Checklist for initial diagnosis of hyperglycaemia during pregnancy.

Time/event	What to do
First visit during pregnancy before Week 24	risk analysis for pre-pregnancy diabetes as per risk list
Risk present	venous plasma glucose measurement: random or fasting
Random or fasting measurement out of range?	second venous fasting plasma glucose measurement
Manifest diabetes	immediate referral to a diabetologist
First visit during pregnancy after Week 24	75-g-OGTT (venous plasma glucose)
Week 24 to Week 28 (inclusive)	75-g-OGTT (venous plasma glucose) for all patients for whom no risk was identified at the first visit or blood glucose value was in range
GDM diagnosis	at least 1 value achieved or exceeded (fasting, 1 h, or 2 h) mg/dL: 92/180/153 mmol/L: 5.1/10.0/89.5
OGTT: fasting glucose $\geq 126$ mg/dL (7.0 mmol/L)	no glucose load, second measurement $\rightarrow$ if confirmed, refer to diabetologist
OGTT: 2 h value $\geq 200$ mg/dL (11.1 mmol/L)	diabetes $\rightarrow$ refer to a diabetologist
Confirmed GDM diagnosis	initial medical consultation instruction/education: blood glucose self-management (state target values) diet consultation (ascertain calories needed, set carb units and distribution) set target values for weight development (IOM Guideline) education: diet, activity, ketone monitoring, life style, abstinence from nicotine
Within 2 weeks after GDM diagnosis	fetal biometry (abdominal circumference – AC), relate abdominal and head circumferences to each other
Ultrasound: AC > percentile 75	asymmetric growth $\rightarrow$ adjust target values symmetric growth $\rightarrow$ leave target values unchanged
Ultrasound: AC < percentile 10	IUGR identified $\rightarrow$ increase target values
Modified target values concept: fetal growth pattern known	blood glucose above targets: start insulin therapy (education) blood glucose at or below targets: continue diet control
$\geq 50\%$ blood glucose target values increased in one week	AC not available: start insulin therapy (education) AC available: asymmetric growth $\rightarrow$ decrease target values symmetric growth $\rightarrow$ leave target values unchanged IUGR identified $\rightarrow$ increase target values
Every 3 weeks	fetal biometry (AC) adjusting therapy as necessary
Premature labour	obstetric diagnosis possibly admission as in-patient, bed rest, tocolytics: p. o. nifedipine (off label), i. v. atosiban
Impending premature birth before Week 34	induction of fetal lung maturity ( $2 \times 12$ mg betamethasone every 24 hours) tight metabolic monitoring
Preeclampsia look out for HELLP syndrome	def. from Week 20 BP $\geq 140/90$ mmHg + proteinuria $\geq 300$ mg/day (alternatively: urine protein Sticks at least ++ for two times) admit as in-patient to perinatal centre, blood pressure reduction if BP $\geq 160/100$ mmHg
Delivery clinic	first visit: in Week 36 at latest insulin: perinatal centre level 2 or 1 diet control: inform patient of advantages of clinic with neonatal service
CTG	diet control: not until the due date insulin: from Week 32 (individualize)
Induction of Labour	diet control: delivery after due date permissible insulin: induction of labour to be considered on due date with high risks, consider induction of labour as early as Week 38 on individual basis
Cesarean section	only if indicated obstetrically
Newborn	first breast feeding 30 minutes after birth first blood glucose 2 hours post-partum see guideline 024/006 of the German Association of Scientific Medical Organisations
Nursing	recommendation: mother's milk only for the first four months
6 – 12 weeks postpartum	75-g-OGTT (venous plasma) BMI < 30 kg/m <sup>2</sup> + insulin therapy: check for anti-GAD + AntiIA <sub>2</sub> antibodies depression screening: EPDS questionnaire (score $\geq 10$ $\rightarrow$ psychiatric assessment)
Postpartum glucose metabolism	glucose tolerance disorder: life style counselling/intervention diabetes: guidelines oriented therapy normal: checkups every 1 to 3 years, depending on the risks
Desire to have another child	planning of pregnancy oral. 0.4 – 0.8 mg folic acid 4 weeks before planned conception
Documentation	basic data, course of pregnancy and result of mother and child