Current Trends in DIABETES

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Diagnosis of Diabetes: A Reality Check

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ABSTRACT

This chapter discusses about diagnosis of diabetes. Over the years, blood glucose has remained the primary diagnostic criteria for diabetes and, in recent times, glycosylated hemoglobin (HbA1c) is also a standard test for diagnosis in clinical practice. The HbA1c has advantages in terms of detecting chronic hyperglycemia, which correlates well with the complications associated with diabetes. Also, it can be performed any time of the day without any relation to fasting or postprandial state unlike plasma glucose. Recommendation of the International Expert Committee for the diagnosis of diabetes has been listed in this chapter. Gestational diabetes mellitus (GDM) is defined as "any degree of glucose intolerance with onset or first recognition during pregnancy." Detection and diagnosis of GDM and Hyperglycemia and Adverse Pregnancy Outcomes (HAPO) study are also covered in this chapter.

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder affecting millions of people all over the world. It is associated with long-term complications (microvascular and macrovascular). These complications have detrimental effect on the mortality and morbidity of the subjects. An early diagnosis has a positive impact on reducing and even preventing the dreaded complications by institution of the necessary lifestyle modifications and treatment leading to improvement in the quality of life and reduction in the mortality outcomes and reduces the economic burden of the individual as well as the state. At the same time, it is imperative that diagnosis of diabetes must be done according to universally accepted guidelines.

Prior to 1997, at least six different criteria were being used for the diagnosis of diabetes.[1] In 1979, the National Diabetes Data Group (NDDG) resolved this and gave one set of criteria based on the development of diabetic complications.[2] They gave the fasting criteria as >140 mg/dL and postprandial plasma glucose of >200 mg/dL. After the NDDG data was released, the expert committee met in the mid-1990s and brought out the criteria for diagnosis of diabetes, defined by the American Diabetes Association (ADA) and the World Health Organization (WHO) as a fasting blood glucose level of ≥126 mg/dL (7 mmol/L) or more or a 2-hour blood glucose level of ≥200 mg/dL (11.1 mmol/L) or more during an oral glucose tolerance test (OGTT) conducted with a standard loading dose of 75 g.[3,4] These recommendations also considered the symptoms associated with uncontrolled hyperglycemia. The fasting plasma glucose (FPG) concentration that gave a prevalence of diabetes equivalent to the 2-hour value of ≥200 mg/dL on an OGTT

was ~126 mg/dL (7.0 mmol/L). These were based on three prospective studies that showed increased risk of development of retinopathy at higher cut offs at 140 mg/dL fasting. The above criteria were based on the lowest deciles of risk of developing diabetic retinopathy.[5-7] Actually, the mean or the median values of the decile that represent the risk of developing retinopathy were found to be at levels of FPG 167 mg/dL, 155 mg/dL, and 165 mg/dL; 2-hour glucose 298 mg/dL, 252 mg/dL, and 292 mg/dL; and glycosylated hemoglobin (HbA1c) 7.8, 7.5, and 7.4%, respectively.[8]

Currently, blood/plasma glucose estimation and oral glucose tolerance test (OGTT) remain the standard practice for a definitive diagnosis of diabetes. American Diabetes Association (ADA) criteria is widely accepted in many countries[15] (**Box 1**).

Considering that the diagnostic criteria are based on the risk of developing retinopathy, the HbA1c correlates well with the risk of development of microvascular complications. The results of five longitudinal studies in over 2,000 diabetic patients followed from 4 to 9 years supported the concept demonstrating little development or progression of diabetic retinopathy or nephropathy, if the average HbA1c levels were maintained between 6 and 7% and none, if they were kept in the normal range below 6%.[8,9-11] A study by Colagiuri, the DETECT 2 was included in the 1997 report.

The study (DETECT-2) examined the association between HbA1c and retinopathy (objectively assessed and graded by fundus photography).[12] About 28,000 subjects from nine countries were included and showed that the glycemic level at which the prevalence of "any" (any retinopathy includes minor changes that can be due to other conditions, such as hypertension retinopathy), and for the more diabetes-specific "moderate" retinopathy, was 6.5%. Among the 20,000 subjects who had HbA1c values of 6.5%, "moderate" retinopathy was virtually not seen. The receiver operating characteristic curve analysis of the same data indicated that the optimal cut-point for detecting at least moderate retinopathy was an HbA1c of 6.5%.[13,14] This cut-off point is not an absolute divider for the risk of development of diabetic retinopathy but a continuum for development of long-term complications.

The HbA1c as a criterion for diagnosing diabetes in nonpregnant adults was recommended by an International Expert Committee with members appointed by the ADA, the European Association for the Study of Diabetes, and the International Diabetes Federation in 2008.[13]

RECOMMENDATION OF THE INTERNATIONAL EXPERT COMMITTEE (2008) FOR THE DIAGNOSIS OF DIABETES[13]

- The HbA1c assay is an accurate and precise measure of chronic glycemic levels and correlates well with the risk of diabetes complications.
- The HbA1c assay has many advantages over laboratory measures of glucose.
- Diabetes should be diagnosed when HbA1c is >6.5%. Diagnosis should be confirmed with a repeat HbA1c test. Confirmation is not required in symptomatic subjects

BOX 1 **Current American Diabetes Association (ADA) criteria for the diagnosis of diabetes.[15]**

- FPG ≥126 mg/dL (7.0 mmol/L). Fasting is defined as no caloric intake for at least 8 hours

OR

- 2-hour PG ≥200 mg/dL (11.1 mmol/L) during OGTT. The test should be performed as described by the WHO, using a glucose load containing the equivalent of 75-g anhydrous glucose dissolved in water*

OR

- HbA1c ≥6.5% (48 mmol/mol). The test should be performed in a laboratory using a method that is NGSP certified and standardized to the DCCT assay

OR

- In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma glucose ≥200 mg/dL (11.1 mmol/L)

*In the absence of unequivocal hyperglycemia, results should be confirmed by repeat testing.

(DCCT: Diabetes Control and Complications Trial; FPG: fasting plasma glucose; PG: plasma glucose; NGSP: National Glycohemoglobin Standardization Program; OGTT: oral glucose tolerance test)

with plasma glucose levels 200 mg/dL (11.1 mmol/L).
- If HbA1c testing is not possible, previously recommended diagnostic methods (e.g., FPG or 2-hour plasma glucose (PG), with confirmation) are acceptable.
- The HbA1c testing is indicated in children in whom diabetes is suspected but the classic symptoms and a casual plasma glucose 200 mg/dL (11.1 mmol/L) are not found. For the identification of those who are at high risk for diabetes.
- Risk for diabetes based on the levels of glycemia is a continuum; therefore, there is no lower glycemic threshold at which risk clearly begins.
- Categorical clinical states namely prediabetes, impaired fasting glucose (IFG), and impaired glucose tolerance (IGT) fail to capture the continuum of risk and will be phased out of use as HbA1c measurements replace glucose measurements.
- As for the diagnosis of diabetes, the HbA1c assay has several advantages over laboratory measures of plasma glucose in identifying individuals at high risk for developing diabetes.
- Those with HbA1c levels below the threshold for diabetes but above 6.0% should receive effective preventive strategies. Those with HbA1c below this range may still be at risk and, in the presence of other diabetes risk factors, may also benefit from prevention efforts.
- The HbA1c level at which population-based prevention services begin should be based on the nature of the intervention, the resources available, and the size of the affected population.

Signs and symptoms depend on the level of hyperglycemia: Milder levels of hyperglycemia may be asymptomatic. Moderate to severe hyperglycemia may present with the following:
- Increased thirst
- Frequent urination
- Extreme hunger
- Unexplained weight loss
- Fatigue
- Irritability
- Blurred vision
- Slow-healing ulcers
- Frequent infections, such as gums or skin infections, and vaginal infections
- Presence of ketones in the urine
- Acanthosis nigricans in the neck and axilla

CATEGORIES OF INCREASED RISK FOR DIABETES*[15]

- Fasting plasma glucose 100 mg/dL (5.6 mmol/L) to 125 mg/dL (6.9 mmol/L): IFG
- 2-hour plasma glucose (PG) in the 75-g OGTT 140 mg/dL (7.8 mmol/L) to 199 mg/dL (11.0 mmol/L): IGT
- HbA1c 5.7–6.4%

*Termed Prediabetes

For all three tests, risk is continuous, extending from the lower limit of the range and becoming disproportionately greater at higher ends of the range.

The World Health Organization (WHO) expert committee met in March, 2009 and concluded that HbA1c can be used as a diagnostic test for diabetes, provided that stringent quality assurance tests are in place and assays are standardized to criteria aligned to the international reference values, and there are no conditions present, which preclude its accurate measurement.[16]

An HbA1c of 6.5% is recommended as the cut point for diagnosing diabetes. A value <6.5% does not exclude diabetes diagnosed using glucose tests. The expert group concluded that there is currently insufficient evidence to make any formal recommendation on the interpretation of HbA1c levels below 6.5%. Due consideration should be given to the interference of the HbA1c assay.

Some of the factors that influence HbA1c and its measurement* (Adapted from Gallagher et al.):[17]
- *Erythropoiesis increased HbA1c*: Iron, vitamin B12 deficiency, and decreased erythro-

* Some of the above interfering factors are "invisible" in certain of the available assays.

poiesis. *Decreased HbA1c*: Administration of erythropoietin, iron, vitamin B12, reticulocytosis, and chronic liver disease.

- *Altered hemoglobin genetic or chemical alterations in hemoglobin*: Hemoglobinopathies, HbF, methemoglobin may increase or decrease HbA1c.
- *Glycation increased HbA1c*: Alcoholism, chronic renal failure, and decreased intraerythrocyte pH.
  - *Decreased HbA1c*: Aspirin, vitamin C and E, certain hemoglobinopathies, and increased intraerythrocyte pH.
  - *Variable HbA1c*: Genetic determinants.
  - *Erythrocyte destruction increased HbA1c*: Increased erythrocyte lifespan: Splenectomy.
  - *Decreased HbA1c*: Decreased erythrocyte lifespan: Hemoglobinopathies, splenomegaly, rheumatoid arthritis, or drugs such as antiretroviral, ribavirin, and dapsone.
- *Assays increased HbA1c*: Hyperbilirubinemias, carbamylated hemoglobin, alcoholism, large doses of aspirin, and chronic opiate use.
  - *Variable HbA1c*: Hemoglobinopathies.
  - *Decreased HbA1c*: Hypertriglyceridemia.

There are advantages and disadvantages of using HbA1c versus plasma glucose levels as highlighted in the **Tables 1** and **2**.

GESTATIONAL DIABETES MELLITUS

Definition

Gestational diabetes mellitus (GDM) is defined as "any degree of glucose intolerance with onset or first recognition during pregnancy".[18] The definition applies whether insulin or only diet modification is used for treatment and whether or not the condition persists after pregnancy. It does not exclude the possibility that unrecognized glucose intolerance may have antedated or begun concomitantly with the pregnancy.

According to the International Diabetes Federation (IDF) statistics from the year 2017:[19]

- *21.3 million or 16.2% of live births* had some form of hyperglycemia in pregnancy. An estimated 85.1% were due to gestational diabetes.
- *One in seven births* was affected by gestational diabetes.
- The vast majority of cases of hyperglycemia in pregnancy are in *low- and middle-income countries*, where access to maternal care is often limited.

In 1952, Pedersen[20] postulated that maternal hyperglycemia was transmitted to the fetus, which, in turn, produced and released large amounts of insulin, with the resultant fetal hyperinsulinemia being the cause of various aspects of diabetic fetopathy, including deposition of

TABLE 1: Advantages and disadvantages of various glycosylated hemoglobin (HbA1c) assay methods.

Assay principle	Principle	Advantages	Disadvantages
Ion exchange chromatography	HbA1c has lower isoelectric point and migrates faster than other Hb components	• Can inspect chromograms for Hb variants • Measurements with great precision	Variable interference from hemoglobinopathies, HbF, and carbamylated Hb, but the current ion exchange assays correct for HbF and carbamylated Hb does not interfere
Boronate affinity	Glucose binds to m-Aminophenylboronic acid	Minimal interference from hemoglobinopathies, HbF, and carbamylated Hb	Measures not only glycation of N-terminal valine on β-chain, but also β-chains glycated at other sites and glycated α-chains
Immunoassays	Antibody binds to glucose and between 4–10 N-terminal amino acids on β-chain	• Not affected by HbE, HbD, or carbamylated Hb • Relatively easy to implement under many different formats	May be affected by hemoglobinopathies with altered amino acids on binding sites. Some interference with HbF

TABLE 2: Advantages and disadvantages of assays for glucose and glycosylated hemoglobin (HbA1c).

	Glucose	HbA1c
Patient preparation prior to collection of blood	Stringent requirements, if measured for diagnostic purpose	None
Processing of blood	• Stringent requirements for rapid processing • Separation and storage of plasma or serum minimally at 4°C	Avoid conditions for >12 hours at temperatures >23°C, otherwise keep at 4°C
Measurement	Widely available	Not readily available worldwide
Standardization	Standardized to reference method procedures	Standardized to reference method procedures
Routine calibration	Adequate	Adequate
Illness interference	Severe illness may increase glucose concentration	Severe illness may shorten red cell life and artifactually reduce HbA1c values
Hemoglobinopathies	Little problem unless the patient is ill	May interfere with measurement in some assays
Hemoglobinopathy traits	No interference	Most assays are not affected
Affordability	Affordable in most low- and middle-income countries	Unaffordable in most low- and middle-income countries

large amounts of body fat, which gave the infant its characteristic appearance fetal macrosomia. Pedersen documented increased body weight in infants of diabetic mothers compared with control subjects.

Detection and Diagnosis

The first antenatal visit must screen for high-risk factors for the development of GDM. Women with the clinical characteristics consistent with a high risk of GDM are marked obesity, personal history of GDM, glycosuria, or a strong family history of diabetes. These women should undergo glucose testing as early as feasible. If not found to have GDM at initial screening, they should be retested between 24 and 28 weeks of gestation.

Women of in-between risk profiles should undergo testing at 24–28 weeks of gestation.

Women with low risk requires no glucose testing, but this category is limited to those women meeting all of the following characteristics: Age <25 years, normal weight before pregnancy, belonging to an ethnic group with a low prevalence of GDM, no known diabetes in first-degree relatives, no history of abnormal glucose tolerance, and no history of poor obstetric outcome.[21]

O'Sullivan and Mahan were the first to propose the diagnostic criteria in the year 1964, during a 3-hour OGTT[22] using whole blood assay. Glucose levels of 90 mg/dL, 165 mg/dL, 145 mg/dL, and 125 mg/dL (for fasting, 1-hour, 2-hour, and 3-hour postglucose load, respectively) were proposed as diagnostic thresholds for GDM. In 1979, the NDDG suggested measuring plasma instead of whole blood glucose and set new threshold values (105 mg/dL, 190 mg/dL, 165 mg/dL, and 145 mg/dL).[2] In 1982, Carpenter and Coustan proposed changing the values to 95 mg/dL, 180 mg/dL, 155 mg/dL, and 140 mg/dL. According to the NDDG and Carpenter and Coustan criteria, the diagnosis of GDM is established, if two or more glucose values are higher than the defined cutoffs during a 3-hour OGTT.[23]

In 1989, Sacks et al. proposed the more inclusive criteria of 96 mg/dL, 172 mg/dL, 152, and 131 mg/dL, after calculating glucose concentrations in paired whole blood and plasma specimens of 995 consecutive pregnant women.[24]

The diagnostic thresholds mentioned in all the above were based on data from women who were diagnosed with diabetes after gestation and not on any short-term adverse pregnancy outcomes. In 2010, the International Association

of Diabetes and Pregnancy Groups (IADPSG) proposed a new set of criteria, based on the incidence of adverse perinatal outcomes, as assessed in the Hyperglycemia and Adverse Pregnancy Outcomes (HAPO) study.[25,26] The diagnosis of GDM is made, if at least one value of plasma glucose concentration is equal to or exceeds the thresholds of 92 mg/dL, 180 mg/dL, and 153 mg/dL (for fasting, 1-hour, and 2-hour postglucose load glucose values respectively), after performing a 75-g OGTT.[27]

THE HYPERGLYCEMIA AND ADVERSE PREGNANCY OUTCOMES STUDY[28]

It is a large multinational prospective study, which included 25,505 women in the third trimester of gestation. The subjects underwent a 2-hour OGTT with 75 g of glucose between 24 and 32 weeks of gestation and their glycemia levels were investigated in relation to predefined adverse pregnancy outcomes. The four predefined primary outcomes were—primary cesarean section delivery, clinical neonatal hypoglycemia, birth weight, and cord serum C-peptide above the 90th percentile. Premature delivery, shoulder dystocia or birth injury, intensive neonatal care, hyperbilirubinemia, and preeclampsia were chosen as secondary outcomes. In respect to secondary outcomes, glucose levels were analyzed only as a continuous variable. For the primary outcomes, glucose concentration was also analyzed as a categorical variable, after stratifying the women into seven categories according to the glucose values obtained during the 2-hour OGTT.

The frequency of the primary outcomes increased in parallel with increasing maternal glucose levels and odds ratios (ORs) were calculated for all seven glycemia categories, using as reference (OR = 1). The ORs increased across the categories of maternal glycemia and these results were statistically significant for all primary outcomes, with the exception of neonatal hypoglycemia. Similarly, when glucose concentration was analyzed as a continuous variable, a continuous association of maternal glucose with primary and secondary outcomes was observed. Notably, these associations were detected even for low-glucose levels and did not differ among the 15 centers in nine countries that participated in the study.[28]

Even though the HAPO study indicated the need to revise the diagnostic criteria of GDM, it did not deduce any threshold glucose values that can be used in clinical practice. Therefore, even after completion of the study, screening and diagnostic methods of GDM still differ among various associations and organizations.

American diabetes Association recommends either a one-step or a two-step strategy.[15]

One-step strategy: The OGTT is performed with 75 g of glucose in women at 24 28 weeks of pregnancy after an overnight fast of minimum 8 hours.

The diagnosis of GDM is made with any one of the following plasma glucose values are met or exceeded:

- *Fasting*: >92 mg/dL (5.1 mmol/L).
- *1-hour postglucose challenge*: 180 mg/dL (10.0 mmol/L).
- *2-hour postglucose challenge*: >153 mg/dL (8.5 mmol/L).

Two-step strategy:

- *First step*: Screening with a 50-g oral glucose (nonfasting) challenge. If the plasma glucose level after 1-hour is >130 mg/dL, 135 mg/dL, or 140 mg/dL (7.2 mmol/L, 7.5 mmol/L, or 7.8 mmol/L, respectively), proceed to second step. These are the commonly used threshold values as recommended by the International Committee of Obstetrics and Gynecology (ICOG).[29]
- *Second step*: On positive screening with the above test, proceed to a 100-g OGTT.

The diagnosis of GDM is made when at least two of the four plasma glucose criteria match either the Carpenter-Coustan or NDDG criteria. The different diagnostic criteria identify different degrees of hyperglycemia in gestation with its effect on the maternal and fetal outcomes. Also, the limited resources in some countries may not be able to identify these women at risk and to improve the outcomes for the mother and child.

The one-step strategy defined by IADPSG diagnostic cut points for GDM as the average fasting, 1-hour, and 2-hour PG values during a 75-g OGTT is shown in the **Table 3**. A single parameter above the cut off is sufficient to

diagnose GDM. This increases the frequencies of women with GDM. This can lead a substantial burden on the costs on the healthcare system as well as the individual. This could pave the way for medicalizing the pregnancies. However, these criteria used by IADPSG were based on studies that led to better outcomes by reducing the number of preeclampsia and large for gestational births.[25]

The American Council of Obstetricians and Gynecologists (ACOG) recommends either of two sets of diagnostic thresholds for the 3-hour 100-g OGTT[30] that is either the Carpenter and Coustan criteria or NDDG criteria with only one raise in the cut off value instead of using two of the cutoff values.[2,23]

The National Institutes of Health (NIH), in 2013, convened a consensus development conference to consider diagnostic criteria for diagnosing GDM. They found that the one-step approach increased the medicalization of pregnancies and felt that the two-step approach

TABLE 3: Criteria from different organizations and from different global regions.

		Year	Plasma glucose concentration (mg/dL)			
Organization	OGTT Glucose load		Fasting mmol/L mg/dL	1-hour	2-hour	3- hour
NDDG		1979	5.8 mmol 105 mg/dL	10.5 mmol/L 189.2 mg/dL	9.2 mmol/L 165.7 mg/dL	8 mmol/L 144 mg/dL
Carpenter and Coustan*	100 g	1982	5.3 mmol/L 95 mg/dL	10.0 mmol/L 180 mg/dL	8.6 mmol/L 155 mg/dL	7.8 mmol/L 140 mg/dL
ADA[15]*	100 g		5.3 mmol/L 95 mg/dL	10.0 mmol/L 180 mg/dL	8.5 mmol/L 153 mg/dL	7.8 mmol/L 140 mg/dL
ACOG[29]*	100 g		5.3 mmol/L 95 mg/dL	10.0 mmol/L 180 mg/dL	8.5 mmol/L 153 mg/dL	7.8 mmol/L 140 mg/dL
WHO[31]§	75 g	2016-Revised 2013	5.1 mmol/L 92 mg/dL	10.0 mmol/L 180 mg/dL	7.8 mmol/L 140 mg/dL	
IADPSG[25]§	75 g	2010	5.1 mmol/L 92 mg/dL	10 mmol/L 180 mg/dL	8.5 mmol/L 153 mg/dL	
DIPSI (INDIA)[32]	75 g (either fasting or non-fasting)	2009	–	–	7.8 mmol/L 140 mg/dL	
NICE (UK)[34]	75 g	2015	5.6 mmol/L 100 mg/dL	–	7.8 mmol/L Or 140 mg/dL	
JDS	75 g	2013	5.1 mmol/L 92 mg/dL	10.0 mmol/L 180 mg/dL	8.5 mmol/L 153 mg/dL	7.8 mmol/L 140 mg/dL
ADIPS[33]§	75 g	2014	5.1 mmol/L 92 mg/dL	10.0 mmol/L 180 mg/dL	8.5 mmol/L 153 mg/dL	

Note:
*Diagnosis of GDM if two or more glucose values equal to or exceeding the threshold values.
§Diagnosis of GDM if one or more glucose values equal to or exceeding the threshold values GDM.

(OGTT: oral glucose tolerance test; ADA: American Diabetes Association; ACOG: American Council of Obstetricians and Gynecologists; WHO: World Health Organization; IADPSG: International Association of Diabetes and Pregnancy Groups; DIPSI: Diabetes in Pregnancy Study Group in India; ADIPS: Australian Diabetes in Pregnancy Society; JDS: Japanese Diabetes Society; NICE: National Institute for Clinical Excellence; NDDG: National Diabetes Data Group)

was better in identifying those pregnancies, which could have increased risk of preeclampsia, large for age babies, and shoulder dystocia. Also, this approach could prevent the risk for small for date births.[35]

In India, the DIPSI guidelines for diagnosing GDM is accepted, which is easy to perform. A 75-g oral glucose challenge (either in fasting or nonfasting state) and a 2-hour PG level of >140 mg/dL is accepted as diagnostic criteria. This strategy is irrespective of the gestational age. The blood sugar can be done with a calibrated standardized glucometer as provided by the state in limited resources. With this screening procedure, those unable to perform this test due to vomiting or other high-risk pregnancies should be referred to higher resource facility.[36]

CONCLUSION

Over the years, blood (of late, plasma) glucose has remained the primary diagnostic criteria for diabetes and in recent times; HbA1c is also a standard test for diagnosis in clinical practice. The HbA1c has advantages in terms of detecting chronic hyperglycemia, which correlates well with the complications associated with diabetes. Also, it can be performed any time of the day without any relation to fasting or postprandial state unlike plasma glucose. However, it may not be easily available in limited resources countries. Plasma glucose levels are easily available and can give accurate results in subjects with hemoglobinopathies. Development of a single simple test, which is easily available and performed at any time of the day with good sensitivity and specificity, is required to diagnose diabetes. Such a test may go a long way in early detection, diagnosis, and prevention of diabetes and help in drastic reduction of the mortality and morbidity.

EDITOR'S NOTE

With the prevalence of diabetes continuing on an upward trajectory worldwide and in India, healthcare professionals are advancing to search for more effective methods of preventing, detecting, and treating the disease. Prior to the year 1977, there were agreement and discrepancy in the evaluation of normal and diabetic individuals by oral glucose tolerance test. Citing this, Dr Shekar and Dr Lalitha summarize how diagnosis of diabetes has evolved over the period and reached a consensus through the guidelines of NDDG, ADA, WHO, and others. This review highlights the current ADA criteria for the diagnosis of diabetes, advantages, and disadvantages of glucose and HbA1c assays and provides an updated information on the diagnosis of GDM referring to international and national guidelines. As several new and non-invasive tests are also under evaluation, the diagnosis of diabetes may foresee the development of a single test that can be performed any time of the day with good specificity and sensitivity.

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Current Trends in DIABETES
Focus on South Asians

Salient Features

- A comprehensive monograph on the current issues in diabetes.
- A useful guide and reference book for students, healthcare providers, scientists, and clinicians.
- Covers all the recent research work and advances in diagnostic technologies for type 2 diabetes mellitus, particularly among South Asian population.
- Includes six major topics: Diagnosis and Classification, Epidemiology, Etiopathogenesis, Comorbidities and Clinical Complications, and Special Issues in Diabetes and recent advances and technologies in diabetes.
- Contains 34 chapters; all are written by expert authors from India and abroad.
- Detailed overview on advances in diagnostic technologies, genomics of diabetes, gestational diabetes, epigenetics of diabetic complications, diabetes and comorbid factors such as cardiovascular disease, kidney disease, Alzheimer's disease, and their management.
- The monograph highlights TM- Flow System, precision medicine, and contributions of various foundations like SASAT for creating awareness of cardiometabolic diseases in South Asians, Diabetes Clinic, KEM Hospital, Pune, for studies on Pune Maternal Nutrition Studies; Madras Diabetes Research Foundation (MDRF), Chennai, for CURES studies; and Karnataka Institue for Endocrinology and Research (KIER), Bengaluru, establishing a national-level state-of-the-art Diabetes Clinic.

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