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A REVIEW ON TYPES, DIAGNOSIS, AND TREATMENT MODALITIES OF DIABETES MELLITUS

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ABSTRACT

"Diabetes mellitus" is one of the most commn non-communicable diseases worldwide. India faces several challenges in diabetes management, including the rising prevalence in both urban and rural areas, lack of public awareness, limited healthcare facilities, high treatment costs, suboptimal glycaemic control, and an increasing rate of diabetic complications. The objective of this review is to provide a comprehensive overview of the role of lifestyle modifications in diabetes management, the standard medications currently used for treatment, and recent advancements in the development of novel therapeutic approaches that may serve as future interventions. A literature search was conducted using databases such as PubMed, Web of Science, Scopus, ScienceDirect, Wiley Online Library, and Google Scholar. Insulin therapy, the most common treatment for diabetes, is typically administered via subcutaneous injections up to four times daily. Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder with a steadily increasing global prevalence. This trend is pushing the condition toward epidemic levels in some countries, with the number of affected individuals expected to double in the next decade due to the ageing population. This will add to the already significant burden on healthcare systems, particularly in low-resource settings. T2DM is a serious and common chronic disease that arises from a complex interaction between genetic predisposition, environmental influences, and additional risk factors such as obesity and sedentary lifestyle.

KEYWORDS: Diabetes mellitus, Type 1 DM, Type 2 DM, diagnosis, managemet, classification, cause and treatment.

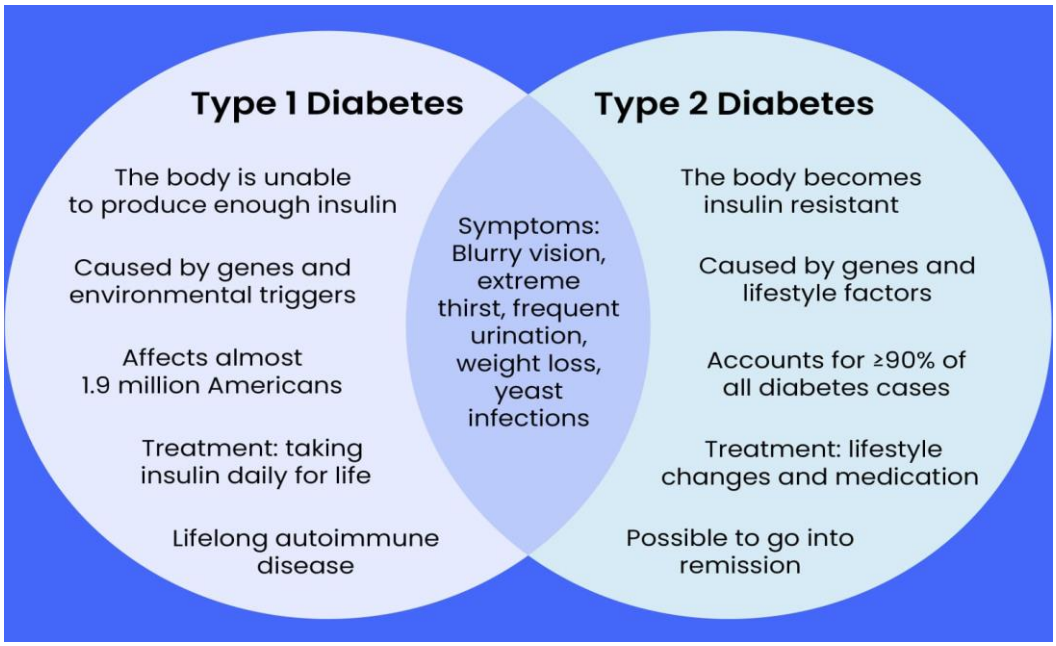
INTRODUCTION

Diabetes mellitus (DM) is a group of metabolic disorders characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels.[1] Diabetes mellitus is a chronic disorder of carbohydrates, fats and protein metabolism. A defective or deficient insulin secretary response, which translates into impaired carbohydrates (glucose) use, is a characteristic feature of diabetes mellitus, as is the resulting hyperglycemias[2] Diabetes mellitus (DM) is commonly referred to as a "sugar" and it is the most common endocrine disorder and usually occurs when there is deficiency or absence of insulin or rarely, impairment of insulin activity (insulin resistance).[3] In 1936, the distinction between type 1 and type 2 DM was clearly made.[4] Type 2 DM was first described as a component of metabolic syndrome in 1988.[5] Type 2 DM (formerly known as non-insulin dependent DM) is the most common form of DM characterized by hyperglycemia, insulin resistance, and relative insulin deficiency.[6] Type 2 DM results from interaction between genetic, environmental and behavioral risk factors.[7] It is caused by deficiency or ineffective production of insulin by pancreas which results in increase or decrease in concentrations of glucose in the blood. It is found to damage many of body systems particularly blood vessels, eyes, kidney, heart and nerves.[8] Diabetes mellitus has been classified into two types i.e. insulin dependent diabetes mellitus (IDDM, Type I) and non-insulin dependent diabetes mellitus (NIDDM, Type II). Type I diabetes is an autoimmune disease characterized by a local inflammatory reaction in and around islets that is followed by selective destruction of insulin secreting cells whereas Type II diabetes is characterized by peripheral insulin resistance and impaired insulin secretion.[9] Uncontrolled diabetes frequently results in hyperglycemia, or elevated blood glucose, which over time seriously damages numerous bodily systems, including the blood vessels and neurons.[10]

Classification of Diabetes Mellitus

The first mostly accepted classification of diabetes mellitus was published by WHO in the year 1980[11] and, it is modified in the year 1985.[12] The most common and important form of Primary or idiopathic diabetes mellitus, which is focus of our discussion. The old and new

terms of insulin-dependent(IDDM) or non insulin-dependent (NIDDM) which were proposed by WHO in1980 and 1985 have disappeared and the terms of new classification system identifies four types of diabetes mellitus: type 1(IDDM), type 2(NIDDM),"other specific types" and gestational diabetes.[13]

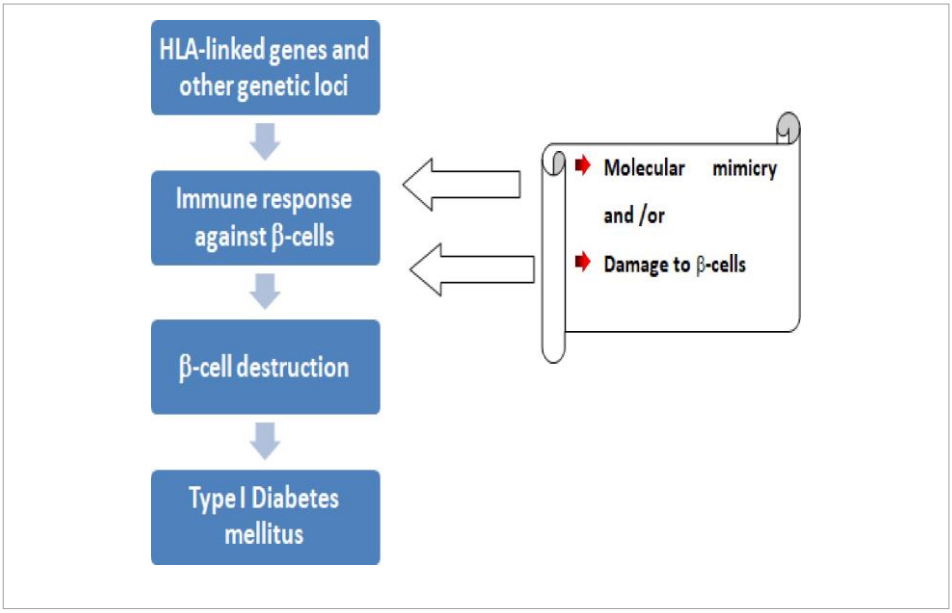


Types of Diabetes mellitus and there Symptoms

1. Insulin Dependent Diabetes Mellitus (Type1 IDDM)

This type of diabetes mellitus is also called autoimmune diabetes and previously known as juvenile-onset or ketosis prone diabetes. The individual may also seek with other autoimmune disorders such as Graves' disease, Hashimoto's thyroiditis, and Addison's disease.[14] Type 1 is usually characterized by the presence of anti–glutamic acid decarboxylase, islet cell or insulin antibodies which identify the autoimmune processes which leads to beta-cell destruction.[15] Type I diabetes mellitus is also known as insulin- dependent diabetes mellitus (IDDM), this occurs mainly in children and young adults.[16]

T1DM is a complicated disorder that results from both genetic risk (Figure 3) and environmental triggers that alter immune pathways. T1DM arises from the cell-mediated autoimmune destruction of insulin producing pancreatic b-cells by CD4+ and CD8+T-cells and macrophages. There are four different markers for this pancreatic b-cell destruction namely; 1) islet cell autoantibodies, 2) autoantibodies to insulin, 3) autoantibodies to glutamic acid decarboxylase (GAD65), and 4) autoantibodies to the tyrosine phosphatases IA-2 and IA-2b.[17,18]



There is a severe deficiency or absence of insulin secretion due to destruction of ß-islets cells of the pancreas. Treatment with injections of insulin is required.[16] Markers of immune destruction, including islet cell auto-antibodies, and/or auto antibodies to insulin, and auto antibodies to glutamic acid decarboxylase (GAD) are present in 85-90 % of individuals with Type 1 diabetes mellitus when fasting diabetic hyperglycemia is initially detected.[19]

2. Non-Insulin Dependent Diabetes Mellitus(Type2 NIDDM)

Type 2 diabetes mellitus is also known as adult-onset diabetes. The progressive insulin secretary defect on the background of insulin resistance (American Diabetes Association, 2014).[20] People with this type of diabetes frequently are resistant to the action of insulin.[21] T2DMisbyfarthemostcommonDMthataccountsfor>90% of cases affectingpeople of all age groups.[22] The twomain frequentlycitedhallmarksofT2DMareimpairedinsulinsecretion due todysfunctionof thepancreaticb-cell and impaired insulin actiondue to insulin resistance. Themass of pancreaticb-cells transformscapableof elevating insulinsupplyandcompensating for excessive andabnormal demand insituationswhere insulin resistance predominates.[23,24] Generally, themode of inheritance forT2DMisunclear, except for theMaturity-Onset Diabetes of the Young (MODY). MODY is inherited as an autosomal dominant trait resulting frommutations in the glucokinasegeneonchromosome7p.[25] The long-term complications in blood vessels, kidneys, eyes and nerves occur in both types and are the major causes of morbidity and death from diabetes.[26]

Symptoms of Type 1 and Type 2 DM

3. Gestational Diabetes Mellitus

Gestational Diabetes Mellitus (GDM) is defined as any degree of glucose intolerance with onset or first recognition during pregnancy, regardless of whether insulin or only diet modification is required for treatment, and whether the condition persists after pregnancy (American Diabetes Association, 2014).[27] It does not exclude the possibility that glucose intolerance may have existed before pregnancy.

Prevalence

- GDM affects approximately **7–14% of pregnancies worldwide**, but the rate varies depending on diagnostic criteria and population studied.[28]

Risk Factors

- Obesity or overweight before pregnancy
- Family history of type 2 diabetes
- Advanced maternal age (>25–30 years)
- Previous history of GDM or delivery of a large baby (>4 kg)
- Polycystic ovary syndrome (PCOS)

Pathophysiology

- During pregnancy, placental hormones (human placental lactogen, progesterone, cortisol) create a state of **insulin resistance**.
- Normally, pancreatic β-cells compensate by increasing insulin secretion.
- In women with GDM, this compensatory response is inadequate, leading to **maternal hyperglycemia.**

Diagnosis

- Usually tested at **24–28 weeks gestation** using:
  - **Oral Glucose Tolerance Test (OGTT)** (most common).
  - International Association of Diabetes and Pregnancy Study Groups (IADPSG) criteria.

Complications

- **Maternal risks**: Higher risk of preeclampsia, cesarean delivery, and later development of type 2 diabetes.
- **Fetal risks**: Macrosomia (large baby), neonatal hypoglycemia, respiratory distress, and increased lifetime risk of obesity and diabetes.

Management

- Lifestyle modification (diet, physical activity).
- Self-monitoring of blood glucose.
- Insulin therapy if glycemic targets are not met with lifestyle changes.
- Some cases may use oral hypoglycemic agents (e.g., metformin), though insulin remains the gold standard.

Prognosis & Long-term Risk

- About **50% of women with GDM** develop type 2 diabetes within 10 years after pregnancy.[29]
- Regular postpartum glucose screening is recommended

Classification of Diabetes mellitus

A. Enhance Insulin Secretion

1. Sulfonylureas

- **First Generation:** Tolbutamide
- **Second Generation**: Glibenclamide, Glipizide ,Gliclazide, Glimepiride

2. Meglitinide analouges: Repaglinide, Nateglinide

3. Glucagon-like peptide (GLP-1)receptor agonists: Exenadite**,** Liraglutide

4. Dipeptidyl peptidase-4 (DPP-4)inhibitors: Sitagliptin**,** Alogliptin**,** Linagliptin

B. Overcome Insulin Resistance

1. Biguanides: Metformin

2. Thiazolidinediones: Pioglitazone

C. Miscellaneous

1. **α-Glucosidase inhibitors:** Acarbose, Miglitol, Voglibose
2. **Amylin analogue:** Pramlintide
3. **Dopamine D2 receptor agonist:** Bromocriptine
4. **Sodium Glucose Co-Transport 2(SGLT 2) inhibitor:** Dapagliflozine[30]

Comparison of Type 1 and Type 2 DM

Feature	Type 1 DM	Type 2 DM
Onset	Usually childhood/adolescence	Usually adulthood, increasing in youth
Pathophysiology	Autoimmune β-cell destruction (no insulin)	Insulin resistance + β-cell dysfunction
Insulin requirement	Lifelong, essential	Initially not required, may need later
Risk factors	Genetic + autoimmune triggers	Obesity, sedentary lifestyle, family history
Clinical presentation	Acute, polyuria, polydipsia, weight loss, DKA possible	Gradual, often asymptomatic initially
Prevalence	5–10% of cases	>90% of cases

Management of Diabetes Mellitus

1. Lifestyle Modifications

- **Diet:** Emphasize a balanced diet rich in whole grains, fruits, vegetables, and lean proteins.
- **Physical Activity:** At least 150 minutes of moderate-intensity aerobic activity per week.
- **Weight Management:** Achieving and maintaining a healthy weight is crucial for glycemic control.[31]

2. Pharmacologic Therapy

- **Type 1 Diabetes:** Insulin therapy is essential.
- **Type 2 Diabetes:** Medications may include:
  - **Metformin:** First-line therapy.
  - **Sulfonylureas:** Increase insulin secretion.

- **GLP-1 Receptor Agonists:** Enhance insulin secretion and inhibit glucagon release.
- **SGLT2 Inhibitors:** Reduce glucose reabsorption in the kidneys.
- **Insulin:** May be required as the disease progresses.[32]

3. Monitoring

- **Blood Glucose Levels:** Regular monitoring to assess glycemic control.
- **A1C Levels:** Target A1C is <7.0% for most adults.
- **Screening for Complications:** Regular screening for diabetic retinopathy, nephropathy, and neuropathy.

4. Management of Comorbidities

- **Cardiovascular Disease:** Manage blood pressure and cholesterol levels.
- **Chronic Kidney Disease:** Monitor kidney function and adjust medications accordingly.
- **Mental Health:** Address diabetes-related distress and mental health issues.

Diagnosis of Diabetes Mellitus

According to the American Diabetes Association (ADA), diabetes can be diagnosed using the following criteria:

- **Fasting Plasma Glucose (FPG):** ≥126 mg/dL (7.0 mmol/L)
- **Oral Glucose Tolerance Test (OGTT):** 2-hour plasma glucose ≥200 mg/dL (11.1 mmol/L) during a 75-g OGTT
- **Glycated Hemoglobin (A1C):** ≥6.5%
- **Random Plasma Glucose:** ≥200 mg/dL (11.1 mmol/L) with symptoms of hyperglycemia.[33]

Pharmacological Agents

Biguanides

Biguanides, of which metformin is the most commonly used in overweight and obese patients, suppresses hepatic glucose production, increases insulin sensitivity, enhances glucose uptake by phosphorylating GLUT-enhancer factor, increases fatty acid oxidation, and decreases the absorption of glucose from the gastrointestinal tract. It has a low incidence of hypoglycemia compared to sulfonylureas.[34]

Sulfonylureas

These generally well tolerated but because they stimulate endogenous insulin secretion, they carry a risk of hypoglycemia.[35] Sulfonylureas are a class of oral hypoglycemic agents primarily used in **Type 2 Diabetes Mellitus (T2DM)**. They act by **stimulating insulin secretion from pancreatic β-cells**, thereby lowering blood glucose levels.[36]

Dipeptidyl-Peptidase IV Inhibitors

Dipeptidyl-peptidase (DPP) IV inhibitors inhibit dipeptidyl peptidase-4 (DPP-4), DPP-4 inhibitors are a new class of anti-diabetogenic drugs that provide comparable efficacy to current treatments. They are effective as monotherapy in patients inadequately controlled with diet and exercise and as add-on therapy in combination with metformin, thiazolidinediones, and insulin.[37]

Meglitinides

Meglitinides are a class of short-acting oral hypoglycemic agents used in Type 2 Diabetes Mellitus (T2DM). Like sulfonylureas, they stimulate insulin secretion from pancreatic β-cells, but with a faster onset and shorter duration, making them particularly effective for controlling postprandial glucose.[35] Meglitinides have a rapid onset and a short duration of action (4-6 hrs) and thus lower risk of hypoglycemia.[38]

Thiazolidinediones

Thiazolidinedione is an insulin sensitizer, selective ligands transcription factor peroxisomes proliferator-activated gamma. Pioglitazone use is not associated with hypoglycemia and can be used in cases of renal impairment and thus well tolerated in older adults.[39] Thiazolidinediones (TZDs), also known as **glitazones**, are oral antidiabetic agents used primarily in **Type 2 Diabetes Mellitus (T2DM)**. They act as **insulin sensitizers**, improving **insulin action in peripheral tissues** (mainly muscle and adipose tissue) rather than stimulating insulin secretion.[36]

Insulin

Insulin is a **hormone produced by pancreatic β-cells** and is essential for **glucose metabolism**. It is the mainstay treatment for **Type 1 Diabetes Mellitus (T1DM)** and is also used in **Type 2 Diabetes Mellitus (T2DM)** when oral agents are insufficient. Insulin binds to **insulin receptors** on cell membranes, activating a cascade of intracellular signaling pathways. Hormone from pancreatic β-cells; essential for glucose metabolism.

Main treatment for **Type 1 Diabetes** and sometimes **Type 2 Diabetes**.[40]

Other

Inhibitors of the sodium-glucose cotransporter 2, which increase renal glucose elimination, and inhibitors of 11ß-hydroxysteroid dehydrogenase 1, which reduce the glucocorticoid effects in liver and fat.[41]

CONCLUSION

Diabetes mellitus is a common and growing metabolic disorder with serious health consequences. Effective management requires early diagnosis, lifestyle changes, and appropriate pharmacological therapy tailored to the type of diabetes. Medications like metformin, sulfonylureas, meglitinides, thiazolidinediones, DPP-4 inhibitors, SGLT2 inhibitors, and insulin help control blood glucose and prevent complications. Combining healthy lifestyle practices with regular monitoring and individualized treatment is essential to reduce morbidity and improve quality of life for people with diabetes. Diabetes mellitus is a serious complication in today life. The lifestyle and day today circumstances are play major role in occurring this type of serious complications. In this review we get some idea regarding diabetes mellitus.

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