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Diabetes Mellitus: An Updated Review of Disease Mechanisms, Risk Factors, Complications, and Integrated Management

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Abstract: ***Diabetes mellitus refers to a group of metabolic disorders in which circulating glucose rises because insulin production is inadequate, insulin action is impaired, or both abnormalities are present. Major categories include type 1, type 2 and gestational diabetes, alongside less common forms associated with inherited defects, pancreatic disorders, endocrine disease or medicines. Persistent hyperglycaemia can gradually injure blood vessels and organs, particularly the heart, kidneys, retina and peripheral nerves. This review discusses diabetes classification, underlying mechanisms, risk assessment, diagnostic approaches, complications and current management. It also considers person-centred nutrition and activity plans, glucose monitoring, appropriate medicine use and the contribution of pharmacists. Comprehensive care should aim for safe glucose control while addressing cardiovascular and renal risk, preventing complications and maintaining day-to-day wellbeing.***

Keywords: ***diabetes care, blood glucose, insulin action, screening, complications, lifestyle modification, glucose-lowering medicines, pharmaceutical care.***

I. INTRODUCTION

Diabetes mellitus is not a single disease but a collection of conditions in which blood glucose regulation is disrupted. Normally, pancreatic beta cells release insulin, a hormone that helps tissues use glucose and influences how the body stores energy. When insulin is unavailable or the body's tissues respond inadequately to it, glucose accumulates in the circulation. Because the condition may remain unnoticed for a long period, especially in type 2 diabetes, timely testing and continued follow-up are important. Appropriate management can ease symptoms and lower the chance of damage to organs over the years.

II. TYPES OF DIABETES MELLITUS

In type 1 diabetes, the immune system commonly damages the pancreatic beta cells responsible for insulin production. The resulting insulin deficiency means that insulin therapy is required for survival. The condition may appear at different ages, and symptoms can progress rapidly.

Type 2 diabetes accounts for most diabetes cases. It usually develops through a combination of insulin resistance in tissues such as muscle, liver and fat, and a progressive inability of beta cells to compensate. Genetic susceptibility, abdominal adiposity, inactivity and ageing may contribute, but the condition can also affect people who do not have obesity.

Gestational diabetes is identified during pregnancy and reflects, in part, the increased insulin resistance associated with pregnancy. Monitoring and treatment are important because raised glucose may affect pregnancy outcomes and is linked with a greater likelihood of developing type 2 diabetes later in life.

Diabetes can also arise from single-gene disorders, pancreatic injury or disease, hormonal disorders, and exposure to particular medicines. Establishing the correct category helps clinicians select suitable treatment and follow-up.

III. EPIDEMIOLOGY AND PUBLIC-HEALTH IMPORTANCE

Rates of diabetes have risen across many populations. Demographic ageing, changes in food environments, urbanisation and less physically active routines are among the factors associated with this trend. Inherited risk and social circumstances influence both disease development and a person's ability to obtain care. Access to screening, medicines, testing equipment and specialist advice remains unequal. For that reason, prevalence figures should be drawn from dated, credible national surveys or public-health reports rather than assumed to remain constant.

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India faces a substantial diabetes burden, making prevention and early detection important priorities. Useful approaches include affordable nutritious foods, accessible places for physical activity, community education and testing for people with elevated risk. Programmes are more likely to be practical when they reflect local food habits, languages and available resources.

IV. PATHOPHYSIOLOGY AND INSULIN RESISTANCE

Insulin normally promotes glucose uptake by skeletal muscle and adipose tissue and reduces the liver's release of glucose. With insulin resistance, these effects weaken, so the pancreas may initially release extra insulin to compensate. If beta-cell capacity later becomes inadequate, glucose levels rise both between meals and after eating.

Insulin resistance is influenced by multiple interacting factors. Excess visceral fat, changes in intracellular signalling, low levels of muscular activity, inflammatory processes, disturbed sleep and inherited susceptibility may all play a part. The liver may continue releasing glucose despite signals to reduce production, while muscle removes less glucose from the blood. Increased fat breakdown can further alter metabolic balance. In type 1 diabetes, the central problem is usually autoimmune loss of insulin-producing cells, rather than the typical pattern of insulin resistance.

V. RISK FACTORS AND PREVENTION

Some diabetes risk factors cannot readily be modified, including age, family history, a history of gestational diabetes and certain inherited conditions. Other factors may be improved, such as inactivity, tobacco exposure, low-quality dietary patterns, excess abdominal weight and poorly controlled blood pressure or blood lipids. Risk differs from person to person, so prevention advice should be based on an individual assessment rather than a single profile.

Risk reduction can involve regular movement, meals built around vegetables, pulses, whole grains and other fibre-rich foods, and choosing water or unsweetened drinks instead of sugary beverages. Adequate sleep and avoiding tobacco are also beneficial; gradual weight loss may be appropriate for some people. Screening can identify diabetes earlier in people with relevant risk factors. Advice should be achievable, respectful and suited to a person's health needs, preferences and finances.

VI. CLINICAL FEATURES AND DIAGNOSIS

Possible symptoms include thirst, passing urine frequently, fatigue, blurred eyesight and weight loss without an obvious explanation. However, type 2 diabetes may cause few clear symptoms, and some people discover it only through routine blood tests. Vomiting, abdominal pain, marked dehydration, unusually deep or rapid breathing, confusion or profound drowsiness can signal a medical emergency and require urgent assessment.

Clinicians diagnose diabetes using established laboratory criteria. For non-pregnant adults, commonly used thresholds are fasting plasma glucose of 126 mg/dL (7.0 mmol/L) or above; HbA1c of 6.5% or above when measured with a standardised method; glucose of 200 mg/dL (11.1 mmol/L) or above two hours after a 75-g oral glucose load; or random plasma glucose of at least 200 mg/dL when classic symptoms or a hyperglycaemic crisis are present. Unless the presentation is unequivocal, a second test is generally needed to confirm the diagnosis. Pregnancy requires separate criteria and testing pathways.

HbA1c provides an estimate of average blood glucose over approximately the previous two to three months. Its interpretation may be affected by some disorders of haemoglobin or red blood cells. Depending on the person's needs, assessment may also include fasting or post-meal glucose, kidney and liver function, urine albumin-to-creatinine ratio, lipid levels, blood pressure, retinal screening, and examination of the feet and peripheral nerves. C-peptide or diabetes-associated autoantibody tests can be useful when the diabetes type is uncertain.

VII. ACUTE AND CHRONIC COMPLICATIONS

Important acute problems include low blood glucose (hypoglycaemia), diabetic ketoacidosis (DKA) and hyperosmolar hyperglycaemic state (HHS). Hypoglycaemia may develop when medicine effects exceed the body's immediate needs, for instance after a delayed meal or unexpected exertion. Symptoms range from sweating, shaking and hunger to confusion, seizures or unconsciousness. DKA is associated with severe insulin deficiency and ketone accumulation; HHS involves profound hyperglycaemia and dehydration. Both DKA and HHS need emergency hospital care.

Long-term damage is commonly described as microvascular or macrovascular. Injury to small vessels can affect the retina, kidneys and nerves, contributing to visual impairment, chronic kidney disease, pain or loss of sensation. Larger-vessel disease raises the likelihood of coronary disease, stroke and impaired circulation in the limbs. Foot ulcers may develop when nerve damage, reduced blood flow, structural changes and infection occur together. Regular checks, appropriate footwear, tobacco cessation and prompt care of wounds can help prevent worsening injury.

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VIII. PHARMACOLOGICAL MANAGEMENT AND NEWER THERAPIES

A suitable treatment plan depends on the diabetes category, glucose pattern, heart and kidney health, weight-related goals, hypoglycaemia risk, cost and the person's preferences. People with type 1 diabetes need insulin. Insulin may also be appropriate for some people with type 2 diabetes, including those with marked hyperglycaemia, acute illness or inadequate control with other treatments; decisions in pregnancy require individual clinical guidance.

Metformin remains a common option for type 2 diabetes when it is appropriate, although the best initial medicine varies with clinical circumstances. SGLT2 inhibitors may provide important benefits for selected people with heart failure or chronic kidney disease. GLP-1 receptor agonists can lower glucose and often support weight reduction; certain medicines in this group also reduce cardiovascular events in eligible patients. Other available classes include DPP-4 inhibitors, sulfonylureas and thiazolidinediones. Their effectiveness, side-effect profiles, precautions and costs differ.

Medicine selection should be reviewed against current guidelines and the person's complete clinical picture. Kidney function, concurrent prescriptions, pregnancy, dehydration risk, previous adverse effects and the possibility of hypoglycaemia can influence the choice. Patients should not independently begin, discontinue or adjust diabetes medicines; changes should be discussed with an appropriately qualified healthcare professional. Because evidence and product guidance evolve, newer therapies and combinations should be checked against up-to-date recommendations.

IX. NUTRITION, PHYSICAL ACTIVITY, AND SELF-MONITORING

Long-term eating habits that a person can maintain are generally preferable to highly restrictive short-term diets. Practical choices may include suitable portions, vegetables and pulses, high-fibre grains and appropriate protein, while limiting excess added sugar, refined carbohydrate and heavily processed foods. Meal planning should account for local cuisine, culture, budget and other medical conditions. A dietitian or trained healthcare professional can help individualise recommendations.

Regular physical activity can improve the body's response to insulin and benefit cardiovascular health. Where safe and suitable, many adults can work toward at least 150 minutes of moderate aerobic activity per week, alongside muscle-strengthening activity. The plan should reflect ability and medical advice. People using insulin or medicines that may cause hypoglycaemia may need to coordinate activity with meals, glucose checks and treatment instructions.

Monitoring plans differ according to treatment, glucose stability, symptoms and agreed care goals. They may include self-testing with a blood-glucose meter, continuous glucose monitoring for suitable individuals, and HbA1c measurements at intervals recommended by the care team. Follow-up should also consider blood pressure, cholesterol, kidney function, eye health, dental care, vaccinations and foot checks. Targets may need adjustment for older adults and people living with other significant conditions.

X. ROLE OF THE PHARMACIST

Pharmacists can help people understand the purpose, timing and correct use of diabetes medicines. They may demonstrate injection technique and glucose-monitoring procedures, explain storage requirements and expiry dates, identify potential drug interactions, and reinforce the instructions provided for missed doses. They can also teach patients to recognise hypoglycaemia and signs of a hyperglycaemic emergency, with timely referral when urgent care is needed.

Reviewing the full medicine list is especially valuable for people taking multiple drugs or those with impaired kidney or liver function. Pharmacists can support regular refills, discuss barriers such as treatment cost, provide reliable lifestyle information and communicate concerns to prescribers and other members of the healthcare team. Any action must remain within the pharmacist's professional scope; unsupported changes to prescribed therapy should be avoided.

XI. DISCUSSION

Good diabetes care involves more than achieving a glucose target. Cardiovascular and kidney risk, treatment burden, personal priorities and social circumstances also influence outcomes. Detecting the condition early creates an opportunity to address risk factors before complications become advanced. Since disease progression and treatment-related risks can change over time, care plans should be reassessed regularly and adjusted with the patient.

Ongoing research is examining how to match medicines to individual needs, make better use of continuous glucose data and deliver prevention services fairly. Progress will depend not only on new therapies but also on education, affordable treatment, culturally appropriate support and effective collaboration among patients and healthcare professionals.

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XII. CONCLUSION

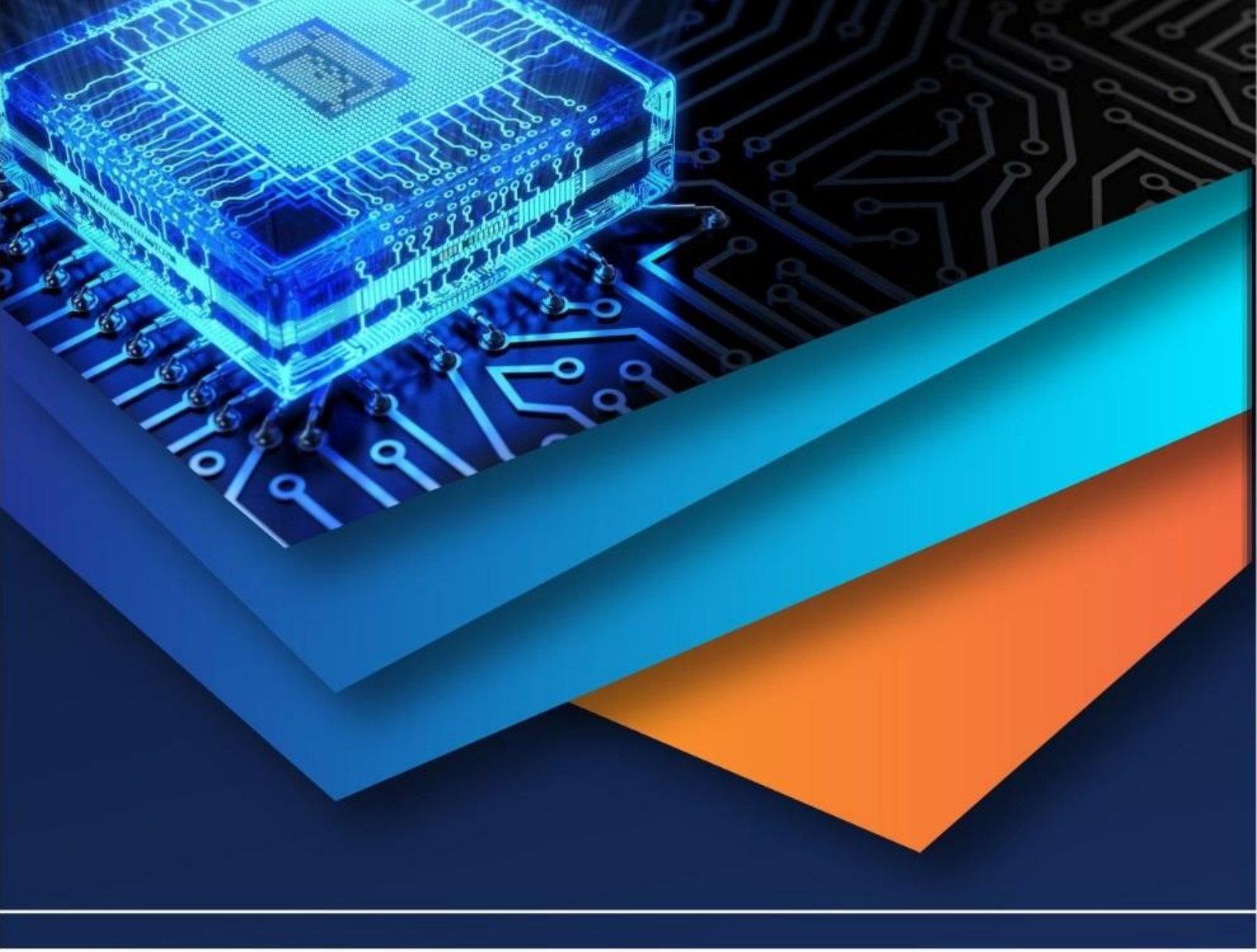
Diabetes mellitus includes several conditions with different causes but a shared feature of elevated blood glucose. Accurate classification, appropriate laboratory assessment and early recognition of complications underpin safe management. A tailored combination of medicines, nutrition, activity, monitoring and routine screening can improve health outcomes and reduce preventable organ damage. Pharmacists contribute through medicine education, safety checks, adherence support and referral. Continued research and fair access to evidence-based care remain important priorities.

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