DIABETES MELLITUS AND ITS COMPLICATIONS: A MODERN PERSPECTIVE ON THE PROBLEM

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Abstract Diabetes mellitus (DM) is one of the global medical and social problems of modern times, occupying leading positions in terms of prevalence and incidence growth rates. This article is dedicated to a comprehensive analysis of the problem of diabetes mellitus and its complications. The paper reviews the main types of diabetes, epidemiological data, and details the mechanisms of development of micro- and macrovascular complications. Special attention is paid to the pathogenesis of diabetic retinopathy, nephropathy, neuropathy, and diabetic foot syndrome. Modern approaches to the treatment and prevention of complications are presented, and the importance of a multidisciplinary approach is emphasized. The article will be useful for physicians of various specialties, medical university students, and researchers dealing with endocrinology problems.

Keywords: diabetes mellitus, hyperglycemia, insulin resistance, complications, diabetic nephropathy, retinopathy, neuropathy, diabetic foot, glycated hemoglobin.

Introduction Diabetes mellitus represents a group of metabolic diseases characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action, or both. According to the International Diabetes Federation (IDF), as of 2026, there are more than 500 million adults living with diabetes worldwide, and this figure continues to grow steadily. In the structure of incidence, 90–95% are accounted for by type 2 diabetes mellitus (T2DM), which is inextricably linked with obesity and a sedentary lifestyle. Type 1 diabetes mellitus (T1DM) accounts for 5–10% and is more often diagnosed in childhood and adolescence. The main danger of diabetes lies not in hyperglycemia itself, but in its long-term consequences. Chronically elevated blood glucose levels trigger a cascade of biochemical reactions leading to damage in virtually all organs and systems. It is precisely the complications of diabetes that are the main cause of disability and premature death in patients. Complications are subdivided into acute (diabetic ketoacidosis, hyperosmolar state, hypoglycemia) and chronic (microangiopathies and macroangiopathies). Understanding the molecular mechanisms behind the development of these pathologies is key to developing effective methods for their prevention and treatment.

Purpose of the Study The purpose of this work is to systematize and analyze modern data on the pathogenesis, clinical presentation, and approaches to correcting the main chronic complications of diabetes mellitus, as well as to evaluate the impact of chronic hyperglycemia on the prognosis and quality of life of patients.

Materials and Methods The research materials utilized data from scientific publications in peer-reviewed medical journals, guidelines from the International Diabetes Federation (IDF), the American Diabetes Association (ADA), and the World Health Organization (WHO) over the past 10 years. An analytical literature review was conducted using PubMed, Scopus, and eLibrary databases. Research

methods included theoretical analysis, data systematization, and logical generalization of the results of clinical studies and meta-analyses addressing the problem of diabetic complications.

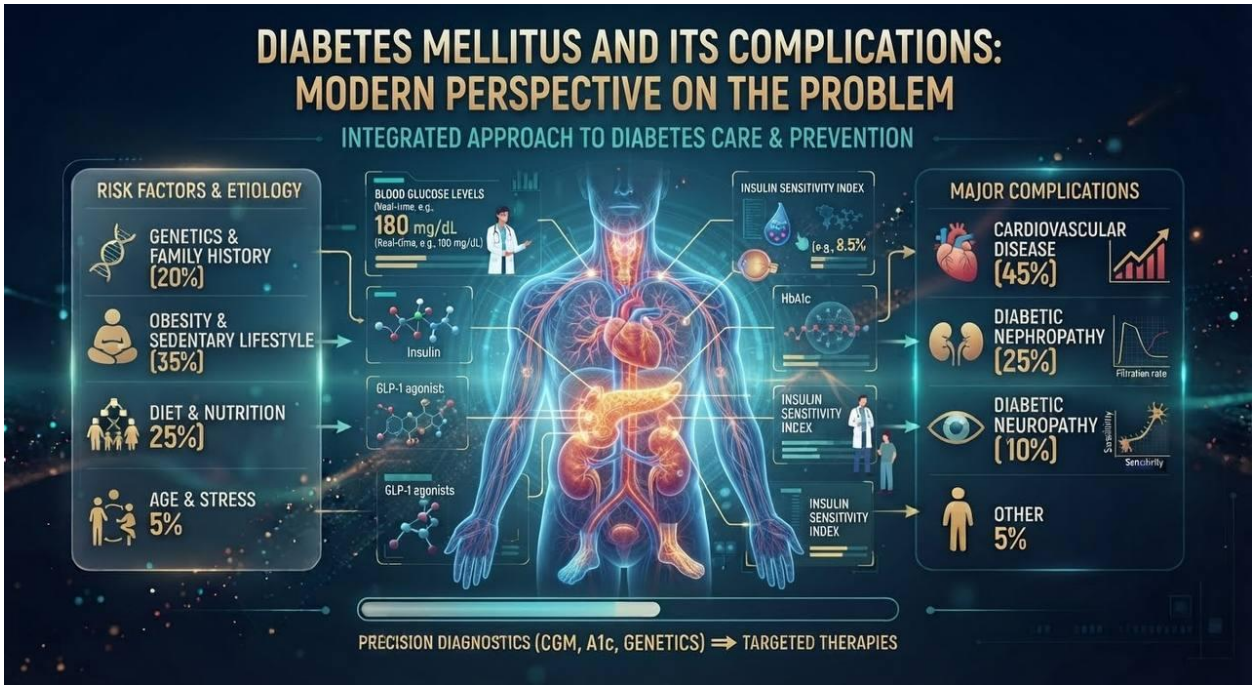
Results and Discussion: ***Pathophysiology of Chronic Hyperglycemia*** The primary trigger for the development of complications is prolonged hyperglycemia. It activates four key biochemical pathways that are interrelated and exacerbate each other: **Polyol pathway:** Glucose is converted into sorbitol, which accumulates in cells, causing osmotic stress and damaging eye structures (lens, retina) and nerves. **Protein kinase C (PKC) pathway:** PKC activation leads to increased proliferation of vascular smooth muscle cells, increased vascular permeability, and impaired blood flow, which is critical for the kidneys and retina. **Hexosamine pathway:** Hyperglycemia increases hexosamine synthesis, which alters the expression of genes responsible for fibrosis and inflammation, especially in renal tissues. **Advanced glycation end products (AGEs) formation:** Glucose irreversibly binds to proteins, forming AGEs that disrupt collagen structure, activate inflammatory receptors, and promote accelerated atherosclerosis development. ***Microvascular Complications***: **Diabetic Retinopathy:** This is one of the leading causes of blindness in adults. In the early stages, non-proliferative retinopathy develops, characterized by microaneurysms and pinpoint hemorrhages. As it progresses, the proliferative stage occurs, featuring neovascularization (growth of new fragile vessels) in response to retinal ischemia. These vessels are prone to rupture, leading to hemophthalmus and retinal detachment. Of particular danger is diabetic macular edema, leading to central vision loss. Studies show that regular fundus screening (at least once a year) reduces the risk of blindness by 90% with timely treatment (laser photocoagulation, intravitreal anti-VEGF injections). **Diabetic Nephropathy:** Kidney damage develops in stages: from hyperfiltration and microalbuminuria to macroalbuminuria and, ultimately, chronic renal failure (CRF). The basis of pathogenesis is damage to the glomerular filter: thickening of

the basement membrane and mesangial matrix, leading to glomerulosclerosis. Diabetes mellitus is the leading cause of end-stage renal disease requiring dialysis or kidney transplantation. A key role in slowing progression is played by strict blood pressure control (target values <130/80 mmHg) and the prescription of RAS blockers (ACE inhibitors, sartans), which have a nephroprotective effect. A new standard of therapy has become SGLT2 inhibitors (e.g., dapagliflozin, empagliflozin), which reliably reduce the risk of nephropathy progression and heart failure independently of glycemic lowering. **Diabetic Neuropathy:** The most common form is distal symmetric sensorimotor polyneuropathy. It manifests as numbness, burning, pain in the lower extremities, and reduced sensitivity (vibratory, thermal, pain). The danger lies in the fact that the patient may not notice minor injuries, which, combined with impaired microcirculation, leads to trophic ulcers. Autonomic neuropathy affects the cardiovascular system (impaired heart rate variability, orthostatic hypotension), the gastrointestinal tract (gastroparesis, diarrhea), and the urogenital system (erectile dysfunction). Treatment includes glycemic control, the use of anticonvulsants (gabapentin, pregabalin) and tricyclic antidepressants for pain relief, as well as physical therapy. ***Macrovascular Complications****:* Diabetes significantly accelerates the development of atherosclerosis. The combination of hyperglycemia, dyslipidemia (elevated LDL, reduced HDL), and insulin resistance leads to early damage to coronary, cerebral, and peripheral arteries.**Cardiovascular Diseases:** Myocardial infarction in patients with diabetes often proceeds painlessly (atypical form) due to neuropathy, complicating diagnosis. Heart failure is a frequent companion of T2DM. **Cerebrovascular Diseases:** The risk of stroke in patients with diabetes is 2 to 4 times higher than in the general population.

Diabetic Foot Syndrome: This is a formidable complication combining neuropathy, angiopathy, and secondary infection. Neuropathic (without pronounced ischemia), ischemic, and mixed forms are distinguished. The development of ulcer

defects in the absence of treatment can lead to gangrene and major amputation. Prevention includes daily foot inspection, wearing orthopedic shoes, thorough hygiene, and foot offloading. Modern ulcer treatment methods include the use of growth factors, skin equivalents, and hyperbaric oxygenation techniques. ***Modern Approaches to Prevention*** The results of major trials (UKPDS, DCCT) proved that intensive glycemic control (target HbA1c <7% for most patients) significantly reduces the risk of microangiopathies, but does not always effectively impact macrovascular risks. Therefore, in modern diabetes management strategies (personalized approach), the emphasis is shifting not only to glucose control, but also to weight management, blood pressure, and lipid profiles. Early detection of complications (albuminuria screening, eye exams, foot sensitivity assessment) is an obligatory component of patient management.

Conclusion Diabetes mellitus remains one of the most severe chronic non-communicable epidemics. Its complications, affecting the vascular, nervous systems, and organs of vision, are the main cause of disability and mortality. Analysis results showed that the development of complications directly correlates with the duration of the disease and the degree of carbohydrate metabolism compensation. The pathogenesis of complications is multifactorial and includes both metabolic disorders (AGEs, polyol pathway) and functional ones (endothelial dysfunction). Success in combating complications is achieved only through a comprehensive approach: intensive glucose-lowering therapy, aggressive management of risk factors (blood pressure, lipids), and regular screening for early diagnosis. The introduction into clinical practice of modern drug classes (SGLT2 inhibitors, GLP-1 agonists) with organoprotective action opens up new possibilities for reducing the progression rate of diabetic complications and improving patients' quality of life.



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