NEW APPROACHES TO THE TREATMENT OF TYPE 1 AND TYPE 2 DIABETES MELLITUS: A 2025 PERSPECTIVE

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Abstract: *This article discusses current treatment methods, preventive measures, innovations, and the 2025 outlook for type 1 and type 2 diabetes mellitus (T1DM and T2DM). It highlights the primary factors contributing to diabetes, as well as the major preventive strategies necessary to understand and reduce the risks of life-threatening complications.*

Keywords: *diabetes mellitus, prevention, T1DM, T2DM, insulin, glucose, cell, cardiovascular, clinical.*

INTRODUCTION

According to the latest findings as of 2025, significant updates have emerged in the treatment approaches to type 1 and type 2 diabetes mellitus (T1DM and T2DM). These approaches extend beyond traditional insulin therapy and standard oral medications, incorporating next-generation therapeutics, advanced technologies, and personalized treatment strategies.

Novel Therapies and Approaches for Type 1 and Type 2 Diabetes

"Organ-protective" therapies – GLP-1, SGLT2, and GIP–GLP-1 combinations. In the management of type 2 diabetes, treatment is shifting from simply lowering blood glucose toward the use of medications that also provide cardiovascular and renal protection. One notable example is Tirzepatide, a dual GIP and GLP-1 receptor agonist, which has demonstrated remarkable efficacy in patients with type 2 diabetes and obesity. It lowers blood glucose levels, supports significant weight reduction, and thereby helps prevent long-term complications of the disease.

Main Body: AI-Driven and Digital Management Systems — "Smart" Insulin Regimens and Digital Twin Modeling. One of the studies published in 2025 introduced ABBA, a reinforcement-learning–based system designed for individualized insulin adjustment. In simulation models, ABBA demonstrated superior outcomes compared to the traditional basal–bolus regimen by maintaining blood glucose within the target range (time-in-range) more effectively.

Another innovative project, GlyTwin, uses a digital twin approach—reconstructing a patient's metabolic state through an artificial model. Based on this

simulation, it recommends optimal insulin doses, dietary adjustments, and lifestyle modifications. This method may be particularly beneficial for individuals with type 1 diabetes and advanced, long-standing type 2 diabetes.

Why this is important: These innovations enable insulin regulation without manual guesswork, allowing for automated, highly personalized insulin delivery. This reduces glucose fluctuations and lowers the risk of long-term complications.

Cell Therapy, Transplantation, and Immunological Approaches (Aiming to Eliminate Complications). Contemporary scientific literature highlights several emerging possibilities for diabetes therapy, including gene therapy, cell transplantation, and hybrid treatment approaches such as surgical or bariatric interventions.

"Functional" approaches—aimed at restoring endogenous insulin production by regenerating beta cells—are also gaining scientific attention.

Challenges and Opportunities: Most of these methods remain experimental or are applied on a limited scale. Significant challenges include immunological compatibility, long-term safety, and donor availability. However, if successful, these approaches may break a major "human barrier" for individuals living with type 1 diabetes.

A Broader Treatment Paradigm: Physical and Psychological Health Combined

In 2025, the European Association for the Study of Diabetes (EASD) released its first clinical guidelines addressing diabetes distress. This marks an important recognition that diabetes treatment involves not only glycemic control but also the patient's psychological well-being and overall quality of life.

Additionally, modern monitoring tools—continuous glucose monitoring (CGM), insulin pumps, automated insulin delivery systems—along with dietary and lifestyle management, are now considered essential components of comprehensive diabetes therapy.

Core Idea: Diabetes management is not limited to medication. It is a multidimensional, chronic condition requiring a combined approach that includes lifestyle, mental health, technology, and medical therapy. By 2025, diabetes management has shifted beyond lowering blood glucose. Treatment strategies increasingly aim to reduce cardiovascular and renal risks, prevent complications, and improve overall quality of life.

Technological innovations—artificial intelligence, automated insulin systems, and digital twin models—together with advancements in cell and gene therapy, offer breakthrough potential, especially for type 1 diabetes. However, many of these developments are not yet ready for widespread clinical use.

Modern diabetes care is becoming more individualized, integrating medication, nutrition, lifestyle, mental health, and technology into a single comprehensive therapeutic strategy.

2025 — Classification of Emerging and Current Clinical Approaches:

1) Established / Widely Implemented Methods (Approved and in Clinical Practice)

GLP-1 and GIP/GLP-1 Combination Therapies (e.g., semaglutide, tirzepatide)

Purpose: To simultaneously manage type 2 diabetes and obesity by lowering blood glucose, promoting weight reduction, and reducing cardiovascular and renal complications. These drug classes demonstrated strong efficacy in large clinical trials and real-world evaluations in 2024–2025 and are widely recommended for many patients.

SGLT2 Inhibitors (Cardioprotective and Nephroprotective Agents)

Purpose: Beyond glucose lowering, these agents reduce the risk of cardiovascular and renal complications. As of 2025, SGLT2 inhibitors remain a standard therapy across multiple treatment pathways, with clinical guidelines and outcome studies continuing to support their use.

2) Active Clinical Trials / Recent Large-Scale Investigations

Automated Insulin Delivery (AID) Systems — Closed-Loop "Smart" Pumps

Purpose: To provide automated glycemic control for patients with type 1 diabetes and insulin-dependent type 2 diabetes. Randomized controlled trials and real-world studies conducted in 2024–2025 show that AID systems significantly improve HbA1c and time-in-range metrics. These systems are transitioning from clinical trials to broader implementation in several countries.

Beta-Cell / Cell-Based Replacement Therapies (Encapsulated stem-cell–derived β-cells, advancements in islet transplantation)

Purpose: To restore endogenous insulin production, aiming toward a "functional cure" for type 1 diabetes. Between 2023 and 2025, several trials using encapsulated cell devices and iPSC-derived beta cells released early phase data (1–2 year outcomes). These therapies remain in the pre-widespread adoption stage but show promising results.

3) Experimental / Research-Stage Approaches (Potential Future Breakthroughs)

Genetically Modified or Immuno-Evasive Cell Therapies

Purpose: To create beta cells with intrinsic immunological protection, reducing or eliminating the need for chronic immunosuppression. These approaches are currently in pre-clinical or early phase I–II trial stages.

Immune-Modulating Therapies (Aiming to Delay or Prevent Disease Onset)

Purpose: To slow or stop beta-cell destruction in early or pre-diabetic stages of type 1 diabetes. Some experimental models and early-stage clinical trials exist, though results are limited and inconsistent. These approaches may become better defined in future research.

4) Key Safety and Regulatory Updates (2025 Focus)

GLP-1 / Tirzepatide Class — Safety Surveillance

In 2025, certain regulatory bodies (e.g., Australia's TGA) issued warnings regarding potential safety signals—mental health considerations, caution in combination with specific contraceptives, and other risk factors. As these medications gain broader global use, post-market surveillance becomes increasingly important. Ongoing patient monitoring and counseling are strongly recommended.

1. Type 2 Diabetes, Obesity, and Cardiovascular Risk:

GLP-1 agonists and tirzepatide significantly reduce weight and HbA1c but require careful assessment of side effects, safety concerns, and interactions with contraceptive therapies.

2. Type 1 Diabetes:

AID (closed-loop) systems have become effective tools for improving glycemic control through automated insulin delivery integrated with CGM technology. Beta-cell replacement and cell-based therapies may offer a future curative pathway, although they are not yet available as widespread clinical treatments.

Symptoms of Diabetes Mellitus: General Symptoms (Common in Both Type 1 and Type 2 Diabetes); Polyuria — frequent urination; Polydipsia — excessive thirst; Polyphagia — increased appetite (often accompanied by weight loss); Fatigue and general weakness; Blurred vision; Itching of the skin; Slow healing of wounds; Numbness, tingling, or reduced sensitivity in the hands and feet (peripheral neuropathy).

Signs Specific to Type 1 Diabetes: Rapid onset and often severe presentation; Keton odor on the breath (acetone smell); Intense thirst; Rapid weight loss; Most commonly occurs in children and young adults.

Signs Specific to Type 2 Diabetes. Gradual development; Often asymptomatic in early stages; Frequently associated with overweight or obesity; Abdominal (central) fat accumulation.

Major Factors Causing Diabetes Mellitus: Causes of Type 1 Diabetes; Type 1 diabetes is an autoimmune disease in which the body destroys insulin-producing beta cells. Main contributing factors include: Genetic predisposition; Autoimmune mechanisms; Viral infections (e.g., Coxsackie virus); Stress or severe infections (indirect triggers).

> Note: There is currently no proven method to prevent type 1 diabetes.

Main Risk Factors Leading to Type 2 Diabetes. Key risk factors include: Obesity, especially abdominal (visceral) fat; Unhealthy diet (excess sugar, white bread, fatty foods); Physical inactivity; Genetic predisposition (risk increases significantly if parents have diabetes); Stress and sleep deprivation; High blood pressure; Elevated blood lipids (cholesterol and triglycerides); Advancing age (risk increases after age 40); History of gestational diabetes, which increases the risk of type 2 diabetes later in life.

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