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Review Article

Recent Trends in Diabetic Management: Strength Against Diabetes

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ABSTRACT

Diabetes mellitus is a chronic metabolic disorder characterized by elevated blood glucose levels due to insulin deficiency, resistance, or both and diabetes mellitus can lead to severe complications such as neuropathy, nephropathy, retinopathy and cvs. Diabetes mellitus is a major health concern affecting millions of people and requires long term pharmacological and non-pharmacological management. Basically, diabetes mellitus is of two types- Type-I and Type-II diabetes. Achieving optimal glycemic control remains the cornerstone in the management of both type 1 and type 2 diabetes mellitus. A substantial body of clinical evidence has demonstrated that maintaining targeted blood glucose levels significantly reduces the risk of both microvascular and macrovascular complications. Despite its seriousness, diabetes mellitus is manageable through lifestyle modifications and pharmacotherapy. Both modern allopathic such as Dapagliflozin, Insulin analogs (Insulin glargine, Insulin degludec) and traditional ayurvedic such as Diarex, Glymin plus facilitate the management of diabetes mellitus.

INTRODUCTION

Diabetes mellitus is a heterogeneous group of metabolic disorders characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The resultant elevated plasma glucose levels lead to classical clinical manifestations including polyuria (excessive urination), polydipsia (excessive thirst), and polyphagia (excessive hunger)

Diabetes mellitus, a chronic metabolic disorder characterized by sustained hyperglycemia, poses one of the most significant global health burdens today. The disease affects millions and is associated with long-term complications involving the eyes, kidneys, nerves, and cardiovascular system. With the rising incidence of both Type 1

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(T1DM) and Type 2 diabetes mellitus (T2DM), innovative and patient-centric strategies are gaining importance. This review outlines the emerging trends under the theme "Strength Against Diabetes", emphasizing progress in personalized care, technology, therapeutics, and public health policy.

1. Personalized Medicine and Precision Diabetes Care

Personalized or precision medicine is revolutionizing diabetes management by aligning treatment with an individual's genetic makeup, lifestyle, and comorbidities.

- **Pharmacogenomics** helps identify how a patient's genes influence their response to specific antidiabetic medications (e.g., sulfonylureas, metformin).
- **Biomarker-based risk stratification** is now used to predict disease progression and complications.
- In **monogenic diabetes**, genetic testing helps in accurate diagnosis and treatment (e.g., switching from insulin to sulfonylureas in MODY).

Example: The use of *GCK*, *HNF1A*, and *HNF4A* gene testing to identify maturity-onset diabetes of the young (MODY) and avoid unnecessary insulin therapy.

2. Continuous Glucose Monitoring (CGM) & Artificial Pancreas Systems

Technological innovations are offering better glycemic control and reducing diabetes-related complications.

- **CGMs** provide continuous, real-time glucose readings with alerts for hyper/hypoglycemia.
- When combined with **automated insulin delivery systems (AID)** or **closed-loop systems**, CGMs can mimic physiological insulin regulation.
- Smart pens and Bluetooth-enabled devices help in insulin dose optimization.

Example: The *MiniMed 780G* by Medtronic — an advanced hybrid closed-loop system that adjusts basal insulin every 5 minutes.

3. Digital Health and Telemedicine

The digital revolution has transformed diabetes self-care, especially during and after the COVID-19 pandemic.

- **Mobile apps** such as mySugr, BlueLoop, and Glucose Buddy allow tracking of glucose, meals, and medication.
- **AI-based platforms** can suggest diet plans, physical activity routines, and even predict glucose excursions.
- **Teleconsultation** improves access to endocrinologists and diabetes educators, especially in rural or underserved areas.

Example: India's *Digital India* initiative integrates telemedicine platforms like *eSanjeevani* for diabetes consultations.

4. Novel Antidiabetic Drugs

Recent pharmacological advancements go beyond glucose control to address associated comorbidities.

- **SGLT2 inhibitors** (e.g., empagliflozin, dapagliflozin) lower glucose and offer cardiovascular and renal protection.
- **GLP-1 receptor agonists** (e.g., semaglutide, dulaglutide) aid in weight loss and reduce cardiovascular events.

- **Dual-action therapies** such as *tirzepatide* (GIP/GLP-1 receptor agonist) show remarkable HbA1c and weight reduction.

Example: The SURPASS trial demonstrated significant benefits of tirzepatide in T2DM management.

5. Lifestyle, Nutrition, and Behavioral Interventions

Behavioral and lifestyle changes are cornerstone strategies, especially in T2DM and prediabetes.

- Structured **Diabetes Prevention Programs (DPPs)** involve nutritional counseling, physical activity promotion, and motivational support.
- **Cognitive Behavioral Therapy (CBT)** and **Diabetes Self-Management Education and Support (DSMES)** programs improve adherence and mental health.
- Focus is shifting to **plant-based diets**, **low GI foods**, and **intermittent fasting** as adjunctive strategies.

Example: The *Diabetes Prevention Program Study* (USA) showed that lifestyle modification reduced diabetes incidence by 58%.

6. Regenerative Medicine and Immunotherapy (Type 1 Diabetes Focus)

Breakthroughs in cell therapy and immunomodulation hold curative potential for T1DM.

- **Stem cell-derived beta cells** are being explored for transplantation to restore insulin production.
- **Encapsulation technology** protects implanted cells from immune attack without immunosuppression.
- **Immunotherapy** (e.g., teplizumab) can delay the onset of T1DM in high-risk individuals.

Example: *Vertex Pharmaceuticals* is working on VX-880, an investigational stem cell-derived therapy for insulin-independent glucose control.

7. Public Awareness, Education, and Health Policy Initiatives

Governments and health organizations are focusing on early detection, education, and equitable access to care.

- **India's NPCDCS (National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke)** promotes screening and lifestyle intervention.
- **WHO's Global Diabetes Compact** aims for universal access to diagnostics and affordable medications.
- **"Strength Against Diabetes"** campaigns focus on community mobilization and behavior change.

Example: November 14, *World Diabetes Day*, marks a global effort to spread awareness with themes such as "Access to Diabetes Care."

CLASSIFICATION OF DIABETES MELLITUS:

There are three primary types of diabetes mellitus:

1. Type 1 Diabetes Mellitus (T1DM)

This type happens when the pancreas makes little or no insulin due to destruction of beta cells.It usually starts in childhood or teenage years, so it's also called juvenile diabetes.

People with Type 1 diabetes need insulin injections daily to control their blood sugar.

2. Type 2 Diabetes Mellitus (T2DM)

This is the most common type. It generally affects adults but can occur in children too.

It happens due to insulin resistance (body does not use insulin properly) and less insulin production.Earlier, it was called non-insulin dependent diabetes mellitus (NIDDM).

3. Gestational Diabetes Mellitus (GDM)

This type occurs only during pregnancy in women who didn't have diabetes before.

It is caused by hormones from the placenta that lead to insulin resistance.

Usually, it goes away after delivery, but it increases the risk of developing Type 2 diabetes later.

MANAGEMENT OF DIABETES MELLITUS

Diabetes mellitus is a lifelong condition that affects millions of people worldwide.

Managing diabetes requires a mix of proper diet, regular exercise, medicines, and sometimes insulin. Good sugar control helps prevent complications like kidney damage, eye problems, and nerve issues. Modern treatment focuses on personalized care, where each patient gets a plan that suits their needs. Over the years, many new drugs and therapies have come up due to scientific research. Education and awareness about diabetes are also very important for long-term control.

Following are some of the important strategies and drugs used in the management of diabetes:

Allopathic drugs:-

1) Tirzepatide (Mounjaro)

Across the world, the number of individuals dealing with both obesity and type 2 diabetes is steadily increasing. Many epidemiological studies have clearly shown a strong link between these two conditions. It is believed that over 80% of people diagnosed with type 2 diabetes are either overweight or obese. Managing such individuals requires a consistent and significant reduction in body weight.[1]

The American Diabetes Association suggests that patients should aim for an A1C level below 7%. Findings from the Diabetes Prevention Program indicate that losing even one kilogram of weight can reduce the risk of developing type 2 diabetes by 16%. Even modest weight loss has shown benefits like improving insulin sensitivity, reducing complications, lowering cardiovascular risks, and achieving better control of blood sugar levels. Still, many patients with type 2 diabetes struggle to meet their glycemic targets with diet and exercise alone.[2]

On May 13, 2022, the US FDA gave approval to a novel and innovative medication, Tirzepatide (Mounjaro), for treating type 2 diabetes. This once-a-week subcutaneous injection shows a dual benefit by significantly lowering blood glucose levels and supporting better weight loss than conventional therapies.[3]

Tirzepatide shows a stronger affinity for the GIP receptor compared to GLP-1, indicating a selective or biased mechanism of action. Research suggests it acts similarly to natural GIP at the receptor but enhances cAMP signaling and avoids receptor internalization seen with GLP-1. In lab studies, arrestin1 reduced insulin activity with GLP-1 but not with GIP or Tirzepatide, highlighting Tirzepatide's ability to sustain insulin production through biased agonism.[4]

Across five clinical trials, Tirzepatide was tested in three dosage levels (5, 10, and 15 mg), either as a standalone treatment or combined with other diabetes medications. Its effectiveness was compared with a placebo, semaglutide (a GLP-1 agonist), and long-acting insulin.

In one clinical trial, people who took 15 mg of Tirzepatide had a greater drop in HbA1c—about 16% more than those who took a placebo, and 15% more than those using insulin. This dose gave better results compared to other drugs, with slightly better HbA1c reduction than semaglutide, insulin degludec, and insulin glargine. Most people in the study were overweight, with average BMIs between 32 and 34.[5]

Those using Tirzepatide also lost more weight. On average, they lost about 15 pounds more than the placebo group, and 23 pounds more when taken along with insulin. People taking the highest dose had the best results, losing 12 pounds more than the semaglutide group, 29 more than the insulin degludec group, and 27 more than those taking insulin glargine. On the other hand, participants who only took insulin gained weight during the study.[6]

Another study also confirmed that Tirzepatide helped with weight loss better than a placebo. However, there were some limits in the research—such as a short testing period, not tracking body changes closely, and not including enough types of participants. Most individuals were dealing with both obesity and its related health issues, which affected the accuracy of the results.[7]

The most common side effects reported by participants taking Tirzepatide included nausea, vomiting, diarrhea, and constipation. Severe cases of low blood sugar were rare. Scientists are still evaluating the long-term safety of the drug, especially regarding heart-related risks such as stroke, heart attack, or death. Animal studies showed that Tirzepatide caused thyroid tumors in rats, but it's not confirmed whether the same occurs in humans. Therefore, the drug is not advised for individuals with a personal or family history of medullary thyroid cancer or multiple endocrine neoplasia type 2. Also, it hasn't been studied in patients with pancreatitis and is not recommended for those with type 1 diabetes.[8]

Tirzepatide's early development as a multifunctional drug showed promising results. It demonstrated strong ability to reduce blood sugar levels drastically while offering weight loss benefits—making it a valuable single therapeutic option for managing type 2 diabetes and obesity together.[9]

2) Insulin pump

Since the year 2000, various advancements in insulin pump technology have played a major role in improving blood sugar control. In recent years, insulin pumps have improved a lot. They now offer more flexible options for giving insulin, work better with glucose monitors, and deliver insulin more accurately. These updates also allow the pumps to connect easily with other health devices. Because of these changes, people with diabetes are finding it easier to control their blood sugar, and their HbA1c levels are improving.

However, as these devices become more advanced, they also become more complex. This can make it harder to check if they are safe and to protect the patient's personal data.

Between 2005 and 2009, there were nearly 56,000 reports of problems related to infusion pumps. About 45% of these were linked to insulin pumps.[10 11]

According to the FDA, insulin pump systems include the pump itself and all the tools that are used with it. These may either work together or help the pump function. This definition is slightly different from the one given for infusion pumps in 2010, which includes other connected devices tooI. It also does not consider any part of the infusion set.

A typical insulin pump system may consist of the insulin pump itself, a wireless remote control for the pump, a wireless glucose meter used to check blood sugar levels, and a CGM (Continuous Glucose Monitoring) device that continuously transmits glucose readings to the pump.[12]

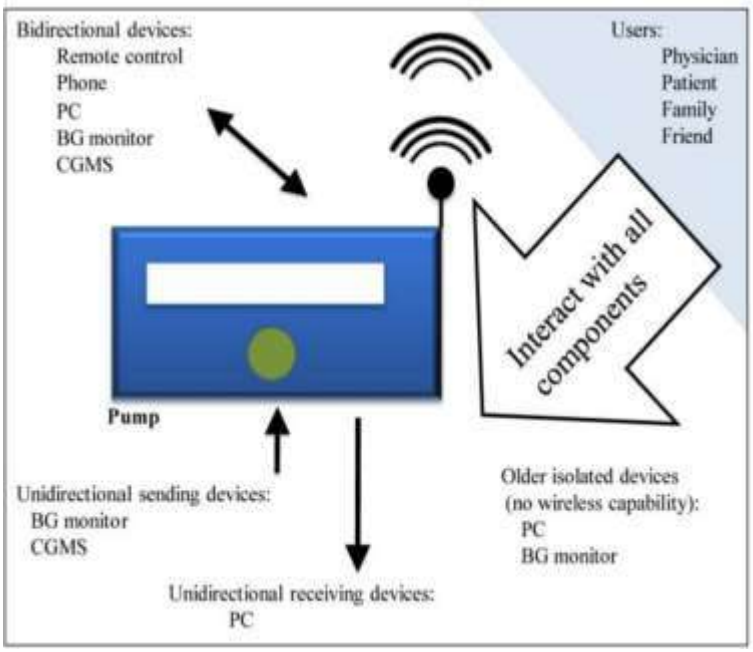

Fig.1 Insulin pump system

AYURVEDIC MANAGEMENT OF DIABETES MELLITUS

Rasausadhis, i.e., Ayurvedic organo-metallic formul ck to the 8th century AD during the era of the alchemist Nagarjuna, these formulations have played a significant role in diabetes management within the Rasashastra discipline. Modern processing methods such as Shodhana (purification), Marana (incineration), and others have enabled the transformation of metals and minerals into bioavailable and effective forms. Madhumeha (diabetes) is a multifactorial metabolic disorder resulting from complex gene-environment interactions. Given the alarming global rise in diabetes, as noted by WHO, this review compiles current evidence supporting the therapeutic efficacy of Rasausadhis for Madhumeha, thereby promoting further scientific inquiry.

Role of Rasausadhis in Managing Madhumeha: In Ayurvedic practice, numerous herbal and herbo-mineral formulations have shown efficacy in managing diabetes. Rasausadhis, owing to their rapid action and bioavailability, are frequently employed in complex or chronic cases of Madhumeha.[12]

Rasausadhis Commonly Used for Madhumeha (Diabetes): The following is a comprehensive list of Rasausadhis, their constituents, recommended dosage and adjuvants:-

Sr. No	Name of Rasaaushadhi's	Contained in classical text / Yog Sangrah	Dose	Anupana (Adjuvant)
1	Silajatu Rasayana	R. Rasatarangini, Yogratnakar, Rasayogsagar, Yogratnakar	500mg increased up to 1 gm	Honey, Sadaridrigana churna
2	Makaradhwaja Rasa	R. Rasaratnasamucchaya, Yogratnakar	125-250mg	Honey
3	Makaradhwaja Rasa	R. Rasaratnasamucchaya, Yogratnakar	125-250mg	Honey
4	Prawal Panchamrita Rasa	R. Rasayogsagar, Bhaishajya Ratnavali, Yogratnakar	125-250mg	Honey
5	Vanga Bhasma	R. Rasayogsagar, Bhaishajya Ratnavali	125-250mg	Honey, cold water
6	Naga Bhasma	R. Rasayogsagar, Bhaishajya Ratnavali, Yogratnakar	125-250mg	Honey, cow's milk
7	Yashada Bhasma	R. Rasayogsagar, Bhaishajya Ratnavali, Yogratnakar	125-250mg	Honey
8	Yashada Bhasma	R. Rasayogsagar, Bhaishajya Ratnavali, Yogratnakar	62.5-125mg	Honey, swarasa
9	Chandrakala Rasa	R. Siddha Yoga Sangrah	250mg	Honey, swarasa
10	Mahalakshmivilasa Rasa	R. Siddha Yoga Sangrah	125-250mg	Honey, butter, swarasa
11	Shrunga Bhasma	R. Siddha Yoga Sangrah	125-250mg	Honey
12	Swarnamakshika Bhasma	R. Siddha Yoga Sangrah	125-250mg	Honey
13	Swarn Vanga	R. Siddha Yoga Sangrah	125-250mg	Honey
14	Swarn Vanga	R. Siddha Yoga Sangrah	125-250mg	Honey
15	Vasantkusumakar Rasa (B.R.)	R. Siddha Yoga Sangrah	125-250mg	Honey, butter, swarasa
16	Chandraprabha Vati	R. Siddha Yoga Sangrah	250mg	Honey, water
17	Pramehaghna Vati	R. Siddha Yoga Sangrah	125-250mg	Honey, water
18	Pramehaghna Rasa	R. Siddha Yoga Sangrah	125-250mg	Honey, water
19	Vasantkusumakar Rasa	R. Siddha Yoga Sangrah	125-250mg	Honey, butter, swarasa
20	Vasantkusumakar Vati	R. Siddha Yoga Sangrah	250-500mg	Honey, butter, swarasa[13,14,15,16]

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