

EMERGING TRENDS IN THE MANAGEMENT OF TYPE 2 DIABETES MELLITUS

Sukh Chain¹, Smriti Bhargava², Rakesh Kumar Ola³

¹Senior specialist, M.D. General Medicine, S.K. Government medical college and Hospital, Sikar

²Associate professor, Department of Obstetrics and Gynecology, PDU Medical College, Churu

³Director, M.D. Medicine, D.M. Cardiology, Nobel Heart Centre, Nobel Care Hospital, Sikar

*Corresponding Author: Dr Rakesh Kumar Ola

Director, M.D. Medicine, D.M. Cardiology, Nobel Heart Centre, Nobel Care Hospital, Sikar

KEYWORDS

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ABSTRACT:

Background: Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder with increasing global prevalence. Recent advancements in pharmacotherapy, lifestyle interventions, and digital health technologies have transformed diabetes management. This study aimed to evaluate emerging trends in T2DM treatment over one year.

Methods: A prospective observational study was conducted on 200 patients with T2DM from January 1, 2024, to December 31, 2024. Data on demographic characteristics, pharmacological treatments, lifestyle modifications, and digital health interventions were collected. Changes in glycemic control, treatment adherence, and diabetes-related complications were analyzed using SPSS version 26.0. Statistical significance was set at $p < 0.05$.

Results: The use of Sodium-Glucose Co-Transporter 2 (SGLT2) inhibitors (10% to 22.5%) and Glucagon-Like Peptide-1 (GLP-1) receptor agonists (7.5% to 15%) significantly increased, while insulin therapy (12.5% to 10%) and combination therapy with three or more drugs (20% to 7.5%) declined. The adoption of digital health tools, including continuous glucose monitoring (CGM) (5% to 20%), mobile applications (7.5% to 30%), and telemedicine (12.5% to 45%), showed a marked rise. Lifestyle modifications, such as regular exercise (25% to 55%) and diet modifications (20% to 47.5%), also improved. Glycemic control significantly enhanced, with mean HbA1c reducing from 8.2% to 7.1% ($p < 0.001$). Diabetes-related complications, including neuropathy, retinopathy, and nephropathy, decreased by 5–7.5%.

Conclusion: Emerging trends in T2DM management indicate a shift towards newer pharmacological agents, increased use of digital health interventions, and enhanced lifestyle modifications. These advancements contribute to improved glycemic control and reduced complications, emphasizing the need for patient-centered and technology-driven approaches to diabetes care.

INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder characterized by insulin resistance and relative insulin deficiency, leading to persistent hyperglycemia. It is a significant global health challenge, with an estimated 537 million adults affected worldwide in 2021, a number projected to rise to 783 million by 2045. Uncontrolled diabetes contributes to severe complications, including cardiovascular disease, nephropathy, neuropathy, and retinopathy. Effective management of T2DM involves pharmacological interventions, lifestyle modifications, and emerging technological advancements aimed at improving glycemic control and reducing complications.

Traditionally, treatment for T2DM has relied on oral hypoglycemic agents (OHAs) such as metformin and sulfonylureas, as well as insulin therapy for advanced cases. However, recent developments have introduced newer drug classes, including Sodium-Glucose Co-Transporter

2 (SGLT2) inhibitors, Dipeptidyl Peptidase-4 (DPP-4) inhibitors, and Glucagon-Like Peptide-1 (GLP-1) receptor agonists, which have demonstrated superior efficacy in glycemic control and cardiovascular protection.

Alongside pharmacotherapy, non-pharmacological approaches have gained prominence. Lifestyle interventions, including structured exercise programs and dietary modifications such as low-carbohydrate diets and intermittent fasting, have shown promising results in improving insulin sensitivity and reducing HbA1c levels. Furthermore, digital health interventions, including mobile applications, continuous glucose monitoring (CGM), and telemedicine, are revolutionizing diabetes management by enhancing patient adherence and engagement.

Given the rapid evolution of diabetes management strategies, this prospective observational study aims to assess emerging trends in treating T2DM. The study will analyze shifts in pharmacological therapies, the adoption of digital health tools, and the impact of lifestyle interventions over a one-year period. Understanding these trends will provide valuable insights for optimizing diabetes care and improving patient outcomes.

MATERIAL AND METHODS

Study Design

This prospective observational study was conducted to assess emerging trends in managing Type 2 Diabetes Mellitus (T2DM).

Study Duration

The study will be conducted from **January 1, 2024, to December 31, 2024.**

Study Population

A total of **200 patients** diagnosed with **Type 2 Diabetes Mellitus (T2DM)** will be included in the study.

Inclusion Criteria

- Patients aged **≥18 years** diagnosed with T2DM.
- Patients receiving **any form of anti-diabetic therapy**, including oral hypoglycemic agents (OHAs), insulin, or emerging treatment modalities.
- Patients willing to provide **informed consent**.

Exclusion Criteria

- Patients with **Type 1 Diabetes Mellitus**.
- Patients with **severe comorbid conditions** such as advanced malignancies or end-stage renal disease.
- Pregnant or lactating women.
- Patients unwilling to participate in the study.

Data Collection

Data will be collected using a **structured proforma**, which includes:

1. **Demographic details** (age, sex, BMI, socioeconomic status).
2. **Medical history** (duration of diabetes, family history, comorbidities).
3. **Current diabetes management** strategies:
 - a. Use of OHAs (Metformin, SGLT2 inhibitors, DPP-4 inhibitors, GLP-1 receptor agonists, etc.).
 - b. Insulin therapy.
 - c. Lifestyle interventions (dietary patterns, exercise regimen).
 - d. Digital health interventions (telemedicine, mobile applications).
4. **Laboratory parameters:** HbA1c, fasting blood glucose (FBG), postprandial blood glucose (PPBG), lipid profile, and renal function tests.
5. **Complications assessment:** Diabetic neuropathy, nephropathy, retinopathy, or macrovascular complications.

Statistical Analysis

- Data will be analyzed using **SPSS version 26.0**.
- Descriptive statistics (mean, standard deviation, percentage) will be used for baseline characteristics.
- Paired t-tests and ANOVA will be used for assessing changes in glycemic control.
- Logistic regression analysis will evaluate factors influencing treatment outcomes.
- A **p-value <0.05** will be considered statistically significant.

RESULTS AND OBSERVATIONS;

Table; 1 Baseline Characteristics of Study Participants

| Characteristic | Mean ± SD / N (%) |
|------------------------------|----------------------|
| Age (years) | 54.3 ± 9.8 |
| Gender (Male/Female) | 110 (55%) / 90 (45%) |
| BMI (kg/m ²) | 28.6 ± 4.2 |
| Duration of Diabetes (years) | 7.2 ± 3.5 |
| Family History of Diabetes | 126 (63%) |
| Hypertension | 98 (49%) |
| Dyslipidemia | 115 (57.5%) |
| Smoking Status (Smokers) | 40 (20%) |
| Alcohol Consumption | 35 (17.5%) |

Table; 2 Trends in Diabetes Management

A. Pharmacological Treatment

| Treatment Type | Baseline (N = 200) | After 1 Year (N = 200) | % Change |
|--------------------------------|--------------------|------------------------|----------|
| Metformin Monotherapy | 65 (32.5%) | 50 (25%) | ↓ 7.5% |
| Metformin + SGLT2 Inhibitors | 20 (10%) | 45 (22.5%) | ↑ 12.5% |
| Metformin + DPP-4 Inhibitors | 35 (17.5%) | 40 (20%) | ↑ 2.5% |
| GLP-1 Receptor Agonists | 15 (7.5%) | 30 (15%) | ↑ 7.5% |
| Insulin Therapy | 25 (12.5%) | 20 (10%) | ↓ 2.5% |
| Combination Therapy (≥3 drugs) | 40 (20%) | 15 (7.5%) | ↓ 12.5% |

B. Use of Technology in Diabetes Management

| Intervention | Baseline Usage | Usage After 1 Year | % Increase |
|-------------------------------------|----------------|--------------------|------------|
| Continuous Glucose Monitoring (CGM) | 10 (5%) | 40 (20%) | ↑ 15% |
| Mobile Apps for Diabetes Tracking | 15 (7.5%) | 60 (30%) | ↑ 22.5% |
| Telemedicine Consultations | 25 (12.5%) | 90 (45%) | ↑ 32.5% |

Table; 3 Changes in Glycemic Control

| Parameter | Baseline | After 1 Year | p-value |
|------------------------------------|-----------|--------------|---------|
| HbA1c (%) | 8.2 ± 1.1 | 7.1 ± 0.9 | <0.001 |
| Fasting Blood Glucose (mg/dL) | 160 ± 25 | 130 ± 20 | <0.001 |
| Postprandial Blood Glucose (mg/dL) | 210 ± 30 | 170 ± 25 | <0.001 |

Table 3 presents the improvements in glycemic control after one year of intervention. HbA1c levels decreased significantly from 8.2% to 7.1% (p < 0.001), indicating better long-term

glucose regulation. Fasting blood glucose levels reduced from 160 mg/dL to 130 mg/dL, while postprandial blood glucose levels dropped from 210 mg/dL to 170 mg/dL, both with statistically significant p-values (<0.001). These results suggest that the implemented management strategies, including medication, lifestyle modifications, and patient education, were effective in improving overall glycemic control in individuals with type 2 diabetes mellitus.

Table; 4. Impact of Lifestyle Modifications

| Lifestyle Factor | Baseline | After 1 Year | % Change |
|---|----------|--------------|----------|
| Regular Exercise | 50 (25%) | 110 (55%) | ↑ 30% |
| Diet Modification (Low-carb/Intermittent Fasting) | 40 (20%) | 95 (47.5%) | ↑ 27.5% |

Table 4 highlights the positive impact of lifestyle modifications over one year. The proportion of participants engaging in regular exercise increased from 25% to 55%, reflecting a 30% improvement. Similarly, adherence to diet modifications, such as low-carb diets or intermittent fasting, rose from 20% to 47.5%, showing a 27.5% increase. These findings suggest that lifestyle interventions played a crucial role in improving diabetes management and overall health outcomes in the study population.

Table;5 Reduction in Diabetes-Related Complications

| Complication | Baseline (N=200) | After 1 Year (N=200) | % Reduction |
|----------------------|------------------|----------------------|-------------|
| Diabetic Neuropathy | 45 (22.5%) | 30 (15%) | ↓ 7.5% |
| Diabetic Retinopathy | 35 (17.5%) | 20 (10%) | ↓ 7.5% |
| Diabetic Nephropathy | 20 (10%) | 10 (5%) | ↓ 5% |

Table 5 highlights the reduction in diabetes-related complications over one year of follow-up. Diabetic neuropathy cases decreased from 22.5% to 15%, indicating a 7.5% reduction, likely due to better glycemic control and early intervention strategies. Similarly, diabetic retinopathy cases declined from 17.5% to 10%, reflecting improved screening and management practices. Diabetic nephropathy also showed a 5% reduction, suggesting the benefits of optimized pharmacotherapy, lifestyle modifications, and regular monitoring in preventing disease progression. These findings underscore the importance of a comprehensive approach to T2DM management in minimizing long-term complications.

DISCUSSION

The present study analyzed emerging trends in the management of Type 2 Diabetes Mellitus (T2DM) over one year, focusing on pharmacological advancements, technological interventions, and lifestyle modifications. Our findings suggest a paradigm shift towards the utilization of newer anti-diabetic agents and digital health tools, along with a greater emphasis on structured lifestyle interventions.

Trends in Pharmacological Therapy

The study observed a decline in the use of conventional monotherapy with metformin (32.5% to 25%) and an increasing preference for combination therapies incorporating newer drug classes such as Sodium-Glucose Co-Transporter 2 (SGLT2) inhibitors and Glucagon-Like Peptide-1 (GLP-1) receptor agonists. The rise in SGLT2 inhibitor usage (10% to 22.5%) aligns with current evidence suggesting their dual benefits in glycemic control and cardiovascular protection [8]. Additionally, the increased adoption of GLP-1 receptor agonists (7.5% to 15%) underscores their role in weight management and improved beta-cell function [9]. The

reduction in insulin dependency (12.5% to 10%) reflects a growing preference for oral and non-insulin injectable therapies with lower risks of hypoglycemia and weight gain [10].

Impact of Technological Interventions

A substantial increase was observed in the adoption of digital health tools, with continuous glucose monitoring (CGM) usage rising from 5% to 20%, and telemedicine consultations increasing from 12.5% to 45%. Previous studies highlight the role of CGM in improving glycemic variability and reducing HbA1c levels by facilitating real-time feedback and adherence to treatment regimens [11]. Similarly, telemedicine interventions have proven effective in enhancing patient education, adherence, and accessibility to specialist care, especially in remote and underserved regions [12].

Effectiveness of Lifestyle Modifications

Lifestyle interventions, including regular exercise and dietary modifications, demonstrated significant improvement in glycemic outcomes. The proportion of patients adhering to structured exercise programs increased from 25% to 55%, while those adopting low-carbohydrate diets or intermittent fasting rose from 20% to 47.5%. Previous trials, such as the Diabetes Remission Clinical Trial (DiRECT), have demonstrated that dietary interventions can lead to diabetes remission by improving insulin sensitivity and pancreatic beta-cell function [13].

Glycemic Control and Reduction in Complications

Improvements in glycemic control were evidenced by a significant reduction in HbA1c (8.2% to 7.1%, $p < 0.001$), fasting blood glucose (160 mg/dL to 130 mg/dL, $p < 0.001$), and postprandial glucose levels (210 mg/dL to 170 mg/dL, $p < 0.001$). These findings support prior studies that emphasize the effectiveness of integrated pharmacological and non-pharmacological approaches in diabetes management [14]. Furthermore, the observed reduction in diabetes-related complications, including neuropathy (22.5% to 15%), retinopathy (17.5% to 10%), and nephropathy (10% to 5%), reinforces the benefits of early intervention and optimized management strategies [15].

Limitations and Future Directions

Despite its strengths, this study has certain limitations. The relatively short follow-up period of one year limits the assessment of long-term outcomes. Additionally, adherence to lifestyle modifications and digital interventions may have been influenced by external factors such as socioeconomic status and healthcare accessibility. Future research should focus on long-term, multi-center studies to validate these findings and explore additional emerging therapies, including precision medicine approaches and artificial intelligence-driven diabetes

CONCLUSION;

Emerging trends in T2DM management, including newer pharmacological agents, digital health tools, and lifestyle modifications, have significantly improved glycemic control and reduced complications. Increased use of SGLT2 inhibitors, GLP-1 receptor agonists, and digital interventions like CGM and telemedicine have enhanced patient outcomes. A multidisciplinary approach integrating these advancements is crucial for optimizing diabetes care and long-term disease management.

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