Pravara Med Rev; June 2024, 16 (02), 42 - 46
DOI: 10.36848/PMR/2024/00011150777

Original article

Study of Role of Continuous Glucose Monitoring Systems in Optimizing Insulin Therapy for Type 1 Diabetes Patients

[1]Dr. Nitin Sukadev Hivale, [2]Dr. Pallavi Pradip Gaikwad, [3]Dr. Firoz Mubarak Tadavi*

[1]Ex Assistant Professor, SRTR, Medical College, Ambajogai
[2]Ex Senior Resident, Tata Memorial Hospital, Mumbai
[3]Professor (Additional), Department of Pharmacology, LTMMC & GH, Sion, Mumbai
Corresponding author: Dr. Firoz Mubarak Tadavi

Abstract:
Background: Continuous glucose monitoring (CGM) systems have emerged as a promising tool for optimizing insulin therapy in Type 1 diabetes (T1D) management.
Methods: A one-year prospective observational study was conducted with 50 T1D patients to assess the impact of CGM-guided insulin therapy optimization on glycemic control and patient outcomes. Baseline characteristics, including HbA1c levels, CGM metrics, and insulin regimen, were recorded. Changes in glycemic parameters, insulin therapy adjustments, and patient-reported outcomes were evaluated.
Results: CGM-guided insulin therapy optimization led to significant improvements in glycemic control, as evidenced by reductions in HbA1c levels ($p < 0.05$) and increased time spent within the target glucose range ($p < 0.05$). The frequency of hypoglycemia events decreased substantially, with fewer severe, symptomatic, and nocturnal hypoglycemic episodes ($p < 0.05$). Insulin therapy adjustments, including reductions in total daily, basal, and bolus insulin doses ($p < 0.05$), were observed. Patients reported high levels of treatment satisfaction, improved quality of life, and enhanced device adherence.
Conclusion: CGM-guided insulin therapy optimization improves glycemic control, reduces hypoglycemia events, and enhances patient-reported outcomes in T1D management. Keywords: Type 1 diabetes, continuous glucose monitoring, insulin therapy optimization.

Introduction:
Type 1 diabetes (T1D) is a chronic autoimmune condition characterized by the body's inability to produce insulin, a hormone vital for regulating blood sugar levels. Managing T1D requires a delicate balance of insulin administration, diet, exercise, and monitoring to prevent complications such as hyperglycemia and hypoglycemia. (1) Historically, self-monitoring of blood glucose (SMBG) has been the cornerstone of diabetes management. However, the emergence of continuous glucose monitoring (CGM) systems has revolutionized how individuals with T1D manage their condition.(2)
CGM systems offer real-time insights into glucose levels, providing users with continuous data on their glycemic status, trends, and patterns. This technology not only reduces the burden of fingerstick testing but also allows for more precise adjustments to insulin therapy based on individualized data. By providing alerts for impending hypo- and hyperglycemia, CGM systems empower patients and healthcare providers to proactively intervene and optimize insulin therapy, thereby improving glycemic control and quality of life.(3)
Our study aims to explore the pivotal role of CGM systems in optimizing insulin therapy for T1D patients. By synthesizing existing literature and clinical evidence, we seek to elucidate the benefits, challenges, and future implications of integrating CGM technology into diabetes management protocols. (4) Understanding the impact of CGM on insulin therapy optimization is crucial for advancing personalized diabetes care and enhancing outcomes for individuals living with T1D.(5)
Methodology:
Our study employed a prospective observational design to investigate the role of continuous glucose monitoring (CGM) systems in optimizing insulin therapy for patients diagnosed with Type 1 diabetes

(T1D). A sample size of 50 patients was recruited from endocrinology clinics across diverse demographics. The inclusion criteria comprised individuals aged 18-65 years diagnosed with T1D for at least one year and currently using insulin therapy. Patients with comorbidities affecting glucose metabolism or contraindications to CGM use were excluded from the study.

Baseline data including demographic information, duration of diabetes, insulin regimen, and glycemic control metrics were collected for each participant. The study duration spanned one year, during which participants were provided with CGM systems and received standardized education on device use, interpretation of glucose data, and insulin adjustment principles. Throughout the study period, patients were instructed to wear the CGM sensor continuously and record any changes in insulin dosing, dietary habits, physical activity, or symptomatic hypoglycemia.

Continuous glucose data collected from the CGM systems were analyzed to assess glycemic patterns, variability, time in target range, and frequency of hypo- and hyperglycemia episodes. Insulin therapy adjustments, including changes in basal and bolus insulin doses, were made based on CGM data interpretation and clinical judgment by healthcare providers. The primary outcomes included improvements in glycemic control parameters such as HbA1c levels, reduction in hypoglycemic events, and patient-reported outcomes related to quality of life and treatment satisfaction. Statistical analyses were conducted using appropriate methods to evaluate the impact of CGM-guided insulin therapy optimization over the one-year study period.

Results:

Table 1: Baseline Characteristics of Study Participants (n=50)

Characteristic	**Mean ± SD or Frequency (%)**
Age (years)	38.2 ± 9.4
Gender (Male/Female)	28 (56%) / 22 (44%)
Duration of T1D (years)	15.6 ± 7.2
Insulin Regimen	
- Multiple Daily Injections (MDI)	35 (70%)
- Insulin Pump	15 (30%)
HbA1c (%)	8.3 ± 1.1
BMI (kg/m²)	26.4 ± 3.5
Baseline CGM Metrics	
- Time in Range (%)	54.8 ± 9.6
- Time Below Range (%)	5.2 ± 2.3
- Time Above Range (%)	40.0 ± 8.5

Table 2: Changes in Glycemic Control Parameters after One Year of CGM-guided Insulin Therapy Optimization

Parameter	Baseline	12-Month Follow-up
HbA1c (%)	8.3 ± 1.1	7.6 ± 0.9*
Time in Range (%)	54.8 ± 9.6	72.3 ± 6.8*
Time Below Range (%)	5.2 ± 2.3	3.1 ± 1.5*
Time Above Range (%)	40.0 ± 8.5	24.6 ± 7.2*
Mean Glucose (mg/dL)	180 ± 25	150 ± 20*

*p < 0.05 compared to baseline

Table 3: Frequency of Hypoglycemia Events (≤70 mg/dL) Before and After CGM-guided Insulin Therapy Optimization

Hypoglycemia Events	Baseline (events/year)	12-Month Follow-up (events/year)
Severe Hypoglycemia	0.8 ± 0.3	0.4 ± 0.2*
Symptomatic Hypoglycemia	15.5 ± 4.2	8.2 ± 3.5*
Nocturnal Hypoglycemia	6.2 ± 1.5	3.1 ± 1.2*

*p < 0.05 compared to baseline

Table 4: Insulin Therapy Adjustments Over One Year of CGM-guided Optimization

Insulin Parameter	Baseline (units/day)	12-Month Follow-up (units/day)
Total Daily Insulin	50.6 ± 8.2	45.2 ± 7.5*
Basal Insulin	26.8 ± 5.6	24.1 ± 4.8*
Bolus Insulin	23.8 ± 4.7	21.1 ± 3.9*

*p < 0.05 compared to baseline

Table 5: Patient-reported Outcomes after One Year of CGM-guided Insulin Therapy Optimization

Outcome Measure	Mean Score (0-10)
Treatment Satisfaction	8.7 ± 1.2
Quality of Life	7.9 ± 1.4
Device Adherence	9.2 ± 0.8

Discussion:

The findings of our study provide valuable insights into the role of continuous glucose monitoring (CGM) systems in optimizing insulin therapy for individuals with Type 1 diabetes (T1D). Overall, the results demonstrate significant improvements in glycemic control, reduction in hypoglycemia events, and positive patient-reported outcomes following one year of CGM-guided insulin therapy optimization.(5)

One of the key observations from this study is the substantial improvement in glycemic control parameters after implementing CGM-guided insulin therapy optimization. The reduction in HbA1c levels from baseline (8.3 ± 1.1%) to the 12-month follow-up (7.6 ± 0.9%) reflects a clinically meaningful improvement in long-term glucose management. This decrease in HbA1c is consistent with previous research demonstrating the effectiveness of CGM in enhancing glycemic control among T1D patients. The increase in time spent within the target glucose range (54.8 ± 9.6% to 72.3 ± 6.8%) further supports the notion that CGM facilitates tighter glycemic control by providing real-time feedback and enabling timely intervention to prevent glucose excursions.(6)

Moreover, the significant reduction in the frequency of hypoglycemia events, including severe, symptomatic, and nocturnal hypoglycemia, highlights the impact of CGM-guided insulin therapy optimization on mitigating hypoglycemic episodes. This is particularly noteworthy given the considerable burden that hypoglycemia poses on T1D management and patient well-being. The ability of CGM to detect impending hypoglycemia and provide early warnings allows for proactive adjustments to insulin dosing, thereby reducing the risk of hypoglycemic events without compromising glycemic control.(7)

The observed changes in insulin therapy parameters further underscore the role of CGM in facilitating personalized insulin dose adjustments tailored to individual glucose patterns and insulin requirements. The decrease in total daily insulin dose, as well as basal and bolus insulin doses, reflects a more refined and optimized insulin regimen achieved through CGM-guided therapy. By providing continuous glucose data and trend analysis, CGM empowers patients and healthcare providers to make informed decisions regarding insulin dosing, resulting in improved glycemic outcomes while minimizing the risk of insulin-induced hypoglycemia.(8)

The positive patient-reported outcomes, including high levels of treatment satisfaction, improved quality of life, and enhanced device adherence, further support the clinical benefits of CGM-guided insulin therapy optimization. Patients reported greater confidence in managing their diabetes, reduced fear of hypoglycemia, and increased satisfaction with their overall treatment experience. This aligns with previous research highlighting the psychosocial benefits of CGM, such as reduced diabetes-related distress and improved treatment adherence, which are essential for long-term diabetes management success.

While the results of this study are promising, several limitations warrant consideration. Firstly, the study design was observational in nature, limiting the ability to establish causality between CGM use and improved outcomes. Future randomized controlled trials are needed to validate these findings and elucidate the specific mechanisms underlying the observed benefits of CGM-guided insulin therapy optimization. Additionally, the study sample consisted of a relatively small cohort of 50 patients, which may limit the generalizability of the results to broader T1D populations. Larger-scale studies with diverse patient demographics are warranted to confirm the reproducibility of these findings across different settings and patient populations.

The study duration of one year may not capture the long-term effects of CGM-guided insulin therapy optimization on glycemic control and clinical outcomes. Longitudinal studies with extended follow-up periods are needed to assess the sustainability of the observed improvements and to evaluate the impact on long-term diabetes-related complications, such as cardiovascular disease and microvascular complications.

Conclusion:

In conclusion, our study provides evidence supporting the efficacy of CGM systems in optimizing insulin therapy and improving glycemic control among individuals with Type 1 diabetes. The results highlight the importance of clinical benefits of CGM-guided therapy, including enhanced glycemic control, reduced hypoglycemia events, and positive patient-reported outcomes. As CGM technology continues to evolve and become more accessible, its integration into routine diabetes management protocols holds great promise for improving outcomes and enhancing quality of life for individuals living with Type 1 diabetes.

References:

1. Rodbard, D. Continuous glucose monitoring: a review of recent studies demonstrating improved glycemic outcomes. *Diabetes Technol Ther* 2017;**19**:S25–37
2. Riddlesworth T, Price D, Cohen N, Beck RW. Hypoglycemic event frequency and the effect of continuous glucose monitoring in adults with type 1 diabetes using multiple daily insulin injections. *Diabetes Ther*. 2017; (4):947–951. PMID: 28616804; PMCID: PMC5544617. doi: 10.1007/s13300-017-0281-4

3. Beck RW, Riddlesworth T, Ruedy K, et al.; DIAMOND Study Group. Effect of continuous glucose monitoring on glycemic control in adults with type 1 diabetes using insulin injections: the DIAMOND randomized clinical trial. *JAMA*. 2017;**317**(4):371–378. PMID: 28118453.
4. Polonsky WH, Hessler D, Ruedy KJ, Beck RW; DIAMOND Study Group. The Impact of continuous glucose monitoring on markers of quality of life in adults with type 1 diabetes: further findings from the DIAMOND randomized clinical trial. *Diabetes Care*. 2017;**40**(6):736–741. PMID: 28389582. doi: 10.2337/dc17-0133
5. El Sayed NA, Aleppo G, Aroda VR, et al. American Diabetes Association. 7. Diabetes technology: standards of care in diabetes-2023. *Diabetes Care*. 2023;**46**(Suppl. 1):S111–S127.
6. Peters AL, Ahmann AJ, Battelino T, et al. Diabetes technology—continuous subcutaneous insulin infusion therapy and continuous glucose monitoring in adults: an endocrine society clinical practice guideline. *J Clin Endocrinol Metabol*. 2016;**101**(11):3922–3937.
7. Grunberger G, Sherr J, Allende M, et al. American association of clinical endocrinology clinical practice guideline: the use of advanced technology in the management of persons with diabetes mellitus. *Endocr Pract*. 2021;**27**:505e537.
8. Christiansen MP, Klaff LJ, Brazg R, et al. A prospective multicenter evaluation of the accuracy of a novel implanted continuous glucose sensor: PRECISE II. *Diabetes Technol Ther*. 2018;**20**(3):197–206. PMID: 29381090; PMCID: PMC5867508.