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Case Report

Optimizing glycaemic control in a complex T2DM patient using basal-bolus insulin and continuous glucose monitoring

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Abstract

This case study presents the management of a 65-year-old female with Type 2 Diabetes Mellitus (T2DM), renal impairment and hypertension who experienced significant glycaemic variability and recurrent hypoglycaemic events. Due to poor control of a premixed insulin regimen, a shift to basal-bolus insulin therapy combined with intermittent continuous glucose monitoring (CGM) was implemented. This approach improved glycaemic control, increased percentage time in target range (TIR), and reduced hypoglycemia, highlighting the effectiveness of personalized insulin management and patient engagement in glycaemic monitoring.

Keywords: glycaemic variability, CGM, hypoglycemia, premixed insulin, basal-bolus insulin.

Introduction

Glycemic variability (GV) refers to fluctuations in blood glucose levels, including episodes of hyperglycemia and hypoglycemia over time [1]. In people with type-2 diabetes mellitus (T2DM), GV has been increasingly recognized as an independent risk factor for diabetes-related complications [2]. Studies suggest that greater GV is associated with increased levels of inflammatory markers and a higher risk of microvascular and macrovascular complications [3].

Premixed insulin regimens, often used in T2DM, may contribute to higher GV due to their fixed ratios of basal and prandial components, which may not align with an individual's specific glycemic needs throughout the day [4]. Continuous glucose monitoring (CGM) has emerged as a valuable tool for assessing GV in real time, enabling healthcare providers to identify patterns and optimize therapeutic strategies. Tailored insulin regimens, such as basal-bolus therapy, have shown promise in reducing GV and improving time in range (TIR), thereby mitigating the risks associated with glucose fluctuations [5].

Here, we report a case of an older woman with T2DM on linagliptin and a premixed insulin regimen with high GV and frequent hypoglycemic events leading to falls. The transition from a premixed insulin regimen to a basal-bolus regimen supported by intermittent CGM led to enhanced glycemic stability and reduced hypoglycemic episodes.

Case presentation

Patient profile

A 65-year-old female had a longstanding history of T2DM spanning over 15 years. In addition to diabetes, she also had comorbid hypertension and moderate renal impairment, with an estimated glomerular filtration rate (eGFR) of 50 mL/min/1.73m [2]. Her cardiac profile revealed left ventricular hypertrophy and

a reduced left ventricular ejection fraction (LVEF) of 40%. At the time of her first visit, she was on cilnidipine 10 mg, metoprolol 50 mg, and chlorthalidone 12.5 mg once daily for the management of her hypertension. For the management of her T2DM, she was prescribed linagliptin and premixed 30/70 insulin (25 units before breakfast and 15 units before dinner. She also received statin and aspirin treatment.

Clinical challenges

The patient exhibited poor glycemic control, with an HbA1c of approximately 9% over the past year, along with frequent hypoglycemic episodes that resulted in physical falls, albeit without fractures.

Intervention and management

It was decided to evaluate glycemic variability with CGM for the ongoing treatment regimen of oral antidiabetic drug (OAD) and premixed insulin regimen for 14 days to understand her glycemic patterns better. CGM was recommended and introduced to her. She consented to the use of CGM, and the FreeStyle Libre Pro 1.0.6 system was utilized for this purpose. She received instructions for the proper use of the device, including sensor application, calibration procedures, and data interpretation.

Insulin dosing was adjusted based on intermittent CGM data, which the patient shared via WhatsApp. This communication and data-sharing approach allowed for timely adjustments to insulin doses.

Average blood glucose level, percentage TIR percentage time above target range (TAR) and percentage time below target range (TBR) were determined. The low glucose events, CGM sensor data capture and number of CGM scans per day were also evaluated. In this patient TIR was kept between 80–140 mg/dl.

Results

CGM pattern for OAD and premixed 30/70 insulin regimen

The CGM data collected for the evaluation of glycemic variability due to OAD and premixed 30/70 insulin regimen from 26 November to 09 December 2021 has been provided in Figure 1. The estimated A1c during this period was 6.6% (49 mmol/mol), with an average glucose level of 143 mg/dL. She spent 44% of the time above the target glucose range, 33% of the time within the target range, and 23% of the time below the target range. Notably, there were 16 low-glucose events, with an average duration of 200 minutes. The CGM sensor captured 95% of the data during the monitoring period, and the patient performed an average of 17 scans per day.

Higher glycemic variability and a higher frequency of hypoglycemic events were noticed with the ongoing treatment regimen of OAD and premixed 30/70 insulin. Therefore, it was decided to replace the premixed 30/70 insulin regimen with a basal-bolus regimen of Detemir and Lispro.

CGM pattern for OAD and basal-bolus regimen of Detemir and Lispro evaluated at first follow-up

The CGM data collected to evaluate glycemic variability due to basal-bolus regimen of insulin Detemir and Lispro from 09 December – 18 December 2021 has been provided in Figure 2. During this period, the estimated A1c was 6.4% (46 mmol/mol), with an average glucose level of 138 mg/dL. The patient spent 41% of the time above the target glucose range, 40% of the time within the target range, and 19% of the time below the target range. A total of 11 low-glucose events were recorded, with an average duration of 171 minutes. The CGM sensor captured 85% of the data during the monitoring period, and the patient performed an average of 16 scans per day.

After visible improvements in the glycemic variability and low rates of hypoglycemic events, it was decided to continue with the changed drug regimen with further CGM monitoring.

CGM pattern for OAD and basal-bolus regimen of Detemir and Lispro evaluated at the second follow-up

The CGM data collected from 04 January to 17 January 2022 at the second follow-up visit has been provided in Figure 3. During this period, the estimated A1c improved to 5.7% (39 mmol/mol), with an average glucose level of 118 mg/dL. The patient spent 19% of the time above the target glucose range, 79% of the time within the target range, and only 2% of the time below the target range. A total of 5 low-glucose events were recorded, with an average duration of 88 minutes. The CGM sensor captured 93% of the data during the monitoring period, and the patient performed an average of 19 scans per day. These results highlight a trend towards reduced glycemic fluctuations, with a marked increase in the time spent within the target range and

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low rates of hypoglycemia. Enhanced patient engagement was also observed, which is evident from increased self-monitoring and active participation.

Table 1 shows the progress in glucose management, showing a trend toward improved glycemic control and reduced GV over time alongside a decrease in hypoglycemic events and their average duration. The increased patient involvement was also observed.

Discussion

This case underscores the effectiveness of transitioning from premixed insulin to a basal-bolus regimen for people with T2DM who struggle with glycaemic control and hypoglycemia. The CGM data collected over three periods demonstrate a progressive improvement in glycemic control following the transition from a premixed 30/70 insulin regimen to a basal-bolus regimen with insulin Detemir and Lispro.

Basal-bolus insulin therapy, consisting of long-acting (basal) and rapid-acting (bolus) insulins, has emerged as a preferred approach for managing T2DM in patients with significant GV [6]. This regimen mimics physiological insulin secretion more closely, addressing both fasting glucose levels and postprandial excursions. Compared to premixed insulin regimens, basal-bolus therapy offers greater flexibility in dose adjustments, allowing personalized control of glucose levels and reducing fluctuations throughout the day [7].

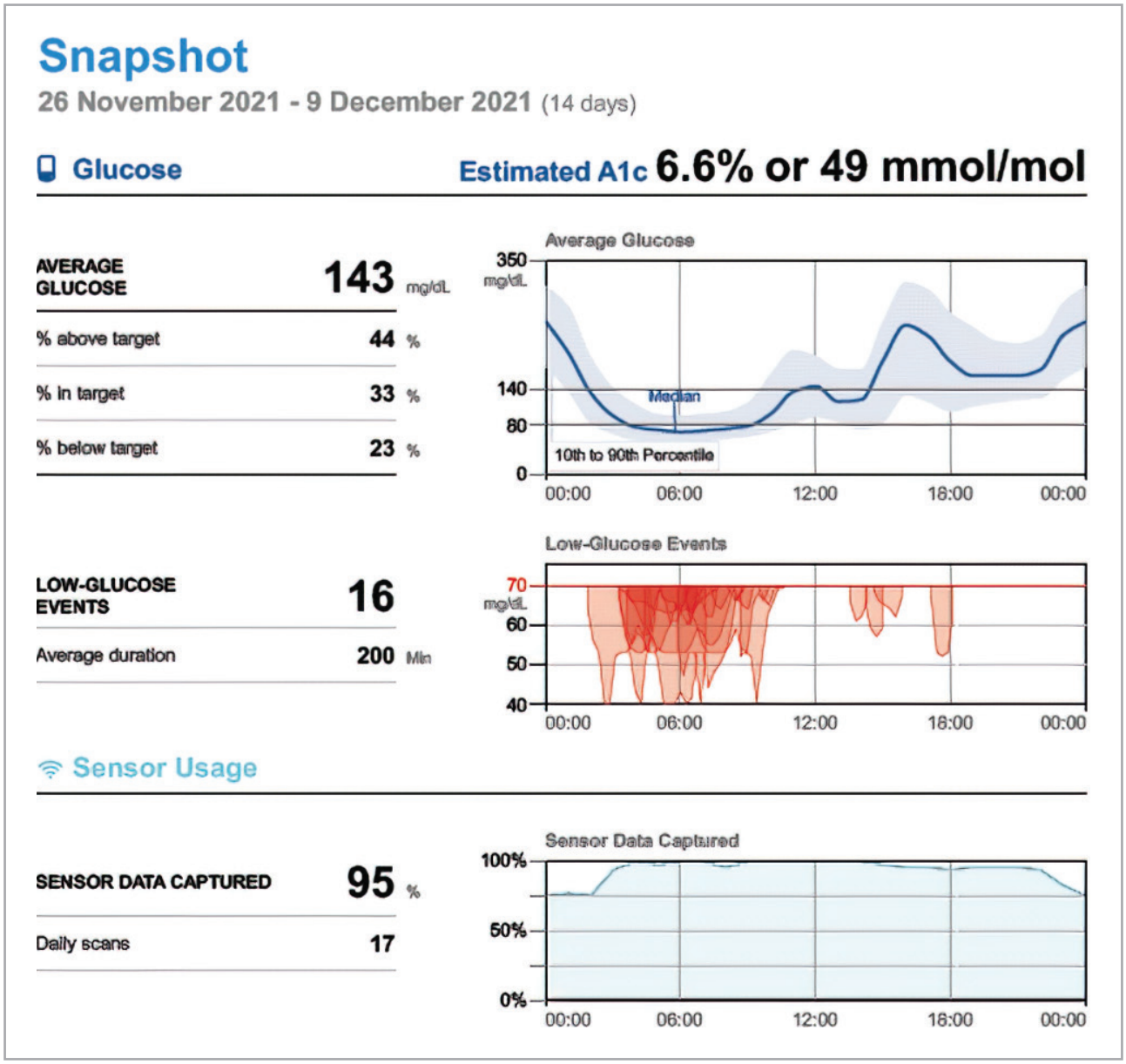

Figure 1: CGM pattern for OAD and premixed 30/70 insulin regimen [26 November – 09 December 2021 (14 days)].

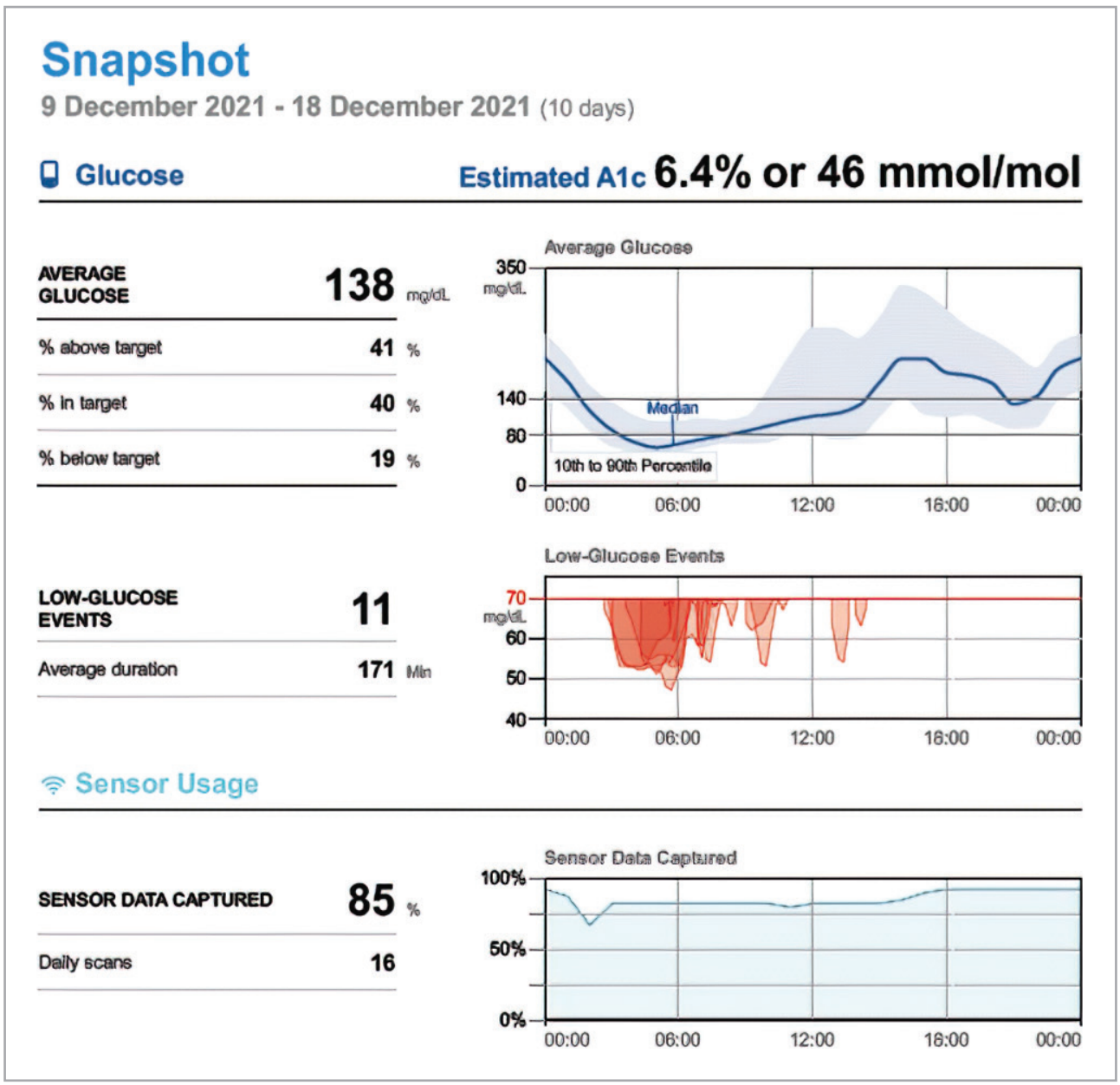

Figure 2: CGM pattern for OAD and basal-bolus regimen of Detemir and Lispro at first follow-up [09 December – 18 December 2021 (10 days)].

CGM, either from real-time use or intermittently viewed, has beneficial effects on metabolic control, reducing risks of hyperglycemia and hypoglycemia and decreasing GV, mean glucose concentration, and HbA1c values [8]. The international consensus on the use of CGM highlighted the importance of assessing and reporting the percentages of TIR, TAR and TBR in conjunction with the evaluation of glucose control [9].

Clinical studies have demonstrated that basal-bolus therapy improves TIR, reduces time spent in hyperglycemia, and minimizes hypoglycemic episodes, leading to better glycemic stability [10].

In our case, the drug regimen of OAD and premixed 30/70 insulin exhibited significant glycemic variability and frequent hypoglycemic episodes (16 events averaging 200 minutes). This prompted a switch to basal-bolus therapy, which led to better control during the first follow-up, reducing A1c, lowering the frequency and duration of hypoglycemia, and increasing time in the target range. The regimen achieved remarkable results at the second follow-up, with an A1c of 5.7%, 79% of time spent in the target range, and minimal hypoglycemia (5 events averaging 88 minutes).

This case study's finding highlights basal-bolus therapy's effectiveness in reducing glycemic variability,

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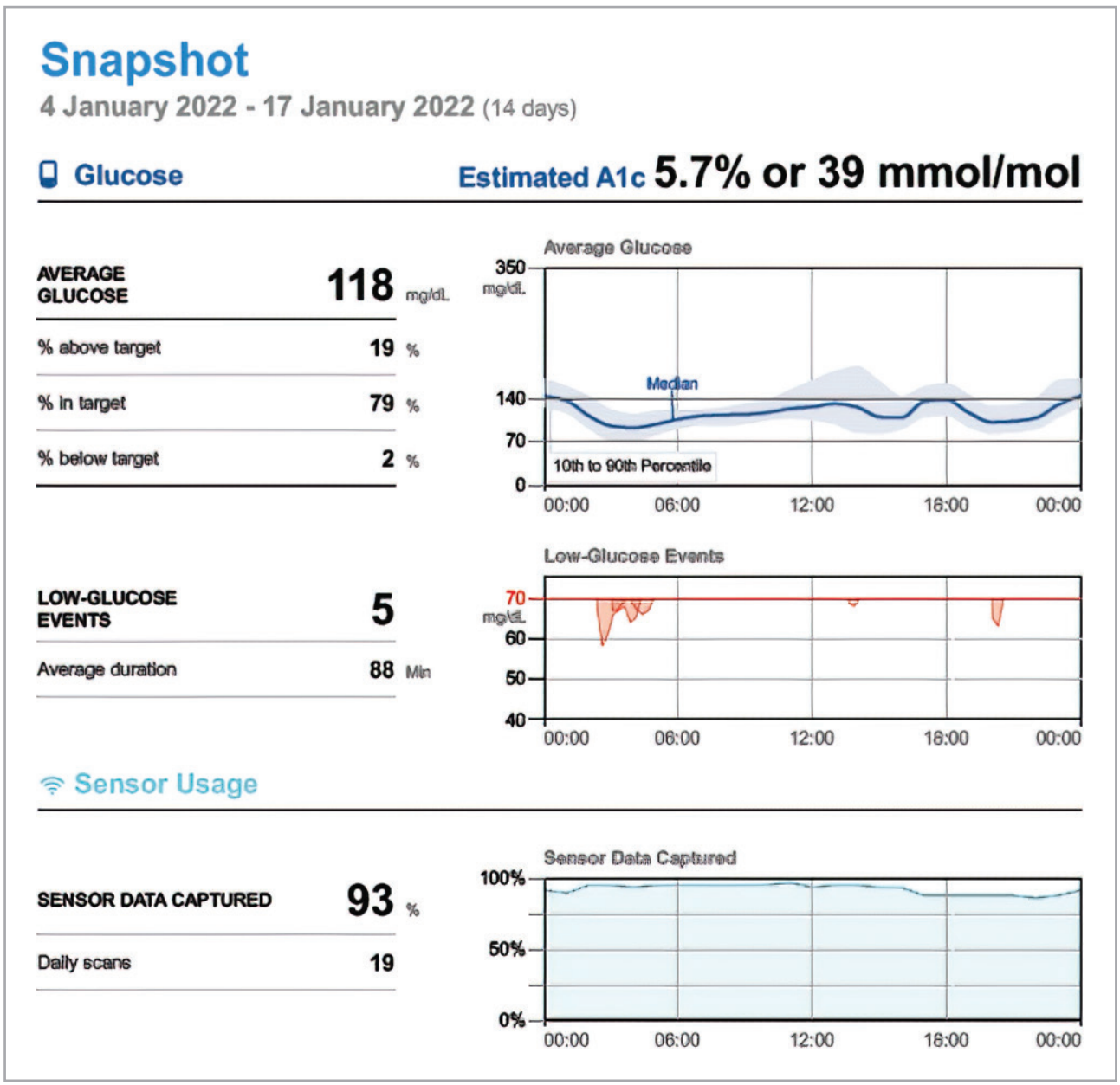

Figure 3: CGM pattern for OAD and basal-bolus regimen of Detemir and Lispro at second follow-up [04 January – 17 January 2022 (14 days)].

enhancing time in range, and achieving optimal glycemic control with fewer hypoglycemic events.

The use of CGM not only facilitated tailored insulin dosing adjustments but also empowered the patient through regular feedback and monitoring. Increasing scanning frequency and sharing CGM data with healthcare providers may enable closer monitoring and timely intervention, demonstrating the role of patient engagement in achieving optimal glycemic outcomes.

The patient's history of recurrent hypoglycemia and fall risk highlights the need for individualized insulin regimens, particularly in older adults with T2DM and cardiovascular or renal comorbidities. Additionally, this case illustrates the benefits of technology-assisted diabetes management in overcoming barriers to effective glycaemic control.

This study underscores the importance of tailored insulin therapy in managing patients with significant glycemic variability. Basal-bolus regimens, guided by intermittent CGM data, proved more effective than premixed insulin in achieving better glycemic control and reducing variability. Additionally, the consistent use of CGM enhanced patient engagement by promoting self-monitoring and active participation, which are critical in managing complex diabetes cases. The integration of telemedicine, including virtual

Table 1: Comparison of CGM patterns.

Parameter	CGM data for OAD + premixed 30/70 insulin (26 November – 09 December 2021)	CGM data for OAD + basal-bolus Detemir and Lispro at first follow-up (09 December – 18 December 2021)	CGM data for OAD + basal-bolus Detemir and Lispro at second follow-up (04 January – 17 January 2022)
Estimated A1c	6.6% (49 mmol/mol)	6.4% (46 mmol/mol)	5.7% (39 mmol/mol)
Average glucose	143 mg/dL	138 mg/dL	118 mg/dL
% Above target	44%	41%	19%
% In target	33%	40%	79%
% Below target	23%	19%	2%
Low-glucose events	16	11	5
Average duration (low-glucose events)	200 min	171 min	88 min
Sensor data captured	95%	85%	93%
Daily scans	17	16	19

communication and data sharing via messaging apps, may further facilitate better monitoring and effective management, particularly for elderly or rural patients. These findings highlight the potential of personalized approaches and technology-driven strategies in optimizing diabetes care.

This case study has several limitations that should be considered while interpreting the findings. The analysis is based on a single patient's data, which restricts the generalizability of the results to broader populations. Larger, multi-patient studies are needed to validate these findings across diverse groups. While the patient demonstrated a marked increase in engagement, as evidenced by higher CGM scanning frequency over three consecutive sensor cycles, this enhanced involvement may not be reflective of all patients with similar conditions. Future research should address these limitations.

Conclusion

For older adults with T2DM and substantial glycemic variability, shifting from premixed to basal-bolus insulin combined with intermittent CGM may improve glycemic outcomes and reduce hypoglycemic risk. This case reinforces the importance of individualized diabetes management strategies and the utility of telecommunication in facilitating patient-provider interactions for ongoing insulin adjustments.

Conflict of interest

Dr. Suhas Gopal Erande has no conflicts of interest to disclose. Dr. Abhijit Trailokya and Mr. Avinash Talware are affiliated with the pharmaceutical industry and actively participate in research studies focused on antidiabetic drugs.

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