https://rijournals.com/research-in-medical-sciences/

RESEARCH INVENTION JOURNAL OF RESEARCH IN MEDICAL SCIENCES 4(1):1-5, 2025

©RIJRMS Publications

ONLINE ISSN: 1115- 6198

Print ISSN: 1597-3107

https://doi.org/10.59298/RIJRMS/2025/4115

The Impact of Continuous Glucose Monitoring (CGM) Versus Self-Monitoring of Blood Glucose (SMBG) on Glycemic Control in Adults with Type 2 Diabetes

Kibibi Muthoni L.

Faculty of Science and Technology Kampala International University Uganda

ABSTRACT

Diabetes mellitus, particularly type 2 diabetes (T2D), presents a significant global health challenge, necessitating effective glycemic control to reduce the risk of complications. Blood glucose monitoring is a cornerstone of T2D management, with self-monitoring of blood glucose (SMBG) traditionally serving as the standard approach. However, the episodic nature of SMBG limits its ability to capture glycemic variability. Continuous glucose monitoring (CGM) offers real-time glucose readings and trend analysis, providing a comprehensive picture of glycemic fluctuations. This narrative review compared the impact of CGM versus SMBG on glycemic control in adults with T2D, employing a systematic synthesis of peer-reviewed literature to assess metrics such as HbA1c, time in range (TIR), glycemic variability, and patient-reported outcomes. The findings indicated that CGM outperforms SMBG in reducing HbA1c, mitigating glycemic variability, and improving TIR, adherence, and quality of life. While CGM presents barriers such as high cost and a learning curve, it significantly enhances patient engagement and safety, particularly for high-risk populations. Conversely, SMBG remains a viable, cost-effective option, particularly in resource-limited settings. Emerging advancements in CGM technology, including AI integration, hold promise for broader accessibility and improved outcomes. This review underscored the transformative potential of CGM in optimizing T2D management and informing future diabetes care strategies.

Keywords: Continuous Glucose Monitoring (CGM), Self-Monitoring of Blood Glucose (SMBG), Glycemic Control, Type 2 Diabetes (T2D), HbA1c and Time in Range (TIR).

INTRODUCTION

Diabetes mellitus, particularly type 2 diabetes (T2D), is a prevalent global health challenge, characterized by chronic hyperglycemia due to impaired insulin secretion or action [1–3]. Effective glycemic control is crucial in managing T2D to reduce the risk of complications such as cardiovascular disease, neuropathy, and retinopathy. Monitoring blood glucose levels is a cornerstone of diabetes management, enabling timely adjustments in therapy and lifestyle. Traditionally, self-monitoring of blood glucose (SMBG) has been the standard approach, where patients measure glucose levels intermittently using finger-prick tests. While SMBG provides valuable insights, its episodic nature often fails to capture glycemic variability and trends over time, potentially limiting its efficacy in achieving optimal glycemic control.

Continuous glucose monitoring (CGM) technology has emerged as an innovative alternative, offering real-time glucose readings and trend analysis [4, 5]. Unlike SMBG, CGM systems continuously measure interstitial glucose levels through a sensor inserted under the skin, providing a comprehensive picture of glycemic fluctuations throughout the day and night. This capability allows patients and healthcare providers to make more informed decisions about treatment adjustments, diet, and exercise. Furthermore, CGM offers features such as alarms for hypo- and hyperglycemia, fostering better patient engagement and proactive diabetes management. This review examines the impact of CGM compared to SMBG on glycemic control in adults with T2D. Specifically, it explores

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited

how these monitoring approaches influence metrics such as HbA1c levels, time in range (TIR), and the occurrence of hypoglycemic or hyperglycemic events. Additionally, the review considers patient adherence, satisfaction, and quality of life as critical factors. By synthesizing existing evidence, this article aims to provide a comprehensive understanding of the relative benefits and limitations of CGM versus SMBG, offering insights for healthcare providers and policymakers seeking to optimize diabetes care strategies.

PATHOPHYSIOLOGICAL RATIONALE FOR GLUCOSE MONITORING IN T2DM

In T2DM, blood glucose fluctuations result from a combination of impaired insulin action and dysregulated hepatic glucose production [6, 7]. Hyperglycemia often goes unnoticed, especially during nocturnal periods, making it critical to employ effective glucose monitoring techniques. SMBG provides discrete snapshots of blood glucose levels, requiring patients to perform finger-stick tests multiple times daily. In contrast, CGM systems continuously measure interstitial glucose levels, offering a dynamic picture of glycemic trends and variability. By identifying patterns, CGM can facilitate timely interventions, potentially reducing periods of hyper- and hypoglycemia, which are crucial for optimizing diabetes management.

ADVANTAGES AND LIMITATIONS OF SMBG

i. **Benefits of SMBG:** SMBG is a cost-effective and accessible method for monitoring blood glucose levels [8, 9]. Its portability and ease of use make it a practical choice for many patients. SMBG enables individuals to correlate blood glucose readings with specific activities, dietary habits, and medication regimens, thus fostering self-management skills. It remains particularly useful in resource-limited settings where CGM may not be widely available.

ii. **Limitations of SMBG:** Despite its utility, SMBG has notable limitations. Finger-stick testing can be painful, discouraging adherence, and it provides only isolated glucose readings [10]. This episodic nature may fail to capture critical fluctuations, such as nocturnal hypoglycemia or postprandial hyperglycemia. Additionally, SMBG requires consistent patient engagement and accurate technique, which can vary widely across individuals.

ADVANTAGES AND LIMITATIONS OF CGM

i. **Benefits of CGM:** CGM systems, such as those incorporating sensors and wearable transmitters, offer a transformative approach to glucose monitoring [11, 12]. By providing continuous data on glucose levels, CGM devices enable users to detect trends and variability, including previously undetected hyperglycemic and hypoglycemic episodes. These systems can provide alerts for critical glucose thresholds, enhancing safety, particularly for individuals at high risk of severe hypoglycemia. The data generated by CGM can be analyzed retrospectively, enabling healthcare providers to refine treatment plans. Studies have shown that CGM use is associated with improved glycemic outcomes, including reductions in HbA1c levels and glycemic variability. For example, time-in-range (TIR) metrics, which quantify the percentage of time glucose levels remain within a target range, have emerged as valuable indicators of glycemic control and can be directly monitored using CGM. By reducing glycemic excursions, CGM may also alleviate the cognitive burden of diabetes management, enhancing patients' quality of life.

ii. **Limitations of CGM:** However, CGM systems are not without drawbacks. The high cost of devices and sensors remains a significant barrier to widespread adoption [13, 14]. Furthermore, CGM requires a learning curve, and not all patients may be willing or able to integrate this technology into their daily lives. Sensor accuracy can be influenced by factors such as dehydration, skin irritation, and delayed response in interstitial fluid glucose measurements. Additionally, some patients report feeling overwhelmed by the continuous stream of data, underscoring the need for effective patient education and support.

COMPARATIVE EFFECTIVENESS OF CGM AND SMBG IN GLYCEMIC CONTROL

i. **HbA1c Reduction:** HbA1c is a critical metric for assessing long-term glycemic control [15]. Numerous studies have compared CGM and SMBG in their ability to reduce HbA1c levels among adults with T2DM. For instance, randomized controlled trials have demonstrated that CGM users achieve greater reductions in HbA1c compared to those relying solely on SMBG. This difference is attributed to CGM's ability to provide actionable insights and facilitate timely adjustments in therapy. SMBG, by contrast, may not adequately capture glycemic variability or inform proactive interventions.

ii. **Glycemic Variability:** Glycemic variability, characterized by fluctuations in blood glucose levels, is increasingly recognized as an independent risk factor for diabetes complications [16]. CGM's capacity to continuously monitor glucose levels makes it particularly effective in identifying and mitigating variability. Studies have shown that CGM users experience fewer episodes of hypoglycemia and hyperglycemia, as well as reduced mean amplitude of glycemic excursions (MAGE). While SMBG can identify variability to some extent, its episodic nature limits its effectiveness in capturing a comprehensive glycemic profile.

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited

iii. **Patient Adherence and Satisfaction:** Adherence to glucose monitoring regimens is a key determinant of glycemic outcomes. CGM systems, with their minimally invasive design and real-time data, are generally associated with higher patient satisfaction compared to SMBG. The ability to visualize glucose trends and receive alerts can empower patients, fostering a sense of control over their condition. In contrast, the discomfort and inconvenience of frequent finger-stick testing can deter adherence to SMBG, potentially compromising glycemic control.

iv. **Quality of Life:** Quality of life (QoL) is an important consideration in diabetes management [17]. By reducing the burden of frequent testing and offering actionable insights, CGM has been shown to improve QoL among users. The technology's ability to minimize glycemic excursions and associated symptoms further contributes to enhanced well-being. While SMBG can also support QoL improvements by facilitating self-management, its limitations in data richness and convenience may reduce its overall impact.

v. **Economic Considerations:** The cost-effectiveness of CGM versus SMBG is a contentious issue. While CGM systems are associated with higher upfront costs, their potential to improve glycemic outcomes and reduce complications may yield long-term economic benefits. For example, fewer hospitalizations for severe hypoglycemia or hyperglycemia could offset the initial investment in CGM technology. In contrast, SMBG remains the more affordable option in the short term, making it a viable choice for patients with limited financial resources or inadequate insurance coverage.

SPECIAL POPULATIONS

i. **Older Adults:** Older adults with T2DM often face unique challenges, including an increased risk of hypoglycemia and comorbid conditions [18,19]. CGM may offer significant benefits in this population by providing alerts for low glucose levels and reducing the cognitive burden of diabetes management. However, cost and technology-related barriers must be addressed to ensure accessibility.

ii. **Individuals with Limited Resources:** In resource-limited settings, the cost of CGM remains a major obstacle. SMBG, with its lower cost and simpler implementation, is often the preferred option. Efforts to subsidize CGM technology and improve its affordability could expand access and enhance glycemic control in underserved populations.

FUTURE DIRECTIONS

Advancements in CGM technology, including integration with insulin delivery systems and artificial intelligence (AI), hold promise for further improving glycemic outcomes [19]. Hybrid closed-loop systems, also known as artificial pancreas systems, combine CGM with insulin pumps to automate glucose regulation. Additionally, wearable devices with extended sensor life and enhanced accuracy are under development, potentially reducing costs and improving user experience. Research into the long-term benefits of CGM, particularly in terms of reducing complications and healthcare costs, will be critical for informing policy and clinical practice.

CONCLUSION

Continuous glucose monitoring (CGM) represents a transformative approach to diabetes management, offering significant advantages over traditional self-monitoring of blood glucose (SMBG) in adults with type 2 diabetes (T2D). This review highlights that CGM's ability to provide continuous, real-time glucose data enables superior glycemic control through enhanced monitoring of HbA1c, reduced glycemic variability, and improved time in range (TIR). These outcomes are complemented by CGM's capacity to reduce the frequency of hypo- and hyperglycemic events, fostering greater safety and improved quality of life for patients. While SMBG remains a practical, cost-effective option for many, its episodic nature and associated patient burden limit its efficacy, particularly in addressing glycemic fluctuations. Conversely, CGM's higher initial costs and learning curve may pose barriers to widespread adoption, particularly in resource-limited settings. However, ongoing advancements in CGM technology, including integration with automated insulin delivery systems and artificial intelligence, are likely to improve accessibility, usability, and cost-effectiveness in the future. In conclusion, CGM offers a comprehensive and patient-centered solution for managing T2D, with demonstrated benefits in glycemic outcomes and patient satisfaction. Broader adoption of CGM, supported by policies addressing affordability and education, has the potential to revolutionize care, particularly for populations most at risk of complications.

REFERENCES

1. Obeagu, E.I., Okechukwu, U., Alum, E.U.: Poor Glycaemic Control among Diabetic Patients: A Review on Associated Factors. (2023)
2. Alum, E.U., Obeagu, E.I., Ugwu, O.P.C., Samson, A.O., Adepoju, A.O., Amusa, M.O.: Inclusion of nutritional counseling and mental health services in HIV/AIDS management: A paradigm shift. Medicine (United States). 102, E35673 (2023). https://doi.org/10.1097/MD.0000000000035673

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited

3. Ugwu, O.P.-C., Alum, E.U., Okon, M. Ben, Aja, P.M., Obeagu, E.I., Onyeneke, E.C.: Ethanol root extract and fractions of *Sphenocentrum jollyanum* abrogate hyperglycaemia and low body weight in streptozotocin-induced diabetic Wistar albino rats. RPS Pharmacy and Pharmacology Reports. 2, (2023). https://doi.org/10.1093/rpsppr/rqad010
4. Liu, X., Zhang, J.: Continuous Glucose Monitoring: A Transformative Approach to the Detection of Prediabetes. J Multidiscip Healthc. 17, 5513–5519 (2024). https://doi.org/10.2147/JMDH.S493128
5. Galindo, R.J., Aleppo, G.: Continuous glucose monitoring: The achievement of 100 years of innovation in diabetes technology. Diabetes Res Clin Pract. 170, 108502 (2020). https://doi.org/10.1016/J.DIABRES.2020.108502
6. Dandona, P.: Minimizing Glycemic Fluctuations in Patients with Type 2 Diabetes: Approaches and Importance. Diabetes Technol Ther. 19, 498–506 (2017). https://doi.org/10.1089/DIA.2016.0372/ASSET/IMAGES/LARGE/FIGURE1.JPEG
7. London, A., Lundsgaard, A.M., Kiens, B., Bojsen-møller, K.N.: The Role of Hepatic Fat Accumulation in Glucose and Insulin Homeostasis—Dysregulation by the Liver. Journal of Clinical Medicine 2021, Vol. 10, Page 390. 10, 390 (2021). https://doi.org/10.3390/JCM10030390
8. Ajjan, R.A., Heller, S.R., Everett, C.C., Vargas-Palacios, A., Higham, R., Sharples, L., Gorog, D.A., Rogers, A., Reynolds, C., Fernandez, C., Rodrigues, P., Sathyapalan, T., Storey, R.F., Stocken, D.D.: Multicenter Randomized Trial of Intermittently Scanned Continuous Glucose Monitoring Versus Self-Monitoring of Blood Glucose in Individuals With Type 2 Diabetes and Recent-Onset Acute Myocardial Infarction: Results of the LIBERATES Trial. Diabetes Care. 46, 441–449 (2023). https://doi.org/10.2337/DC22-1219
9. García-Lorenzo, B., Rivero-Santana, A., Vallejo-Torres, L., Castilla-Rodríguez, I., García-Pérez, S., García-Pérez, L., Perestelo-Pérez, L.: Cost-effectiveness analysis of real-time continuous monitoring glucose compared to self-monitoring of blood glucose for diabetes mellitus in Spain. J Eval Clin Pract. 24, 772–781 (2018). https://doi.org/10.1111/JEP.12987
10. The Effect of Illness Identity and Social Relationships on Treatment Adherence in Adolescents with Type 1 Diabetes - ProQuest, https://www.proquest.com/openview/24cb34e38dce13093f80bfd246b0fcb0/1?pq-origsite=gscholar&cbl=18750
11. Ghosh, N., Verma, S.: Technological advancements in glucose monitoring and artificial pancreas systems for shaping diabetes care. Curr Med Res Opin. (2024). https://doi.org/10.1080/03007995.2024.2422005
12. Yu, T.S., Song, S., Yea, J., Jang, K.-I.: Diabetes Management in Transition: Market Insights and Technological Advancements in CGM and Insulin Delivery. Advanced Sensor Research. 3, 2400048 (2024). https://doi.org/10.1002/ADSR.202400048
13. Datye, K.A., Tilden, D.R., Parmar, A.M., Goethals, E.R., Jaser, S.S.: Advances, Challenges, and Cost Associated with Continuous Glucose Monitor Use in Adolescents and Young Adults with Type 1 Diabetes. Curr Diab Rep. 21, 1–8 (2021). https://doi.org/10.1007/S11892-021-01389-1/METRICS
14. Barnard-Kelly, K.D., Martínez-Brocca, M.A., Glatzer, T., Oliver, N.: Identifying the deficiencies of currently available CGM to improve uptake and benefit. Diabetic Medicine. 41, e15338 (2024). https://doi.org/10.1111/DME.15338
15. Kovatchev, B.P.: Metrics for glycaemic control — from HbA1c to continuous glucose monitoring. Nature Reviews Endocrinology 2017 13:7. 13, 425–436 (2017). https://doi.org/10.1038/nrendo.2017.3
16. Valente, T., Arbex, A.K.: Glycemic Variability, Oxidative Stress, and Impact on Complications Related to Type 2 Diabetes Mellitus. Curr Diabetes Rev. 17, (2020). https://doi.org/10.2174/1573399816666200716201550
17. Rodríguez-Almagro, J., García-Manzanares, Á., Lucendo, A.J., Hernández-Martínez, A.: Health-related quality of life in diabetes mellitus and its social, demographic and clinical determinants: A nationwide cross-sectional survey. J Clin Nurs. 27, 4212–4223 (2018). https://doi.org/10.1111/JOCN.14624
18. Freeman, J.: Management of hypoglycemia in older adults with type 2 diabetes. Postgrad Med. 131, 241–250 (2019). https://doi.org/10.1080/00325481.2019.1578590
19. Ghosh, N., Verma, S.: Technological advancements in glucose monitoring and artificial pancreas systems for shaping diabetes care. Curr Med Res Opin. (2024). https://doi.org/10.1080/03007995.2024.2422005

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited

CITE AS: Kibibi Muthoni L. (2025). The Impact of Continuous Glucose Monitoring (CGM) Versus Self-Monitoring of Blood Glucose (SMBG) on Glycemic Control in Adults with Type 2 Diabetes. RESEARCH INVENTION JOURNAL OF RESEARCH IN MEDICAL SCIENCES 4(1):1-5. https://doi.org/10.59298/RIJRMS/2025/4115

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited