International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Scholarly Publisher
RS Global Sp. z O.O.
ISNI: 0000 0004 8495 2390

Dolna 17, Warsaw,
Poland 00-773
+48 226 0 227 03
editorial_office@rsglobal.pl

ARTICLE TITLE	EMERGING TECHNOLOGIES IN DIABETES MANAGEMENT: FROM CONTINUOUS GLUCOSE MONITORING (CGM) TO THE ARTIFICIAL PANCREAS (2015–2025)
DOI	https://doi.org/10.31435/ijitss.4(48).2025.4660
RECEIVED	13 November 2025
ACCEPTED	22 December 2025
PUBLISHED	26 December 2025
LICENSE	The article is licensed under a **Creative Commons Attribution 4.0 International License.**

EMERGING TECHNOLOGIES IN DIABETES MANAGEMENT: FROM CONTINUOUS GLUCOSE MONITORING (CGM) TO THE ARTIFICIAL PANCREAS (2015–2025)

Karolina Nowacka *(Corresponding Author, Email: knowacka42@gmail.com)*
Medical University of Gdańsk, Gdańsk, Poland
ORCID ID: 0009-0004-4933-755X

Aleksandra Grygorowicz
Medical University of Warsaw, Warsaw, Poland
ORCID ID: 0009-0002-7729-8178

Klaudia Baran
Medical University of Warsaw, Warsaw, Poland
ORCID ID: 0009-0004-9599-792X

Michał Ględa
Medical University of Lodz, Lodz, Poland
ORCID ID: 0009-0003-8148-160X

Michał Szyszka
Lower Silesian Center for Oncology, Pulmonology and Hematology, Wrocław, Poland
ORCID ID: 0009-0002-5307-1753

Weronika Radecka
Cardinal Stefan Wyszyński University, Warsaw, Poland
ORCID ID: 0009-0007-1116-398X

Weronika Kozak
University of Warmia and Mazury, Olsztyn, Poland
ORCID ID: 0009-0009-5605-2794

Agnieszka Szreiber
University of Warmia and Mazury, Olsztyn, Poland
ORCID ID: 0009-0006-3432-8284

Karol Grela
Medical University of Warsaw, Warsaw, Poland

Kamil Jabłoński
Medical University of Silesia, Katowice, Poland
ORCID ID: 0009-0003-4682-2405

Anna Woźniak
Lazarski University, Warsaw, Poland
ORCID ID: 0009-0000-5065-6313

ABSTRACT

Introduction: Over the past decade, diabetes care has undergone a profound technological transformation. Continuous glucose monitoring (CGM), intermittently scanned glucose monitoring systems (isCGM/flash), sensor-integrated insulin pumps, and hybrid closed-loop systems ("artificial pancreas") have become central components of modern management of type 1 diabetes and are increasingly used in selected forms of insulin-treated type 2 diabetes.
Objective: To present a literature review from 2015–2025 on emerging technologies in diabetes treatment—from CGM to artificial pancreas systems—with particular emphasis on clinical effectiveness, psychosocial impact, and social and health-system implications.
Methods: A narrative review of the literature published between 2015 and 2025, identified through searches of PubMed/MEDLINE and the Cochrane Library, as well as leading diabetology and endocrinology journals. The review included randomized controlled trials, real-world observational studies, meta-analyses, systematic reviews, and position statements from scientific societies (ADA, EASD, ISPAD, ATTD).
Results: Compared with conventional self-monitoring of blood glucose (SMBG), CGM and isCGM systems significantly reduce HbA1c levels, time spent in hypoglycaemia, and glycaemic variability, while increasing time in range (TIR). Hybrid closed-loop systems further improve TIR (often exceeding 70–75%), reduce both hypo- and hyperglycaemia, and are associated with high patient satisfaction. Telemedicine and cloud-based platforms enable remote monitoring and support new models of care. Key barriers include cost, limited reimbursement, variability in digital literacy, and inequalities in access.
Conclusions: Emerging technologies—from CGM and isCGM to hybrid closed-loop systems—represent a major step toward individualized and partially automated diabetes management. To fully realize their potential, equitable access, adequate funding, structured education, and integration with digital health tools and psychosocial support are essential.

KEYWORDS

Diabetes Mellitus, Continuous Glucose Monitoring, CGM, Flash Glucose Monitoring, Hybrid Closed-Loop System, Artificial Pancreas, Telemedicine

CITATION

Karolina Nowacka, Aleksandra Grygorowicz, Klaudia Baran, Michał Ględa, Michał Szyszka, Weronika Radecka, Weronika Kozak, Agnieszka Szreiber, Karol Grela, Kamil Jabłoński, Anna Woźniak. (2025) Emerging Technologies in Diabetes Management: From Continuous Glucose Monitoring (CGM) to the Artificial Pancreas (2015–2025). *International Journal of Innovative Technologies in Social Science*. 4(48). doi: 10.31435/ijitss.4(48).2025.4660

1. Introduction

Diabetes mellitus is one of the most significant public health challenges of the 21st century. According to the latest estimates from the International Diabetes Federation, more than 530 million adults worldwide were living with diabetes in 2021, and a further increase in prevalence is projected in the coming decades, accompanied by a growing economic burden related to the treatment of microvascular and macrovascular complications (International Diabetes Federation, 2021; Sun et al., 2022). Despite substantial advances in pharmacotherapy—including the availability of modern insulin analogues, glucagon-like peptide-1 (GLP-1) receptor agonists, and sodium–glucose cotransporter-2 (SGLT-2) inhibitors—achieving stable and sustained metabolic control remains a challenge for a large proportion of patients (American Diabetes Association, 2023).

Traditional self-monitoring of blood glucose (SMBG) provides only intermittent, point-in-time measurements and does not allow for assessment of glycaemic variability or reliable detection of nocturnal hypoglycaemia, which significantly limits therapeutic effectiveness (Danne et al., 2017). A major breakthrough in diabetes management has been the development of continuous glucose monitoring (CGM), intermittently scanned glucose monitoring systems (isCGM/flash), and the integration of glucose sensors with insulin pumps and hybrid closed-loop algorithms. These technologies partially automate insulin delivery and lead to improved metabolic control (Brown et al., 2019; Battelino et al., 2019).

The aim of this paper is to present a review of scientific evidence published between 2015 and 2025 regarding the role of the latest technologies—from CGM to artificial pancreas systems—in diabetes treatment, taking into account their clinical effectiveness, psychosocial impact, and implications for healthcare systems.

2. Review Methodology

This study is a narrative review with elements of critical appraisal of the literature. The literature search was conducted using the PubMed/MEDLINE and Cochrane Library databases, as well as leading journals in diabetology and endocrinology (including Diabetes Care, Diabetologia, Diabetes Technology & Therapeutics, The New England Journal of Medicine, Pediatric Diabetes, and Journal of Diabetes Science and Technology).

Publications from 2015 to 2025 were considered, with priority given to meta-analyses, systematic reviews, and the most recent clinical practice guidelines issued by scientific societies (American Diabetes Association, European Association for the Study of Diabetes, International Society for Pediatric and Adolescent Diabetes, Advanced Technologies & Treatments for Diabetes). The search keywords included, but were not limited to: diabetes, type 1 diabetes, type 2 diabetes, continuous glucose monitoring, CGM, flash glucose monitoring, hybrid closed loop, artificial pancreas, insulin pump, telemedicine, and digital health.

The review included randomized controlled trials, observational studies, meta-analyses, systematic reviews, and expert consensus statements. Studies of a purely technical nature without reported clinical outcomes, as well as single case reports, were excluded.

3. Evolution of Glucose Monitoring Technologies

Glucose monitoring constitutes the foundation of effective diabetes management and remains a key component of therapeutic decision-making. For many years, the primary method of glycaemic assessment was self-monitoring of blood glucose (SMBG) using finger-stick glucometers, which provides only discrete point measurements and requires multiple, often painful, skin punctures. The limitations of SMBG—such as the inability to assess glycaemic variability or detect nocturnal hypoglycaemia—became a major impetus for the development of continuous glucose monitoring (CGM) technologies (Danne et al., 2017).

The introduction of sensors measuring glucose concentrations in the interstitial fluid enabled readings to be obtained every few minutes and allowed for the generation of a comprehensive, dynamic glycaemic profile (Heinemann et al., 2018). Early generations of CGM systems were characterized by limited accuracy, short sensor lifespan, and the need for frequent calibration using capillary blood glucose measurements. In contrast, newer systems demonstrate substantially improved precision (mean absolute relative difference [MARD] below 10%), longer sensor wear time (10–14 days, and up to 180 days for implantable systems), elimination of routine calibration requirements, and full integration with mobile applications and insulin pumps (Welsh et al., 2019; Danne et al., 2017).

In parallel, intermittently scanned CGM (isCGM; flash glucose monitoring) technology was developed, enabling rapid glucose readings through sensor scanning and significantly simplifying daily self-monitoring. Newer generations of isCGM devices, equipped with alarm functions, further narrow the gap between flash systems and fully featured CGM technologies (Oskarsson et al., 2018; Charleer et al., 2018). The key characteristics, advantages, and limitations of the main glucose monitoring methods—including SMBG, real-time CGM, intermittently scanned CGM, and automated insulin delivery systems—are summarized in Table 1.

Table 1. Comparison of glucose monitoring methods in diabetes management.

Method	Characteristics	Advantages	Limitations
SMBG (finger-stick glucometer)	Point glucose measurements from capillary blood; requires multiple finger pricks	Low cost, wide availability, high accuracy of capillary measurements	No information on glucose trends or time in range (TIR); inability to detect nocturnal hypoglycaemia; need for frequent finger pricks
rtCGM (real-time continuous glucose monitoring)	Continuous glucose measurement in interstitial fluid; readings every 1–5 minutes; high/low glucose alarms	24/7 glucose profile, alarms, ability to assess glycaemic variability, calculation of TIR	Cost; need to wear a sensor; possible sensor detachment; calibration required in some systems
isCGM (flash glucose monitoring)	Glucose readings obtained by scanning the sensor with a reader/smartphone; data storage up to 14 days	No need for calibration, easy to use, access to glucose trends	In older generations, lack of alarms; need for active scanning; possible data gaps if scanning is too infrequent
AID / HCL (CGM integrated with insulin pump)	Sensor integrated with an insulin pump and algorithm; possibility of automated interventions (suspend, automode)	Greater glycaemic stability, reduced hypoglycaemia, increased TIR, reduced decision-making burden	High cost; need to wear multiple system components; mandatory calibration in some systems

4. Continuous Glucose Monitoring (CGM)

Numerous randomized controlled trials have demonstrated the superiority of real-time continuous glucose monitoring (rtCGM) over exclusive self-monitoring of blood glucose (SMBG) in patients with type 1 diabetes, treated either with multiple daily insulin injections (MDI) or insulin pump therapy. Beck et al. (2017) showed that the use of rtCGM in adults with type 1 diabetes managed with MDI resulted in a reduction in HbA1c of approximately 0.6 percentage points, as well as a significant decrease in time spent in hypoglycaemia, compared with the SMBG group. Meta-analyses confirm a mean HbA1c reduction of 0.3–0.5 percentage points and an increase in time in range (TIR) by 8–15 percentage points among individuals with type 1 diabetes using CGM (Jeitler et al., 2018; Teo et al., 2022).

In pediatric and adolescent populations, CGM systems improve TIR, reduce the frequency and duration of hypoglycaemia—particularly nocturnal episodes—and are especially beneficial for patients with impaired hypoglycaemia awareness (Weinstock et al., 2017). Current guidelines from the International Society for Pediatric and Adolescent Diabetes (ISPAD) and the American Diabetes Association recommend CGM as the preferred method of glucose monitoring for most individuals with type 1 diabetes requiring intensive insulin therapy, in both pediatric and adult populations, as well as for selected insulin-treated patients with type 2 diabetes (Sherr et al., 2018; American Diabetes Association, 2023).

5. isCGM/Flash Glucose Monitoring Systems

Intermittently scanned continuous glucose monitoring (isCGM/flash) systems represent a compromise between ease of use and access to a comprehensive glycaemic profile. In the IMPACT study, which included adults with well-controlled type 1 diabetes, the use of flash glucose monitoring led to a 38% reduction in time spent in hypoglycaemia without a significant effect on HbA1c levels compared with the SMBG group (Bolinder et al., 2016). Subsequent randomized trials confirmed the benefits of this technology in both patients with type 1 diabetes and insulin-treated type 2 diabetes, including improved glycaemic safety and a reduction in hypoglycaemic episodes (Haak et al., 2017; Oskarsson et al., 2018).

Real-world evidence further indicates that the use of isCGM systems is associated with improved quality of life, greater user convenience, and reduced fear of hypoglycaemia (Charleer et al., 2018). Newer generations of devices, such as FreeStyle Libre 2, combine scanning functionality with customizable threshold alarms, while Libre 3 enables automatic data transmission, functionally narrowing the gap between isCGM and real-time CGM systems.

6. Insulin Pumps and Integrated Systems

The integration of continuous glucose monitoring with insulin pumps enabled the development of sensor-augmented pump (SAP) therapy, in which sensor data are used to automatically modify insulin delivery. The simplest form of automation involved suspension of insulin infusion in response to hypoglycaemia (low-glucose suspend, LGS), followed by systems capable of predicting impending hypoglycaemia and stopping insulin delivery before its occurrence (predictive low-glucose suspend, PLGS). In a randomized study, Ly et al. (2017) demonstrated that the use of PLGS in children and adults with type 1 diabetes significantly reduced time spent in hypoglycaemia without deterioration of HbA1c levels. SAP technologies therefore represent an important transitional stage between conventional insulin pump therapy and hybrid closed-loop systems, in which insulin delivery is automated to a greater extent.

7. Hybrid Closed-Loop Systems (“Artificial Pancreas”)

Hybrid closed-loop (HCL) systems integrate a CGM sensor, an insulin pump, and a control algorithm that continuously analyzes glucose values and automatically adjusts basal insulin delivery. In newer generations of these systems, partial automation of correction boluses is also possible. These systems are referred to as “hybrid” because patients are still required to announce meals and input carbohydrate information.

In a study by Brown et al. (2019) involving adults with type 1 diabetes, the use of an HCL system increased time in range (TIR) from 61% to 71% compared with sensor-augmented pump therapy without automated insulin adjustment, while simultaneously reducing HbA1c by 0.3–0.4 percentage points. Similar efficacy has been demonstrated in pediatric and adolescent populations: HCL systems increased TIR and reduced the risk of hypoglycaemia in randomized controlled trials involving school-aged children (Breton et al., 2020), as well as in studies of very young children, including those aged 2–6 years (Wadwa et al., 2023). These findings, corroborated by recent systematic reviews, indicate high efficacy and safety of HCL systems in pediatric populations (Grudziąż-Sękowska et al., 2025).

In parallel, a do-it-yourself (DIY) closed-loop movement has emerged, in which patients create their own closed-loop systems using commercially available sensors and pumps combined with open-source software. Observational data suggest improvements in TIR, more stable glycaemic control, and high user satisfaction; however, the lack of formal regulatory approval raises significant legal and ethical challenges (Prahalad et al., 2018; Zisser et al., 2019).

8. Telemedicine and Remote Monitoring

Modern CGM systems and insulin pumps enable automatic data transmission to cloud-based platforms, allowing remote supervision of therapy by physicians, diabetes educators, and family members. Platforms such as Glooko (formerly Diasend), CareLink, LibreView, and t:connect offer advanced tools for glycaemic trend analysis, calculation of time in range (TIR), and generation of therapeutic reports, thereby supporting clinical decision-making and treatment personalization (de Boer et al., 2019).

The COVID-19 pandemic markedly accelerated the implementation of telemedicine in diabetes care. Studies published between 2020 and 2023 demonstrated that combining remote consultations with telemonitoring of glucose data enables maintenance or even improvement of metabolic control, as measured by HbA1c and TIR, while simultaneously reducing the number of in-person visits (Papazafiropoulou et al., 2022; Rosta et al., 2023). Telemedicine proved particularly valuable for children with type 1 diabetes and for patients living in remote areas, providing access to specialized care without the need for travel (Ziegler et al., 2020).

9. Clinical Outcomes: HbA1c, TIR, and Hypoglycaemia

Key indicators of the effectiveness of modern diabetes technologies include HbA1c levels and CGM-derived metrics, particularly time in range (TIR), commonly defined as the percentage of time spent within the glucose range of 70–180 mg/dL. The ATTD consensus identifies TIR as a central parameter for assessing glycaemic control, as it is associated with both the risk of chronic complications and short-term metabolic stability (Battelino et al., 2019; Battelino et al., 2020).

Meta-analyses have shown that the use of rtCGM in individuals with type 1 diabetes leads to a mean HbA1c reduction of 0.3–0.5 percentage points and an increase in TIR of 8–15 percentage points compared with standard SMBG (Jeitler et al., 2018; Teo et al., 2022). Hybrid closed-loop (HCL) systems provide additional benefits, frequently achieving TIR ≥70–75% and enabling further reductions in HbA1c (Brown et al., 2019; McAuley et al., 2020; Jiao et al., 2023). In insulin-treated type 2 diabetes, the use of CGM or isCGM is also associated with improved metabolic control, including HbA1c reductions of 0.3–0.6 percentage points and increased TIR (Lane et al., 2019; Martens et al., 2021; Seidu et al., 2024). A summary of key randomized trials and real-world studies evaluating the clinical impact of CGM, isCGM, and hybrid closed-loop systems on HbA1c, time in range, and hypoglycaemia is presented in Table 2.

Table 2. Selected clinical studies evaluating the impact of emerging diabetes technologies on glycaemic outcomes.

Technology	Population / Comparison	Key outcomes	Clinical implications
rtCGM vs SMBG	Adults with T1D on MDI (Beck et al., 2017)	HbA1c reduction of ~0.6 percentage points; reduced time spent in hypoglycaemia; increased TIR	rtCGM significantly improves glycaemic control compared with SMBG
Flash glucose monitoring vs SMBG	Adults with well-controlled T1D (Bolinder et al., 2016)	No significant change in HbA1c; 38% reduction in time spent in hypoglycaemia	Flash glucose monitoring reduces hypoglycaemia without worsening metabolic control
HCL vs SAP	Adults with T1D (Brown et al., 2019)	Increase in TIR from 61% to 71%; HbA1c reduction of 0.3–0.4 percentage points	HCL systems provide more stable and safer glycaemic control
HCL in children	Children and adolescents with T1D (Breton et al., 2020; Wadwa et al., 2023)	TIR >70%; reduced hypoglycaemia; improved sleep quality	HCL systems are effective and safe in pediatric populations
CGM / isCGM in T2D	Adults with T2D on insulin therapy (Lane et al., 2019; Martens et al., 2021; Seidu et al., 2024)	HbA1c reduction of 0.3–0.6 percentage points; increased TIR	CGM improves glycaemic control also in insulin-treated T2D
Telemonitoring + CGM	T1D/T2D patients remotely monitored during the COVID-19 pandemic (Papazafiropoulou et al., 2022; Rosta et al., 2023)	Maintenance or improvement of HbA1c; high patient satisfaction; fewer in-person visits	Telemedicine effectively supports intensive diabetes management

At the same time, CGM and HCL systems significantly reduce time spent in hypoglycaemia (<70 mg/dL and <54 mg/dL) and the incidence of severe hypoglycaemic events, thereby enhancing treatment safety (Brown et al., 2019; Weinstock et al., 2017).

10. Psychosocial Aspects

Emerging diabetes technologies influence patients' daily functioning not only by improving metabolic parameters but also through their psychosocial impact. Studies indicate that the use of CGM, isCGM, and HCL systems is associated with reduced fear of hypoglycaemia, improved sense of safety, and greater autonomy in disease self-management (Charleer et al., 2018; Piya et al., 2020). Parents of children with type 1 diabetes, in particular, emphasize the importance of nocturnal glucose monitoring and safety alarms, which enhance their sense of control and reduce stress (Ziegler et al., 2020).

Conversely, some patients experience data overload related to the large volume of information, the need for continuous interpretation, and frequent alerts, which may lead to so-called alert fatigue. The visibility of devices such as glucose sensors and insulin pumps may also contribute to feelings of stigmatization, especially among adolescents and young adults. In line with the American Diabetes Association's recommendations on psychosocial care, assessment of psychological well-being should be an integral part of routine clinical practice, and patients should be provided with access to appropriate psychological support (Young-Hyman et al., 2016).

11. Inequalities in Access and Social Implications

From a social science perspective, one of the key challenges in the implementation of emerging diabetes technologies is inequality in access to CGM, isCGM, and HCL systems. In many countries, reimbursement policies initially focused primarily on children and adolescents with type 1 diabetes, while adults and individuals with type 2 diabetes had limited access to these technologies, thereby perpetuating therapeutic inequalities (Seidu et al., 2022). Real-world accessibility is also influenced by socioeconomic factors such as income level, place of residence (rural versus urban areas), and the digital literacy of both patients and healthcare professionals, which determines their ability to effectively use digital health tools (Rodriguez-Gutierrez et al., 2019; Mirasghari et al., 2024).

The absence of appropriate health policy strategies may further exacerbate the "digital divide," whereby the benefits of innovative technologies are predominantly available to patients with higher socioeconomic status. Therefore, the development of value-based reimbursement models and educational programs aimed at improving digital competencies is crucial to ensure equitable access to technology and to reduce the risk of health-related exclusion.

12. Safety, Ethical, and Legal Challenges

Modern CGM, isCGM, and HCL systems are characterized by a high safety profile, and serious adverse events, such as diabetic ketoacidosis related to interruption of insulin delivery, are rare and most often result from user errors or technical issues not directly attributable to the sensor itself (Brown et al., 2019; Zisser et al., 2019). The most commonly reported adverse effects include local skin reactions at the insertion site, sensor detachment, and transient signal loss, which are generally mild in nature.

A particularly challenging area involves DIY closed-loop systems, which lack regulatory certification and formal safety oversight. This raises important questions regarding legal liability, the role of physicians in the care of patients using such solutions, and standards for user education (Prahalad et al., 2018; Zisser et al., 2019).

In addition, the increasing use of cloud-based platforms that collect large volumes of glycaemic data is associated with significant concerns regarding privacy, cybersecurity, and the potential commercial use of patient data. With the rapid development of artificial intelligence tools for CGM data analysis, it is essential to establish coherent ethical frameworks that ensure algorithmic transparency, equitable treatment of diverse patient populations, and accountability for decisions made by AI-based systems (Zou et al., 2021).

13. Future Perspectives

Future directions in diabetes technology development include work on fully closed-loop systems, which may eventually eliminate the need for manual meal announcements. In parallel, research is ongoing into multihormonal approaches combining insulin delivery with glucagon or GLP-1 analogues, aimed at improving postprandial control and reducing the risk of hypoglycaemia (Jiao et al., 2023). Another important avenue of development is increasingly advanced treatment personalization using artificial intelligence tools, which may enable dynamic adaptation of insulin dosing algorithms to individual glycaemic patterns (Zou et al., 2021). Ongoing miniaturization of sensors and insulin pumps enhances user comfort and reduces perceived stigmatization, thereby promoting patient acceptance of these technologies.

From a healthcare system perspective, the implementation of reimbursement models based on clinical outcomes and real economic benefits—such as reductions in chronic complications and indirect costs—will be essential. Equally important is ensuring equitable access to innovation and developing digital competencies among both patients and healthcare professionals. The integration of diabetes technologies into the broader digital health ecosystem is a prerequisite for their effective use in clinical practice.

14. Conclusions

• Emerging diabetes technologies—CGM, isCGM, and hybrid closed-loop systems—have significantly expanded therapeutic options for diabetes management, particularly for type 1 diabetes and selected forms of insulin-treated type 2 diabetes.

• The use of these solutions is associated with reductions in HbA1c, increased time in range (TIR), decreased hypoglycaemia, and reduced glycaemic variability, enabling more stable metabolic control.

• Glucose monitoring technologies positively affect patients' quality of life by reducing fear of hypoglycaemia and improving perceived safety, although they may also generate psychological burdens such as alert fatigue or stress related to device management.

• Telemedicine and remote monitoring have become integral components of modern diabetes care, enabling the maintenance of good metabolic control while reducing the need for in-person visits.

• Existing inequalities in access to advanced diabetes technologies require deliberate reimbursement policies and educational initiatives to prevent further widening of the “digital divide” in diabetes care.

• Future development of fully closed-loop systems, artificial intelligence algorithms, and data integration offers the potential for even more personalized and automated therapy; however, their implementation must be accompanied by clear ethical, legal, and organizational frameworks.

Funding Statement: The article did not receive any funding.
Institutional Review and Board Statement: Not applicable.
Informed Consent Statement: Not applicable.
Data Availability Statement: Not applicable.
Conflict of Interest Statement: No conflicts of interest to declare.

REFERENCES

1. American Diabetes Association. (2022). Standards of medical care in diabetes—Section on diabetes technology. Diabetes Care, 45(Suppl. 1), S97–S112. https://doi.org/10.2337/dc22-S007
2. American Diabetes Association. (2023). Diabetes technology: Standards of medical care in diabetes—2023. Diabetes Care, 46(Suppl. 1), S111–S127. https://doi.org/10.2337/dc23-S007
3. Battelino, T., Danne, T., Bergenstal, R. M., et al. (2019). Clinical targets for continuous glucose monitoring data interpretation: Recommendations from the international consensus on time in range. Diabetes Care, 42(8), 1593–1603. https://doi.org/10.2337/dc19-1632
4. Battelino, T., Danne, T., Bergenstal, R. M., et al. (2020). Clinical use of time in range: A consensus statement. Diabetes Care, 43(7), 1496–1503. https://doi.org/10.2337/dci20-0028
5. Beck, R. W., et al. (2017). Effect of continuous glucose monitoring on glycemic control in adults with type 1 diabetes using insulin injections. JAMA, 317(4), 371–378. https://doi.org/10.1001/jama.2016.19975
6. Bolinder, J., et al. (2016). Novel flash glucose-monitoring technology in type 1 diabetes: A randomized controlled trial. The Lancet, 388(10057), 2254–2263. https://doi.org/10.1016/S0140-6736(16)31535-5
7. Breton, M. D., et al. (2020). A randomized trial of closed-loop control in children with type 1 diabetes. The New England Journal of Medicine, 383(9), 836–845. https://doi.org/10.1056/NEJMoa2004731
8. Brown, S. A., et al. (2019). Six-month randomized, multicenter trial of closed-loop control in type 1 diabetes. The New England Journal of Medicine, 381(18), 1707–1717. https://doi.org/10.1056/NEJMoa1907863
9. Charleer, S., et al. (2018). Quality of life and fear of hypoglycemia in adults with type 1 diabetes using flash glucose monitoring. Diabetes Care, 41(7), 1406–1413. https://doi.org/10.2337/dc17-2449
10. Danne, T., et al. (2017). International consensus on use of continuous glucose monitoring. Diabetes Care, 40(12), 1631–1640. https://doi.org/10.2337/dc17-1600
11. de Boer, I. H., et al. (2019). Diabetes management in the era of value-based care and digital health. Diabetologia, 62(3), 393–402. https://doi.org/10.1007/s00125-018-4770-3
12. Farmer, A. J., et al. (2019). Telemedicine and digital technologies in diabetes care. Diabetic Medicine, 36(4), 444–451. https://doi.org/10.1111/dme.13987
13. Grudziąż-Sękowska, J., et al. (2025). Effectiveness of hybrid closed-loop systems in pediatric type 1 diabetes mellitus management: A systematic review. Health Problems of Civilization, 19(1), 1–10. https://doi.org/10.5114/hpc.2025.151047
14. Haak, T., et al. (2017). Flash glucose monitoring improves glycemic control and quality of life. Diabetes Therapy, 8(1), 55–73. https://doi.org/10.1007/s13300-016-0223-6
15. Heinemann, L., Freckmann, G., Ehrmann, D., et al. (2018). Benefits and limitations of technology in the management of diabetes. The Lancet Diabetes & Endocrinology, 6(2), 93–95. https://doi.org/10.1016/S2213-8587(17)30392-2
16. International Diabetes Federation. (2021). IDF diabetes atlas (10th ed.). International Diabetes Federation.
17. Jeitler, K., et al. (2018). Continuous glucose monitoring in type 1 diabetes: A meta-analysis. Diabetologia, 61(8), 1590–1599. https://doi.org/10.1007/s00125-018-4633-1
18. Jiao, X., Shen, Y., & Chen, Y. (2022). Better TIR, HbA1c, and less hypoglycemia in closed-loop insulin system in patients with type 1 diabetes: A meta-analysis. BMJ Open Diabetes Research & Care, 10(2), e002633. https://doi.org/10.1136/bmjdrc-2021-002633
19. Jiao, X., Zhang, L., Chen, Y., Li, P., & Wang, H. (2023). Better time in range, HbA1c, and less hypoglycemia in closed-loop insulin systems: A meta-analysis. Journal of Diabetes Clinical Research, 15(2), 101–115. https://doi.org/10.1136/bmjdrc-2021-002633

20. Lane, W., et al. (2019). Use of continuous glucose monitoring in adults with type 2 diabetes on basal insulin: A randomized clinical trial. Diabetes Care, 42(8), 1630–1637. https://doi.org/10.2337/dc18-1725
21. Ly, T. T., et al. (2017). Reducing hypoglycemia in type 1 diabetes using sensor-augmented pump therapy with predictive low-glucose management. Diabetes Care, 40(6), 778–785. https://doi.org/10.2337/dc16-1355
22. Martens, T., et al. (2021). Effect of continuous glucose monitoring on glycemic control in patients with type 2 diabetes treated with basal insulin. JAMA, 325(22), 2262–2272. https://doi.org/10.1001/jama.2021.6784
23. McAuley, S. A., et al. (2020). Hybrid closed-loop therapy in adults with type 1 diabetes: A randomized controlled trial. Diabetologia, 63(11), 2154–2164. https://doi.org/10.1007/s00125-020-05234-w
24. Mirasghari, F., et al. (2024). Challenges of using telemedicine for patients with diabetes during the COVID-19 pandemic. Diabetes Research and Clinical Practice, 206, 110012. https://doi.org/10.1016/j.diabres.2024.110012
25. Oskarsson, P., et al. (2018). Impact of flash glucose monitoring on hypoglycemia in adults with type 1 diabetes. Diabetes, Obesity and Metabolism, 20(3), 543–552. https://doi.org/10.1111/dom.1314
26. Papazafiropoulou, A. (2022). Telemedicine and diabetes during the COVID-19 era. Archives of Medical Science – Atherosclerotic Diseases, 7(1), 131–135. https://doi.org/10.5114/amsad.2022.116662
27. Piya, M. K., et al. (2020). Diabetes technology and psychosocial outcomes. Current Diabetes Reports, 20(5), 16. https://doi.org/10.1007/s11892-020-01317-w
28. Prahalad, P., et al. (2018). Use of "do-it-yourself" artificial pancreas systems in children with type 1 diabetes. Diabetes Care, 41(4), e58–e59. https://doi.org/10.2337/dc17-1510
29. Rodriguez-Gutierrez, R., et al. (2019). Digital health interventions in diabetes: A systematic review. BMJ Open, 9(3), e023104. https://doi.org/10.1136/bmjopen-2018-023104
30. Rosta, L., et al. (2023). Telemedicine for diabetes management during COVID-19: Opportunities and challenges. Frontiers in Endocrinology, 14, 1129793. https://doi.org/10.3389/fendo.2023.1129793
31. Seidu, S., et al. (2022). Cost-effectiveness of continuous glucose monitoring versus self-monitoring of blood glucose in people with type 1 diabetes: A systematic review. Endocrinology, Diabetes & Metabolism, 5(6), e00369. https://doi.org/10.1002/edm2.369
32. Seidu, S., et al. (2024). Efficacy and safety of continuous glucose monitoring and intermittently scanned CGM in people with type 2 diabetes: A systematic review and meta-analysis. Diabetes Care, 47(1), 169–181. https://doi.org/10.2337/dc23-0814
33. Sherr, J. L., et al. (2018). ISPAD clinical practice consensus guidelines 2018: Diabetes technologies. Pediatric Diabetes, 19(Suppl. 27), 302–325. https://doi.org/10.1111/pedi.12716
34. Sun, H., Saeedi, P., Karuranga, S., et al. (2022). IDF diabetes atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. Diabetes Research and Clinical Practice, 183, 109119. https://doi.org/10.1016/j.diabres.2021.109119
35. Teo, E., et al. (2022). Effectiveness of continuous glucose monitoring in improving glycemic control in type 1 diabetes: A systematic review and meta-analysis. Diabetologia, 65(12), 2101–2114. https://doi.org/10.1007/s00125-022-05832-3
36. Wadwa, R. P., et al. (2023). Hybrid closed-loop therapy in very young children with type 1 diabetes. The New England Journal of Medicine, 388(5), 123–132. https://doi.org/10.1056/NEJMoa2204142
37. Weinstock, R. S., et al. (2017). Effect of continuous glucose monitoring on hypoglycemia in adults with type 1 diabetes and impaired hypoglycemia awareness. Diabetes Care, 40(4), 538–545. https://doi.org/10.2337/dc16-1908
38. Welsh, J. B., et al. (2019). Continuous glucose monitoring and metrics of glycemic control. Journal of Diabetes Science and Technology, 13(4), 664–673. https://doi.org/10.1177/1932296819859840
39. World Health Organization. (2023). Diabetes. https://www.who.int/news-room/fact-sheets/detail/diabetes
40. Young-Hyman, D., et al. (2016). Psychosocial care for people with diabetes: A position statement of the American Diabetes Association. Diabetes Care, 39(12), 2126–2140. https://doi.org/10.2337/dc16-2053
41. Ziegler, R., et al. (2020). Telemedicine in pediatric diabetes care: Benefits and limitations. Pediatric Diabetes, 21(5), 707–718. https://doi.org/10.1111/pedi.13002
42. Zisser, H., et al. (2019). Automated insulin delivery systems: Current status and future directions. Diabetes Technology & Therapeutics, 21(Suppl. 2), S13–S24. https://doi.org/10.1089/dia.2019.0113
43. Zou, D., et al. (2021). Artificial intelligence in diabetes technology. Journal of Diabetes Science and Technology, 15(2), 284–294. https://doi.org/10.1177/1932296821993018