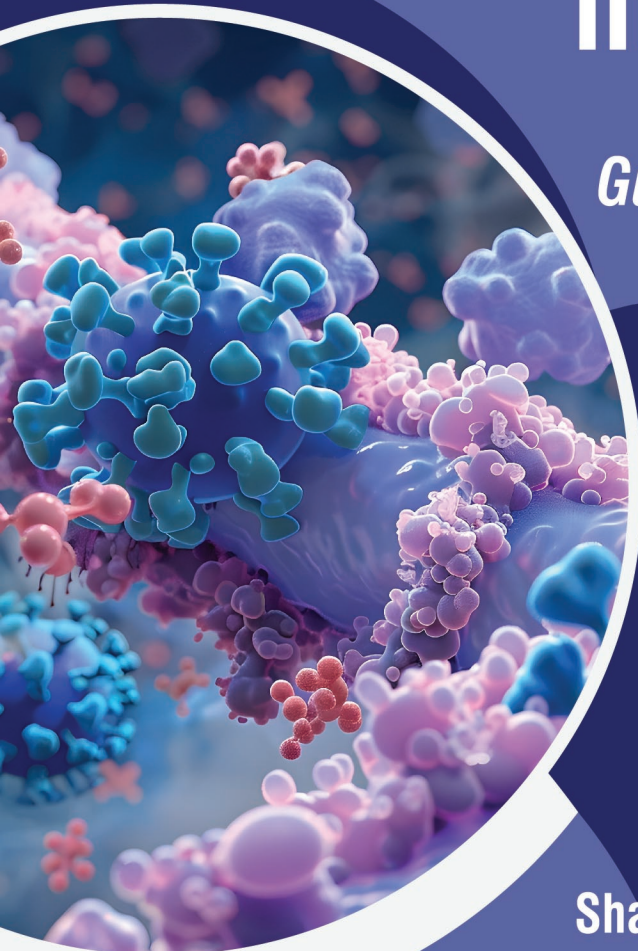


Diabetes in Practice

*A Comprehensive
Guide for Physicians*



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Diabetes Technology

INTRODUCTION

Advances in diabetes technology have revolutionized diabetes management, improving glycemic control, reducing complications, and enhancing quality of life for patients. Technologies such as *continuous glucose monitoring (CGM)*, *insulin pumps*, and *artificial pancreas systems* are becoming integral tools for managing type 1 diabetes (T1D) and, increasingly, for type 2 diabetes (T2D). These tools provide real-time data, automate insulin delivery, and reduce the burden of daily diabetes management.

This chapter explores the key aspects of diabetes technology, focusing on CGM, insulin pumps, and artificial pancreas systems, and their clinical applications. A real-world case illustrates the role of technology in achieving intensive glucose control.

CONTINUOUS GLUCOSE MONITORING

Overview

Continuous glucose monitoring systems provide real-time glucose readings, trends, and alerts, allowing patients and clinicians to make informed decisions about diabetes management. CGM measures interstitial glucose levels through a sensor inserted under the skin, offering continuous feedback compared to traditional fingerstick monitoring (Table 1).

TABLE 1: Common continuous glucose monitoring (CGM) systems.

System	Features	Duration
Dexcom G6	No calibration required; Mobile app integration	10 days
FreeStyle Libre 2	Scanned sensor; hypoglycemia/hyperglycemia alarms	14 days
Medtronic Guardian	Integrates with Medtronic insulin pumps	7 days

Key Features of Continuous Glucose Monitoring Systems

- *Real-time data:*
 - Continuous readings every 1–5 minutes
 - Visual graphs show glucose trends, enabling proactive adjustments.
- *Alerts and alarms:*
 - Warn users of hypoglycemia, hyperglycemia, or rapid glucose changes.
- *Integration:*
 - Many CGM systems integrate with insulin pumps or Mobile apps for seamless data sharing.

Clinical Benefits

- *Improved glycemic control:*
 - Reduces glycated hemoglobin (HbA1c) levels by 0.5–1.0% in T1D and T2D
 - Increases time in range (TIR) for glucose levels (70–180 mg/dL)
- *Hypoglycemia prevention:*
 - Alerts enable timely interventions, reducing severe hypoglycemia risk
- *Behavioral insights:*
 - Provides real-time feedback on the effects of diet, exercise, and medications

Challenges

- Cost and insurance coverage can be barriers to widespread use.
- Skin irritation and sensor placement issues affect some users.

INSULIN PUMPS

Overview

Insulin pumps deliver insulin subcutaneously in a programmed manner, mimicking physiological insulin secretion. These devices provide both basal (continuous) and bolus (mealtime) insulin delivery, offering more precise control compared to multiple daily injections (MDIs) (**Table 2**).

Key Features

- *Customizable delivery:*
 - Basal rates and bolus doses can be adjusted based on individual needs.

TABLE 2: Common insulin pumps.

Pump	Features	Integration
Medtronic MiniMed	SmartGuard system for hypoglycemia prevention	Pairs with CGM (Guardian)
Tandem t:slim X2	Basal-IQ technology; Mobile control	Integrates with Dexcom G6
Omnipod DASH	Tubeless pump; Mobile app control	CGM optional

- *Integration:*
 - Many pumps pair with CGM systems to automate insulin delivery.
- *Convenience:*
 - It reduces the burden of frequent injections.

Clinical Benefits

- *Tighter glycemic control:*
 - Reduces HbA1c levels by 0.5–1.0% compared to MDI
- *Flexibility:*
 - Adjusts for variable eating patterns, exercise, and illness
- *Reduction in hypoglycemia:*
 - Automated basal adjustments minimize the risk of nocturnal hypoglycemia.

Challenges

- Risk of infusion site infections or occlusions
- Requires frequent monitoring and troubleshooting

ARTIFICIAL PANCREAS SYSTEMS

Overview

Artificial pancreas systems, also known as hybrid closed-loop systems, automate insulin delivery by combining CGM, insulin pumps, and advanced algorithms. These systems represent the next evolution in diabetes technology, requiring minimal user intervention (**Table 3**).

Key Components

- *CGM sensor:*
 - Continuously measures glucose levels
- *Insulin pump:*
 - Adjusts insulin delivery based on CGM data
- *Control algorithm:*
 - Uses artificial intelligence to calculate insulin needs in real-time

Clinical Benefits

- *Optimal glycemic control:*
 - Maintains glucose levels within the target range with minimal manual input

TABLE 3: Notable systems.

System	Features	Clinical benefit
Medtronic 780G	Real-time autocorrections; CGM integration	Reduces time spent in hypoglycemia
Tandem Control-IQ	Predictive technology for glucose control	Increased time in range (TIR)
Omnipod 5	Tubeless closed-loop system	Simplified management

- *Reduction in hypoglycemia:*
 - Automated insulin suspension during predicted hypoglycemia
- *Improved quality of life:*
 - Reduces the cognitive burden of diabetes management

Challenges

- Requires user training for optimal use
- High upfront cost and limited insurance coverage

CASE: USING TECHNOLOGY FOR INTENSIVE GLUCOSE CONTROL

Scenario

A 35-year-old male with T1D for 10 years presents with HbA1c of 8.8% and frequent nocturnal hypoglycemia. He is on MDIs and performs fingerstick glucose monitoring four times per day. He reports difficulty maintaining consistent glucose levels due to an unpredictable work schedule.

Approach

- *Transition to technology:*
 - Initiate *Dexcom G6 CGM* to monitor glucose trends and provide alerts for hypo- and hyperglycemia.
 - Prescribe *Tandem t:slim X2 insulin pump* with Control-IQ technology for automated insulin delivery.
- *Education:*
 - Train the patient on CGM insertion, pump use, and interpreting data.
 - Discuss strategies to manage high glucose variability with pump adjustments.
- *Monitoring and follow-up:*
 - Schedule follow-ups to review CGM and pump data, adjust basal rates, and optimize bolus settings.

Outcome

- HbA1c reduced to 7.2% within 3 months.
- Significant reduction in nocturnal hypoglycemia events
- Improved quality of life and confidence in managing diabetes

PRACTICAL CONSIDERATIONS

- *Patient selection:*
 - CGM and insulin pumps are particularly beneficial for T1D patients or T2D patients with insulin dependence.
 - Consider patient motivation, technical skills, and access to resources.

- *Overcoming barriers:*
 - Advocate for insurance coverage to offset costs.
 - Provide hands-on training to reduce the learning curve.
- *Integration with care:*
 - Utilize data from CGM and pumps during clinical visits to personalize therapy.
 - Leverage remote monitoring tools to enhance patient engagement.

RECOMMENDATIONS FOR CLINICIANS

- *Continuous glucose monitoring:*
 - Recommend for patients on intensive insulin therapy to reduce hypoglycemia and improve time in range.
 - Use data to identify patterns and make targeted adjustments.
- *Insulin pumps:*
 - Ideal for patients struggling with MDI regimens or frequent glucose variability
 - Educate on troubleshooting infusion set issues.
- *Artificial pancreas systems:*
 - Preferred for T1D patients with suboptimal control or high risk of hypoglycemia
 - Provide close follow-up during the initial adjustment period.

CONCLUSION

Diabetes technology has significantly transformed the management of both type 1 and type 2 diabetes, providing patients and clinicians with advanced tools to optimize glycemic control and improve quality of life. The integration of *CGM*, *insulin pumps*, and *artificial pancreas systems* has enhanced the precision and personalization of diabetes care, reducing the burden of self-management while minimizing the risks of hyperglycemia and hypoglycemia.

CGM systems have proven invaluable in providing real-time glucose data, allowing for timely interventions and improved glycemic outcomes. *Insulin pumps* offer flexible and customizable insulin delivery, reducing glycemic variability and enhancing patient convenience. Meanwhile, *artificial pancreas systems* represent the next frontier in diabetes care, using real-time glucose readings and predictive algorithms to automate insulin dosing with minimal user input.

Despite their immense benefits, challenges such as cost, accessibility, and the learning curve associated with these technologies remain barriers to widespread adoption. Overcoming these hurdles requires greater advocacy for insurance coverage, structured patient education, and continued advancements in affordability and ease of use.

As diabetes technology continues to evolve, its integration into clinical practice must be guided by individualized patient needs, ensuring that those

who can benefit most receive access to these life-changing tools. By leveraging these innovations, healthcare providers can help patients achieve better glycemic control, reduce complications, and improve overall well-being in diabetes management.

SUGGESTED READINGS

1. Dovic K, Battelino T. Evolution of Diabetes Technology. *Endocrinol Metab Clin North Am.* 2020;49(1):1-18.
2. Zahid M, Dowlathshahi S, Kansara AH, Sadhu AR. The Evolution of Diabetes Technology - Options Toward Personalized Care. *Endocr Pract.* 2023;29(8):653-62.

Diabetes in Practice

A Comprehensive Guide for Physicians

Salient Features

- **Comprehensive coverage:** The book offers an in-depth exploration of diabetes management, including pathophysiology, therapeutic approaches, lifestyle modifications, and the role of emerging technologies, making it an essential guide for clinicians.
- **Patient-centered care:** Emphasizes evidence-based, personalized approaches to diabetes management, addressing special populations such as pregnant women, children, and the elderly, as well as integrating mental health and adherence strategies.
- **Practical insights:** Includes real-world clinical case studies, prescriber-friendly tables, and practical tips for day-to-day management, bridging the gap between theory and practice.
- **Focus on innovations:** Highlights advancements in diabetes care, such as continuous glucose monitoring (CGM), SGLT-2 inhibitors, GLP-1 receptor agonists, and hybrid closed-loop systems, preparing clinicians for the future of diabetes management.

Shambo Samrat Samajdar is a highly accomplished clinical pharmacologist and therapeutics specialist with an MBBS, MD, DM in Clinical Pharmacology, a Diploma in Allergy Asthma Immunology (Gold Medal), and a Fellowship in Respiratory and Critical Care from WBUHS. Renowned for his expertise in diabetes and allergy-asthma therapeutics, he has published over 110 articles in indexed journals and authored more than 60 book chapters. He serves as a Consultant Physician at the Diabetes and Allergy-Asthma Therapeutics Specialty Clinic and Allergy Asthma Treatment Centre in Kolkata, West Bengal, and as a faculty member at JMN Medical College & Hospital, Nadia, West Bengal, India. Dr Samajdar has been honored with numerous awards, including the Indian Academy of Diabetes Innovation Award 2022 and the RSSDI USV Innovation Award 2024. His contributions to research and patient care have established him as a leader in his field.

Rupak Chatterjee MBBS(Hons, Triple Gold Medalist) MD(Tropical Medicine, Gold Medalist, WBUHS Topper) is a distinguished physician with a stellar academic record. An alumnus of the College of Medicine & Sagore Dutta Hospital, Kolkata, West Bengal, India, he earned honors in 12 MBBS subjects and received Gold Medals in pharmacology, pathology, and medicine. He completed his MD in Tropical Medicine at the Calcutta School of Tropical Medicine, achieving the highest marks in the subject's history and earning a Gold Medal as the WBUHS Topper. With certifications in Critical Care and Diabetes, Dr Chatterjee has a keen interest in endocrinology and infectious diseases. He has authored 62 publications in esteemed indexed journals, including BMJ, JRCPE, PMJ, and AJM. His exceptional academic achievements and research contributions make him a valued expert in the fields of medicine and diabetes care.

Shashank R Joshi MD DM FICP FACP(USA) FACE(USA) Hon DSc(Medicine) FRCP(London, Glasgow, Edinburgh), is a towering figure in the field of endocrinology and a Padmashri Awardee, recognized for his pioneering work in diabetes, thyroid disorders, and metabolic health. Currently practicing at Joshi Clinic, Lilavati Hospital, and Sir HN Reliance Foundation Hospital, Mumbai, Maharashtra, India, he has held several prestigious positions, including Past-Chair of the International Diabetes Federation (Southeast Asia), President of the Indian Academy of Diabetes, President of the Indian Thyroid Society (2023–2024), and Past-Dean of the Indian College of Physicians. He has also served as Past-President of the Association of Physicians of India (API), Endocrine Society of India, Research Society for the Study of Diabetes in India (RSSDI), All India Association for Advancement of Research in Obesity (AIAARO), and the International College of Nutrition, while also being the Founder Vice-President of the PCOS Society and Past-Chapter Chair (India) for the American Association of Clinical Endocrinology. A distinguished academician, Dr Joshi is the Emeritus Editor of JAPI and Editor of the API Textbook of Medicine, and his prolific contributions to medical literature have significantly influenced endocrinology and internal medicine. Recognized internationally, he holds the title of Master of the American College of Endocrinology (MACE) and an Honorary Doctor of Science (DSc) in Medicine, along with Fellowships from the Royal Colleges of Physicians in London, Glasgow, and Edinburgh. His leadership in professional societies and editorial boards, combined with his relentless advocacy for public health, has earned him global acclaim. Dr Joshi's exceptional career, enriched by numerous accolades and pioneering initiatives, stands as an inspiration to medical professionals worldwide, exemplifying excellence in clinical practice, research, and education.

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