The latest advancements in diabetes technology: A comprehensive guide for patients

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It has been estimated that 7.4 million Americans with diabetes use insulin.[1] Insulin therapy has many challenges, including a narrow therapeutic range with the risk of hypoglycemia, multiple daily injections, and complex decisions about dosing/timing based on meal selection and exercise.[2] Glycemic control is key in the treatment of diabetes, and the prevention of complications.[3] However, less than one quarter of the adults in the U.S. can meet the HbA1c goal of <7%.[4] This has led to advances in diabetes technology, including the development of continuous glucose monitors (CGM), smart insulin pens, insulin pumps and automated insulin delivery systems (AID) to improve glycemic outcomes.[5] Randomized controlled trials and U.S. national registry studies have demonstrated better glycemic control with the use of CGM compared with the self-monitoring of blood glucose and with AID use compared with CGM and pump alone.[4] Similarly, a single center observational study showed that the daily use of CGMs with and without an AID improves glycemic outcomes in adults with type 1 diabetes mellitus. Over a period of 8 years.[4] Both the growth in diabetes technology in the past decade and the increase in use, has made possible for more people to achieve goal A1c < 7.[4] Apart from the glycemic lowering effect, the ability to provide real-time integrated data through these devices allows improvement in diabetes education, medication adherence, and health related quality of life.[2,6] Tables 1–4 describe the technologies currently available for patients with diabetes and provide a comparison among different devices with the goal of creating awareness and facilitating selection.

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Discussion

The development of new technologies for diabetic patients has transformed the management of this disease with a focus on patient centered and individualized care.[3] For instance, CGM allows both patients and medical staff to understand glucose variability and unique patterns.[7] Smart pens combined with CGM provide immediate feedback on insulin response to a meal and thus can serve to reinforce certain health related behaviors.[2] However, multiple challenges remain in the implementation of diabetes technologies across different populations. In fact, studies show suboptimal outcomes and less use of diabetes technologies in minorities with Type 1 diabetes mellitus.[4] Human factors such as age, co-morbidities, socioeconomic status, education, access to services, patient satisfaction/perceived benefit, and language barriers, have an important effect in the patient's ability to achieve optimal glycemic control. Therefore, using these technologies to reduce disparities in diabetes care and continuing research on their long-term cost effectiveness should be a priority. This technology continues to evolve, and these tables will need periodic updating.

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Table 1. Current Devices Used in the Management of Diabetes

Diabetes Technology	Description	Operational Features	Target Patients
Continuous glucose monitor (CGM)	Device that continuously measures glucose levels in real-time via sensors placed under the skin.	Provides real-time glucose data, trend analysis, and alerts for high/low glucose levels.	Type 1 and Type 2 diabetes patients. Prediabetes and Gestational Diabetes Mellitus.
Insulin pump	Device used to infuse insulin throughout the day replacing multiple insulin shots. Patch pumps and smart pumps.	Eliminates the need for multiple daily shots and creates more convenience with insulin administration.	Type 1 and Type 2 diabetes patients.
Hybrid closed Loop Systems (Automated insulin delivery systems-AID)	Smart insulin pump integrated with continuous glucose monitor (CGM) that adjusts the insulin delivery based on real time blood glucose levels.	Automatic insulin adjustments by using pump-specific algorithm. Maximizes time in range. Requires patient to enter carbohydrate intake.	Type 1 and Type 2 diabetes patients.
Smart insulin pens	Advanced insulin pens with digital technology to synchronize data with mobile apps.	Dose calculations, insulin dose tracking, and reminders.	Type 1 and Type 2 diabetes patients.
Connected pens and caps	Devices to assist with advancing diabetes management using digital technology.	Dose calculations, insulin dose tracking, and reminders. Can be used with most commercially available pens.	Type 1 and Type 2 diabetes patients.
Diabetes management apps	Mobile apps track blood sugars, insulin doses, and assist with carbohydrate counting.	Life style modifications, dietary education, and tracking diabetes management.	Type 1 and Type 2 diabetes patients. Prediabetes and Gestational Diabetes Mellitus.

Table 2. Continuous Glucose Monitors

Device Name	Manufacturer	Indications	Operational Features	Expected Benefit	Potential Hazards
1. Dexcom Pro	Dexcom	Professional diagnostic monitoring, office based.	10-day monitor for office use only.	Blinded and non-blinded.	Rash, skin infections or abscess, pain.
2. Freestyle libre Pro	Abbott	Professional diagnostic monitoring, office based.	14-day monitor for office use only.	Blinded only.	Rash, skin infections or abscess, pain.
3. Freestyle Libre 2/2 plus	Abbott	Continuous glucose monitoring and hybrid loop system.	Prescription based, 14-day wear.	Real time glucose monitoring. Low and high alarms.	Rash, skin infections or abscess, pain.

Table 2. Continuous Glucose Monitors (*Continued*)

Device Name	Manufacturer	Indications	Operational Features	Expected Benefit	Potential Hazards
4. Freestyle Libre 3/3 plus	Abbott	Continuous glucose monitoring.	15-day wear.	Real time glucose monitoring. Low and high alarms.	Rash, skin infections or abscess, pain.
5. Dexcom G6	Dexcom	Continuous glucose monitoring and hybrid loop system.	10-day wear, 2-hour warm time.	Real time glucose monitoring. Low and high alarms.	Rash, skin infections or abscess, pain.
6. Dexcom G7	Dexcom	Continuous glucose monitoring and hybrid loop system.	10-day wear, 30-minute warm time.	Real time glucose monitoring. Low and high alarms.	Rash, skin infections or abscess, pain.
7. Dexcom Stelo	Dexcom	Blood glucose monitoring for prediabetes and type 2 diabetes not on insulin.	OTC, 15-day wear.	Real time glucose monitoring. No alarms.	Rash, skin infections or abscess, pain.
8. Guardian 3	Medtronic	Medtronic insulin pump.	7- day wear. Needs calibrations.	Specific pump uses only. Limited to Medtronic.	Rash, skin infections or abscess, pain.
9. Guardian 4	Medtronic	Medtronic insulin pump.	7-day wear. Does not need calibrations; more accuracy.	Specific pump uses only. Limited to Medtronic.	Rash, skin infections or abscess, pain.
10. Simplera	Medtronic	Medtronic insulin pump.	7-day wear. Simplified insertion. 2-hour warm time.	Specific pump uses only. Limited to Medtronic.	Rash, skin infections or abscess, pain.
11. Eversense XL	Senseonics holdings, Inc.	Continuous glucose monitoring.	180-day wear.	Real time glucose monitoring	Surgical procedure required, infection, scars, bleeding/ bruising, movement restrictions
12. Eversence 365	Senseonics holdings, Inc.	Continuous glucose monitoring.	365-day wear.	Real time glucose monitoring	Same as Eversense XL
13. Lingo	Abbott	Blood glucose monitoring for prediabetes and type 2 diabetes not on insulin	OTC, 15-day wear	Real time glucose monitoring. No alarms	Rash, skin infections or abscess, pain

Table 3. Insulin Pumps

Device Name, Manufacturer	Indication	Operational Features	Expected Benefit	Potential Hazards	Other Features
1. Cequr Simplicity (Cequr)	Type 1 and type 2 diabetes.	Patch pump.	Replaces multiple daily injections. On demand bolus in 2-unit increments.	Rash, skin infections or abscess, pain.	Holds 200 units of rapid acting insulin. Change every 3 days.
2. V-Go (Mankind Corporations)	Type 2 diabetes.	Patch pump.	Basal and bolus. Replaces multiple daily injections.	Limited doses available. Rash, skin infections or abscess, pain.	Basal doses: 20, 30, 40 units. Bolus on demand in 2-unit increments
3. Omnipod Go (Insulet)	Type 2 diabetes patients >18 years.	Patch pump.	Basal only.	Limited doses available. Rash, skin infections or abscess, pain.	Basal doses: 10,15, 20, 25, 30, 3, 40. 3-day wear
4. Omnipod 5 (Insulet)	Type 1 diabetes patients >2 years. Type 2 diabetes patients on insulin.	Smart pump.	Automatic insulin delivery; integrates with CGMs. No tubing.	Rash, skin infections or abscess, pain. Lipodystrophy. Software or hardware malfunction.	No autocorrections. Smart bolus calculator. Hypo Protect mode.
5. Medtronic 780G (Medtronic)	Type 1 diabetes patients >7 years.	Smart pump.	Automatic insulin delivery; integrates with specific CGMs-Guardian only.	Rash, skin infections or abscess, pain. Lipodystrophy. Battery life. Software issues.	Auto boluses q5min. Meal detection. 7-day infusion set option. AA battery operated. Holds 300 units.
6. Tandem T: Slim (Tandem)	Type 1 diabetes patients >6 years.	Smart pump.	Automatic insulin delivery; integrates with most available CGMs.	Rash, skin infections or abscess, pain. Lipodystrophy. Battery life. Software issues.	Automatic corrections every 1 hour. Holds 300 units.
7. Tandem Mobi (tandem)	Type 1 diabetes patients >6 years.	Smart pump.	Automatic insulin delivery; integrates with most available CGMs.	Rash, skin infections or abscess, pain. Lipodystrophy. Battery life. Software issues.	Hold 200 units Works on control IQ technology. 5-inch tubing.

Table 3. Insulin Pumps (*Continued*)

Device Name, Manufacturer	Indication	Operational Features	Expected Benefit	Potential Hazards	Other Features
8. Beta Bionics iLet (beta bionics)	Type 1 diabetes patients >6 years.	Smart pump	Automatic insulin delivery; integrates with most available CGMs.	Rash, skin infections or abscess, pain. Lipodystrophy. Battery life. Software issues.	Holds 180 units. Meal estimations-no carbohydrate counting.
9. Sequel MedTech twist (Med Tech)	Type 1 diabetes patients >6 years.	Smart pump	Automatic insulin delivery; integrates with most available CGMs.	Rash, skin infections or abscess, pain. Lipodystrophy. Battery life. Software issues.	Holds 300 units. Apple watch compatibility. More flexibility with meal choices. No carbohydrate counting.

Table 4. Smart Insulin Pens/Caps/Buttons

Device Name, Manufacturer	Indication	Operational Features	Expected Benefit	Potential Hazards	Other Features
1. InPen (Medtronic)	Type 1 diabetes Type 2 diabetes patients on insulin	Paired with InPen App. Compatible with Humalog, Novolog and Fiasp U100. 1 year life span. Integrates with Dexcom and Guardian CGMs.	Assists with calculating correction dose; dose reminders and data are downloadable.	Accidental insulin delivery. Incorrect dosing.	Bolus calculator.
2. Bigfoot Unity Diabetes Management System (Bigfoot)	Type 1 and Type 2 diabetes patients >12 years.	Smart insulin pen cap. Fits on most commercially available insulin pens. Integrates with freestyle libre CGMs.	Assists with calculating correction dose, dose reminders, and integrates active insulin time.	Accidental insulin delivery. Incorrect dosing.	Bolus calculator.
3. Lilly Tempo Smart Button	Type 1 and Type 2 diabetes patients >18 years.	Smart insulin pen button. Available with Lyumjev, Basaglar and Humalog insulin. Integrates with freestyle libre CGMs.	Integrates insulin dosing data with glucose, food, exercise and sleep data. Sets personalized reminders and alerts.		Bolus calculator and basal titration tool.

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