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Advanced technology used in pediatric type 1 diabetes management

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It's been 100 years since the first patient with diabetes received an insulin injection to manage their disease. With the world's latest rapid growth in innovative technology, the diabetes realm is competitive and continues to create a wide range of cutting-edge devices. These devices offer various features that make diabetes management less cumbersome for children with diabetes and their caregivers.

Proper Type 1 diabetes mellitus management requires patients to check frequent blood glucose via fingersticks and administer insulin shots up to 5 times daily. Often, newly diagnosed pediatric patients are overwhelmed with this sudden need for highly regimented care that they are to manage independently at home. With recent advancements and innovations in blood glucose monitoring and insulin delivery, newly diagnosed children may be able to better adhere to their care (Sangave et al., 2019). Continuous glucose monitoring (CGM) devices and insulin pumps can be used in conjunction with one another to help ease the cumbersome and painful daily management for healthy diabetes care. The purpose of this column is to review the latest continuous glucose monitor (CGM) options and various insulin pumps with advanced technology features. Challenges and barriers to using and obtaining a diabetes device and future technological advances will also be discussed.

What is a CGM?

A continuous glucose monitor (CGM) is a worn device that can detect blood glucose levels. Enhancements made to CGMs have played a significant role in stabilizing blood glucose levels, thereby improving control of diabetes, and diminishing long-term complications (Prahalad et al., 2018). CGM technology replaces the need for children with Type 1 diabetes to obtain blood 5–10 times a day with a painful fingerstick. CGM technology incorporates checking blood glucose when fasting, before meals and snacks, before bedtime, before physical activity, when hypoglycemia is suspected, after treating a low blood glucose event, and before critical moments such as driving (American Diabetes Association [ADA], 2022). Additionally, the advancement of CGM technology provides predictive blood glucose trends (Prahalad et al., 2018). CGMs continuously measure and display glucose level updates every 1 to 5 min (Reddy et al., 2020). CGM pumps have alarm alerts for hypoglycemic events, providing a safeguard that improves the quality of life for children and their caregivers (Allen & Gupta, 2019).

Devices such as the Abbott Freestyle Libre 2 ™ and the Dexcom G6™ are a few of the latest versions of CGM pumps. Both devices use Bluetooth technology that works with coordinating apps on a cell phone or a receiver to record the child's blood glucose readings and keep track of the data. Another advantage of both CGM devices is that they have waterproof sensors that can be worn in the pool or the shower and do not disrupt the child's daily life habits.

Abbott's Freestyle Libre 2 ™ is a CGM worn for up to 14 days before needing a change to a new sensor. The device is about the size of a half-dollar coin and includes a thin adhesive strip around the perimeter of the apparatus. Once the sensor is placed onto the skin, there is a 1-h warm-up period before the patient can view blood glucose readings. A cell phone or reader must scan the sensor to obtain a blood glucose reading. The display on the receiver device shows the child's current blood glucose, a trend arrow that helps to predict whether the child's blood glucose will fall or rise in the next 30 min and can give an 8-h history of past blood glucose readings (Allen & Gupta, 2019). Ideally, the sensor is scanned at least three times daily to obtain 24 h' worth of data. LibreView™ is a free online account where families can upload, store, and share up to 90 days of their child's blood glucose data with their health care provider. Abbott's Freestyle Libre 2 ™ CGM does not provide minute-to-minute blood glucose readings; therefore, it is more prevalent for use in the treatment of children with Type 2 diabetes and less desirable for use for children with Type 1 diabetes.

The Dexcom G6 ™ CGM offers blood glucose readings every 5 min, which feels like a real-time reading. Sensors are worn for ten days and are slightly larger than Abbott's Freestyle Libre 2 ™ sensor. The Dexcom G6 ™ CGM is thicker because it includes a separate 90-day transmitter (about the size of a house key) and a wider adhesive patch surrounding the sensor. Once the sensor is placed onto the child's skin, there is a 2-h warm-up period before the patient can view blood glucose readings through a receiver or a cell phone device. Like Abbott's Freestyle Libre 2 ™, Dexcom cell phone apps allow blood glucose data to be shared directly with the child's healthcare team. Many caregivers of Type 1 diabetic children utilize the cell phone feature to view their child's blood glucose readings on their cell phone while they are at work and their child is in another location, such as school.

The innovative Dexcom G6 ™ CGM system works in conjunction with the t:slim X2 Control IQ © insulin pump and the newly released Omnipod 5® pump to provide a Hybrid Closed Loop (HCL) system or more automated control of blood glucose levels. The advent of CGM devices has drastically increased the compliance of the child with Type 1 diabetes in managing their disease. The advancement of newer versions

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of CGM devices has proven reliable, shown to improve A1C levels, lessen hypoglycemic events, and improve time in goal glucose range (Reddy et al., 2020). The ADA recommends CGM device use in all Type 1 diabetic children and adolescents, whether with insulin injections or insulin pumps, to improve glycemic control (as cited by Reddy et al., 2020).

What is an insulin pump?

Children with Type 1 diabetes require insulin for the remainder of their life; in essence, insulin pumps perform the work for an entire organ, the pancreas, which is no easy task. Insulin pumps assist in the painless delivery of short-acting insulin to the child. Because of recent advances in technology, insulin pumps are small, user-friendly, and have also become wearable. A new cartridge or pod is loaded with short-acting insulin every three days, and the cannula is placed subcutaneously. Most children prefer the insulin pump over getting up to 5 injections daily. While many believe that an insulin pump is entirely automated, the pump does require the work of the user to enter the number of carbohydrates consumed and uses blood glucose readings to calculate and administer insulin doses. Insulin pumps offer much flexibility for children in eating and dosing carbohydrate snacks at any time with their meals. Because the pump can formulate how much active insulin is in the body, there is less concern for insulin stacking. Most vitally, insulin pumps have improved glycemic control for children, resulting in lower hemoglobin A1C levels (Allen & Gupta, 2019). The ultimate goal in the management of pediatric Type 1 diabetics is to lower their risk for long-term complications, maintain goal A1C levels, and provide the knowledge and education so that they possess the skills to care for their diabetes into adulthood independently.

The Food and Drug Administration (FDA) approved two insulin pumps for children with Type 1 diabetes; the Omnipod 5® pump and the t:slim X2 Control IQ © pump. The Omnipod 5® insulin pump is the only tubeless insulin pump. The pods are waterproof and offer set basal rates that administer background insulin doses every hour, even when the child is in the shower or pool. The t:slim X2 Control IQ © pump includes connector tubing that attaches to the personal diabetes manager (PDM), which must be disconnected in the shower or pool. Both pumps have their version of an HCL system and work in conjunction with the Dexcom G6 ™ CGM system. The t: slim X2 Control IQ © pump automatically administers correction boluses of insulin every hour according to blood glucose levels and predictive trends received from the Dexcom G6 ™. The Omnipod 5® works slightly differently, using the Dexcom G6 ™ blood glucose data to adjust the basal background rate every 5 min. Coordination of insulin pump and CGM frameworks are readily accessible; this has removed the complications of insulin delivery and helped to prevent the most dreaded complication of treatment with insulin, severe hypoglycemia (Allen & Gupta, 2019). Current endeavors that interface CGM data with automated insulin pump use will one day result in an independent artificial pancreas organ (Reddy et al., 2020). Even though these devices do not completely rid the child and caregiver of daily self-care tasks, the specified tools make life with Type 1 diabetes much less demanding (ADA, 2022).

Technology challenges/barriers

While various devices can aid in diabetes care, it is not a complete fix for the autoimmune disease. First and foremost, just because an individual possesses a diabetes device does not improve glycemic control or prevent long-term complications unless the user is motivated and positively engaged.

There are many challenges and barriers to the use of diabetes devices. These devices are susceptible to malfunctions such as catheter or cannula kinks, pod failure, loss of Bluetooth signal, or simple user error. Caregivers report challenges related to "the effectiveness of the adhesive when sweating, insurance coverage, CGM connectivity problems, concern about health implications of 'an object stuck into her skin,' (mom, 16-year-old daughter), as well as fear of who else could see the data" (Mencher et al., 2022, p.253). In addition, with devices worn directly on the skin, younger children who are very lean may not possess much surface area or fatty tissue to use. Also, adolescents wanting to be involved or already engaged in sports activities must anticipate challenges in wearing diabetes devices with sporting gear. Subsequently, diabetes management companies continue to collect consumer feedback and use it to fine-tune their device features to decrease the incidences of pump failure.

The most recently approved diabetes devices require a cellphone; consequently, low-income families may be disadvantaged as they may not have the financial ability to support their children using this technology. Insurance plans may not cover the use of newer medical devices as they are usually quite expensive and not on the formulary when initially released. While HCL frameworks may diminish the burden when compared to conventional strategies of diabetes management, the extra barriers encountered might avert diabetic users, specifical adolescents, in complex psychosocial circumstances (Prahalad et al., 2018). For black parents and patients with Type 1 diabetes, a lack of trust in the healthcare system is a reason for disparities in device use (Mencher et al., 2022). In black people newly diagnosed with Type 1 diabetes, misconceptions were found about the need for disease management with a diabetic device when most other family members were diagnosed with Type 2 diabetes (Mencher et al., 2022). Confusion about the need for different management modes led to the black Type 1 diabetic patient discontinuing the use of the diabetes device entirely. Most providers do not accept that it is their role to direct their patients to use "the best" device but rather present the pros and cons of using the various diabetes devices readily available (Forlenza et al., 2016).

Upcoming advancements

Newer and more advanced technology for diabetes management is on the docket and ready for FDA approval in the United States. There is hope that the future holds the innovative development of a fully closed-loop artificial pancreas, which does not require the user's work by carb counting or initiating calibrations (Prahalad et al., 2018). The Dexcom G6 ™ CGM system will be coming out with a device that is 60% smaller in size and with a transmitter and sensor combined into one unit rather than two separate pieces. The device is to be tested to offer a longer wear time than ten days, potentially worn for two weeks, and have a shorter warm-up period of 30 min. The Freestyle Libre 3 ™ CGM will advance Abbott's technology to see blood glucose readings through an app on the patient's cell phone and is said to be the size of 2 stacked pennies. Insulin pump companies are working on a feature that allows the user to dose from a cellular device rather than carrying or wearing separate PDM devices.

Summary

Current diabetes devices have improved disease management and the quality of life for children and their caregivers; however, owning a device does not equate to a no hands-on approach. Management of diabetes with a device requires engagement and cooperation from the child and their caregiver. Even though these devices do not completely rid the child and caregiver of daily self-care tasks, the pumps make life with Type 1 diabetes much less demanding (ADA, 2022).

While there are several advantages to using a diabetes device, there are challenges and barriers, including access to equipment, technical malfunctions, or the ability to keep probes adhered to a child's skin. Still, the future remains opportunistic with the rapid growth in innovative technology for managing diabetes; staying competitive sets the stage for companies to continue creating a wide range of innovative devices; thus, the technology will continue to evolve.

References

Allen, N., & Gupta, A. (2019). Current diabetes technology: Striving for the artificial pancreas. *Diagnostics (Basel, Switzerland)*, *9*(1), 31. https://doi.org/10.3390/diagnostics9010031.

American Diabetes Association (2022). *Standards of medical care in diabetes—2022* abridged for primary care providers. *Clin Diabetes*, *40*(1), 10–38. https://doi.org/10.2337/cd22-as01.

Forlenza, G. P., Buckingham, B., & Maahs, D. M. (2016). Progress in diabetes technology: Developments in insulin pumps, continuous glucose monitors, and progress towards the artificial pancreas. *The Journal of Pediatrics*, *169*, 13–20. https://doi.org/10.1016/j.jpeds.2015.10.015.

Mencher, S. R., Weinzimer, S. A., Nally, L. M., Van Name, M., Nunez-Smith, M., & Sadler, L. S. (2022). Technology utilization in black adolescents with type 1 diabetes: Exploring the decision-making process. *Diabetes Technology & Therapeutics*, *24*(4), 249–257. https://doi.org/10.1089/dia.2021.0413.

Prahalad, P., Tanenbaum, M., Hood, K., & Maahs, D. M. (2018). Diabetes technology: Improving care, improving patient-reported outcomes and preventing complications in young people with type 1 diabetes. *Diabetic Medicine: A Journal of the British Diabetic Association*, *35*(4), 419–429. https://doi.org/10.1111/dme.13588.

Reddy, N., Verma, N., & Dungan, K. (2020). Monitoring technologies- continuous glucose monitoring, mobile technology, biomarkers of glycemic control. In K. R. Feingold (Eds.), *Endotext*. MDText.com, Inc.

Sangave, N. A., Aungst, T. D., & Patel, D. K. (2019). Smart connected insulin pens, caps, and attachments: A review of the future of diabetes technology. *Diabetes Spectrum: A Publication of the American Diabetes Association*, *32*(4), 378–384. https://doi.org/10.2337/ds18-0069.