

Pediatric Diabetes: What is new with insulin and the use of technology for Diabetes Management

By Christine Richardson, RN, BScN, CDE

The management of pediatric diabetes has seen many changes with the introduction of new insulins and a movement toward the use of technology. The Canadian Diabetes Clinical Practice Guidelines recommend a target A1c of <8.0% in children under six years of age, ≤ 7.5% in children aged six to twelve and ≤ 7.0 in youth 13 and over with diabetes¹. These targets are lower than has been recommended in the past and can be challenging to achieve without a child or youth experiencing frequent hypoglycemia. Among children and youth, type 1 (T1DM) diabetes is the most common and insulin must be administered by injections or an insulin pump. About 1 in 300 children have T1DM diabetes.

In your medical and surgical units you will often have patients admitted with diabetes. Has it happened that they were using a new insulin or technology to manage their diabetes that you were unfamiliar with? Did you wonder how does this insulin pump work? How is this insulin different? The following article will provide an update of new insulins and technologies that are currently being utilized to manage diabetes as well as how they impact ongoing management for children and youth with diabetes.

What is new with insulin?

When insulin was first discovered in 1921, it was extracted insulin from the islets of animals and although this was a life-saving discovery, many patients experienced allergic reactions. In 1982 we experienced the first of semisynthetic insulins, in which the pork insulin was biochemically altered replacing some amino acids. Currently we have insulin analogues, which are an altered form of insulin, through genetic engineering of the underlying DNA.

Bolus (prandial) insulins

These are called rapid acting insulins that have an onset in 10-15 min after injection and peaks in 1-2 hours, with a duration of only 4 hours in total effect time. They are produced under the tradenames of Humalog®, Apidra® and NovoRapid®.

Basal insulins

Humulin N® and Novolin NPH® are intermediate acting insulins and are often used in pediatrics to provide an overlap of insulin at lunch when no support for injections is available at school. They begin to work in 1-3 hours, peak in 5-8 hours and have a duration up to 18 hours.

Basalglar®, Lantus® and Levimer® are new long-acting basal insulin analogues, given once daily to help control the blood sugar level. They have an onset of 90 minutes; there is no peak and the duration is up to 24 hours. Given this action with no distinct peak, they are frequently prescribed for patients using multiple daily injections (MDI) to manage their diabetes. They administer the long acting at the same time each day and take injections of a bolus insulin at each meal. The common administration of insulin has been by syringe or insulin pens. Insulin pens are more popular as they are easy to use and more discreet. The pen has a cartridge of insulin and the user will dial up a selected dose to be administered.

Insulin pumps have been used for many years and the technology is constantly improving. An insulin pump is a device that administers insulin continuously through a small tube inserted under the skin. A pump is not an artificial pancreas; it requires a user to determine when and how much insulin to give. What is unique is that the insulin pump uses only rapid acting insulin (Humalog®, Apidra® and NovoRapid®) and delivers the insulin in two ways: as a **basal** dose or **bolus** dose. The **BASAL** automatically delivers small amounts of insulin steadily every hour as programmed in the pump. The starting dose will be determined by the health care provider and can be adjusted as needed by the user. The **BOLUS** dose is taken at meal times and programmed by the user to cover the carbohydrates (CHO) in the meal or to correct any high BG readings. These smart pumps have bolus calculators that can be programmed to easily calculate the amount of insulin needed to cover food and correct a high or low blood glucose reading if needed. BG meters are linked to the pump in order to automatically send all blood glucose readings to the pump.

In addition to these new smart pumps we have continuous glucose monitors (CGM). This technology involves the patient inserting a glucose sensor (tiny electrode) under the skin into the interstitial fluid, using an automatic insertion device. The glucose sensor is then connected to an insulin pump or a transmitter that will record a sensor glucose reading (SG) every 5 minutes. This results in 288 glucose readings per day that are displayed on the pump or transmitter as a number and in a graph. In addition to providing a real-time sensor glucose value, these CGM devices will also provide trend data. Arrows pointing flat (→) indicate the BG level is stable, while arrows pointing up or down (↑, ↓ or ↑↑, ↓↓) will indicate that SG is rising or dropping at a determined rate. This SG data, combined with trend arrow readings can guide patients in adjusting their insulin needs and to prevent hypoglycemic and hyperglycemic excursions. What is critical to be aware of is that the SG and blood glucose (BG) are different. The sensor glucose is measuring the glucose levels in the interstitial fluid between our cells whereas a blood glucose done by glucometer is measuring glucose levels in the blood. As there is a natural difference between these two samples and a lag time in the transfer of glucose between the cells, there can be a difference in the readings. Patients using CGM are advised to do an actual “fingerstick” glucose to verify the reading before making any treatment decisions. Recently the DexcomG5™ was Health Canada approved to make treatment decisions as long as the glucose alerts and readings match the users symptoms or expectations. Patients that are taking medications containing paracetamol/ acetaminophen are advised to perform a fingerstick to confirm their blood glucose level, as these medications can affect sensor glucose readings². For all CGM systems, a blood glucose is needed every 12 hours to calibrate.

When we combine insulin pumps with a CGM we have a very integrated system in which a child/youth or parent is able to see the CGM data on their insulin pump to determine if they need more or less insulin and are able to live more in the moment without the constant fear of hypoglycemia. Alerts or alarms can be programmed to warn the user if they are going to be trending low/high. Some systems will even automatically suspend delivery of insulin once a preset threshold is reached. This is really the first step towards an artificial pancreas in which the pump is making a decision on insulin delivery based on data obtained from the CGM.

Available CGM systems in Canada

<p>Medtronic 630G™ with CGM</p> 	<p>Animas Vibe Pump with DexcomG4™</p> 	<p>Dexcom G5™</p> 
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Case Study:

Sarah is a 14-year-old girl diagnosed with type 1 diabetes since age 5. At diagnosis her insulin was a twice-daily regime of NPH and NR, as she had no support at school to provide an injection at lunch. This worked well for Sarah until she became very active in sports. When she was 12 years of age and she decided to do a multiple daily injection (MDI) routine. She injected a dose of Levimer® at supper with NovoRapid® at each meal based on CHO content of the meal. Sarah was unsure at this time if she wanted to use a pump, as she did not want to have anything attached to her. Now, at age 14, she is ready for a pump with CGM. Her reasons for now choosing to manage her diabetes this way is to have fewer injections per day and less blood glucose monitoring but still being able to be flexible in the timing of her meals and activity. Sarah's pump choice was an Omnipod™ insulin pump and Dexcom G5™ system.

Sarah's Omnipod™ pump and DexcomG5™



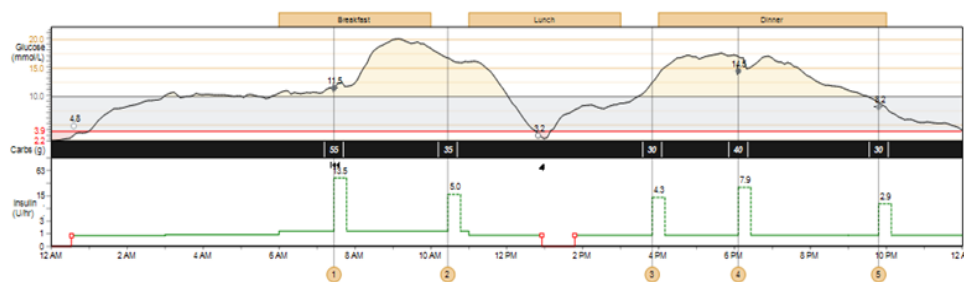
This system allows Sarah to bolus her pump remotely from a personal data management device (PDM) that is also a glucose meter, and the Dexcom G5™ system allows her to view her glucose readings on her iPhone. This combination of devices provides Sarah with all the data she needs to manage her diabetes without having to use a syringe/pen to inject insulin 4 to 5 times per day. With the DexcomG5™, Sarah has chosen to share her data with the soccer coach and her parents. This means that they can view her sensor glucose readings on their phone, while Sarah is playing her sports. Through the use of her CGM, Sarah knows that her coach and parents will be alerted to potential hypoglycemia. Sarah can participate fully in all practices and games, without the fear of going low, knowing she has this added support on the sidelines.

CGM has also changed the way we as health care providers manage diabetes. Each pump and CGM system has a web-based program that allows data to be downloaded and can be viewed by both the healthcare team and the user. Historically all the data provided to us as health care providers was a logbook that was recorded

by the patient as seen below. As health professionals we had to rely that this data was accurate and needed to create a picture for the patient interpreting all the readings and trend situations.

Time	0000	0300	0600	0700	0900	1000	1200	1300	1400	1600	1800	1900	2100	2200	2400
Glucose Level	4.8			11.5				3.2			14.5			8.2	
CHO				55		35					40			30	
Bolus dose for food				13.5		5.0					7.5			2.9	

In the logbook above, the records indicate our patient had a rise in BG from midnight to 0700, and then had a low at 1300. We might assume treatment of this low BG and that this was the cause of the resulting BG of 14.5 at 1800. The BG was corrected and is in target range before bed. When we see this exact same data using the downloaded information we have a more detailed view of what occurred between each BG test.



In the Medtronic carelink™ data report above that was downloaded, we can see that our patient actually had a low BG that occurred prior to the 4.8 BG test at 1230 am, not at midnight as noted. We can see a continued rise overnight waking with a BG of 11.5. There is a rise post breakfast and the low was a result of insulin being given at 1000 with no BG recorded. The BG remains elevated all afternoon but does a steady drop going into midnight. Our plan here would be to adjust insulin going into midnight to prevent the drop in the BG that occurs. The data provided above fills in the gaps between BG readings and allows patients and healthcare providers to make more informed insulin dose adjustments.

The technology to manage diabetes is changing fast. Patients and healthcare professionals are able to view the data obtained from the pump and CGM to make more informed decisions about diabetes management that allow for more precise adjustments for daily activity, food, and sports. With the ongoing use of new insulins and the technology of insulin pumps with or without CGM our goal of achieving recommended A1c targets without frequent episodes of hypoglycemia is very achievable.

Christine Richardson, RN, BScN, CDE is a certified diabetes educator and pump trainer with over twenty years of experience at the Children's Hospital of Eastern Ontario. She has been a leader in the design, development and ongoing management of the insulin pump and CGM programs at CHEO. She was the lead educator in a multicenter clinical trial, The JDRF CCTN CGM TIME Trial. Christine is a passionate advocate for the integration of technology in the management of children and youth with type 1 diabetes.

References:

1. <http://guidelines.diabetes.ca/Browse/Chapter34#sec4>
2. https://www.dexcom.com/en-CA/form2?utm_source=website&utm_campaign=70133000000y KigAAE