The Great CGM Debate: Which System Reigns Supreme?

By Gary Scheiner MS, CDE

Last week, Abbott *finally* announced the official withdrawal of the Freestyle Navigator continuous glucose monitoring (CGM) system from the U.S. market. Not that it came as a surprise. Despite receiving rave reviews for its accuracy, Navigator was plagued with manufacturing and cost/ reimbursement problems and was not being marketed or supported for the past year.

Navigator's demise leaves two systems in contention for CGM supremacy: Medtronic and Dexcom. Having worn all of the systems for extended periods of time and trained dozens of patients on each, and having no formal allegiance to any particular company (other than my own) places me in a somewhat unique position to evaluate the CGMs and offer an unbiased expert opinion.

To add to the fun, a few weeks ago I managed to get my hands on some of Medtronic's new Enlite sensors and an inserter (don't ask how), which are available only in Europe. Medtronic has claimed that their new sensors are superior to their traditional Sof-Sensors, so I figured it was time to do some side-by-side-by-side, three-at-a-time comparisons (Medtronic-Sof Sensor, Medtronic Enlite Sensor, Dexcom 7+). Now keep in mind that I am what they call in scientific circles an "n of 1". That means that this is far from a controlled scientific experiment. It reflects observations from just one person's experience and does not necessarily prove anything… so take this for what it's worth.

So let's get to it. Here's my impression of the Dexcom Seven Plus, Medtronic Real-Time (using Sof-Sensor) and Medtronic Real-Time (using Enlite sensor).

Dexcom Seven Plus has a leg-up in a number of areas. The sensor is very comfortable to insert (I usually feel nothing when inserting and withdrawing the introducer needle), and the sensor itself lasts a long time: usually 12-14 days. The built-in adhesive holds the sensor in place quite well for a week or more. It sensor and transmitter are flat and tapered. The calibrations can be performed at any time (even when the blood sugar is in a state of flux). The transmitter never requires charging. The display on the receiver is large and bright. And the alerts, both audible and vibratory, are strong enough to be noticed by most people even while they are sleeping. The receiver can be set to vibrate initially, and then only beep if the user fails to confirm the vibratory alert.

Another pleasant aspect of the Dexcom is its simplicity. There are very few steps in the start-up process, and only a handful of menus on the receiver/programmer. It is intuitive enough that most people can self-train using the company's online modules. Error messages are few and far between.

Dexcom's accuracy is generally quite good. I find that the sensor matches the fingerstick calibrations fairly well by the end of the first day of sensor usage, and matches most closely from days 3-12, at which point things start to deteriorate. Again, individual use may vary, but my personal experience seems to match that of most of my clients. From initial calibration to sensor failure, I experience an average discrepancy of 10-12% between the Dexcom sensor and simultaneous fingerstick calibrations.

On the downside, Dexcom sensors are more expensive than Medtronic sensors, but the difference isn't much when you consider how long the sensors last. Unlike the Medtronic transmitter, Dexcom's does not store any information for times when you are out of range

of the receiver. Having to charge up the receiver every 3-5 days is a bit of a hassle, especially for people like me who travel a great deal. The charger connects to sensitive filaments in the transmitter; sometimes the filaments bend out of shape, and sometimes the charger cable goes bad, rendering the system unchargeable. In terms of data analysis, the Dexcom receiver does not generate any statistics for the user. Downloading the receiver to a PC (no Mac compatibility) is rather slow. In addition (subtraction?), the Dexcom receiver does not let the user know how long their sensor has been in use, how long until a calibration is due, or when their current sensor expires. One more thing: taking medications containing acetaminophen (such as Tylenol products) will trigger a very high false glucose measurement by the sensor for several hours.

But the major drawback to the Dexcom system is that the display is not yet integrated into an insulin pump. With so many CGM users also being pump users, this is a significant shortcoming. Having to wear a pump and carry around a CGM receiver/display isn't just inconvenient; it can also be impractical – particularly for young children and anyone who is very active. Since it is not tethered to me the way my pump is, I've misplaced my Dexcom receiver more times than I'd care to count. Sometimes I have to bribe my kids to track it down for me: "First one to find dad's Dexcom gets five bucks."

The Medtronic Real-Time CGM (using Sof-Sensors) includes both the Guardian system and sensor-augmented pumps (522, 523, 722 and 723). The major advantage, at least with the sensor-augmented pumps, is the all-in-one concept. No need to carry around a receiver for the CGM since everything displays right on the pump screen. The transmitter stores up to 40 minutes of data, in case the receiver is temporarily out of range. Once back in range, the last 40 minutes of data "dumps" right into the pump or Guardian. The latest Medtronic Real-Time systems allow the user to customize the various alert settings by time of day – a nice feature for those who want to be warned of highs/lows more aggressively at some times of day compared to others. Like Dexcom, Medtronic offers alerts for high/low glucose levels and rise/fall rate of change. But Medtronic also offers predictive alerts – letting the user know if a high or low threshold is expected to be crossed in a given period of time. Although this feature can generate many "false positive" alarms, it can be helpful to those who must be extremely vigilant about preventing hypoglycemia.

When viewing trend graphs on-screen, the user has the option of scrolling back in time to view specific data points. Advanced statistics, such as average, standard deviation, and "area under the curve" can be generated right on the pump/receiver. Data from Medtronic Real-Time downloads through the internet to a website called "Carelink" which produces some excellent graphs, charts and statistical analyses. The download requires a simple USB plug & play device that works on Macs as well as PCs. When using a sensor-augmented pump, the CGM data is combined with pump data (basal & bolus delivery, carb entries, fingerstick readings) to create more comprehensive reports.

There are several downsides to the Medtronic Real-Time system, starting with complexity. Starting a new sensor is a multi-phase process that requires almost as much luck as technical skill. Error messages often occur during the early stages of sensor usage. Calibrations should only be entered when glucose levels are in a steady state, and must be performed on a certain schedule or the system stops generating data.

Medtronic's Sof-Sensors can be uncomfortable to insert, using a long, heavy-gauge introducer needle. Extra tape is needed to hold the sensor and transmitter in place from the get-go. The sensor longevity falls far short of Dexcom, rarely lasting more than a week. Regardless of how long the sensors continue working, they tend to be reasonably accurate only during days 2 to 4 or 2 to 5. Each time I used a sof-sensor beyond 5 days, despite calibrating properly, the accuracy

took a major nosedive. The average difference between Medtronic Sof-Sensors and my simultaneous fingerstick calibrations has been approximately 18%.

In terms of system features, the alerts/alarms on the Real-Time systems are not strong enough to be noticed by many users. This includes both the vibration and the beeps. The display screen is smaller than Dexcom's, and the contrast is not very good. And the transmitter requires re-charging at least once every 6-7 days, or it stops working.

Medtronic's new (pending in the U.S.) **Enlite sensors** have a shorter and much thinner introducer needle, and insert at a 90-degree angle to the skin. There is also extra tape on the sensor to help keep the transmitter (same MiniLink transmitter as is used with the Sof-Sensor) firmly attached. Using the new Enlite insertion device, the new sensors are considerably easier to insert and more comfortable than the Sof-Sensors. I would rank the Enlite sensors equal to Dexcom's in terms of comfort and insertability.

However, the accuracy of the Enlite sensors seems to be no better than that of the Sof-Sensors. Over a three-week period, my Enlite sensors averaged a 19% variance from the fingerstick calibrations. Unlike Sof-Sensors, Enlite tended to err on the *low* side rather than the high side. While this may be beneficial for those trying to prevent hypoglycemia, it can produce enough false low alarms to discourage the average user from fully trusting the device.

So there you have it: My "n of 1" experience with the currently available CGM systems. As you can see, there are pros and cons to everything. That's where your personal preferences come into play. What's really important to you? Accuracy? Convenience? Cost? Comfort? Loudness? Whether you're looking to use a CGM for the first time or are ready to upgrade from your current system, there are many options to consider. As for me? I'll just stick with my

Editor's note: The author's printer ran out of ink just before the article was completed. He apologizes for any grief this may cause. Questions (or complaints) may be sent to gary@integrateddiabetes.com. Gary's practice, Integrated Diabetes Services, offers a CGM trial service for those looking to sample a CGM and receive expert analysis of the data. This service, along with all of the practice's diabetes management consulting services, are available in-person or remotely via phone and the internet. Call (877) 735-3648 or visit www.integrateddiabetes.com for details. To learn more about using CGM to improve your control, visit www.type1university.com.