Podcast 45: Diabetes Technology: Continuous Glucose Monitors

Dr. Rita Kalyani, MD: Welcome to Diabetes Deconstructed, a podcast for people interested in learning more about diabetes. I'm your host, Dr. Rita Kalyani, at Johns Hopkins. We developed this podcast as a companion to our patient guide to diabetes website. If you want a trusted and easy to understand resource for diabetes or to listen to previous podcasts, please visit hopkinsdiabetesinfo.org.

Today, we are thrilled to welcome Adena Goldstein, who will speak with us about diabetes technologies. Adena graduated from Villanova University with her Bachelor of Science in Nursing. She is currently a clinical diabetes nurse and Certified Diabetes Care and Education Specialist (CDCES) at the Johns Hopkins Outpatient Diabetes Center in Baltimore.

Welcome, Adena.

Adena Goldstein, RN, BSN, CDCES: Thank you for having me. I'm excited to be here.

RK: We are thrilled to learn from you today about the latest in diabetes technologies. This is increasingly getting attention as we have more and more technologies available for people with diabetes.

While it has been life-changing for so many people, it can also make the management seemingly more complicated. We're hoping you can break it down for us, in terms of what people with diabetes may want to consider as they're thinking about these technologies and how to facilitate the smooth integration of these technologies into their diabetes care. Perhaps we could start with continuous glucose monitors, could you tell us, what are continuous glucose monitors?

AG: Continuous glucose monitors, also known as CGMs, are a little device that is worn on a patient, and it has a little filament that goes just beneath the skin and measures the glucose in the interstitial fluid every few minutes. Then there is a transmitter that sends the readings to a device: it can be a phone; it can be a separate receiver; it can be a smartwatch; it can be an insulin pump. There are a lot of different ways that it can be used. That provides data every few minutes regarding blood sugars.

I always tell patients who are transitioning to them that it's like treating diabetes with your eyes open versus your eyes closed.

When you use a glucometer, you're pricking your finger, and it is really a surprise whenever you get that number—you don't know if it's going to be in the good range, a little high, or a little low—but with a sensor, because you're getting so many readings, you have a sense for where the blood sugars are going. In addition to the number that you get from the CGM, you also will get a direction arrow showing where your blood sugar is going. It helps you plan what you're doing next, how you're going to give your insulin or treat with food based on where that arrow is going.

RK: Sounds like the CGMs just really have changed the day-to-day management for so many people with diabetes. You mentioned some of the functions—the trend arrows and the alarms—that we see with CGMs. In your experience, having worked with so many people with diabetes in implementing these into their day-to-day care, how do most people feel after using these continuous glucose monitors? Especially those who've been pricking their fingers for a long period of time?

AG: There are very few people who actually like to prick their fingers. Most people are very happy to put their meter aside and use it very sporadically. People still need to have a meter because things can happen with the sensor, or sometimes there can be an issue with the prescription. So, we are not getting rid of meters completely at this point, but patients usually really welcome having that data without having to prick their finger. The sensors have become so much more accurate, smaller and more comfortable over the years that people really wear CGMs all the time. Years ago, people wore them sporadically; they'd be on and then off of them. Now people have become so reliant on CGMs for their day-to-day management of their diabetes.

RK: Technology is great—we know it's not for everyone, and it really is an individual or personal decision on whether you want to use them. But it sounds like the CGM technology itself has become not only smaller but also smoother to use. Have you been finding that people have difficulty keeping the sensors on? Or are there some people who just aren't interested in it? What has your experience been?

AG: You have to get used to having so much data in your face all the time. I usually tell people, at the beginning, for the first few days, to just watch it like a movie. You are seeing numbers that have been happening; you're just unaware of them when you are pricking your finger two, three, four, five, or six times a day. You don't see all the numbers that you see with the sensor.

For some people, that's okay; they can get past that. But for other people, there is a small portion of the population that just so many numbers, all the time, can make them anxious. They're worried about them, or they may react to them prematurely, the numbers and the alerts. We also don't want to set the alarms tightly because we don't want them to be going off all the time.

We want it to alert the patient when there's something that needs to happen. If it's going off more than it needs to, some patients will just not like it because of all the alerts.

RK: It is great to have all the functions, but they need to be used within the appropriate context, and having a device go off every few minutes. If the alerts for high glucose, for instance, are set at a value that's within a range where the sugar might vary, it is probably not as helpful as really setting an alert for a number where we would be very concerned.

The educational component of it is so important. What you were saying is that we don't want to make people more anxious with more data. If you have well-managed diabetes, perhaps you're on just one pill for type 2 diabetes, and you're otherwise doing great; perhaps having all those numbers might be more overwhelming than is needed. Really, the individual context is so important in terms of the goals of care. What are the continuous glucose monitors really being used for? What are some of the reasons you've seen them being used in people with type 1 or type 2 diabetes?

AG: Sometimes we'll prescribe it for patients if they let's say, [have] type 2 [diabetes] and are on multiple medications, still not at goal. Sometimes we will prescribe a CGM, and it teaches them a lot about their lifestyle, their food choices, and their exercise. If someone knows their blood sugar is high going into lunch, they might make different food choices than someone just not knowing what their blood sugar is and just going with how they feel.

It teaches people a lot about their diet. I've had patients who think their daily breakfasts of oatmeal, or whatever it is for them, is really good for them, but then they put a sensor on, and they see that their blood sugars don't react well to that. Then they make

adjustments—here's a non-medication intervention that sometimes really impacts the A1c and the overall blood sugar control.

RK: It certainly can be insightful for people to see how their foods and their activity patterns impact blood glucose during the day. I know, even people who are healthcare providers who have worn CGMs just to understand themselves how these patterns can vary throughout the day so that they can also educate patients about it too.

We do have these professional CGMs that even if you don't wear one at home, you can wear it for—let's say, a week or two—to get some insight into daily patterns. What we're really talking about here today is those continuous glucose monitors that are worn every day by the person at home, the personal CGM. You mentioned with type 2 diabetes, it could be someone on multiple diabetes medications who's having wide fluctuations in their blood sugars, highs and lows. I found them very effective for people who might have lows overnight, for instance, or are fearful of lows and really benefit from having the alarm go off when the sugar is too low. What has your experience been?

AG: That's really where the sensors shine, having the alerts for patients. Someone who has had diabetes for a very long time, type 1 specifically, sometimes they lose their sense of feeling lows and they can just not have them. Without a sensor alerting them, particularly people who live alone, they wouldn't necessarily know they were low until it was too late, and they were having a severe reaction. Having those alerts is so helpful. There's also now an alert that goes off before they get low, so they can prevent lows. We don't want them to just get low and know they're low. We want them to prevent the lows and treat them early with a little bit, just so they can be in a safe range.

RK: I agree. Thanks for mentioning that unawareness. With the hypoglycemia unawareness, it's especially helpful in people who might not feel symptoms anymore of lows. When we're talking about lows, we're usually talking about numbers below 70. So, for our audience who's wondering what we're talking about, when do you usually set the alerts for the lows? What number do you usually set alarms for?

AG: It depends on the patient. So that's very individual, which is what we were talking about before, setting them not too tightly, but it depends on the patient and what their normal blood sugars are at the time that we start. I always tell them they could always adjust it to be notified at different numbers, but you want to be notified at a point where you would need to treat or do something.

It does depend on the patient; some older patients want to be notified at 80; some younger patients just want to be notified at 70. Again, there's a low alert soon, which looks 20-30 minutes ahead and says, “Hey, you're going to be low soon.” That could happen at any number—that could happen at 100. It's just looking ahead at what it thinks the blood sugar is going to do.

RK: That's such a great technological function that it can do this predictive algorithm to anticipate the low before it happens. We know that CGMs also have a little bit of a time lag, don't they, compared to blood levels? Can you talk a little bit about that too?

AG: The sensors measure the glucose and the interstitial fluid. Compared to the blood glucose, it can lag about 5–15 minutes behind where the blood is. What I always teach

patients when I train them on their CGM is that they need to keep that lag time under consideration when they're treating their lows, for instance.

If someone has a low blood sugar [reading] on their glucometer and they eat some glucose, it takes about 15 minutes for the meter and for their blood to catch up to that. If the CGM is 5–15 minutes behind that, it may take a full 25–30 minutes before they see that arrow start changing.

Sometimes patients will just keep eating because they see their number's low on their monitor, but we really have to tell them, "As soon as you take enough and you start feeling better, just let the sensor catch up." There's a learning curve with that, but they do get used to how to use that number.

RK: That's a really important point. Also, another reason—even though we're talking about the continuous glucose monitor and the sensor today — to have that finger-prick glucose meter to get an even more immediate number. Even though there's still a little bit of a 15–minute lag there too for the sugar to bounce up. But with the sensor and the CGM, that's also another 15–20 minute lag compared to the blood value. That's a hugely important point that it's based on symptoms. When you're feeling better from your low and also starting to see the numbers go up on the glucose meter too.

AG: We see that lag mostly when the blood sugar is moving quickly. When the blood sugar is steady, there shouldn't be that much of a difference in terms of the discrepancy of the numbers. But if you just ate, your blood sugar is going to be leading, and then the sensor is going to catch up to that afterwards. That's where we see the biggest discrepancy.

RK: That makes a lot of sense. Since we're talking about discrepancy, one of the questions that I often get is how accurate is a continuous glucose monitor compared to blood readings? What do we know about how accurate continuous glucose monitors are, especially at extremes of blood sugar, such as very low or very high?

AG: In the regular ranges, they're very accurate. The FDA has said you can dose insulin based off of these numbers. So they are very accurate. At the extreme lows and highs, there's a bit more of a margin of error. Those are some times where you may want to take out your meter just to double-check what it is. We always tell people, "If the number doesn't match what you think it's going to be, also test with your blood." Or sometimes the monitor will give you a number, but no arrow, or no number. If it just says high or low, those are times that you also would want to verify with your glucometer.

RK: What about sensor wear? Some of the sensors last 10 days; some last 14 days. Are they just as accurate near the end of their lifetime as they are at the beginning?

AG: The first 24 hours of a sensor are generally the least accurate out of all the subsequent days. So, as you wear it, the longer you wear it, the more accurate it does get. On that first day, if the numbers don't quite seem right, that might be an opportunity to prick your finger to check. But in general, even that first day, it's still pretty accurate.

RK: I've heard of some studies where not all sensors necessarily read to the full 10 to 14 days. Have you seen that in your clinical experience in terms of the accuracy near the tail end of that time period?

AG: I think it depends on the patient. I have some patients that have no problems ever; they'll last the whole time without any issues. Some people will say it doesn't quite last the full amount of time for them. I'm not sure if that's related to their activity level, to how it was placed originally, or to the location where it's worn. I'm not sure.

RK: I think it's an interesting question because, like you said, it depends on the individual. I think the main point to keep in mind is that it's a tool—the CGM is a tool. If there's any suggestion of a discrepancy or that the accuracy might not be as you would expect, check the numbers with a finger stick just to make sure or to change the sensor if needed.

AG: I also tell people that "people may feel very comfortable with their meter, and there are discrepancies within meters." If you take different meters or test on different fingers, you're going to get lots of different numbers. So, you're really looking for patterns when you're getting these alerts.

There is a margin of error with the meters, but there's a similar margin of error with the sensors. The meters also have the user input: Are the patient's hands clean when they take the blood sugar reading? Are they dry? Have the strips expired? Were the strips left in the car?

There are these other human factors that could affect the blood sugar reading. So people feel very comfortable with their meter—it is a great too— but the sensors also are very accurate as well.

RK: That's great; since we are talking about the continuous glucose monitor and the sensor, perhaps you could just break down the anatomy for us. What are the components of a continuous glucose monitor? You mentioned the sensor; what is a sensor? What is a transmitter? When can a mobile device or cell phone be used? I wonder if you could just talk about the different components that make up the system.

AG: The sensor is inserted with an applicator. Some of the sensors are as small as two pennies stacked on top of each other; they're each a little bit different. You wear the sensor on your skin; it has an adhesive patch that it sticks to. There's a small filament that goes right beneath the skin; it looks like a thick eyelash, and that is what measures the glucose. Part of the sensor has a transmitter, which then sends the data to a device.

RK: I really like the way that you described the thickness of the sensor and then also the filaments, the tubing that goes underneath to read the glucose in the interstitial space. As you mentioned, that sensor also has a transmitter that transmits that glucose number to a receiver, which could be either its own receiver or it could be on a cell phone. Where do people usually wear the sensors? Where do you tell people to wear them?

AG: Sensors can be worn in a variety of places. Some are FDA approved; some are not. Common places are the back of the arm, abdomen, and thighs.

RK: Yes and it is personal preference, where people decide to place a sensor.

AG: Generally, people will start with an area that's FDA approved. Then if there's any issue, they'll talk to their health care provider about trying alternate sites.

RK: Then how often do the sensors need to be changed?

AG: Depending on the sensor, some get changed every 7 days, every 10 days, every 14 days, or every 15 days. There's even an implanted sensor that gets replaced every year now. There are a lot of different options.

Going back to the placement of the sensor, I always try to guide people away from placing it directly where they sleep. There's something called a compression low that can happen if you sleep directly on the sensor. It will look like your blood sugar is fine, and then all of a sudden, you're at an urgent low. It's because that fluid beneath the skin is getting compressed where you're sleeping, and it looks like you're low when you're not actually low. I try to tell people to just avoid placing it if they sleep in one specific spot to just avoid that area.

RK: That's a good tip and important to consider when people are thinking about where to place the sensor. Especially if it's in the arm, when people are side sleepers, that might be something to think about when you're placing it there. Especially if you're worried about nocturnal lows, it may be hard to know if it's because the sensor is being compressed or if it's a true low. That's a great tip. Given that these sensors are changed anywhere between 10 to 14 or 15 days, how easy is it for someone to change their own sensor at home?

AG: The applicators for the insertion have become so much easier over the years. Most patients don't even feel it going in. It's just quick; the little needle inserts the sensor, and then the needle is retracted, and you're just left with the sensor. So, it's really easy; they're generally one-handed button pressing. Occasionally people will have a loved one or caregiver help them with it if they want to wear it somewhere they can't reach. But generally, most of our patients can apply them by themselves.

RK: It's fantastic that it's become so much easier to do at home, with some instruction initially. It makes it so nice for the person with diabetes and their caregiver to just be able to do this at home.

Can you talk a little bit about the receiver and the fact that some continuous glucose monitors allow you to see the numbers on your phone? This is pretty amazing; you don't have to carry a separate receiver though some people might still prefer a receiver, which is just a separate device where they see the numbers. Can you talk about that difference?

AG: The receivers came to the market first. Some of the advantages of the receiver are that you don't have to use your phone. Some people don't want to drain their battery. Some people don't want to sleep with their phone next to their bed. So they just have their monitor to alert them to the blood sugars without having their phone with them. It's simpler; that's all it does is just monitor the blood sugar; some people like that.

The advantage is when you use the phone as opposed to the receiver, you can connect to the clinic portals, and then we can monitor the blood sugars remotely. You can do that with the receiver as well, but the patient needs to physically plug it into the computer to upload it for us to see the data. When you use the phone, the data is updated all the time and can go straight to the portal without the patient having to do anything else once they're connected to the clinic.

Using the phone also allows loved ones to follow the patient's blood sugars as well. You can invite followers to see the blood sugar in real time, which is extremely helpful for a

variety of cases. To have that ability to follow sometimes gives patients comfort, if they live alone, to have a child monitoring their blood sugar or a parent monitoring the child's blood sugar or spouses, a spouse that travels; they want to make sure their blood sugars are okay. There are a lot of different varieties of cases where that can be very helpful when using the phone.

RK: I find that as long as the phone is compatible, some older phones may not be; patients appreciate having the same technological device that they use to talk to people to be able to also monitor their blood sugar. It's amazing that those have become integrated.

Now, we're talking a lot about the anatomy, and I hope we will get into the different kinds of CGMs, but I think it's important to break down what people can expect if they're thinking about placing a CGM and how much easier it has become to do this at home. Those are sometimes the types of obstacles that people might see to starting something new, but it's reassuring to hear from you about how much more straightforward it has become how people can use the phone also as the receiver. What about downloading the data? You can see it on your phone. You can see it on the receiver, the numbers as you need them in real time. But when your healthcare provider wants to know what your numbers were like, with a glucose meter we used to have the old-school written logs of blood sugars, or they would be stored in the glucose meter where individuals could see their trends over time. How does it work for a continuous glucose monitor? How easy is it to extract the data from that so you can share it with your healthcare provider?

AG: It is straightforward. The receiver would be plugged in physically to a computer to upload to the portal. The phones, we just put a code in, and it automatically syncs with our portal. It gives us as providers so much information to look at and so many different factors to consider, as opposed to just glucometers again being just like pinpoints in time.

Here you're getting the full picture of what's going on with the patient. You can really pinpoint patterns much more easily with the sensor. It gives us different metrics to look at. In the past we just looked at A1C, and that's all we had to assess a patient's blood sugar control.

Now with the sensors, in addition to the A1C, we also look at something called time and range, which is really the time you spend between 70 and 180. For most patients with type 1 and type 2, we want that to be about 70% of the time. That's important because you can have an average A1C of 7%, which is about a 154-blood sugar, but have wide fluctuating blood sugars—extremes.

With the sensors, you can see that you have an A1C of 7, but your time in range is above 70%. We know that most of those blood sugars are in a good range. These reports really show us a lot of information aside from just the pattern.

RK: I love the ambulatory glucose profiles that we get from the CGM as a healthcare provider: you can see patterns, you can see time in range, you can see the mean, the 50th percentile, you can see the percent of the time that you're low, and when you're low over the day too. It's a standardized 24-hour profile of your average sugars in the ranges over time, usually during a two-week period, but sometimes longer. They are so helpful.

You talked about how they can easily be plugged in; the receiver can be plugged into a computer. Do patients usually do that on their own, or is that usually done at their healthcare provider's office?

AG: It depends on the provider, but most clinics have the ability to download all the devices. If a patient needs to be monitored remotely—they had a virtual visit or something like that—that would be a time that they would want to upload their data remotely from home.

RK: I think that's one of the things that has made it a little bit easier for us in diabetes care.[The ability] to do virtual visits or telemedicine visits, that capability. If the person with diabetes is able to download their numbers remotely, we can read them from anywhere. Then otherwise, coming into clinic and the clinic can easily download it. At every point from the insertion of the CGM to seeing the numbers on your phone or your receiver to downloading the data, I would say that more and more we have seen these processes become more efficient and smoother. Wouldn't you say, overtime?

AG: Definitely. More patients are using them. A very large percentage of our population is using them because they're so easy. They're so accessible, a lot of insurances cover them well, and patients just find them so useful for their care. It takes a lot of the guesswork out of their diabetes.

RK: It doesn't have to be a mystery. We have numbers now, and we can get lots of them. That has been really helpful. We've talked about the basic anatomy of a continuous glucose monitor. Now moving towards the categories of continuous glucose monitors. We know that these devices monitor blood glucose continuously, but the way that those numbers are displayed and available to the user may differ. I wonder if you could talk a little bit about real-time continuous glucose monitors versus intermittent continuous glucose monitors. Then if you want to touch a little bit about implantable continuous glucose monitors, that'd be great too.

AG: The intermittent, continuous glucose monitor, the one that's on the market right now, is the Libre 2. Or the old Libre 14-day, which required the user to physically take their receiver or their phone and place it up against the sensor to scan it for the number. You can do that continuously; you could do it every few minutes, so you get a lot of data that way, but it won't show you the number on the monitor unless you scan it. It will show you the patterns, though. If you scan at least every eight hours, it will fill in the data and show you what happened.

For instance, if you tested when you woke up in the morning and then scanned it and got your reading with the intermittent monitor and then scanned again at lunchtime, you would see what your blood sugar did from breakfast to lunch.

The disadvantage of that is if you only test twice a day, once in the morning and once at night, for instance, you might get gaps in your data, but some patients like that model because you don't necessarily have it in your face all the time—you monitor it when you want to know what your blood sugar is.

The continuous glucose monitors send numbers every 1-5 minutes straight to the device, to the receiver, or the phone, or the pump, or the watch without having to do anything. You just look at it. So, a lot of patients find that more discreet. They don't have to be in public and scan themselves, although it's become so popular that it's socially accepted to do that too. Some people just like having the discreet data. They could be in a meeting and just look at their watch and know what their blood sugar is—which is very valuable.

The implanted CGM, which is the Eversense, is very unique. It's a little sensor that is surgically implanted under the skin. It just got approval for wearing it for a whole year, which

is really exciting. On top of that, you wear the transmitter, which also sends the blood sugars to the phone. As opposed to the other sensors, if you take it off, you can't put it back on that specific sensor. This one, you could take off the adhesive patch with the transmitter and then your sensor is still good, and you could just replace the transmitter when you need to.

RK: So that's really helpful. You talked about the intermittent or flash CGMs, which currently sounds like we just have the Libre 2 or the 14-day Libre before. I like to think of those as the on-demand, CGMs. You get the numbers when you want them, but you really do have to wave that receiver over the transmitter to get the numbers.

Then you talked about the real-time CGMs, which are probably the most common type that we've had for a while. What are some examples of real-time CGMs that people might be familiar with on the marketplace?

AG: That would be the Dexcom G6, Dexcom G7, the Libre 3, and the Guardian sensor. Those are all sensors that send the data directly to the device without having to scan.

RK: The Guardian sensor, that's the one that's in Medtronic devices, is that right?

AG: That's a Medtronic sensor. They have a specific sensor that can be worn as a standalone, and they also have a sensor that is worn just specifically with their pumps.

RK: So some of these CGMs, like we talked about, are standalone. You just use them on your own. Some of them, like the Guardian, can be part of a pump itself integrated into the pump and can transmit numbers to the pump to help with dose adjustments. Some are two different devices that communicate with each other. Isn't that right? The pump and the continuous glucose monitor.

There are so many different variations. I think that the compatibility of these different technologies with each other is also remarkable, especially as we start thinking about an artificial pancreas or something like that in the future, and we could touch upon that later. But it is really remarkable all the different ways that these CGMs can communicate also with the insulin pump and other devices.

You lastly talked about the implantable sensor. Who usually places that sensor for the patient?

AG: There are some endocrinologists who do this in their office. Not all of them, not every office, but there are some providers that have been doing a lot of these. You'd reach out to the company to find a doctor in your area that is very comfortable with placing and removing these sensors.

RK: It is not something that a patient can do on their own—they have to go in. It is a minor procedure that they get done within a few minutes, I think.

AG: The sensor is really small. The Eversense also, the way it's designed, to give on-body vibrations; if you're low, the actual transmitter vibrates. Even if you didn't have your phone with you, you still would know you were low because it would vibrate. That's a different feature that some of the other sensors don't have.

RK: That's interesting—so you'd be shaken awake. Are there any new models on the horizon? Is there a Libre 4?

AG: No, there's a Libre 3 Plus. I think where the future is going with these sensors is, like you touched upon before, more integration with more devices. The idea is we want to give patients a full range of choices. Eventually, you can pick your pump, you can pick your sensor, and hopefully they'll all combine with each other. All the sensors are trying to get the most wear time to get that 2-week to 15-day wear time.

Recently there have been a couple of over-the-counter CGMs, which are new and unique. Dexcom now has one called Stelo, which is designed for people who have diabetes but are not on insulin and not on any medications that could cause low blood sugars. But they still, like we talked about before, really find it valuable to learn about their lifestyle and have that feedback. That's an over-the-counter sensor that is not available at local pharmacies at this point. It is purchased online from their website. It is essentially a G7 sensor; it looks like a G7 sensor, but it doesn't have the alerts in the app. The app is different; it gives a lot of lifestyle coaching, feedback, and education—it really guides patients and gives them feedback regarding their blood sugars. It is not intended for people who have the potential for low blood sugars.

Abbott also has one; it's called the Lingo, which is essentially the form of a Libre 2. That's actually not even for people with diabetes. That's just for people that want to monitor their metabolic health and to get feedback that way. That's also over the counter. It is not going to have alerts but just gives people blood sugar feedback.

RK: These over-the-counter continuous glucose monitors are really interesting. I think we're learning more about them; they're relatively new. I do think an important consideration that I share with patients or family members who are interested in using this or even friends is the accuracy, especially in people without diabetes, as we had talked about, particularly in the extremes of readings, if they are as accurate. The accuracy has been validated because they are on the market. But it's always something to think about with any of these devices. If there is any discrepancy with what you're expecting, consider the finger sticks or even a lab draw.

The availability is important because we know that not everyone who wants to use CGMs necessarily has access to them. I wonder if we could talk briefly about who CGMs are usually covered for; type 1 diabetes versus type 2 diabetes, and some of the challenges that you've seen in getting access or coverage for CGMs for patients that you have seen with diabetes.

AG: With anything related to insurance, obviously it varies widely regarding coverage and access. In general, patients with type 1 or anyone on insulin can access a sensor. Medicare requires at least one shot of insulin a day or a history of severe hypoglycemia, defined as needing assistance to treat. Sometimes the sensors are ordered through the local pharmacy, and some insurances require you to use medical equipment companies. So sometimes navigating that can be a little confusing for patients, which way it will be covered for them. For someone with type 1 or a patient with type 2 on insulin, it really should be covered (by insurance), and they should have access to it.

Some patients who may not be on insulin, who have type 2, some insurances will cover it. They just will cover it regardless of what medication they're on. If there is a patient who, let's say, doesn't have coverage, that's where something like the Stelo is helpful because they can purchase it at a more reasonable price and still have that benefit of seeing their data.

RK: Like you mentioned, anyone on insulin, with type 1 diabetes, whether they're on an insulin pump or even insulin injections, or type 2 diabetes, one insulin injection or more a day coverage - while it differs by insurance company usually we can get coverage. Usually it is recommended to check your glucose readings multiple times a day if you're on multiple injections a day of insulin, or at least once a day if you're on basal insulin. So having the CGM can be helpful. I've seen, as you mentioned, people with type 2 diabetes who are on oral treatments; sometimes it can be more challenging if they don't have private insurance to get coverage for a CGM because of what you mentioned with the Medicare specifications. For those patients, I do think that these over-the-counter CGMs could offer, hopefully, a cost alternative that might be more accessible. Wouldn't you think?

AG: They're still not cheap. They're about $90 to $100 a month. For someone, though, who may be just wanting to monitor their patterns and food intake and things like that, it could be they may not need to wear it for a whole month straight, or it could be they can wear it for two weeks out of each month to just get a snapshot of what's going on with their diabetes. They're still not really cheap, but they are more accessible.

RK: Thank you for pointing that out. Do you know how much, non over the counter CGMs cost, with a prescription?

AG: I think it differs a little bit. Libre used to have a coupon that would get it to $75 a month with a prescription. But some insurances are starting to not, or the coupon may not work so well with everyone now. Then it could be, for Dexcom, about $170 per month for it. There is a bit of a cost saving.

RK: Needless to say, these devices are not cheap. Having coverage is incredibly important for those who could benefit from it, and having it be accessible to people with diabetes, not only in the United States but around the world, that really could benefit from them, is also important.

I think as we think about technology and diabetes, it's an exciting time, but it does need to be an exciting time for everyone who can benefit from them.

We talked about the different categories of CGMs and you talked about a few models within each of those categories. I wonder if you could just broadly talk about some different features that continuous glucose monitors can offer.

We talked about the trend arrows telling you if you're going high or low. You talked about the functionality of being able to predict almost in 15-20 minutes if you're going to go low or not. Are there other features that might be interesting for our listeners to hear about?

AG: he share feature, I think I mentioned before, is one of my favorite features. It's not for everybody, but it is a nice feature for a lot of people to have that ability to share their data. Other features—what devices they're integrated with...

RK: How about calibration? Do all of these continuous glucose monitors require finger sticks to confirm values that might be too high or too low, or do they replace the need for finger sticks altogether?

AG: We talked a little bit about when you might want to take out your meter to test. With some of the monitors, you can't calibrate. The Libre is a sensor that you can't calibrate. The Dexcom, while we don't recommend it often, you do have the ability to calibrate if you want to, but you don't need to. The Guardian and the Eversense, you do need to calibrate. They do differ in that way.

RK: What does that mean? What does calibration mean?

AG: Calibration means [that] at the same time you prick your finger with your glucometer and input that number into the monitor, and then it matches up the sensor and the blood sugar number together.

RK: In terms of using the numbers from a sensor for treatment decisions, from what I understand and what I've seen with my patients, some of the sensors, you don't need to do anything more than that. They replace the need for finger sticks, as long as they're not too low or not too high. Could you talk a little bit more about that and what devices those might be?

AG: All of the available sensors right now are approved to dose that your insulin off of. As long as you have a number and an arrow on the monitor, you can dose off of it. Sometimes if there's no arrow or if the monitor is telling you to prick your finger, that may be a time where you wouldn't trust the sensor necessarily—you would take out your glucometer. In general, most patients don't need to do that, and they're testing their blood infrequently and relying mostly on the sensor.

RK: I have patients who've been finger-pricking four times a day for decades and then finally now are at a place where they have a sensor, where they almost never need to do that anymore. It's pretty remarkable. These have been game changers, haven't they?

AG: Yes, definitely.

RK: So we covered a lot of ground today, and we really appreciate you, Adena, breaking down the types of CGMs, their functionalities, who usually can benefit from them, and the over-the-counter options as well. In this rapidly changing time, it just seems like there are so many new updates to the technologies. How do you recommend your patients keep up with them? To know the newer models, I'm sure there are software updates that need to be done at times too. How can they keep up with the changing technology to make sure that they're getting the most up-to-date versions that are out there?

AG: In terms of technology in general, I think when you come in for your office visit with your doctor, I think that's a great time to revisit what's happened, because the technology does change every 3, 6, or 12 months. I think, from a bigger picture, checking in with your doctor's office is important, and there are lots of other resources online. The Johns Hopkins Patient Guide to Diabetes has a very good reference for technology and updates and comparison charts between the different devices because they're all so nuanced.

We talked generally today, but they're all very specific and a little bit different from each other. In terms of making sure your device is up to date, if you register your device, which you typically do when you get it, you should get a notification if you do need to update something. Generally, when there's phone integration with the sensors, we tell patients to turn

their automatic updates off on their phones because sometimes the latest version of the operating system may not be tested yet with the sensor. So, leave that off, and then when you get the go-ahead and you find out that it's okay to use, you can go ahead and update your phone with that latest operating system.

RK: That's important to emphasize registering your device so you can get those communications. Thanks for pointing out the resources out there to continue to learn more about new technologies and new devices that might be coming out on the horizon.

Adena, it's been so great to talk to you today and to hear in a practical way the things that people with diabetes should be aware of as they consider these technologies, the exciting developments we've seen with continuous glucose monitors, who might be suitable for them and for whom, perhaps the glucose meter or less frequent glucose checks might be more appropriate, and then also, what are some of the functionalities that have really facilitated the day-to-day management for people with diabetes.

In parting, I wonder if you might have a few words for people out there that are listening who might still be a little reluctant to try these new technologies out. Maybe they're used to their day-to-day management. Maybe they don't want to complicate things anymore. What would you say to them about considering these technologies and integrating them into their day-to-day management?

AG: I have so many patients who tell me that the CGM has been the one most life-changing thing for them in the course of their diabetes management. It is a lot of information, and you do have to get used to that. For most people, there's really a comfort to it, and it really takes a lot of the mental burden and worry out of their diabetes. You're not worrying [about] what your blood sugar is because you know what it is. If you're not feeling well, you can confirm, "Am I just not feeling well, or is my blood sugar abnormal?" It really gives people a big comfort. It's much smaller, much more comfortable to wear—most people forget they're even wearing it.

I would really encourage people to just talk to your provider about trying it. It's not a big commitment. You could try it for a few days, a week, or two weeks; see if you like it; see if it helps you. For the majority of our patients, it is really life-changing and such a helpful tool to help them thrive with their diabetes.

RK: Definitely, talking to the healthcare provider, seeing if this might be for you, and seeing what the options are, especially if these numbers can give some reassurance and also some insights into behavioral patterns that can ultimately lead to improved outcomes. That's ultimately what we want for everyone.

Adena, thank you so much for being here on our podcast. We really appreciated all your expert insights and your input today.

AG: Thank you for having me.

RK: I'm Dr. Rita Kalyani, and you've been listening to Diabetes Deconstructed. We developed this podcast as a companion to our Patient Guide to Diabetes website. Our vision is to provide a trusted and reliable resource based on the latest evidence that people affected by diabetes can use to live healthier lives.

For more information, visit hopkinsdiabetesinfo.org.

We love to hear from our listeners. The email address is hopkinsdiabetesinfo@jhmi.edu.

Thanks for listening. Be well and see you next time.