

EPISODE 37: Diabetes Emergencies

Rita Kalyani: 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 Susan Renda to our podcast. Susan has been a nurse for over 43 years and 34 of those as a nurse practitioner. She's currently an associate professor and associate director of the DNP advanced practice program at the Johns Hopkins University School of Nursing. She has precepted, mentored and taught nurse practitioner students and developed curriculum to support their success. In all settings, she brings a passion for education as every moment with patients and students is a teaching moment. Her clinical history is in primary care as a nurse practitioner and diabetes educator at the Johns Hopkins Diabetes Center. We are so thrilled to have Susan Renda on the podcast today. Welcome Susan.

Susan Renda: Thank you, Dr. Kalyani. I'm really happy to be here.

RK: We are really excited to hear from you today about something that I think all people with diabetes think about at one time or another, which is "what do I do in case of a diabetes emergency?" I wonder if you could start off by telling us what are the different types of diabetes emergencies?

SR: Thank you, Dr. Kalyani. I think this is something that really frightens people a lot, and the more they know about them, the better it'll be to be able to handle these things. But I'll go over three of the more common things that people with diabetes may have with having their blood sugars up or down or particular to their type 1 or type 2 diabetes. But the first I would mention is diabetic ketoacidosis, or DKA, as it's commonly called. This is much more common in people with type 1 diabetes who are insulin dependent. What happens is there's a lack of insulin and the glucose, or what we call the sugar, cannot get into the body cells and provide necessary energy.

The body starts to break down something for energy, it ends up breaking down fat and that serves as an alternative energy source. This will cause a critical imbalance in the body of what we call our pH level, how acidic or alkaline we are, and it messes with our electrolytes. We think about potassium and sodium, and we also build up something called ketone acids, which aren't supposed to be high in the bloodstream. It is most common above a glucose of 250, which is rather high, and often illness or infection is what's the underlying cause. People will become thirsty, have frequent urination, but then nausea, vomiting, abdominal pain, get weak, have a fruity scented breath, and also confusion. If left unchecked, it leads to really severe illness and even death, if we don't take care of that. We watch for the beginning symptoms, and we make sure we monitor blood sugar with that.

There's also something that can affect people with type 2 diabetes more commonly and that's hyperosmolar hyperglycemic crisis. People will get really dehydrated from severe elevations of glucose or the sugar and with this it's often associated with an infection. The signs and symptoms that you may see or experience are very high blood sugar— levels over 600. And mental changes: confusion, delirium, you can't get someone to wake up, they're experiencing maybe hallucinations, a loss of consciousness. [Their] mouth will become really dry, and there's extreme thirst and frequent urination until they're extremely dehydrated and [have] blurred vision or loss of vision. The dehydration also has an elevated pulse rate and a low blood pressure, and that's very characteristic. Fortunately, it's not super common, but it is more common in people who are older, who experience an infection, who have type 2 diabetes.

Now the more common thing that we really try to avoid is hypoglycemia. Which can affect anyone who has a risk of a condition that lowers the blood sugar, or if they are on a particular medication that can lower the blood sugar, such as insulin or pills that may lower the blood sugar. Hypo means low, glycemia means blood sugar; that's what we mean when we talk about hypoglycemia. With this, the glucose number, we consider that it's going pretty low if it's below 70, and severe hypoglycemia is less than 50. Symptoms people have usually come on pretty suddenly as the blood sugar gets below that threshold of the 70, and it's dizziness, hunger, cold, sweat, shaking, visual changes, irritability, there can be some confusion with it. If left unchecked and the blood sugar continues to lower, there can be confusion, seizures, and then passing out. And ultimately it could cause someone to die if it's not brought back up into a good level.

RK: Thanks so much for going through those three most common emergencies that we worry about. You mentioned diabetic ketoacidosis, or DKA, and this is something especially in our patients with type 1 diabetes can be a concern, as you mentioned, when the sugars perhaps go too high, the 250s, 300s, 400s, and really those acids that build up in the blood from breakdown of fat, which can lead to quite a bit of complications. I know in children, DKA, more commonly is the presenting symptom.

Usually, children are found to have type one diabetes when they come to the hospital in DKA. How about an adult who is diagnosed with type one diabetes? How common is DKA in adults?

SR: It can also occur, but sometimes it can occur more with an infection or a sudden stress that can occur. And we have people who are diagnosed for the first time as adults with type one the common thought is, "oh, only children develop type one." But in reality, we've got a quarter to a third of adults [who] are adults when they get their type one diabetes [diagnosis]. They can present with the DKA at that point too.

But you also have people who have had diabetes for a while, and then something comes along like a bad infection think about a stomach virus, that may occur and someone is vomiting and not able to take in proper nutrition and they get the energy that their cells need. There can be problems having to do with insulin access, insulin cost, need for more insulin, changes in body weight, and maybe they need more insulin and then they can suffer from DKA. And it's important to note stress does a lot to bring on illness and to mess with how the blood sugars are well controlled. If someone is under severe stress, like someone may be in a car accident or someone can even have severe emotional stress. And when we have stress in our body, we have something that would be nice to save us. And that's our liver gives us extra sugar. That's fine if I'm out in the woods and a bear is starting to chase me and I've got to run, my muscles might need some extra sugar. If the liver goes and sees those stress hormones, it'll give me extra sugar. But in a person with diabetes who experiences stress, they may already have an elevated sugar. And then to get that additional liver sugar on top of it, or times of prolonged stress where you can have just constant elevation of the blood sugar, then we worry more about the DKA being a possibility.

RK: Yeah, I agree. There's so many potential factors that can go into the risk of DKA and stress is probably one that we don't think about as much as we should. For those who might be on an insulin pump device that delivers insulin continuously sometimes if there's a malfunction, we might also worry about the risk of this complication. What about in people with type two diabetes? Can you ever see diabetic ketoacidosis or DKA and type two diabetes?

SR: Yes, it's more rare, but when you get an imbalance where there just isn't enough insulin to deliver the glucose or sugar into the cells, the body is going to try to always have a source of energy. It's going to go to whatever it can, and if it has to break down fats you can have some issues with poor nutrition that can occur with this. Alcohol can play a role as well to go and give DKA to a person who has type 2 diabetes, who we generally think won't get it as much because they do have some insulin. But sometimes there are just situations where the situation overwhelms the ability for the insulin to keep up.

RK: Yeah I have definitely, in my own practice and I'm sure you have as well, had some people with type two diabetes who've had diabetic ketoacidosis, but it is much more rare, isn't it? And can sometimes be seen in certain populations. I wonder if you wanted to just briefly comment on that.

SR: There are some types of type two diabetes that become much more insulin dependent. And they're also, I don't like the word, but we call it "brittle diabetes," where the person, may be highly sensitive to insulin that you give them, but they just don't produce enough insulin in a situation where they're under stress or they have an infection to deal with. We have a name called "flatbush" diabetes, and there's also in certain ethnic minorities, they may be more prone to a diabetic ketoacidosis situation.

RK: Yeah, it's something that we don't see that often as we've talked about. But this ketosis prone type two diabetes sometimes, in African Americans or even high risk ethnic minorities, we may see it, but really not something that we think of too often. By and large diabetic ketoacidosis as a complication would be something that we would worry about in someone with type one [diabetes]. What about the hyperosmolar hyperglycemic crisis that you talked about? You mentioned that is something that can be seen I think almost exclusively in type two diabetes. How are the symptoms of that or even the blood sugar levels compare to someone with DKA?

SR: In DKA, we can see the problem at much lower levels of blood sugar, like 250, 300, sometimes even a little bit less than 250. But when we start talking about hyperosmolar hyperglycemic crisis, it's more likely to occur at pretty astounding levels of glucose. I had mentioned over 600 and dehydration is such a factor in this. People become hyperosmolar; think about salty and dry in a sense, where you just don't have enough fluid with this. We can have people come into the hospital like a 1700 glucose with hyperosmolar, which you really wouldn't see DKA going that high. You would see it at the much lower levels where their symptoms would come in and the illness part of the DKA would do that at a lower blood sugar with this. But both can be very severe and also lead to death. It's really important that we go ahead and treat it pretty quickly, especially hyperosmolar.

It is more prone to happen in an older person, and sometimes people with hyperosmolar can't relay their symptoms the way a person with DKA might be sensing the symptoms early on, especially if they've had it before. They get worried about it when they start having the nausea, the vomiting, the types of feelings that they would have. But instead, an older person, especially maybe they have some cognitive decline, can't express how they're feeling. They may be more prone to some infections,

especially urinary tract infections, which can become much more serious — something called sepsis. And their blood sugars will start to rise. They're maybe not engaging as much; they're getting more confused; the delirium is worse; they may be having loss of consciousness. This may be something that family members or caretakers may pick up more on than, as in DKA, people can sometimes express, "I'm really sick, I'm vomiting, and I my abdomen hurts," those kinds of things.

RK: I agree. Both diabetic ketoacidosis and hyperosmolar hyperglycemic crisis can be seen when the sugars are high. And as you mentioned, quite a bit higher, even in hyperosmolar crises where perhaps it could be going on for hours or days before someone presents with the symptoms, but in both cases, due to blood sugars being higher than they should be. You mentioned what caregivers or patients themselves can look out for. What might someone see at home when they're checking their sugar? Or how could someone detect at home if they are either prone to this or developing this diabetic emergency?

SR: The sugars would start to go up and they wouldn't necessarily be responding as well to insulin as they had been previously, or the person may now need insulin and not be on it in the case of hyperosmolar hyperglycemic crisis or new onset of DKA. Sometimes people with type one diabetes, who are adults, have a slower to develop type that we call late autoimmune diabetes of adulthood. And in that case, they may get to the point where they need insulin, [but] may not be on it yet. It can develop in different ways. One of the most important things is that they are checking blood sugar and seeing these trends and then also noting what else is going on in their body. Because if they know that infection, [or] stress, those kinds of things, can lead to this, [they] have to be more acutely aware and maybe even check more often. With people with diabetic ketoacidosis, if we have had them present with that, or they've had episodes of that, we would strongly encourage them to be checking their urine for ketones erwat that's those little acid bodies that float around in the bloodstream that can cause so much problem. They can go ahead and test that. Anything beyond a trace [of ketones], and they have to go ahead and assess what symptoms they're feeling; definitely get in touch with their care providers and seek emergency care. Because even giving their insulin injection may not reverse it at that point; they may need fluids; they may need to get balanced out. They may have electrolyte problems in both of these things, both the diabetic ketoacidosis and also hyperosmolar hyperglycemic crisis. A person isn't necessarily able to monitor their own potassium and sodium and other critical electrolytes that are going on with this. I think it's really important if someone is at any risk for DKA, that they have strips to test their urine for ketones and they know how to report or when to go to the emergency room if they have those. And that's a really important provider communication about that.

RK: Yeah. Thanks for emphasizing the importance of monitoring blood sugars at home. That is most definitely one of the ways that we can know as healthcare providers and as patients can know as well, whether their blood glucoses are rising and whether there is a potential concern for this complication arising. And you mentioned also the urine ketone strips, which can be used?

SR: That's assuming they're still taking in fluids; they're not actively vomiting; they're not running a high fever; they're not having confusion or changes in their whole mental status and all. If any of that, they should go to the emergency room. They shouldn't wait because these things can accelerate pretty quickly. When you see a high on a meter, I just would want to emphasize, that a meter is a tool; it is a tool to guide us, but it is not the be all end all with this. It helps us. The first thing I would say to do is go wash your hands thoroughly, and then go ahead and get another reading and see what that looks like. Because sometimes if you had checked your blood sugar, but your hand had been on the counter where someone had spilled a Pepsi Cola, and you go ahead and check, you're getting the sugar of the Pepsi Cola and not your hand. It's really important to wash your hands thoroughly before you do a finger stick to check for your blood glucose. And [if] at that point, it remains high they may have already direction as to what to do if their blood sugar is high, how to administer a particular insulin dose, how to titrate something. But then after a few hours, if it's not coming back down, especially if they've got some symptoms to go with it, then they need to seek emergency help with that.

RK: That's so important to emphasize that a high reading at home is not necessarily an immediate sign of concern, but warrants further confirmation and rechecking with the techniques that you mentioned to ensure there's nothing interfering with the testing. But if it's still high, even after, perhaps adjusting your insulin as your provider might have recommended or hydrating yourself at home, then definitely pursuing other steps by going to the emergency room. When a person does go to the emergency room with this complication and let's say is found to be in diabetic ketoacidosis or hyperosmolar hyperglycemic crisis based on blood work, what would be the next steps for treatment? What kind of treatments are usually offered for this?

SR: When the emergency room gets hold of the person, often the person does get admitted because it may take more than just an emergency room stay to get things turned around. Be expecting that, but that's okay. What's important is that a person goes home safe. The immediate problem will be attended to; really high blood sugars. They're going to have full assessment and insulin administration if the elevation is there. If someone has a really low blood sugar, that's the first thing that's going to be attended to, [that] is the different methods for getting the blood sugar back up like glucagon or giving them a really concentrated sugar solution to be able to get the blood sugar back up as well. And also, fluids for any dehydration that's there, that's really important. If you think about insulin, it's something that we call water soluble — it likes to swim along in our bloodstream. The way I tell patients about this is that, "if the insulin is swimming in this nice clear pool, it's going to get to its destination quickly. If it's

trying to swim through maple syrup with a really high sugar, it's just not going to get there as easily." It's going to take more and it's gonna take the hydration. To really get the insulin working the best way it possibly can. The other things they'll do at the hospital, though, is to really monitor the glucose and the electrolytes. These things get really out of balance when you have one of these problems and then start looking for the cause. I always say, "let's recreate the crime." What led to this particular awful thing happening? Is there an underlying infection? If we think about the hyperosmolar problem, in an older person, they may be more prone to it. Often urinary tract infections are at the root of it. Or if someone has flu or some kind of viral illness that can also get things out of balance as well. You want to treat that underlying infection that might be there. The same thing for someone with DKA, are they presenting with it? Is it new? Are they a new onset diagnosis of diabetes or do they have a really bad infection or have they had really recent stress that's a problem? It's really important, if someone has been in some kind of accident, to look at that blood glucose because the stress will raise it regardless of whether the person took their medicine before they came in or not.

And then while they're in the hospital, the very best thing is to begin self-management education. We as providers are only a small part of the success that people have with their diabetes and management. Education is such a huge thing. This becomes something that you really need to learn about and obviously we don't want people to go through this again. And they may be lucky that they didn't have [a] really bad outcome with this. We want things to go much better in detecting this and preventing the problem from happening in the first place.

RK: I really like that analogy that you gave, Susan, about the maple syrup, having the insulin trying to get through this very thick, very high sugar content blood like getting through maple syrup and really trying to get that blood more dilute by giving more hydration, allowing the insulin to work more effectively, and then also looking at the electrolytes, especially potassium and sodium, I think, are ones that we focus on that can be affected in ketoacidosis and hyperosmolar hyperglycemic crisis as well.

And as you mentioned, just making sure that you're being monitored, usually in the hospital, sometimes in the intensive care unit, but that's okay. This is to ensure that the complication is treated as quickly as it can, and then the education, and this is an opportunity, isn't it? For education in the hospital?

SR: Yes.

RK: Sometimes after we end a clinic visit with a person with diabetes, while we can continue to educate in between, it really is the time points when we see people, especially in the hospital for education. And you mentioned trying to find, the crime, finding the trigger. And that is so important in order to prevent it from happening again. Just to reemphasize the common triggers that you mentioned: infection, not having enough insulin on hand, stress, substance use such as cocaine, can also lead to it. There are various triggers that can lead to these complications. Really, they potentially could happen in anyone who has diabetes, but the awareness and the education and the monitoring as you touched upon are also key to ensure that they don't occur and that we are treating people with diabetes appropriately.

Now, after people go home from the hospital, are there any new recommendations that people are given or what's usually the follow-up after having one of these complications?

SR: After this complication, assuming that whatever the underlying problem was found. If someone is brand new to diabetes and that's why they ended up in the problem with the hospital, they need some pretty intensive education. It shouldn't be something that's "put on the back burner and wait." And plus, when someone goes on insulin, insulin does not stay stagnant, that the same dose works one day as works another day, there has to be monitoring that goes on. A person who has gone through any of this should definitely be going home with some sort of glucose monitoring, whether it's intermittent with finger sticking, or whether there's continuous glucose monitoring that can be done too. That's very simple that can be done with something that you can wear up to two weeks and it'll give you a reading on a regular basis. We want to make sure we know what the blood glucose is. They should also have; name, number, appointment of where they're going to be seen very soon. It's not something that — "well, you can't get in for three months" — no, they should be seen within just a few weeks, at the most; to go ahead and see how things are going at home and what the blood sugar is doing. Because there's going to need to be probably medication adjustment. If the person had an infection, that's going to have to be followed up on. Has the infection cleared? Are they eating, okay? Can't emphasize enough about a dietitian.

But also looking at some of the other things that people may have problems with. You brought up substance abuse and if someone has a substance use disorder, they need support. It is an illness and [they have] to be seen for that and to be offered whatever help we can give as a health care system, to help them not have as many problems. And if they can go ahead and get into medication assisted treatment or whatever will help them from that will prevent this from happening as well.

We also, it's not something that we talk about a lot in practice, but finance. Because diabetes is a costly thing. We have had people go into some kind of crisis because they couldn't afford their particular medication. It's important to find out what sort of resources they have. Were they able to afford it? Were they able to administer it? How are they giving those injections? It's always important to see how someone is giving the injection. Are they doing it properly? Because mistakes can be made along the way and then they're getting less of a dose or maybe they're overdosing on their particular medication. I would recommend — yes — you need the endocrinologist, the primary care, the diabetes provider, the diabetes educator, the diabetes nutritionist, all of these things are very important. Kind of takes a village to keep diabetes going, so very team based and everyone that communicates with each other is really important. And then, as time goes on, after these visits [we] can get much more into, after we have gotten past this immediate crisis, the wonderful prevention and monitoring that can be done to avoid everything from a foot wound to making sure eye care is done properly. Any of those kinds of things that we do on a regular basis [are] really important.

RK: I appreciate you mentioning the finance part of it, the insulin accessibility part, because this really does become a societal issue when people can't afford their medications. And there's been a lot of discussion over the past few years about insulin pricing and insulin accessibility in the United States and in other parts of the world. And this is something that can occur. These complications can occur when people can't afford their medicines or are rationing medicines. I really appreciate you mentioning that because this was really the worst-case scenario. And unfortunately, I think during the pandemic you mentioned infections, the flu, COVID as well associated with higher risk of ketoacidosis, in particular new onset diabetes where these complications could be seen, hyperosmolar hyperglycemic crisis and the additional financial burdens placed during the pandemic, which may have made it difficult for people to afford insulin in particular. This really is something that can stem from societal policies, health policies as well and can help support preventing these complications when those policies are in place to allow and facilitate people to take their medications as needed. You also talked about monitoring and I do think that being able and educated to monitor your sugars, particularly after these crises are really your best defense and understanding the triggers. Sometimes, though, we don't always know the triggers or the reasons. Isn't that right?

SR: You can do the same thing two days in a row, eat the same exact foods, and think everything was the same, and yet your blood sugars are completely different on two different days. And that's where I tell people it could be stress. "Oh, you were stuck in traffic on your way to work that day, and that ran your blood sugar up, or you were really anxious about an upcoming test or something that you had to do, or what if that night when you slept, your back ached?" It can be such minor, not really minor, but they're happening to you, but they can really affect the blood sugar just because of slight subtle differences in in terms of how stress affects you and all.

That's why it's really important. It'd be one thing, we tell people to come in say, every three months for their cholesterol check. Cholesterol is much more stable. Your bad cholesterol, your LDL cholesterol in your bloodstream is going to be a lot more stable and take longer to change. Whereas your glucose in one hour can do all kinds of crazy things — it can go way up, it can go way down. It's a much more fluctuating thing that really needs daily monitoring.

RK: Yeah, it really is a challenge. It can be a challenge when seemingly everything is the same, your routine is the same, yet the sugars can be variable, minute to minute, day to day, and again, emphasizing the importance of monitoring the blood sugars. For that reason, given that there is variability that perhaps we still don't quite understand and that we're learning more about. And stress, I think, as you mentioned, is a big one, a variability that is really hard to quantify, yet has a profound effect on the blood sugars themselves. Now we talked about the complications that can occur if diabetic ketoacidosis and hyperosmotic crisis aren't treated, particularly the higher risk, unfortunately of mortality, especially in our older adults. Cardiovascular disease as well, myocardial infarction, heart attacks, these can also be seen. These are complications that place tremendous stress on the body. The prevention strategies that you talked about are very important. Are there any other prevention strategies that you think people can do to prevent these complications from happening in the first place? We talked about monitoring and education. Anything else that you would recommend?

SR: Sure. If the underlying reason for some of these complications is or the crises that could occur are infection, we have a really obvious one — vaccinating against preventive illness is huge. Being able to do that and also staying hydrated on a regular basis, make sure you drink plenty of fluids. And I think COVID brought to light that we all need to be much better hand washers. Think about the situation you're going in. Masks have become much more okay, "I need to do it. I don't need to do it." You may be a person that you think if you are at risk for these things, yes, you should wear a mask when you are going into more crowded or close, intense environments with other people where you might be exposed to something as easily as it is at this moment that we're recording this to get COVID, even though people are vaccinated, we have a lot less death and hospitalization rate.

For someone who is vulnerable and has diabetes, it can be a much more serious situation. The hand washing and masks and things like that, but also taking a look at things like, what is my medication supply? Do I have enough on hand if I couldn't get to

the pharmacy in the next couple of days? That kind of thing so that you have access, especially to the insulin, and also, again, the monitoring. Do you have enough strips? Do you have a battery for your meter? Are you going to run into any kind of situations where you won't have these things, that could help you prevent illness or a crisis with the sugar going up or down in these situations?

RK: Yeah, thanks so much for going through all those things because routine preventative care, the vaccinations for sure are very important to prevent the infections. And if you do develop the infection if it can be treated, if it's a bacterial infection, that's great. But if it's a viral infection, sometimes you just have to wait for it to run its course. Getting those flu vaccines, getting the COVID vaccine [are] very important for many reasons, but also to prevent some of these serious complications.

Now, turning to the other diabetes emergency that we talked about diabetic ketoacidosis and hyperosmolar hyperglycemic crisis are really unified by both being related to high blood sugars, too high blood sugars, but hypoglycemia, like you talked about, which is the opposite, when sugars are too low can also be detrimental. I wonder if we could go into a bit more detail. You mentioned that under 70 is the number where we usually start worrying about this potential complication, but what are some instances when hypoglycemia might occur? Are there certain medications that might put someone at risk for hypoglycemia?

SR: Sure. Diabetes medications, there are a lot of oral medications and also injectables and insulin that are meant to lower the blood sugar because they may stimulate the pancreas to put out more insulin. Either the body's going to make more insulin because of the medicine or they're on insulin itself can certainly do this. And if a person goes on a new medication, they should say, is this going to increase my risk of low blood sugar? Because it's important to then be able to watch for it, monitor for it, and also prevent it when you're on something. There's also some interactions of some medications with diabetes medicines that can make them a little bit more potent sometimes. It's important to also know when you're being put on a new medicine — “Will this have an impact on my current diabetes medication regimen?” To see if you'd be at more at risk for that kind of thing.

But also overall we all, we just recently had January 1st and everybody makes their New Year's resolutions and what do people say? — “I'm going to exercise more.” More activity is a big reason why people's blood sugar may go low. It's a beautiful thing that activity can lower the blood sugar because it can be part of your regular diabetes routine to manage your blood sugar, that you go out for a good walk, you get regular activity. And especially in type two, that can also be helpful with weight loss as well. But if you suddenly lose more weight; if you do more activity; if you're not eating as much; “oh, took the incorrect dosage of medication;” you may find yourself with hypoglycemia. It's important to be aware of these different things that could go ahead and lower your blood sugar with this. And some people don't realize I've had people come in and say on a particular day of the week they're more likely to have a low blood sugar. It turns out that's the day they walk their grandchildren to the bus stop and yet hadn't thought about how that activity may have played a role in lowering the blood sugar.

RK: You're absolutely right. I think there are many situations where we might not think about how that physical activity for that day or the diet for that day may lead to changes either in our glucose intake or our utilization of glucose by the body, the energy utilization, which could put someone at higher risk of having this. Whether it's the mismatch between the medications you usually take and having more physical activity or not eating as much as usual, or being on those medications like you talked about, such as insulin or that class of medications that stimulate the body to produce more insulin known as sulfonylureas. Common names for that might be glumaparide, glaburide, and glipizide that can put someone at a higher risk of hypoglycemia if they have other risk factors such as not eating as much, exercising more, or perhaps kidney complications, for instance, that prevent the medications from clearing the body as fast. It doesn't mean that you can't be on these medications or that you shouldn't lose weight. But I think it gets back to what you were talking about before about the importance of blood glucose monitoring. Isn't that right?

SR: Absolutely. The monitoring and also being aware of the symptoms of hypoglycemia. And while we say less than 70, some people will start to feel these symptoms even earlier before it gets down to 70, 80 [or] 90 because maybe their blood glucose, they've been used to having it be higher and it triggers those stress hormones as it drops and people begin to feel shaky; the dizziness; hunger and it's something that happens quickly. Whereas the hyperosmolar hyperglycemia is a little bit more gradual in its development. It's the hypoglycemia, you can be fine and 10 minutes later, you can have a serious problem with low blood sugar. It's pretty fast, as the blood sugar is dropping and all. And it's something that people around someone with diabetes should be aware of. And rather than going into a long thing of “how are you doing? Something doesn't seem right. What can I get you? Do you need any help?” If that person is not cognitively as aware, because they have low blood sugar, they may be irritable and say, “I'm fine leave me alone.” It may be better to just, put a little orange juice in front of them and try to help them realize that “Oh, this is what's going on.” And just to guide them with minimal words and knowing that sometimes if a person is irritable, it may be low blood sugar and they're not really being irritable at you! The people around someone with diabetes, it's super important [that] they know what hypoglycemia looks like as well.

RK: Yeah, I agree. Having education, not only for the person with diabetes, but also their caregivers is so important as well. When we talk about treatment for them to be familiar with that, too. You talked a little bit about symptoms. I wonder if you could just talk a bit more about maybe some of the early signs that someone might see with hypoglycemia and some of the later signs that they might see when the sugars really fall low. And also does everyone with low blood sugars have symptoms?

SR: That's a really good question. The initial thing that someone may feel is that they just may suddenly feel hunger in the pit of their stomach, that they're hungry, and then shakiness, slightly dizzy, a little cold sweat, those kinds of things. Some people have some visual changes, almost looks double or blurry when it goes low. Then it advances to things like irritability, and then there can be confusion and then on to the more late symptoms like passing out and seizures. You can imagine if someone is driving a car, it's really important for them to be aware of these things and not say, "Oh, I'm 10 minutes from home. That's okay. I'll get home and I'll have some hard candies or something." They really should pull over, have something in their glove compartment. Ideally, they're able to monitor even there. And not be driving that car unless their blood glucose is normalized at that point, because that's really dangerous. And unfortunately, people can't think as clearly when their blood sugar goes low, the initial symptoms of just being hungry. Okay. They go, "Oh, my sugar might be low" and they can grab for something. But as it advances, they're not able to think as clearly to where they may do the correct thing, when it goes low. I would also put in a plug that people should have some kind of identification on them that says they have diabetes because if someone were to pass out and yet they have a medical alert bracelet, then right away they could get help, where the person who finds them could realize that's what the problem is. And they might not delay their treatment as much if they do have some kind of identification on them that says they have diabetes.

RK: Yeah, I agree. It's always important to have those emergency identifications on. You mentioned that the spectrum of symptoms that can occur from the earlier stages to the later stages, which might be more serious, such as seizures or coma, or even passing out. Does everyone with low blood sugars have symptoms?

SR: I'm glad you asked that again, because no, some people don't have symptoms from low blood sugar. And it's interesting because some people who don't have the symptoms from low blood sugar will say, "Oh, it's great. I don't get the symptoms" as though that's a good thing. It's like the body's smoke alarm. It's the warning system that's saying, "Uh oh, you need to get some sort of glucose, or sugar source into your body at this point". But people who have frequent low blood sugars, after a while, the body just gets tired of responding, to put it no other way and what'll happen is that you don't get that same robust response. The person who used to feel it as it was going from 80 to 70 and who was very sensitive to their low blood sugar may have immediately gotten the shakiness and the hunger and the cold sweat and all. And then over time, if they keep having them, it dulls the body's response. They may say, "Oh, I can be 40 and feel absolutely fine." But the next step after 40 would be to pass out or have much more serious problems happen. We want to avoid frequent low blood sugar. We want to avoid low blood sugar, but frequent low blood sugar can dull our warning system and make it much, much more dangerous. We should be monitoring on a regular basis. And if someone has a continuous glucose monitoring device, it's nice because there can be alarms that go off to let you know it's dropping rapidly or dropping below a certain level, so that you can go ahead and respond and not let it get as low as it had been. And then we've even found over time, the fewer low blood sugars you have, the more you respond to it much earlier, we can begin to get rid of that insensitivity or hypoglycemia unawareness, as we call that.

RK: Yeah, those alarms are so important, especially for people who might have recurrent low blood sugars or have low blood sugars at night when they're sleeping to be woken up when those sugars are falling. And as you mentioned, if you have hypoglycemia repeatedly, you might develop this hypoglycemia unawareness eventually where you stop having symptoms when hypoglycemia starts to occur. Again, underscoring the importance of making sure that it's detected and monitored and also treated. Also our older adults who may not always have the same symptoms with low blood glucose as well, may not have detection of hypoglycemia as readily. Having the monitoring for them as well is also very important. Now you mentioned some treatment. I wonder if we could go into a bit more detail about how does someone who has hypoglycemia treat their episode, what are the usual recommendations?

SR: First, a person who has any chance of hypoglycemia should never be anywhere without access to some kind of sugar source. So we have something that we call the rule of 15, where it's 15 grams of carbohydrate, which is what turns to sugar in our body. And we do that and then we make sure we recheck in 15 minutes with this. Things that are equal to 15 grams of carbohydrate would be like three glucose tablets that can be in a little canister, that's very easy to carry in a pocket or a purse or glove compartment, any of those places; a tube of glucose gel; or four ounces of juice; or soda, that is not diet soda, like real soda, you can have six ounces of that. We often recommend for health wise, like for a pregnant woman, to have six ounces of milk because milk has something called lactose, which is a type of sugar in it. A lot of people who don't necessarily have glucose tablets or tube of glucose gel and rarely get hypoglycemia, they might carry hard candies with them three to five lifesavers or a lot of people have those red and white peppermints that are wrapped up candies, three of those. I think the problem is that people think that one probably contains a lot more glucose or sugar raising capacity than it does; it is important to get three of them in. What won't work as well, but is delicious is chocolate and ice cream. But the problem is that it has fat and protein in it, it'll reduce the

speed of sugar absorption. Having a chocolate bar may not be as effective as having the hard candies or a little bag of Skittles. Think about at Halloween time, all the snack sizes, hard type candies and things. You can grab one of those from the grandchildren or the kids and make sure that you have that on hand. But people really should not leave the house or be anywhere. And I have people come in for appointments and they say “I knew I was going to be here.” Okay, but what happens when you're walking from the car, you drove here things like that, always have something with you. And when someone has a glucose, it's really low, like less than 50, it may take double that. They might have to have not 15, but 30 grams of the carbohydrates to try to get the blood sugars back up. And then as it's beginning to work, what will happen is it takes a little bit to absorb. And as I say, it's really easy to eat through the pantry or the refrigerator while you're in that sort of sense of doom with the low blood sugar it doesn't work. immediately. That's why we say 15 minutes, but really at 15 minutes, you should definitely see the blood sugar going up. Things should be going better. If it's not going up, then you want to give 15 more grams of carbohydrate and then think about what the cause is; maybe you took the wrong kind of insulin. You took your long acting instead of, or short acting instead of long acting late at night or whatever, or you read the pen wrong or the syringe wrong and you upped the amount of what it was, or maybe you were just really busy and you ate a fast lunch and then did a lot of walking around. Think about that cause sometimes the hypoglycemia that you experienced, and you go, “wow, I didn't eat my whole lunch” or, “Ooh, I think I took my dose for a larger meal than for a smaller meal.” You'd want to make sure that you have a small snack. like peanut butter crackers or cheese and crackers, something with a little bit of mix of foods, not just straight carbohydrate to go ahead and try to level things out so that the blood sugar doesn't continue to go down. But be on alert after you have a low blood sugar episode, because you don't know if the medication that's working in there is continuing to work more than you need it. And just because you get yourself back from a low blood sugar, don't think that it's not going to happen again, maybe over the next hour or it can occur again. And again, I call it recreating the crime. Figure out what exactly happened to cause this low blood sugar? As far as the wanting to eat everything in the refrigerator or the pantry, get your 15 grams in, sit, maybe have a little drink of water, think about what the cause was. It does take a little distraction because, I think what happens more often than we like to see it, is that someone is very afraid of the low blood sugar. It's stress hormones; you get scared. It's as though as you saw something scary or something scary was chasing you. You have that same feeling of panic and that's part of the symptoms. You're not thinking about what your blood sugar is going to be in half an hour. You're thinking about how do I get it back up? You may eat a whole bowl of grapes and just keep eating things and eating things. Often we'll see things like a 225 blood sugar after something like this occurs.

RK: It is so important to treat right away, as you mentioned, with those quick acting glucose sources, but not over treat. I think is what you're talking about because it will take a little bit to work, but in the moment, it can be very scary, to see that sugar dropping, but it will come up eventually. It's important to know that what we call that rebound hyperglycemia, the going from the low to the really high, can also be seen if you do eat the whole pantry like you talked about. So I appreciate you going through those. How about glucagon? When would someone with diabetes need to have that prescribed? And what should family members know about giving their loved one's glucagon, if they are passed out from having a low blood sugar event?

SR: Glucagon is given in an emergency situation where the person is passed out or unable to swallow [or] communicate with you, and it's important for someone who's prone to hypoglycemia on insulin or has had these really bad low episodes or hypoglycemia unawareness that there is glucagon available. But it's not the kind of thing that a person administers to themselves. This is an emergency thing where the family, friends, [or] co-workers get involved. And if they find the person in this kind of state, they can go ahead and give it. Now, glucagon is given either in an injection form or an inhalation, a spray into the nose. But what glucagon does is that it stimulates the liver to produce glucose and elevate the level. Which our liver again comes to our rescue when something is going on and we need extra glucose, that stimulation is really important. If that person is unable to safely ingest or swallow a sugar source, or they're passed out, you inject the upper arm, thigh, or abdomen, or spray the inhaled glucagon into the nose as you're calling 911. You hope that's going to fix it, but it may not completely, or it may be some other cause and you're not sure exactly what's going on. You should be calling 911 if you get to the point where you need that kind of thing. But an important thing to do as well is that if someone is on their back, you want to roll them on their side. One of the side effects of glucagon is nausea and sometimes vomiting. And if that were to occur, you wouldn't want the person to be on their back because something could happen called aspiration — where they inhale anything they vomit would go back into the lungs — you put them on their side and you wait with them as 911 is coming. So that would be the best way to use glucagon. It also expires relatively quickly compared to some of our medicines. As far as where it's kept, it's important for the person with diabetes to check the glucagon expiration, have it in a place where the people who would be most likely to be around them, to find that them in that situation, would know exactly where to find it and how to use it. And to review how you would use the injection, or how you would use the nasal spray ahead of time when things are nice and calm and not in a serious situation.

RK: Yeah, I think that's a really important point, especially since glucagon does need to be mixed. It's usually a powder. And we do have a video on the website, which goes through how someone's loved one could give glucagon and make sure that it's prepared appropriately in an emergency situation. It's important to review that ahead of time because in the heat of the moment, it might not be something that you can look up right away. Thanks for going through all those specific precautions and things to think about while giving glucagon. I wondered if you could just briefly touch upon sick day management as well, because that

might be something more commonly that people should be aware of. And when we talk about sick day management someone who might be managed on their diabetes regimen; their sugars are otherwise in the goal range, but they get an infection. Let's say they get COVID, they get the flu. What kinds of things could they do to prevent one of these diabetic complications, whether it's hypoglycemia or hyperglycemia from ketoacidosis or hyperosmotic crisis from occurring?

SR: Yeah, that's a really good question, because we all get sick at some point. And if someone doesn't have diabetes, okay, we ride it through and we're doing okay. But when someone has diabetes, again, it's stress and it can raise the blood glucose. In a few people, it can lower the blood glucose when they're sick. You should have basic supplies on hand and also a plan. This is important: I would talk to your provider or your educator about, "Okay, if you get sick, what should you do?" First of all, you should have numbers handy in case you need to call specialists, your primary care, or any other people like that. When we're not feeling well, we can't find things as well a lot of times. How things are organized—even if you have to have some things in a little box—as far as your sick day plan.

When we're sick, we may have an increased demand for our medicine or our insulin because the blood glucose goes up. But what can happen is you don't feel good; you don't want to eat anything; you may have nausea. And in that case, I've heard people say, "I just didn't bother taking my insulin or my medicine, but then my blood glucose was very high," because the stress would raise it, whether or not you're eating. Even not eating is a stress to the body. And you can sometimes drive the sugar up, by the liver putting out extra sugar. The way you're going to know about this is you're going to monitor. It's important to have plenty of your supplies for monitoring. And people may be just monitoring once a day. In the case of illness, you may need to do it more often, like every four to six hours, depending on what the blood glucose is doing. If you're not monitoring, you're not going to figure out if it is going up or if it's just beginning to head low, where you could thwart a low blood sugar reaction. Have plenty of monitoring supplies, have your medicines on hand, [and] have numbers of who you would need to call. And the other thing with what we mentioned about the diabetic ketoacidosis or the hyperosmolar is dehydration. So have plenty of fluids, non-sugar fluids, lots of non-sugar fluids on hand to make sure that you stay hydrated. Go ahead and drink regularly at least every hour, be drinking on a regular basis to try to stay hydrated. Make sure that you are urinating on a regular basis, [and] not dizzy when you stand up, which could indicate some dehydration symptoms. Also, when people are sick, they don't feel like eating heavy meals. Think about some light things that you could eat and especially with illness. Like some things that are good are popsicles [or] other forms of clear liquid, [like] soup broth. Lots of soups can be a lot easier to take when you are sick. But with the sick day rules, also if you have glucagon, that's helpful if it goes low. You may look and go, "Okay, I'm monitoring my blood sugar more frequently. Oh. It's going up. Let me go ahead and give more rapid acting insulin." Just be careful and watch how it goes down, because you can get in a situation of what we call insulin stacking, where the insulin that you just gave, you haven't given it at least two to four hours to really go to work. So, there's something called a three-hour rule for the rapid acting insulin, where you want to go ahead and see how it works. It'll start maybe in 15 minutes, it'll peak in an hour, but it's going to continue for two to six hours. The three-hour rule prevents you from insulin stacking where, "Okay, I had insulin in the last three hours," but any questions about elevating blood sugar and you're having a hard time getting it responding, you've got your numbers, you call your provider, you get answers to these questions. And also, let family members know when you're ill, especially if you live alone. Maybe they can check on you a little bit or people can go and give a door drop of some supplies that you might need during that kind of thing. If you find that you're having one of these stomach problems where you're vomiting, you really shouldn't vomit more than once in four to six hours. [If] you're vomiting continuously, you really put yourself much more at risk of a serious complication. And if that's the case [go to] urgent care or the ER, and they can maybe reverse some of that nausea and the vomiting and get you back to where you are able to hydrate yourself. Really think about — "I've got to get in fluids. I've got to get in fluids" with those kinds of things.

RK: Thanks for going through all those important aspects of developing a sick day plan. And I think that's really the key—having a plan in case of emergencies and talking about it with your health care provider—"If I were to get sick, if I were to have an infection, what should I be aware of? What should I have on hand? What should I do?" So that when those situations do occur, because, as you mentioned, we all get sick at some point, you're prepared and know what to do. And at the very least, have the numbers to call to get more information or to talk to your health care provider. [It's] really important to think about that proactively to prevent the complications down the line.

Well, Susan, it's been so great to have you here today on our podcast. And I wonder if, in parting, we've talked about a lot of pretty scary complications today that might make us feel a little hesitant to have our diabetes treated. And I don't think that's the message we want to get across today because clearly, we want diabetes to be treated optimally and safely. But what would you say to our listeners who might be a little bit fearful of these complications? How can they ensure that their diabetes is being treated safely and appropriately?

SR: Yeah, that's super important. I think the really cool part of it is that the patient can play such a tremendous role in this and have tremendous control over what happens. So you want to get your visits on a regular basis and be seen appropriately for the diabetes. Make sure any questions that you have get answered. And as well, I know we have mentioned the word monitoring multiple times. When you come into our offices, yes, we can go and find out information about you, but if we send you out, you really don't know what's going on a regular basis. It's like driving a car down the street with a really dirty windshield. You're on the road, but you don't know if you're about to hit the fire hydrant or a pole or whatever. But when you monitor your blood glucose, it's almost like clearing that windshield. Now you can see where you're going, "Oh, look, my blood sugar was this morning and is now here before lunch it's this level." You have a much better, more intimate way of knowing what is going on with yourself with this and recognizing what the symptoms are. The more [you monitor], the less likely you're going to have problems with all of this. So monitoring is extremely important — and get diabetes education. There are diabetes educators that can spend a lot of time and go over many of these things and help with the fears.

I want to really end on the positive note that we have a lot of knowledge about diabetes now. We also have the ability to help empower you with education, [and] much better medications than there were, when my grandmother developed type one back in the thirties. So much better and you can live an incredibly healthy life through a great lifestyle, monitoring and the better medicines we have, having a good partnership and relationship with the people who take care of you and pulling in your village of your family and friends to help assist with whatever they may be able to help with and that you feel comfortable sharing with.

RK: Thank you so much again, Susan, for being on our podcast and really highlighting the importance of being aware of these complications and also prevention and treatment. We really appreciate your expertise today.

SR: And I really enjoyed being here. Thank you so much.

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.

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