

## Podcast 42: Diabetes in the Hospital

**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](http://hopkinsdiabetesinfo.org). For today's podcast, it is my pleasure to introduce Dr. Demidowich, who will be speaking to us about hospital management of diabetes. Dr. Andrew Demidowich is the chief of inpatient endocrinology at Johns Hopkins Howard County Medical Center and an associate professor of clinical medicine at the Johns Hopkins University School of Medicine.

He completed his residency training at the Mount Sinai School of Medicine in New York City and his fellowship at the National Institutes of Health in Bethesda, Maryland. Dr. Demidowich has published over 50 peer reviewed articles, and his research interests include elucidating the relationship between obesity, inflammation, and diabetes, as well as strategies to improve diabetes care delivery in the inpatient or hospital setting.

Welcome Dr. Demidowich.

**Dr. Andrew Demidowich, MD:** Thank you for having me. It's an honor to be here.

**RK:** We are so excited to learn from you today about how diabetes is managed in the hospital and how it might be different than how people manage their diabetes at home. I wonder if you might start off by telling us: why would someone with diabetes need to be admitted to the hospital in the first place?

**AD:** People might need to go to the hospital either for diabetes-related issues such as very high blood sugar or very low blood sugar—we call those diabetic emergencies. Very high blood sugars can sometimes lead to diabetic ketoacidosis, which is when the body is no longer able to utilize glucose or sugar from our blood to use as fuel or energy for our body.

It then has to go to our backup generator—fat—which we carry around every day, sometimes too much, unfortunately. Our body starts breaking down that fat as a backup energy supply to feed the organs of our body. But when you break down fat, it turns into fatty acids. It eventually acidifies the blood and becomes a potentially life-threatening condition, which requires hospitalization and urgent treatment.

Also, people with diabetes might need to be hospitalized for completely different reasons, such as anything else that other people without diabetes might be hospitalized with: heart attacks, strokes, pneumonias, kidney issues, infections, the whole gamut. Diabetes might be a secondary issue to the cause of their hospitalization, but it is still very important to be managed correctly once they are in the hospital.

**RK:** It does sound like there could be many reasons why someone with diabetes might need either a short or a long term stay in the hospital. You mentioned what we call diabetic emergencies, such as diabetic ketoacidosis hypoglycemia, even hyperosmolar hyperglycemic crisis. We had a previous podcast talking about those issues in detail, I appreciate you bringing those up.

You also mentioned the other common reasons people get admitted into the hospital that might also occur in someone with diabetes. Are any of those types of admissions, you mentioned pneumonia, for instance, more commonly seen in people with diabetes?

**AD:** Yes, exactly, the higher your blood sugar is, the more complications you can develop for several reasons. Not only is sugar fuel for our own bodies, but it's also fuel for bacteria, viruses, fungi, and things that really shouldn't be living on or inside of us. By having higher blood sugar levels at home, you are at increased risk of developing some kind of infection, such as pneumonia or urinary tract infection or something to that effect.

We also know that sugar is sticky. On the outside, I say to my patients, "Honey is sticky, bubble gum is sticky, caramel is sticky, but indeed, inside our bloodstream, sugar is also sticky." Now, the medical term for it is called glycosylation, where the sugar molecules actually stick to things inside our body, like our blood vessel walls or our immune cells. By having those immune cells coated with sugar, they're unable to actually defend our body as much, but this also causes increased levels of inflammation, particularly in our blood vessels.

People with uncontrolled or poorly controlled diabetes are at increased risk of other medical issues such as heart attacks, strokes and nerve damage, which could then lead to issues with vision or falls and unfortunately then therefore leading to fractures.

That is why both in the inpatient and in the outpatient space, the clinicians focus so much on good diabetes control, because just having diabetes per se doesn't increase your risk for many of these things. It is more dependent on whether or not the patient's diabetes is poorly controlled, in which case the risk truly elevates. But for people who have really well-controlled diabetes, I always tell my patients, "You can live a long, healthy life just the same as the person next to you."

**RK:** I agree. I think it is so important to emphasize that following routine preventative care measures and really striving towards whatever metabolic goals are discussed with you and your health care provider on the clinic side can really prevent some of these complications from occurring, including hospitalization.

You mentioned the terms inpatient and outpatient; could you define those for our audience? They are used very commonly but may not be so well defined.

**AD:** Unfortunately, as clinicians, we tend to fall into medical jargon, and we don't even realize that we use it. I do recommend to all my patients, "If there's anything that you don't understand while I'm telling you in our face-to-face interactions, please do not hesitate to stop and interrupt me and ask me. There's no such thing as a stupid question." But yes, to your point, inpatient typically means in the hospital setting. Whereas outpatient really means out of the hospital setting, it really means in the clinic when you're seeing your doctor for a regular checkup or appointment.

**RK:** There are also urgent care centers and emergency room settings. Where would you classify those?

**AD:** We would consider those as technically outpatient. So emergency care, urgent care settings, and even what we call the observation unit, insurance companies still define those as outpatient areas. Even though physically you may be inside the hospital. They have made a delineation that you're not admitted to the inpatient setting, which supposes that you will need

a higher level of care and more than one night in the hospital to help treat and resolve the acute medical issue that brought you to the hospital in the first place.

**RK:** That is an important distinction to keep in mind. If you go to the emergency room, you may be in a hospital, but really what we're talking about today on the inpatient side is when the healthcare team thinks that you need to be formally admitted and perhaps actually have a bed where you stay for a day or longer because of the type of medications and other regimens that are required. What kind of specific regimens, in general, might someone require in the inpatient setting that they can't get at home, for instance, getting an intravenous medication? Sometimes that can be given in the ER as well. Why would someone need to be in the hospital to get these treatments?

**AD:** Typically, once patients are admitted in the inpatient setting in the hospital, we manage diabetes almost exclusively using insulin. Whereas in the outpatient or out-of-the-hospital setting, people frequently are on all sorts of other medications, like pills, such as metformin or glipizide, or the new injectables like Ozempic or Manjaro that we've been hearing a lot about. The issue with those medications is that many of them are really wonderful medications, but of course they have potential side effects or nuances of whether or not they're safe to use if someone has acute kidney or stomach issues.

Insulin is a natural hormone that our body produces and is therefore the best, most well-studied, and most predictable in terms of its action. We know it plays well in the sandbox, no matter what other medication that another doctor might want to give you or any other procedure that you might need to undergo. I do not have to worry when I use insulin about whether or not someone's going to go for imaging, a CAT scan with IV contrast. Are they going to go to surgery? Are their kidneys not working? Or is their liver having difficulty working? In any of those situations, insulin is safe to use, whereas other oral medications might become unsafe. In order to ensure the safety of our patients, sometimes we'd like to just keep it simple and just switch everybody to insulin.

**RK:** That's such an important point to emphasize. I often hear from my patients, and I'm sure you do too, "Why do my medications have to change? Just because I'm in the hospital for a day or two?" Emphasizing this unpredictability of what can happen when you have an acute issue going on, even if it's not directly related to diabetes, is important because the regimen itself needs to be flexible enough to accommodate having to be without food overnight, for instance, before a procedure, or if there are changes in the kidney and liver function. Like you mentioned, many of these medications, particularly the pills, may be metabolized.

I think understanding that the predictability, or unpredictability, of being in the hospital setting is really what necessitates these changes. But it can be confusing for patients who are well managed at home; maybe they get a bad infection that requires hospitalization, and then suddenly, after years and years of being on their medications, they have it flipped to insulin. What do you see in the hospital setting when patients come in and are asked to put on insulin?

**AD:** The most important thing is having discussions with patients and setting expectations and answering questions. Typically, once they have a conversation, exactly like we're having, almost all patients are understanding and agreeable. There's a common misconception amongst patients that if you start on insulin, you are doomed to be on insulin for the rest of your life. There are some patients that are very hesitant to be started on insulin, even just temporarily in the hospital setting, because they think that, "Oh, if I started insulin, that

means I have to go home on insulin. I can no longer be on my pills, which I do really well on, ever again." That is a complete misconception. People who are on insulin in the hospital oftentimes are able to restart their home medications on discharge. It is during that brief stay at the hospital that we want to keep you as safe as possible, so we usually just use insulin just during that time frame.

**RK:** Thank you for making that point. I think that's a great way to describe it: a temporary change to the regimen that may or may not persist after you go home, depending on the reason for why you were admitted to the hospital in the first place. Part of the reason we're having this discussion today is because that new setting of being in the hospital does require some changes for almost everyone who has diabetes, regardless of the regimen they're on. Wouldn't you say that's true?

**AD:** Yes, not only that, but the hospital setting is an opportunity to reassess how everything is going at home. For people who come in and their A1C is at target, which is roughly around an A1C of 7%. We say roughly depending on the person and their comorbidities. There are opportunities to reassess. Some people come in only on pills, but their A1C is 11 or 12%, and you have that conversation of, "Maybe we do need to start some insulin when you go home." Or at the very least, "Let's look at what your current regimen is and how we can improve it."

Some people come in with hypoglycemia, meaning that their blood sugar is low either due to insulin or due to another class of oral pills called sulfonylureas. We might then have the discussion of, "Hey, maybe this is not the best type of medication for you. Once you leave, we can put you on a different class that does not cause hypoglycemia, such as Ozempic, Manjaro, or Metformin." Of course, that is the thing that I enjoy so much about diabetes management: there's so much nuance, and it is a little complicated, but at the end of the day, I also really enjoy having these conversations with my patients. Ultimately, they are the ones who will live with this for the rest of their lives. I really find that shared decision-making is very important to come up with a strategy that allows them to set themselves up for success and understand how they define success.

**RK:** I think that's a great way to describe it, as an opportunity for a tune-up for people who may, for whatever reason, not have had their regimen optimized. It presents an opportunity to focus on what the tweaks are that we can make to get you on a regimen that will eventually help you reach the metabolic goals set by your provider, even when you go home. I think, for a subset of people with diabetes, a hospital admission can be a great opportunity to improve their care. In your experience, having really managed many people with diabetes in the hospital, how many of them go home on the same regimen they came in with to really have a change in the regimen on discharge?

**AD:** I would say it is 50/50, which means that there are still quite a large number of people where there is an opportunity to adjust or improve their regimen. Maybe that's just adjusting their insulin doses, or it might be an opportunity to have the conversation of, "Hey, have you ever discussed with your provider about starting Ozempic or Manjaro?" The patients might not have an outpatient endocrinologist; on the outside, they maybe only have a primary care doctor who possibly is not as well versed or as comfortable prescribing such medications. So it is an opportunity to have shared decision-making and identify strategies to set people up for success.

Then the other thing that I find really exciting in terms of my position as an inpatient or hospital endocrinologist, sometimes we call it an endocrine hospitalist, is to also have a conversation about checking blood sugars. Of course, classically, we use finger sticks, which are painful for some people. They also only give us a brief snapshot of what their blood sugar is doing at that point in time without giving us more robust information about what's going on in between those finger sticks. Continuous glucose monitors (CGMs) have now become much more popular and are much more visible amongst our population of people with diabetes. So, I've become a very strong advocate of starting people on CGMs on discharge. Particularly for those who might be going home on insulin or who have a history of diabetes emergencies, whether it's hypoglycemia or severe hyperglycemia. It helps people understand how their decisions, how their diet, may affect their sugar levels as well as how to set alarms to keep them out of trouble.

With all of these, whether it's medications or discussing sugar monitoring, I feel like there is a wonderful opportunity. We frequently, in one of those two regards, do make some tweaks or changes to help optimize them for the rest of their life. Hopefully, unfortunately, it's sad; I don't have to see people again. But at the same time, I'm happy when I don't have to see people again, because that means that they're doing great.

**RK:** That's right. As much as you enjoy seeing people in the hospital, it's nice when they aren't required to come back to the hospital. So that is interesting to hear, that about half of people with diabetes in your experience who come into the hospital, maybe were well managed on pills, and temporarily are put on insulin in the hospital, might go home on the same regimen of pills after discharge. But then the other half really might either need to stay on a new insulin regimen or might need some tweaks to their existing regimen on discharge. So again, highlighting the importance of reevaluating what the diabetes regimen is at home and what's ideal once someone goes back home from the hospital.

You mentioned putting people on continuous glucose monitors when appropriate, and I do think that highlights another aspect of what occurs in the hospital, which is education. Could you talk about who does the diabetes education in the hospital and the role, not only of the nursing staff, but also when someone with diabetes requires a diabetes consultant or an endocrine consultant in the hospital?

**AD:** Great question. So, education can occur with many different staff members: it can be the bedside nurse; there could be a certified diabetes education care specialist, who I would call a diabetes educator; it could be the hospitalist; it could be the endocrine consultant, as you alluded to, Rita. Any of those people are able to provide diabetes education, and it of course depends on the hospital resources: Do they even have an inpatient endocrinologist or an endocrine hospitalist? Do they even have a diabetes educator on staff? It's not universal for all hospitals. At the hospital where I work, which is the Johns Hopkins Howard County Medical Center, we are blessed to have a diabetes educator on staff. People who come in with either poorly controlled diabetes or having significant changes to their diabetes regimen, such as starting insulin on discharge or starting a continuous glucose monitor on discharge, we usually do have the diabetes educator come and consult on the patients, and frequently I or someone from my endocrine hospitalist team consults on those people.

I am such a firm believer in education because knowledge is power, and what we want to do is empower our patients to feel comfortable and confident that they can manage their diabetes

on their own once they leave the hospital. If they are not comfortable in managing their diabetes, then I feel almost to some effect that we haven't fully set them up for success.

To answer your second question, at what threshold does a patient with diabetes require an inpatient endocrine consultation? Meaning, at what point should an endocrine specialist come and see you while you're in the hospital? Again, that does speak to the specific hospital resources that are there. Some rural settings might not have an endocrinologist, or the endocrinologist in town might not be able to make hospital calls because that physician is working in the clinic all day. But in hospitals, for example, large academic centers or hospitals that are employing an endocrine hospitalist or an inpatient diabetes team, we do set some soft thresholds. Now, these are not set guidelines or set in stone, but I would think that people who present with diabetes emergencies like diabetic ketoacidosis (DKA) or hyperglycemic hyperosmolar state or severe hypoglycemia should be seen by an endocrine specialist. Anybody with an insulin pump and most people with type 1 diabetes, since we know that they tend to have greater sensitivity and more fluctuation in their glucose levels and insulin requirements, would really benefit from having a specialist touch base with them. Pregnant women who have diabetes and are being managed with insulin should have a specialist touch base with them. People who otherwise might be coming in for a hospitalization that is directly related to uncontrolled diabetes, such as an A1C greater than 9 or 10%, and they're coming in with either a foot infection, a heart attack, or a stroke, at which point you really want a specialist to help assess the individual and truly optimize their medication regimen. Not only, again, for what's going on in the hospital, but more importantly, for when they leave, so that they don't have a recurrence of their complication, so that you set them up for success and for health.

**RK:** Yes, those complicated cases sometimes can take some time to think through the regimen and to follow how people respond to the regimen in the hospital. Having a diabetes management service in the hospitals, where they're offered, hopefully in an increasing number of hospitals—it is so great that the hospital where you work at can benefit from your expertise—is so important so that we can ensure that management of people with diabetes is ideal and to reduce potential complications as well.

We talked about education; what about diet? If you could talk a little bit about what kind of diet people with diabetes can expect when they're admitted into the hospital and the role of nutritionists. When might they be consulted during a hospital stay?

**AD:** Nutrition is so important to our health in any setting, both at home as well as in the hospital. I tell my patients, “You truly, you are what you eat. Every cell, every muscle, every brain cell, skin, bone, is truly constructed of the food that you have put into your mouth, digested, and those building blocks literally become you. So that hamburger, or that salmon, or, that juice that you're about to consume, that's future you.” And, as I say, “If you want to have, build an excellent car, a Ferrari, or a beautiful mansion, the Roman Coliseum, you need excellent building blocks to achieve that. If you're going to put bad quality parts into a car or into a building, you're going to have a crummy car or a crummy building, that's weak.”

So, the same truly goes for people, so in the hospital, typically people with diabetes are put on a diet that limits the amount of carbohydrates that they can eat. Now the name might vary from hospital; it might be called a diabetes diet, it might be called a carbohydrate-controlled diet, which is what we call it here at Johns Hopkins. It limits the amount of carbohydrates that someone can eat because a carbohydrate is effectively a type of sugar, and that will potentially raise someone's glucose in their bloodstream. But also, sometimes people may

have other diets included or restrictions depending on their disease. So, if they came in with heart failure, they might be put on a low-salt diet. Additionally, someone who has renal failure on dialysis might have additional restrictions, what we call a renal diet. So, it varies from person to person, but in general, most people with diabetes are put on a carbohydrate-controlled diet.

We find that it is important because even though people might have had conversations with other physicians saying, “Why don't you just let them eat what they eat at home? Then you can find out what their insulin requirements are. Why are you putting them on a restrictive carb control diet in the hospital?” I respond to that with two reasons:

One, they're in the hospital for a reason, and we want to set them up for success. We want to give them the best chance to fight the infection, to recover from a stroke or a heart attack, to have their kidneys recover, for example. So, I would be failing as a physician if I didn't give them the best diet and nutritional status to help them achieve those goals.

Two, I really feel that the hospital is a beautiful opportunity for education and modeling of behavior. So, if we show them, I don't admonish, I don't finger wag, and I don't shame, because that is not the way to educate people and to put them in the right headspace to retain and obtain information. Instead, I like to sit down and say, “What happened, happened, and what you've done at home, you've done at home. That's okay. That's how you grew up, or that's how you're educated, or those are just the decisions that you made. But we're here, right here and now, and we have to look forward to the future rather than backward. So how can we set you up for success going forward in the future? And these are the dietary strategies that are going to afford you the best opportunity to get better, to clear that infection, to improve your A1C, or to improve your vascular disease.”

So that's why, for me, I think it's very important to give them those opportunities and to set them up to model the way that what an ideal diet should be and what better place to learn than in the hospital when you have staff that can also continue to reinforce that, like a diabetes educator, a bedside nurse, or the nutrition team. And to your point, when should a nutritionist come in and speak with an individual? I do feel strongly that, again, education is so important; knowledge is power. So oftentimes we do consult a nutritionist, or otherwise called a registered dietitian, which is the official term, to come and speak with a patient who has poorly controlled diabetes or may benefit from diabetes education. They may even have great, well-controlled diabetes, but as I interact with the individual, I might notice that they were never taught even basic dietary strategies or decision-making on how to eat healthy.

Going into a supermarket and trying to pick healthy food and cook healthy meals for someone who was never taught how to do that can be very overwhelming and scary. For me, all of us are different, but things that you're not familiar with can be scary. If you ask me how to fix a car right now, I know how to change a tire, but that's about it. Besides that, I would be truly terrified. We must not take for granted the things that we know and then impose them on our patients; they might not know it, and they might be afraid to even admit that they don't know. It's always important to have open conversations and then provide them with the resources necessary, both in the hospital setting as well as hopefully setting themselves up for resources to continue to follow up with once they leave the hospital.

**RK:** I agree, I think that registered dietitians, and diabetes educators, are such tremendous resources really for people with diabetes in the hospital. To have the opportunity to take

advantage of that knowledge that they can provide, not only in the hospital, but to carry it over to when you go home is really critical. For those people who can really benefit from that additional expertise and knowledge, it can be critical to have them come by while in the hospital. You mentioned what we call the carbohydrate-controlled diet or a diet where we monitor a certain level of carbohydrates in each meal. There are also alternative nutritional regimens that I wondered if you could talk about just briefly, such as total parenteral nutrition, peripheral parenteral nutrition, maybe just briefly define what those are and when they might be used and how it might impact diabetes management.

**AD:** In situations where we feel that people are unable to eat food safely or in sufficient quantities that meet the needs of their body, and we know that typically people need roughly, depending on their body size, between 1500 to 2000 calories a day. For one reason or another, either if they're intubated and unconscious or unable to swallow, if they're unable to intake that sufficient number of calories to meet the needs of their body, then we have alternative methods to feed people. One method is called tube feeding, and that's usually accomplished through a tube. Either people have what's called a gastric tube or a peg tube, or they have just temporarily what we call a nasogastric tube, just the tube that's in the nose and then goes down into the stomach but can be pulled out easily once they're ready to actually eat food. Usually then they get almost the equivalent of a milkshake, which is continually poured through the tube to provide them nutrition, we call that tube feeding.

Then there's peripheral parenteral nutrition (PPN), and total parenteral nutrition (TPN), which literally means food through the IV, through the vein. So we see that there's usually, if it's just PPN is typically a large, clear bag that has sugars and proteins in the form of amino acids and vitamins in them. Then sometimes we also have a bag of liquid fat because fat is very important as an energy source and as a building block for our bodies. Typically going through another IV into our veins because that's continuous nutrition going in, non-stop, typically throughout the whole day, or even if it's just going through 12 hours, for example. But it's a continuous infusion rather than naturally. What we do is we just have a meal and then we go hours without a meal and then we have another meal and then go hours without. That's how our bodies are meant to be eating, and that's how you evolved to be.

So to have continuous nutrition typically means a nuance and adjustment in terms of our insulin decision-making. Usually people are put on short-acting insulin every 4 hours to compensate for the continual glucose and energy that's coming into their body through either the veins or through a continuous tube feed.

**RK:** Sometimes, especially for people who are on these different regimens, either through the tube feeds or through the veins, as you mentioned, just understanding that it might require a different type of insulin regimen. We haven't really talked specifically about the kinds of insulin regimens that people may be on in the hospital, and this might be a good juncture to do that. We mentioned that most people, if not all people, will need, on a temporary basis, no matter what they were on before the hospitalization, to be on insulin during their stay. But what kinds of regimens might those look like? You mentioned if someone is on continuous nutrition, they are getting insulin injections every 4 hours, or what we call standing doses that they get. But for someone, let's say that was on just metformin or just a few pills at home, what might their insulin regimen look like while in the hospital?



**AD:** Diabetes management in the hospital setting is very nuanced. For people who have, I would consider colloquially, very mild diabetes, so their diabetes is well controlled just on diet alone or maybe just on one pill alone, they might be able to get away with what we just call correctional insulin or sliding scale insulin and nothing else. Just see for 24 hours what their sugar levels are doing, and only if the blood sugar is starting to go high do you get a little dose of correctional insulin to help try to bring it back down to normal.

But for patients who are either taking insulin at home or who are taking multiple pills of diabetes medications at home or who come in and their diabetes is uncontrolled, meaning that their A1C typically is higher, above 9%, for example. Those people, we need to start them right off the bat on what we call basal-bolus insulin. And what does that mean? What is basal insulin? What is bolus insulin?

So, I like to use analogies because I think a picture is worth a thousand words. I like to use the analogy for my patients that our bodies are like a car. On a cold winter day, you don't want to just jump into a cold car. Let me use my remote start, and I'll start the car, but I'm not actually going to drive it, I'm going to let it sit there and just warm up. It's going to be using the same amount, basal amount of gasoline. If I just let it sit in the parking lot for the whole 24 hours, it would continually use the same amount of gasoline, all day long just to maintain the very basic organ functions of the car. Similarly, our body is the same way; if we were just sleeping or resting or not doing anything all day long, we still need a basic amount of glucose to enter our cells as fuel to fuel our heart and our lungs and our kidneys and our liver, but not much else.

So, you just need a basal amount of insulin to allow the glucose to actually go into the cells because insulin effectively acts as a key to open the door and allow the glucose molecules to go into the cells. Because you just need that same base amount, there's actually what we call basal insulin. A common one used in the hospital is glargine, or the brand names are Lantus or Basaglar; some people are on other ones, brand names called Toujeo, Tresiba, Semglee, and Levemir; all of these are basal insulins. They're typically once-a-day insulin; they just have a flat rate of action. It is just using the same amount of activity the whole 24 hours, and that's why you'll need to inject it once a day. It helps compensate just for basic metabolic needs while resting.

Then, on top of that, we have what's called a bolus, or rapid-acting insulin. That is very fast acting, because the car, suddenly, you're ready to go into drive, and you're ready to start driving to work, or to the supermarket, or to your kid's soccer game. The gasoline requirements, when you put it into drive, shoot up quickly until you hit a red light and then back to your basal, then green light, red light. Similarly, in our bodies, when we eat food, the amount of glucose that's now all of a sudden coursing through our bloodstream spikes up quickly. The insulin requirements to compensate for that glucose spike also need to spike up quickly, but they don't need to stay spiked up for 12 or 24 hours because we metabolize the glucose that we've eaten rather quickly.

That's why we eat breakfast at 8 am, and then I'm hungry again at 12 pm, just 4 hours later. Then usually around 3 or 4 pm, you need that mid-afternoon snack. Usually we eat dinner around 6 or 7 pm for most people. Around every 3 or 4 hours we finish metabolizing the nutrition from our food, and we're ready to eat a new meal. For that reason, scientists have invented rapid-acting insulin that typically lasts only 3 or 4 hours to compensate for that rapid short glucose surge. In the hospital you would typically get one shot of basal insulin a day and then a shot of what we call bolus or rapid-acting insulin with each meal.

Then on top of that same rapid acting insulin, also you might get a couple extra units based on what we call, again, we've talked about this correction or sliding scale. Because if

you had a hamburger and your blood sugar is 120 mg/dL, you might only need five units, the nutritional dose to compensate. Five units is just a pure example, it could be ten, could be fifteen, depending on the person. But you just need, let's just say five units to compensate for the nutrition of the person. Hamburger buns that are going into your, eventually into your bloodstream. But if your blood sugar is 220 or 320 mg/dL, that's much different at that point in time, that you're eating that hamburger, than if you're eating the hamburger at 120 mg/dL. So the person eating the hamburger at 320 mg/dL of course needs extra insulin or correctional insulin to help both compensate for the nutrition going in but as well as to correct them to bring them back down to 120 mg/dL hopefully by lunch or dinnertime.

**RK:** I loved that analogy about metabolism and why we need these different durations of insulin and different frequencies of insulin as well.

There's also the insulin drip, giving insulin through the IV that some patients may need even further. I wonder if you could talk about what that is and why and when it might be needed.

**AD:** The insulin infusion, or the insulin drip, as we like to call it, is something that is typically done only in certain situations. A classic situation is diabetes emergencies, such as DKA or hyperosmolar hyperglycemic state. A lot of time people with diabetes or any type of hyperglycemia in the intensive care setting might be put on an insulin drip to help regulate their blood sugars. In these situations, the insulin infusion or the insulin drip is not only really, in some regards, more potent or more powerful than the injection because it goes straight into the bloodstream rather than the injections that go into the adipose tissue (the fat) and they need to be slowly absorbed from the fat into the bloodstream. It also allows us to make quick adjustments or stop the insulin entirely on a moment's notice, whereas we're not given that capability with an injection. Once you inject the basal insulin, that basal insulin is sitting there for 24 hours, whether you like it or not. Even the rapid-acting will be sitting there for 4 hours, whether we like it or not.

Whereas with an insulin infusion, you can change the dose—technically we can change it minute to minute—but most of the time we make adjustments every hour, as necessary, to help keep a blood sugar within the target range, which is typically between 100 and 180 mg/dL. Other instances where we might use an insulin infusion are after certain surgeries, such as cardiac transplant, pancreatectomy, or pancreas transplant, as well as with mothers who might have type one diabetes who are actively in labor. In all of these situations, for these specific and high-risk individuals, it affords us the best opportunity to have maximal glycemic control.

The question is, so then why don't we do it on every person with diabetes? Because it's very labor intensive, and typically the types of people that are on an insulin infusion need to be in a special monitored setting, such as an intensive care unit with typically one-to-one nursing, because the blood sugar can change rapidly when you're on an insulin infusion.

**RK:** I think that is an important aspect to keep in mind, that the degree and frequency of insulin given and really the route by which it's given, whether it's an injection or an infusion through the veins, depend on what the medical reasons are for the admission and what the short- and long-term goals are. Understanding that someone can bounce back from being on an infusion to going into the injections, or maybe the other way, going from the injections to an infusion. This depends on whether their clinical condition is improving or worsening. It is great to have this flexibility, to be able to give insulin and meet the needs of the person in the hospital that might change throughout hospitalization too.

One of the hot topics that is out there is having to hold certain diabetes medications before procedures and before elective hospitalizations or when you know that you have to be hospitalized for whatever reason. Could you talk a little bit about that? What medications might require a little extra attention before a planned surgery? For instance, if you're getting cataract surgery, would you have to hold medications such as GLP-1 receptor agonists or SGLT2 inhibitors beforehand, or even metformin? How far in advance do people need to hold these medications before being admitted to the hospital or undergoing a procedure?

**AD:** I will preface that anything that you hear here must first be discussed with your physician, as everybody is different in everybody's situation. In general, people who are undergoing anesthesia—they will ask that the long-acting, once-weekly GLP-1 receptor agonists be held for at least a week prior to the procedure. They are known to slow down gastric emptying, and therefore they might have a greater risk of having food still left in the stomach, even from the day before. In the unlikely but unfortunate scenario that somebody vomits food, they can aspirate and go into their lungs, which can lead to a very dangerous situation. For that reason, most centers now request that people not take their long-acting, once-weekly medicines at least a week prior to a procedure. The daily versions, such as Victoza (liraglutide) or the oral medication RYBELSUS (semaglutide), typically right now they are still recommending that you can take it up until the day before the procedure and just hold it on the morning of the procedure. There is a lot of research; it is a very hot area of research, and so I'm sure we are going to be having changes of recommendations in the next year or two, so watch this space.

There's another wonderful class of medication that I truly love called the sodium-glucose cotransporter-2 (SGLT2) inhibitors. So for our patients listening, basically the two most common ones are Jardiance and Farxiga; there's also Invokana, Steglatro, and Brenzavvy, and this class of medications is also wonderful because they help protect the heart, they help protect the kidney, but rarely they can predispose people to going into a diabetic emergency, ketoacidosis. That's why the FDA has really recommended that for people undergoing surgery, that really should be held for at least 3 to 4 days prior to undergoing surgery. Now, for something like a very simple cataract surgery, in which their diet is not actually affected, one could argue that it's not as important to hold the SGLT2 inhibitors because they're going to be eating as they normally do right after this very rapid procedure.

For larger surgeries or procedures that involve the gut in which people might not be eating normally; for example, colonoscopies in which you have to do a bowel preparation, and you have to take medications to clean out your stomach, and so you're not eating as you normally would. In those situations, and in larger surgeries, I recommend that you withhold your SGLT2 inhibitors like your Jardiance or your Farxiga at least 3 to 4 days prior to even preparing for the surgery. Other medications, typically we say metformin or the sulfonylureas like glipizide or glimepiride, or the Dipeptidyl peptidase-4 (DPP-4) inhibitors like Januvia or Onglyza—all of those medications—we typically say to hold on the morning of the procedure, but you can still take them the day prior to the procedure. Lastly, insulin is very tricky, because it can depend on the type of insulin that you're using and what time your procedure is taking place. And are you a type 1 or a type 2 individual? But in general, with insulin specifically, it's very important to talk with your provider for your specific recommendation. In general, we say that you can take your medication the night before as you normally would, but on the morning of the procedure, you might need to decrease the doses of your basal insulin down to either 80% or even 50% of your home dose. You should not take any rapid-acting insulin if you are not eating. You should only restart the rapid-acting insulin after you have started eating.

**RK:** Those are all really important general recommendations to keep in mind. As you highlighted, really talking to your health care provider—asking which medications might need to be held and for how long, and practices for withholding or reducing insulin, even the night before in some cases, but definitely the morning of—shows that it is very important to talk to your health care provider.

Then there might be reasons that you're admitted to the hospital; they're unplanned for, and you can't do this ahead of time. But for those where you know you are having a procedure, or you know that you have what we call an elective admission, where you have to be hospitalized for one reason or another, these are all really good tips to keep in mind.

It is also important, as you mentioned, to talk to the health care provider, your clinician, on the outpatient side about when to resume medication again. It could be that you might have to wait to start them again after discharge. Talking about discharge planning now, at the end of the hospitalization, when someone's ready to go home, what are some of the aspects that a patient should expect to receive in terms of details from their health care team? What kind of questions should they ask? For instance, when should they call their health care provider, and for what glucose number? Then how does communication work with the outpatient diabetes provider?

**AD:** I think that the discharge process is actually, potentially, the most important part of what we call inpatient diabetes management. Unfortunately, oftentimes, it is overlooked or is just a second thought to some of the other inpatient diabetes management issues that we encounter. Truly I cannot emphasize enough that it is so important to set people up for success because hopefully they're living outside of the hospital 99% of their life and only in the hospital 1% of their life. So we really need to make sure that 99% is optimized to ensure continued health.

I like to say that there are at least 3 pillars to set people up for a successful discharge. One is, as we've alluded to, medications. Having the discussion, "Does the home medication regimen need to be adjusted?" If it is being adjusted, "Are the medications affordable?" Because there is nothing worse than sending somebody home on, "I think this is going to be the perfect regimen for you. You should be on Ozempic and Jardiance and insulin," and they go to the pharmacy, and they have a second heart attack because the cost of the medications could be \$2,000 or more; Ozempic alone out of pocket is \$1,000 a month. If your insurance doesn't cover it, it becomes unaffordable, and you're setting them up for failure. It's important for the medical team to confirm that any medication changes are actually covered by the insurance and are affordable for the patient.

Secondly, as we alluded to, is checking sugar. How are we going to know that we're achieving success once we've left the hospital? Is it going to be using finger sticks? Or will it be using a continuous glucose monitor? Again, that's a conversation between the clinician and the patient, considering the patient's preferences, cognitive abilities, as well as dexterity and cost. Of course, as you've heard prior, my bias is I'd love to put people in CGMs or continuous glucose monitors when I can. At the end of the day, again, that conversation has to take place of, "Is it affordable for you? And do you even know how to put it on?" I can say you should do it, but if people don't understand how to actually put on a CGM and how to pair it with their smartphone—does the app even exist on their smartphone? Because not all smartphones have a compatible app that can then pair with every CGM. Sometimes people must get a separate standalone reader, and it really depends, and that conversation is important.

On discharge, the threshold that a patient is ready is that they feel comfortable and confident in their ability to manage their diabetes at home once they leave. Now they might not be 100% comfortable, as someone is starting to learn Spanish or starting to learn how to ride a bike. You might not be 100% comfortable doing it, but at the very least you have the basic know-how of what's necessary. So if you're going to be going home on insulin, someone should have taught you how to take insulin. Either a bedside nurse or diabetes educator should have shown you, with an insulin pen, how to put on the pen needle tip, how to dispose of it, and how to inject it. These are very important details that, again, clinicians or healthcare teams might take for granted, but if a patient has never done it before, it's foreign to them. Modeling and the teach-back method, to show that the patient truly knows what they're doing is important.

Every patient on discharge should be given a printout sheet that contains a list of their new medications and doses, follow-up appointments, as well as thresholds on which to go back or thresholds for which to notify their physician or to seek medical attention. I put that in all of my discharges for all the patients that I see; common thresholds might be "recurrent hypoglycemia: blood sugar less than 70, changes in symptoms," or also "severe hyperglycemia: blood sugars that are above 350 and that are unable to come down with the medications that you've been prescribed." In those situations, I think that people should be at least calling their provider or seeking medical attention, and that should be spelled out on their discharge summary.

**RK:** I think those 3 pillars are so important. Especially, making sure that they're all covered during a discharge discussion with the healthcare team. Patients should certainly feel comfortable asking questions during that discharge time, as you mentioned, because the goal is not to just go home and figure everything out on your own, but really to have continued support and a plan of care.

**AD:** People, in order to really achieve success, need continued education and continued follow-up. Once you leave the hospital, how do we make sure that you're not lost in the shuffle, that you don't fall through the cracks, but rather that you have continued guidance in your journey with diabetes? I don't expect somebody to be proficient with the language of diabetes after just one or two educational sessions in the hospital. In my mind, that can mean setting them up with a diabetes self-management training program or other outpatient diabetes education courses. I know here in Howard County we have the Living with Diabetes class to set them up, maybe potentially with a registered dietitian appointment on discharge.

Then really most importantly, is making sure that they actually have a primary care physician appointment, if appropriate, a referral to an outpatient endocrinologist to follow up with them. Usually, again, the same threshold applies for inpatient endocrine consultation as when I refer people to an outpatient endocrinologist, and that they either came in with a diabetes emergency or have poorly controlled diabetes or might be started on insulin and would really benefit from closer follow up with regards to their diabetes.

**RK:** That's all been such great information that you've gone over. It is so important for our listeners to know that if you do have to be admitted to the hospital, for whatever reason, that you will be taken good care of and that the regimens might temporarily change. Most importantly, on discharge, you might have some tweaks to your regimen. Knowing what the follow-up is and having a good plan of care is critical. Hopefully, with this knowledge,

people will feel more comfortable should they have to be hospitalized and also know that it can be a smooth process as well, just even having the basic information.

Are there any last words that you wanted to share with our listeners if they do find themselves in the hospital at some point in the future?

**AD:** Don't feel shy to ask questions, and you have to be your own best advocate. If something either doesn't sound right or something is just confusing, there's nothing wrong with asking and getting a better understanding of why something's happening or what should be done. Ultimately, you are the most important person in the room.

**RK:** I wholeheartedly agree, and thank you so much, Dr. Demidowich, for your expertise, your education, the great analogies, and really walking through this entire process from precautions before being put in the hospital to what happens in the hospital and then what the transition should be back to home. We really appreciate all the knowledge you shared today. So thank you so much.

**AD:** Thank you, Rita, for having me. It was an absolute pleasure.

**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](https://hopkinsdiabetesinfo.org).

We love to hear from our listeners. The email address is [hopkinsdiabetesinfo@jhmi.edu](mailto:hopkinsdiabetesinfo@jhmi.edu).

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