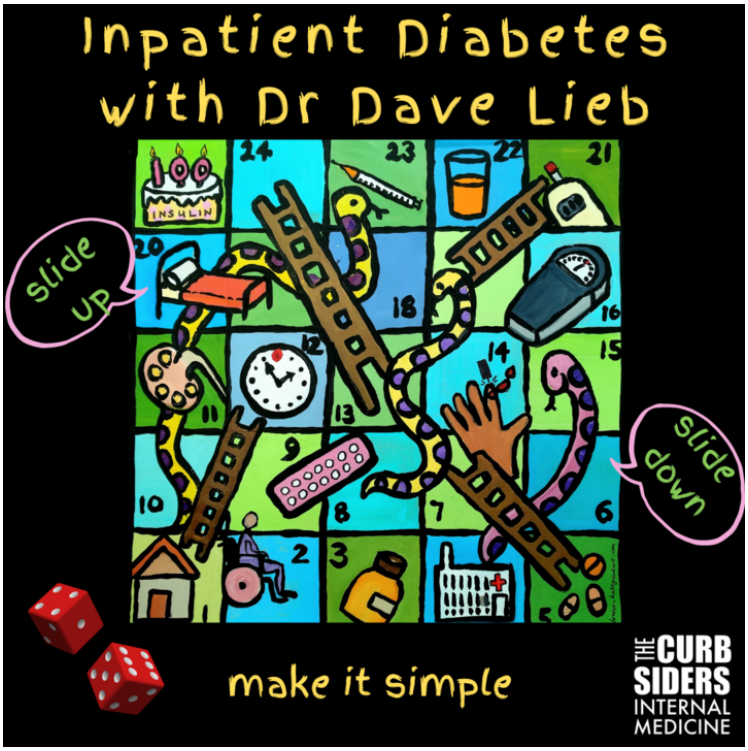
#331 Inpatient Diabetes with Dr. Dave Lieb

Part 2



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[Curbsiders Podcast theme]

Matt: Well, Paul, the intro for Part One, not our best, but you know.

[laughter]

Paul: No, I think top five, easy.

Matt: I think Adam did a great job. I still don't know how to start the show. This, of course, is The Curbsiders. I'm Dr. Matthew Watto, here with my great friend, Dr. Paul Nelson Williams. Hi, Paul.

Paul: Hi, Matt. How are you?

Matt: I'm doing well. And on tonight's show, Part Two of Inpatient Diabetes with Dr. Dave Lieb, our returning guest or not really returning, this is just the rest of the conversation we had. And before we reintroduce our cohost, our guest host for this one, Paul, would you remind people what is it that we do on The Curbsiders?

Paul: Sure, happy to, Matt. As a reminder, we are The Internal Medicine Podcast. We use expert interviews to bring you clinical pearls and practice changing knowledge. And we are joined once again by, and I think we establish firmly as astute listeners will recall, Hospitalist Wizkid, Dr. Adam Barelski.

[chuckles]

Paul: Yeah, it rolls right off the tongue. I really think this one's going to stick, Adam--[crosstalk]

Adam: I am much older than you, Paul.

[laughter]

Paul: No one's older than me. I think that's [crosstalk]. But, anyway, great to see you, Adam. Why don't you tell us a little bit about what you guys talked about tonight?

Adam: You, too. Tonight, we discussed hyperglycaemic emergencies, DKA, HHS, euglycemic DKA, insulin drips, how to transition someone from a drip to a subcu insulin and much more. You don't want to miss this one.

Matt: And, of course, we should thank Dr. Cyrus Askin, who helped cowrite and produce this episode, but as I mentioned on the previous one, parenting emergencies come up and sometimes you have to skip a podcast. But let me tell you our guest, Dr. David C. Lieb, MD, FACE, FACP. He's an Associate Professor of Internal Medicine and the Program Director of the Endocrinology Fellowship Program at Eastern Virginia Medical School in Norfolk, Virginia. As I said, he has an interest in thyroid, type 1 and type 2 diabetes, and transgender endocrine care. So, check him out on EndoTwitter, we'll put his handle in the show notes.

[music]

Matt: Dave, thank you. This is a Part Two for the audience. This is a marathon session, but for the audience, this has been maybe a week since they last heard you. But this time, we're going to talk about a little bit more of a severe case of hyperglycemia. Adam is going to get us into it.

Adam: Yes, thank you for the introduction. Our next case is 27-year-old, previously healthy woman named Dee, who was brought into the emergency department for confusion. She's felt unwell for the past two weeks, said that she lost about 10 pounds, feeling overwhelmingly thirsty and urinating constantly. Labs, on her admission show a glucose of 485, a bicarb of 14, potassium of 4.7, and anion

gap of 26. So, this is a very different case than the last one we talked about. So, how would you approach this case?

Dave: She's got diabetic ketoacidosis. Her glucose is high, it's greater than 250. Her bicarb is low, it's less than 18. And she's got an elevated anion gap. Now, whether she's got type 1 diabetes with sort of classic ketosis or ketosis prone type 2 diabetes, I don't think you know at this point, but she needs fluids, she needs insulin. She probably needs an endocrinologist and she definitely needs an intensivist. So, that's kind of where I would start.

Adam: Getting into the disposition, it sounds like for her, she would not be admitted to the general medical floor.

Dave: No, she's pretty sick. She needs to be on IV insulin. She has more severe ketoacidosis.

Matt: You mentioned fluids for her. I guess, just talking about the triage of this. Where's your head at? I know there're order sets that are a big part in taking care of patients with a more severe hyperglycemia, DKA, or HHS, what's in those sets? What orders are we going to have upfront for a patient like this that are most important?

Dave: Yeah. Everything kind of starts with fluids, because these folks tend to be very dehydrated, they've probably been ketotic for some significant period of time, they're probably urinating a lot if they don't have end-stage renal disease. So, people usually need a lot of fluid, one or two liters in the first couple of hours. Plus, a pretty high rate after that time. You want to be careful about using normal saline because of the hyperkalemic acidosis, that you can see after that, that can confuse the picture as to whether somebody is recovering.

With ketoacidosis, the patient either has an absolute insulin deficiency, like you see in somebody with type 1 diabetes, where there's just no insulin at all, or they have a relative insulin deficiency in the setting of severe insulin resistance, which is what we can see in these folks that come in with ketosis prone type 2 diabetes that require a ton of insulin, and because of the insulin deficiency, you see a rise in glucagon. And the glucagon causes the free fatty acids to be converted into ketone bodies. And that's what eventually leads to acidosis.

You have to treat the dehydration, you have to give them insulin. Along the way, you have to manage any electrolyte abnormalities. The classic teaching is people come in, they're a little hyperkalemic, like Dee because they're so dehydrated, but it doesn't take very long before you recognize that their full body depleted in potassium, and you have to start giving them potassium with their fluids. At some point, typically, when the blood sugar drops below 250, you have to start giving them some glucose as well, some dextrose in their fluids, because otherwise there's a risk for hypoglycemia.

Matt: There's protocols to do all this. And you mentioned with DKA, that the fluid deficit is usually like one to two liters you want to give and then you're going to keep giving more. Is it true with HHS? Are you more aggressive with the fluids if this was patient with HHS and their sugar was 1000? They need more fluid?

Dave: Yeah, they tend to need more fluid. I think one of the common things that we see after we get consulted in somebody with ketoacidosis or with HHS is that they're still not getting enough fluid. And we have to increase their fluids. Even if they're starting to drink a little bit, it's probably still not enough. Of course, that's in the setting of watching for, if they've got heart failure or end-stage renal disease.

Matt: And you alluded to you like lactated ringers or something other than normal saline, so you don't start chasing that hyperchloremic acidosis.

Dave: Yes.

Matt: Got it.

Adam: So, you would use LR as opposed to normal saline in patients like this [crosstalk].

Dave: Yeah, generally. It's interesting, when I made the decision in residency that I wanted to be an endocrinologist, I asked my different attendings for some advice, in a very nerdy way. And one of my absolute favorite teachers, Dana Madison, who is still at OHSU. He told me that no matter what the endocrine emergency was, you could just give more fluid. When they called you and said, "What do we do this guy's got ketoacidosis?" You could just say, "Give more fluid." If they had adrenal crisis, you could say, "Give more fluid," If they were hypercalcemic, you could tell them that the patient needs more fluid. [chuckles] So, I thought that was pretty good advice. And it's usually true.

Adam: You mentioned the pathophysiology for DKA. And we've alluded to HHS a little bit. Do you mind just describing the difference between those two in terms of how you think of them?

Dave: Yeah. I think a lot of it depends on how much insulin is around, and whether they have an absolute insulin deficient state or not, because oftentimes with HHS, the fluids you're going to see a significant improvement in glucose alone. They may still need some insulin, but I don't think it plays as much of a significant role in the pathophysiology.

Matt: Yeah, and I'm not sure if it's worth talking about the specific rates of the drips and things like that, because I think almost every institution at this point has a protocol that you're going to follow once you've decided that this is the diagnosis.

Dave: Yeah. The key thing, and this is something that I try to teach to is everything is algorithm driven when it comes to DKA and HHS, but you still need to think about the patient. We've seen folks that maybe had a drop in their glucose too quickly. The rate of the drip was so much that they dropped their glucose pretty quickly. And they went from having a very low sodium to a much higher sodium. And obviously that can cause issues with respect to demyelination and those sorts of things. Not common in adults, that tends to be more of a concern in children, but we've seen it, it happens. When a patient that's got end-stage renal disease, where maybe you can't give as much fluid, you just need to be cautious about some of these things. Sometimes, if everything is algorithm driven, you feel like the patient is on autopilot, and you may not be paying as close attention to what's going on with them.

Matt: One of the ways to avoid that would be very frequent lab checks, you're paying close attention to the electrolytes, sodium, potassium, make sure you factor in their renal function. And then, with this patient, we gave you a pretty clear-cut case. I tend to see the patient because I don't work in the ICU, I tend to see the patient that maybe their pH was 7.35 and their bicarb was 20. Sometimes we'll just have a borderline low bicarbonate, sugar 275, and someone calls it DKA. Can you talk a little bit about how you make the diagnosis? Do you see these borderline cases? Is that just me or is that pretty common?

Dave: I think it's pretty common. I don't see them as much, because typically, those are patients that you may not get consulted on, so sort of a patient that's that has more mild ketoacidosis. Again, somebody's got a pH that's greater than 7.2, or 7.25, the American Diabetes Association actually has sort of three different categories for who's got mild, who's got moderate, and who's got more severe DKA. The blood glucose is greater than 250, for mild, moderate and severe DKA. For patients with HHS, it's greater than 600. For mild DKA, the pH is 7.25 to 7.3. For moderate, it's 7 to 7.24. And for severe, it's less than 7. The bicarb is less than 18 for everybody, but it's 15 to 18 for mild, 10 to 14 for moderate, less than 10 for severe.

Adam: Dave, if Dee came in a little bit differently and had more mild DKA, and I think you mentioned that the bicarb was in the 18 range, and her pH was 7.3. That would make her more of a mild, would that be appropriate to start a basal bolus or subcu insulin for her? In my practice, I've seen a lot of times, we'll make this decision based on how they respond to initial management triage in the emergency department. She might get regular insulin, and her blood sugar might come down, and she looks clinically well. Is it appropriate to manage her with subcu if those things were the case?

Dave: Yeah. There have been a number of smaller studies anywhere from 20 to 60 patients with mostly mild, maybe moderate DKA that were treated with subcu regimens rather than IV insulin. Potentially treated on the general medical floor rather than in the ICU. And it looks like those patients, if they get subcu injections of rapid acting insulin every one or two hours until their blood sugar is less than 250, under better control, the time to resolution of their ketoacidosis may not be all that different between the two groups. So, it's absolutely reasonable in that patient with more mild disease. But there have not been studies in patients with more severe ketoacidosis using subcutaneous protocols and that's probably not safe.

Matt: Do you think these protocols, are they on the order of 0.3 units per kilogram basal and then they're giving the equal amounts of short acting every two hours or four hours? What are those even look like? I've never done it before. So, I don't even know how you-- You say you subcu, but I'm not even sure what that would look like.

Dave: The studies that have been published talk about initial doses that are 0.3 units per kilo of rapid acting insulin, followed by 0.1 unit per kilo every hour until their blood sugar is less than 250.

Matt: Oh, wow. And it's all rapid.

Dave: Yeah. Or, here's another study, I'm looking over a table, 0.3 units per kilo, followed by 0.2 units per kilo one hour later, and then 0.2 units per kilo every two hours, until the blood sugar is less than 250, and then start reducing it down.

Matt: They're probably checking the glucose every 30 minutes to an hour or something like that just to make sure.

Dave: Yeah, yeah exactly, exactly and the main outcomes that they look at are time to resolution of the DKA, mortality, rates of hypoglycemia. And it looks like in a lot of these studies, there's really no difference between the two groups.

Matt: Yeah. And you would still be doing the fluids, the blood draws to monitor the electrolytes, Same as 7you would otherwise in this case, because they're still at risk for the same kind of big shifts in potassium and things.

Dave: Yes.

Adam: It sounds like a patient, even if we were saying this was more mild or moderate, would still require a decent amount of nursing care and attention, at least in the upfront. A lot of the disposition may be determined by how rapidly they're improving within that emergency department stay is my thought.

Dave: Yeah. I would need to look to see if there were significant differences in the rates of hypokalemia and that kind of thing. Somebody who has more mild DKA, maybe is going to be less likely to develop a significant hypokalemia. The frequency that you're checking a potassium maybe a little bit less than maybe something that you could watch on the floor.

Matt: Cyrus Askin, your friend and our producer, who unfortunately couldn't be with us for this part. He had a question about, in the European DKA guidelines, he was mentioning that it sounds like maybe they're using long-acting insulin upfront, even if the person is going to go on a drip, maybe just to get the basal insulin on board, and maybe that spares the time on the drip. Do you think that's something that might come to the States or have you seen it done?

Dave: For sure. Again, especially during COVID, that became something that was pretty common, where people would get some early basal insulin. And sometimes within the first 12 hours of starting the IV insulin drip. And this group, it may have been the group at Houston Methodist, I need to check that to be sure, but it's in this COVID and DKA paper that I mentioned earlier. They gave people a dose of basal insulin 0.25 units per kilo within the first 12 hours of starting IV insulin. And they saw a reduction in rebound hyperglycemia after DKA resolution that was significantly different in the group that got that dose of basal insulin. So, the thought is that you can give people basal insulin a little bit earlier, and it may help with improving their glycemic control after the DKA is resolved. Sometimes we'll give a dose of basal insulin to help us to kind of estimate how much insulin the patient's going to need when they come off the drip. So, I'll do some of that.

Adam: That's interesting. I think we'll get a little bit toward the transition from the insulin drip in the future during this podcast. I want to ask a different question though. I feel I would be remiss if I didn't have you explain what other things we should be thinking about, what other work up we should do when a patient comes in with DKA?

Dave: Yeah. I think you don't want to miss infection. You don't want to miss ischemia, ischemic heart disease, ischemic peripheral vascular disease. You need to think about different stressors that could potentially cause the patient to develop DKA because usually, there's some sort of stressor. One of the things that I think you have to be really careful about is, the patient that comes into the hospital once a month with ketoacidosis, and you start to become biased towards that person. "Oh, they're always here." Sometimes one of the learners may say, "Oh, this person is noncompliant with their insulin therapy." I have worked really hard especially in the last year to strike the phrase "noncompliant" from rounds, because there's always a reason that somebody isn't taking a medicine including insulin, and you just need to figure out what that reason is. So, we'll talk about that, but that one time that somebody comes in and you're like, "Ah, it's Mr. so and so. He never takes his insulin and that's why he's in the hospital again." That's the time that you're going to miss a sacral wound or cellulitis or some sort of terrible dental infection.

Matt: A rotting toe, I've heard that story,

Dave: Sure. So, you got to think about all of those things and always give the patient the benefit of the doubt.

Adam: So, to summarize, you want to know where those inflammatory cytokines are being generated from that's causing--

Dave: Yes.

[chuckles]

Dave: Actually, in this awesome paper that I mentioned by my friend, Archana, there's a beautiful figure and it's got a conceptual framework for the pathophysiology of diabetic ketoacidosis and there's a lightning bolt shooting out at sort of the middle of the figure, and it says, "proinflammatory cytokines."

[chuckles]

Matt: Of course.

Dave: It's beautiful.

Matt: We'll make sure people can find that from the show notes.

Dave: It's a great article.

Matt: We should get back to the next part of the case here. Adam, do you want to take us forward?

Adam: Our patient Dee has positive urine and serum ketones. She's admitted to the ICU, she started on an insulin drip, and plenty of IV fluids. We talked a little bit about this, but just to pull it out explicitly, what monitoring does she need and what are our treatment goals for her care while she's in the intensive care unit?

Dave: Some folks will follow their serum ketones and look to see an improvement in serum ketones. And typically, we measure serum beta-hydroxybutyrate because the concentration of that is so much higher than other ketone bodies that you can measure. So, that's one big thing. Certainly, watching their potassium, certainly watching their glucose. A lot of it is how the patient is clinically responding to what you're doing. I think that's probably more important than anything else. How do they look? Are they starting to drink? Are they starting to eat? Are they saying they're hungry? Are they still laying on their side saying that their stomach really hurts? Certainly, we monitor electrolytes and those things, but I feel like a lot of it depends on how the patient looks clinically. And that helps me in making decisions about when to start transitioning them off the insulin to subcu insulin.

Matt: For our patient here, I do want to talk about euglycemic DKA. I'm not sure now's the right time, maybe we should talk about transitioning the transition. Adam, do you want to bring us the next part of the case.

Adam: Over the next 36 hours, she's clinically improved, and her blood sugar is now in 180s. Her anion gap has closed. The cultures that we've sent have been negative today, and there are no clear provoking causes. Talk to us a little bit about how and when we could safely transition off of the insulin drip. And how do we actually do that in a practical sense transitioning someone from an insulin drip to subcu insulin?

Dave: This is so important. Oftentimes, there's a lot of pressure to have somebody that's starting to look well come out of the ICU, especially if they look pretty good compared to the other people that are in the intensive care unit. But if someone still has an elevated anion gap, if they have a low bicarb, if they're still nauseated, if they're still throwing up, those people for sure I keep on the drip. I like to see people eating, before we transition them off. I know that that's not always possible. I like to make transitions during the day. It seems like a safer time than making a transition at night just because there's going to be more eyes on the patient. And one of the key things is overlapping that first basal insulin injection, and the drip by at least two hours. It's also usually good to make sure that their sugars are well controlled, less than 180 before you make the transition. And then once someone's on basal insulin and mealtime insulin, they're feeling better and they're drinking and eating, they can move to the general ward and come out of the ICU.

We often see folks that have been transitioned too early. Many of our consults in the ICU start with us putting the patient back on the drip [crosstalk] [chuckles] people very happy, but it may be because the primary team determined a dose of insulin for them for the transition that just wasn't enough, that happens sometimes. Or, there may not have been adequate overlap. And that's why communication with the nursing staff is also really important. And there are a couple of different ways to determine

insulin dosing, when somebody is coming off the drip. Personally, I like to look at the last four to six hours when somebody wasn't eating, or getting any kind of nutrition if possible and you figure out about how much insulin are they getting per hour. And then you can use that to calculate about how much they would need in 24 hours for their basal dose. And then you can give that same amount as mealtime insulin throughout the day. So, you double it to get that total daily dose.

I feel badly when I see a student who's calculating out like the last 12 hours on the drip or like last 24 hours on the drip, and like, "No, you don't have to do all that," because look at what's been going on recently. Sometimes people are getting a lot of insulin on the drip, and it's much more than we would expect them to need, maybe based on how insulin resistant they seem, what their insulin doses were both, in the past or what they're on at home. And we'll look and their goal insulin on the IV insulin software that we use, will be really tight. And the first thing that we'll do is back off on that, let their insulin requirements come down, and then transition them. If somebody is on pressors, I tend to keep them on the drip until the pressors are off. Sometimes when people are on pressors and they're clamped down, and you're giving them subcutaneous insulin injections, they may not be as effective. There're concerns about absorption. So, those are some of the kinds of rules of thumb that I follow.

Adam: Just to summarize a little bit. Generally, if they're on the drip, they're well controlled, their bicarb is normalized, the serum ketones have disappeared, almost somewhat.

Dave: Yeah. Some people measure the ketones and follow them. I don't necessarily do that. Again, for me, it's more how that patient looks. If the anion gap is closed and their bicarb is pretty normal, and they're drinking, and they're like, "Hey, I feel pretty good. I'm ready to eat." Those people aren't going to feel really comfortable with transitioning.

Adam: And blood sugars less than 200, 180?

Dave: Yeah, less than 180, less than 200. Yeah.

Adam: So, you would start dose of basal insulin that's equal to the last four to six hours averaged over 24 hours if they were on one unit an hour, then they get 24 units. And you would start that at least two hours before the drip stops, is that right?

Dave: Yeah. So, you give them the injection of the glargine that you've calculated. And then you let it overlap with the drip, and then you turn the drip off. So, you give it a little bit of overlap time. Some people will reduce that basal dose by 20%, give 80% of it. Again, that's the art of medicine, but you may see that in some review papers too.

Adam: That's good. And if they need to stay in the ICU because they're on pressors, then there's no reason to transition them.

Dave: I don't rush it.

Matt: Well, let's resolve this case. She does well, on basal bolus insulin, off the drip. We talked in the last episode a bit about the transition, there's going to be a lot of education, connecting her with primary care, making sure there's really tight follow up, trying to make sure she can get her medicine. I think we could do a whole separate show about insulin, the cost of insulin, and why it's so expensive, and there's been some great stuff. Adam, I can send an article about the pricing of insulin, why it's so expensive. I think it's from the Atlantic I read or maybe Bloomberg or something like that, but it's sad but a reality.

Dave: It's sad.

Adam: It is very sad.

Matt: Let's say we discharge her and let's switch this case a little bit. Maybe this was an older patient, 45 years old, they were on an SGLT2 inhibitor and a basal insulin and metformin and they came in with what we thought was euglycemic DKA. Can you talk a little bit about how that happens? I have some follow-up questions. Well, let's talk first about like, just what is euglycemic DKA? How does that happen?

Dave: Yeah. This is a fascinating topic. There was a really nice review in The American Journal of Emergency Medicine in 2021, the lead author is Brit Long. Most patients come into the hospital with DKA and have a blood glucose that's greater than 250. But about 5% of people will come in with ketoacidosis, but be euglycemic. It's not really euglycemic, their blood sugar is usually greater than 200. But it's less than 250. It's lower than you would expect it to be. Again, typically, with ketoacidosis, there's either an absolute or relative insulin deficiency that stimulates glucagon production, release of free fatty acids, then serve as brain food as ketones and then the acidosis follows.

In euglycemic diabetic ketoacidosis, there's reduced glucose availability in addition to the insulin deficiency. So, it could be because the person just hasn't been eating very much and they don't have much stores. It could be because they're pregnant, or somebody who is drinking a lot of alcohol, it could be somebody that has chronic liver disease, or somebody who is septic. Or, it could be somebody who's taking a medication that increases urinary excretion of glucose. And that's what happens with patients taking SGLT2 inhibitor. And not only did the SGLT2 inhibitor reduce the reabsorption of glucose in the proximal tubule, but they also reduce the clearance of ketone bodies. So, like double log. [chuckles] It's bad.

Matt: Right. I guess part of my question is, if it was a person that they were taking the SGLT2, they stopped taking their insulin when they felt sick, and they came in with this euglycemic DKA. Does this mean they can never go back on those medications, as long as you give them some sick rules?

Dave: Not necessarily. If somebody is doing really well, otherwise, and there's a clear reason that maybe this happened, and they've got other indications for being on an SGLT2, like chronic kidney disease or heart failure, you don't necessarily want to keep that individual from taking that medication ever again. Personally, I think, it's always worth retrying if the person's the right person, the patient's the right patient, but certainly there needs to be education about it. I don't know that everybody would agree with that. There's a lot of debate about whether to use SGLT2 inhibitors in people with type 1 diabetes.

I've seen enough people at Kashlak that came in ketoacidotic with type 1 diabetes on SGLT2 inhibitors, that I'm not a real fan. But there are other people and the right patient, you have a conversation, you figure it out and make sure that people are being safe. And it might be reasonable to do that. The scary thing is that these folks are still dehydrated, they still need fluid. They may still need potassium, and they still need insulin. If somebody comes in, their glucose is 220, you may miss ketoacidosis completely, if you're really kind of glucose centric and focused on the glucose.

Matt: Right. So, you have to know that they were taking one of these agents, you also gave us another couple of conditions, or situations where it could be set up for a euglycemic DKA. I hadn't really heard of it prior to the SGLT2 inhibitors coming into play.

Dave: In full disclosure, bad endocrinologist, I don't know that I had really heard that before either. [chuckles] It was first described in the 70s. So, the concept has been around for a while. But clearly, I think because I hadn't encountered it before. It's not that common. But the SGLT2 inhibitors have kind of changed that a little bit, maybe a lot.

Matt: It sounds like, maybe, especially with type 1 diabetes. I imagine what happens is people are seeing better numbers. So, they think they don't need to take their insulin or they skip their insulin, and then they're not getting that basal coverage, so their body shifts into ketone mode.

Dave: But one of the key things about the euglycemic ketoacidosis is the patients still feel bad. So, vomiting is the number one. I was looking at a paper that talked about how people present, they still present vomiting. Clearly there's something wrong and they know it and the doctors and nurses and people taking care of them know there's something wrong, but it's just confusing because their glucose may be much more normal than you would expect.

The other thing that can happen is sometimes people will give themselves an injection of insulin on their way into the ER. By the time they get to the emergency room, they're ketoacidotic. But they give themselves insulin two hours ago, and their blood sugar is not so bad. You're like, "Why are you making such a big deal out of this?"

[laughter]

Dave: They did the right thing. Actually, the other thing, especially with COVID, people have been more likely to present with new-onset diabetes with ketoacidosis. Sometimes it's type 1, it may be ketosis prone. And we could do a whole hour about COVID, diabetes, and new diabetes, because it's a really fascinating area, kids with type 1 diabetes, there seems to be an increased incidence of type 1 presentations during the pandemic. And the kids are more sick than they used to be. They're coming in more likely to be ketoacidotic for reasons that aren't entirely clear.

One of the concerns is that during COVID, nobody wants to go to the emergency room, and so people are kind of hanging out at home waiting too long before they come in. Again, I think education is key for people that have diabetes that are on SGLT2 inhibitors, making sure that that they know about this that this could happen. If they're not feeling well, and they go to the hospital, tell them to go to the hospital

and tell them to make sure that their doctors know that they're on this medicine. It's picking up, people generally know about this now, now that it's been a few years.

Adam: David, does the management of these patients differ from patients with hyperglycemic DKA? It sounds like it's all the same principles.

Dave: Yeah. I think it's generally the same, because you're going to be giving them insulin, you may have to give them more dextrose to keep them [crosstalk]

Matt: You start off with dextrose in their fluids, right? [chuckles]

Dave: Exactly. That's probably the key difference.

Matt: Well, I wanted to ask about, and I probably should have done this before we moved to this case. I forgot we had wanted to talk a little bit about continuous glucose monitors and insulin pumps. And I think with Dee, to revisit that case, this happens not too uncommonly, you have a young person or just somebody who has type 1 diabetes, and they're on a pump. Maybe they have a continuous glucose monitor and they come in, and maybe the pump malfunctioned or something. Can you talk a little bit about what we should do if someone who's on a pump comes in, and they're coming in with, I guess let's start off first with DKA, what do you think about there? And then we could talk about pumps in general, maybe patients without DKA.

Dave: Yeah. The first thing to do is to stop using the pump-

[chuckles]

Dave: -in that moment. One of the things that I talk about with my patients because a lot of times people come in on a pump, and we're trying to understand why they've ketoacidosis, they'll say, "It's because of pump malfunctioned, something happened with the pump. I wasn't [unintelligible [00:38:22] the insulin, my sight was bad, something wasn't right." The key thing is if your blood sugar is 300, or 350, or 400 at home, and you're starting to feel achy, and maybe a little bit nauseated, do not use your insulin pump to bring your blood sugar down. Give yourself a freehand injection of rapid-acting insulin, and then deal with the pump business. So, that's something that I try to teach my patients. But, yeah, with respect to ketoacidosis, you just have to figure out what happened. All kinds of things can happen with insulin pumps.

Sometimes you think the site is in place and it's fallen out, you didn't realize it, or it's in an area where the insulin is not getting absorbed very well. My favorite story from residency, my wife Emily and I had gotten two kittens, Hashbrown and Rerun. They were lovely cats. Sadly, they're no longer with us. I don't feel like I'm that old, but they but they're gone now. One day I came home post call and was totally exhausted and kind of passed out on our couch. And when I woke up, I still felt really bad. [chuckles] I was like, "Oh, this isn't what it's supposed to be like." Normally I don't feel this bad. And I looked and the tubing of my insulin pump was just like-- had just been chewed through. And they did it a couple of times, and then they stopped doing it. Thank goodness, because--

Matt: They gave up on killing you.

[chuckles]

Dave: Yeah, they just tried a couple of times but I won. They weren't successful.

Adam: They may have gotten hypoglycemic and passed out.

[laughter]

Dave: Yeah. Insulin is like, I can't imagine why they would keep, like if you've ever smelled insulin, it's really medicinal alcoholy smelling nasty. I don't know why they would do that. But they did it, more than once. There are a lot of different problems that can happen with an insulin pump. And we can talk about insulin pump use in the hospital, and CGM use in the hospital outside of ketoacidosis because it's a fascinating topic.

Matt: The ketoacidosis thing is fairly easy where we put them on the drip, stop using the pump. Once they're ready to get back towards discharge, or let's just say it was like our first patient Enzo coming in the hospital and instead of being on all those oral meds, he was on an insulin pump. How might we have handled that with him coming in the hospital and who manages that and how do we do that?

Dave: For insulin pumps, typically, we'll have the patient sign a form. And I think a number of institutions have something like this, where they sign something that says that they understand that using the pump in the hospital might carry certain risks, but that they're making a decision together with their care team to continue using it. Most people do fine. When I talk to patients, the key thing is that they will know more about that insulin pump and its management than anybody else in the hospital. They'll know more than I do, because it's their body, and it's their insulin pump, and it's what they feel comfortable with. They have to have all their supplies, they have to have all their infusion sets and batteries. People are always forgetting to bring batteries to the hospital. Usually, those are pretty easy to find on the floor, and they have to be awake enough and with it enough to be able to manage the pump. And sometimes people aren't, if something changes with their clinical status, or if they're getting certain medications that affect their ability to take care of themselves.

I don't like it when people say, "Oh, well my wife's going to be here with me the whole time. She knows how to use the pump." She's not going to be there all the time, no matter how much she loves you, she's going to get to leave at some point. Your care, who's taking care of you at that point. There's a lot of education for nursing staff on the floor. But insulin pump stuff is sometimes detailed enough, there's different insulin pumps, that it's not always easy to give enough education. Actually, one of our residents, Zahra Tasneem at EVMS is putting together a QI project with one of our fellows, Toby Nelson, to help educate our residents about insulin pumps and some of the basics. What basal rates are, what carb ratios are, what correction factors are, what a temporary basal rate is. All the things that they are going to potentially need to intervene on in the hospital, or at least know to think about so that they can ask the diabetes educators to come by and make some of those changes.

Matt: So, if we were admitting this guy Enzo with pneumonia, and I think we gave a sugar of 215 to start off, this was the guy from our first part. And he says, "Oh, I've had this thing for 10 years, I feel comfortable managing it." Then we can let him manage it, if he's not on a continuous monitor, we would do the finger sticks and he would know what to do to adjust it. Usually, I will consult the endocrine service just to make sure that they're following along, and overnight, it might be okay for him to self-manage.

Dave: I think so. Depending on the patient, and again always knowing what their clinical status is, but often it's fine. Usually, we like to be consulted. The endocrine team likes to be consulted. And our diabetes educators are really wonderful with pumps too, and so they can also be helpful. And if something comes up in the middle of the night, and there's any concern, you can always give somebody an injection of basal insulin, and then put them back on their pump 24 hours later. There's no rush. The key thing I think to know about people that are using insulin pumps, is that people often feel very attached to their pumps, pun 100% intended because, that was really bad I'm sorry, it's a level of control that you have over what's happening to you. If you're in the hospital, and you're upset, because normally you take your insulin 20 minutes before you eat, if you have a pump, you can take your insulin 20 minutes before you eat. You have some control over that. If you're on fixed doses of insulin, and the person that put in the orders was really anxious and calculates 4 units of insulin for a meal, and you know that your blood sugar is going to be 300, and you really need 8 units. If you're on fixed insulin, you ask the nurse, the nurse is busy, the nurse will maybe call the doctor, the doctor or the nurse practitioner or whoever put in the order, maybe they're not getting back, maybe it's at night, maybe it's dinner, it's a different team. It can be very, very frustrating for people with diabetes to be in the hospital.

When people have an insulin pump, they have some control over what's going on. You have to be careful about taking the pump away and appreciate that there're consequences, sometimes emotionally for the patient. So, you have to have a discussion with them just like about anything else.

Matt: Adam, how do you normally handle that when someone comes in with a pump? Has this come up often?

Adam: Yeah, it's come up more and more. We typically consult the endocrinology team to help manage, but I think, Dave, you perfectly described the experience of hospitalized patients losing autonomy, losing privacy. This is very representative of that. One of the other things that I've seen a lot more recently is, the continuous glucose monitors as well. This comes up a lot where-- and you mentioned that one of your residents is doing QI project. I think this area is just ripe for quality improvement because there's so much to learn, so much improvement in the way our systems serve our patients. But I'm curious a lot of times, the nursing staff is uncomfortable, the residents, our hospitalist team, or other attendings are uncomfortable in terms of how to manage the glucose monitors whether we need to continue to do finger sticks or not. What do you recommend?

Dave: I love this topic. I think that 10 years, 20 years from now, we're going to look back on diabetes management in the hospital, especially for people on drips that are getting their blood sugar checked every hour, and just be shocked at how barbaric management has been. Continuous glucose

monitoring has changed the landscape of diabetes care. I was diagnosed with type 1 diabetes when I was 12 years old. And I was supposed to be checking my blood sugar between four and six times a day, up until I got my first continuous glucose monitor. Now it's been a number of years ago, but just the thousands upon thousands of blood sugar checks that I had done. And once you're using a continuous monitor that stops.

There are some monitors that require calibration where you may have to check your glucose twice a day. Certainly, you can calibrate the monitors anytime. If you're not feeling well, you're supposed to check your blood sugar. If you're hypoglycemic, you're supposed to check your blood sugar. They're not always perfect at extreme highs and lows. So, it's important to still do some finger sticks. But ask your patients that use continuous glucose monitors how often they really check their blood sugar. It's pretty few and far between for a lot of them. What happens when they come into the hospital?

Some people are used to having a CGM and they want to continue using it when they're inpatient. You can make an argument that it's reasonable to consider starting CGM for people that have never used it when they're in the hospital. Those are some of the things that are going to be addressed in some of the upcoming guidelines that we'll see this year. Matt, I think you had mentioned during our last discussion that the ADA standards of care, I know the ADA update their standards of care every year. I don't know how they do it. It's a tremendous amount of work. AACE, the American Association of Clinical Endocrinology has a diabetes guideline and a diabetes algorithm that are coming out this fall on the education oversight committee chair for AACE. So, I've been really involved in their clinical practice guidelines.

The Endocrine Society has two guidelines coming out this year. One is on inpatient hyperglycemia, and the other is on hypoglycemia in people with diabetes. I'm a co-chair for that guideline. The CGM is going to be all over all these guidelines, it's going to be all over everything, because more and more people are using these. Inpatient use of CGM is a very exciting area, lots of active research. The COVID pandemic led to a lot of exciting innovation, because the FDA kind of allowed companies to let folks use CGM inpatient even though it wasn't fully approved, because again, the thought was it would help with reducing the number of times that patients had to get their finger stuck and the number of times that nurses had to go into the rooms. There're still some questions about their accuracy and their safety.

I think that we're going to probably see more continuous glucose monitor use in the hospital, but it's going to be along with finger sticks, when decisions have to be made about insulin dosing. Some of the studies that have been done, suggest that CGMs can pick up hypoglycemia that would otherwise be missed in inpatient populations. The other thing that the CGMs can do that's really important is they have alarms. So, if somebody is dropping, an alarm is going to go off, and you'll catch a low blood sugar before it happens, when it's on its way down and there're some studies that have looked at those sorts of things, too. So, I get pretty excited about CGM because I think it's just a matter of time before it's much, much more commonplace.

Matt: I was reading too that some of them can just transmit wirelessly as well. Theoretically, in the future, probably everyone will have a CGM on and it'll transmit to a central location and people won't even have to walk around and collect the glucose, do the finger sticks, right?

Dave: Isn't that a beautiful image?

[laughter]

Matt: It seems totally attainable right now. In this world, it seems totally attainable.

Adam: For now, the way the hospital system, the hospitals run is that the nurses will go, they will actually get a finger stick, they'll document it in the medical records, they'll compare that to the correctional insulin or what the insulin needs are. And then give a dose of insulin based on that number. If a patient has a CGM, and they have a number and their insulin regimen's been fairly stable for a couple days, do we still do the finger stick?

Dave: I think technically, yes. I think that's probably what's going to be recommended by most people. There're still some concerns I think again about accuracy, especially at extreme highs and lows. I know that's not what you just said, you were saying somebody's kind of doing okay. In certain settings, and folks with end-stage renal disease or in patients that are critically ill it's not clear how accurate they are. So, I think we need more data to feel comfortable, but for patients that are at high risk for hypoglycemia, the patients with a history of severe hypoglycemia, the patients with chronic liver disease or end-stage renal disease, we may see more CGMs in those individuals but I think generally speaking, the recommendation is still going to be to do a finger stick, to make some of those decisions. And to use the CGM to guide some of the in between kind of what's going on.

It'll certainly help the physicians and the nurses and teams that are taking care of the patients with dosing insulin, because you'll be able to see what's going on in between. But these systems are expensive and they require a lot of education. I think that all these things are going to get worked out and we're going to have a glorious future where people are not having their blood sugar checked very often in the hospital, but we're not there yet.

Adam: Not quite prime time.

Dave: No.

Adam: I definitely have had patients, I had one patient recently who was on and off steroids NPO, not NPO and she had a CGM. We had a lot of trouble just adjusting her insulin regimen in the hospital. And there were times when we would be concerned about her blood sugar being too low if she became a little bit altered, but she was fantastic. And her CGM, she would just pull it up and she'd show us the number, and it would be 150. And I'd say, "Wonderful, we don't need to go there anymore," because she had that data readily available, and it really helped some of those in between times.

Dave: Yeah. Now we have sensor augmented insulin pumps. People are coming in with insulin pumps that make decisions about insulin delivery, based on the sensor they're wearing. What do we do with those? We're not asking people to remove them at our institution, we're letting people use them. But that pump is making decisions about their insulin delivery, based on their sensor data. Again, it really depends on the patient, and how sick they are, and how concerned you might be with respect to accuracy of the CGM, and all of those things. But I tell our fellows, and I don't know if they believe me, but I mean, this is like a golden age for diabetes care. When I was a fellow, all the news was really bad. Everybody was excited about thiazolidinediones. They were going to be the future, they lowered cholesterol, they were going to reduce heart attacks and then everything with rosiglitazone came out after Steve Nissen's meta-analysis, and I think 2008 and just shut it all down.

Matt: But if that didn't happen, then we never would have figured out that the newer drugs are better for--[crosstalk]

Adam: [laughs]

Dave: That's the silver lining, Matt. That's the silver lining to the story. And that's where I come full circle when I talk about this.

Matt: I'm sorry to--[crosstalk]

Dave: No, that's okay. And the other thing was a chord in advance, and VA diabetes trial came out. And they were like, "Well, if you really push it to try to get good control, people are just going to die. So, we're not going to--[crosstalk] [chuckles] Everything was very pull back and not terribly exciting. But now, we have drugs that are associated with weight loss that benefit patients with heart failure and chronic kidney disease, cardiovascular disease, and stroke. And we have all this great technology. In the past, tech was like, for people with type 1 diabetes, I kind of saw it that way. But insulin pumps and sensors are for people with type 2 also, and now for people in the hospital. So, it's pretty exciting.

Matt: I know, there's probably a lot more we could talk about, but we've been going almost two and a half hours in our recording time. This is going to be split into two different episodes for the audience. For this second part here, we talked about DKA, HHS, we talked about insulin drips, euglycemic DKA and then we ended up talking about this new technology, the pumps, and the CGMs. Can you give the audience like two or three things that you really want them to remember from this second part of the talk, and then we got to let you to go back to your job as a SuperEndo.

Dave: Be careful about transitioning folks off of their insulin drips too soon. Remember that the technology that people may use their insulin pumps or continuous monitors mean a lot to them and give them a fair amount of control that they otherwise lose in the hospital. And so even if you have to stop those things, just at least come at it from a compassionate angle. And I think just like with our previous discussion, everything really needs to be patient-centered. One size certainly does not fit all in medicine anymore. We need to think about those things when we're taking care of our patients in the hospital with diabetes.

[music]

Paul: This has been another episode of the Curbsiders, bringing you a little knowledge food for your brain hole.

Adam: Yummy.

[chuckles]

Paul: There you go, your time to shine. [crosstalk] show notes at the *curbsiders.com*. And while you're there, sign up for our mailing list to get our weekly show notes in your inbox. Plus, twice each month, you'll get our new Curbsiders Digest, recapping the latest practice changing articles, guidelines and news on internal medicine.

Matt: Yeah, Paul, I was going to let it go. If he didn't say yummy, there would have been no yummy.

[chuckles]

Paul: I was going to wait until somebody said something. I have all the patience in the world.

Matt: I think it's like that button in *Lost,* like if someone forgets to push it, something bad might happen.

[laughter]

Matt: Anyway, so we're committed to providing you with high value practice changing knowledge and to do that, we want your feedback, so please subscribe, rate and review the show on Apple Podcast or contact us at the *curbsiders@gmail.com*. Reminder that this and most episodes are available for free CME through VCU Health at *curbsiders.vcuhealth.org*. And I wanted to give a special thanks to our producers and writers for this episode, Drs. Adam Barelski and Cyrus Askin, and to our whole team. Beth Garbitelli is our executive producer, with production and editing support from the team at Pod Paste. Elizabeth Proto runs our social media. Tima Karginov maintains our website, and Stuart Brigham composed our theme music. Until next time, I've been Dr. Matthew Frank Watto.

Adam: I'm Adam Barelski.

Paul: Hospitalist Wizkid and as always, our main Dr. Paul Nelson Williams. Thank you, and goodbye.

[music]