

# Diabetology Part 2 with Dr. Mike Natter, MD

## Ologies Podcast

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Oh hey. It's still your friend who looks at listings of houses she has no intention to buy: Alie Ward, back with another episode of *Ologies*. Part 2 of a two-parter, so the book-end on the 'betus. I'm gonna keep intro short, I'll keep it *sweet*, but we're back with Part 2 of Diabetology, in which we address *all* kinds of questions that patrons had about blood sugar, and insulin, and pancreatic matters, so if you haven't heard Part 1 first, I'm hereby inviting you and all of your glucose molecules to hop over to that first for a primer.

And also, do you have little ones, or grandparents, or perhaps curse-averse in your life who need to learn more about their blood sugar? Well, after I put up the first half, I thought, "[bleep]. What if some people need to [bleep] listen with kids who have diabetes?! [bleep] So I reined in my potty mouth for this part 2 and I uploaded a kid-friendly and swear-free version of Diabetology Part 1, last week's. It's on my website at [AlieWard.com/Ologies/Diabetology](http://AlieWard.com/Ologies/Diabetology). Jarrett worked extra hours to get that up quickly. There's a link just right in the episode show notes to take you right there in case you need to listen with little kiddos. So, you're welcome.

Thank you to everyone on Patreon who supports the show, it makes things like that possible for everyone else. Thanks to everyone wearing gear from [OlogiesMerch.com](http://OlogiesMerch.com). Thanks of course to everyone making sure you're subscribed and for rating the show, and of course reviewing. I read all your notes. Like a creep. And this week, thank you to [QueetsOnFoot](https://www.instagram.com/queetsonfoot/), who says:

*If you've ever felt afraid of the world, or overwhelmed by any facet of it, listen. We fear the unknown, but Ologies consistently brings me the peace of knowledge, and the gift of regular belly laughs.*

So hot damn. Thank you [QueetsOnFoot](https://www.instagram.com/queetsonfoot/). And also, [JuniperDewdrop](https://www.instagram.com/juniperdewdrop/), special hugs to you and your fam.

Okay, onward. Diabetes, and other such sugary stuff. After our interview for Part 1, we had to dash off to a friend's dinner. So once he was back in New York, we recorded the second half. And it happened to be on World Diabetes Day, of all things! And that day, this Ologist had used his lunch break to speak into a megaphone on Wall Street advocating for a change in policy to make insulin more affordable, and then he went back into the hospital, saved some frickin' lives, finished up his shift, and hopped on a video chat to answer all of your Patreon questions. So sit tight for a healthy serving of answers from physician, type 1 diabetic, and deeply lovely person, Dr. Mike Natter, MD.

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**Alie Ward:** Are you ready to dive into some Patreon questions?

**Dr. Mike Natter:** Oh my God. I'm so excited.

**Alie:** I know, I sound *too* excited. Well, let's start with some that aren't super specific, first. For example... I got a lot. There's gonna be a lot of scrolling, so just pardon.

**Dr. N:** You scroll at your leisure.

**Aside:** So as I pulled up your questions, Dr. Natter mentioned to say hi to editor Steven Ray Morris, and Jarrett Sleeper, and how he wanted to hang out with them IRL. And I love

watching cool dudes make pals, so I suggested that they go kick it without me. Go get some pudding.

**Dr. N:** I had some pudding in the hospital today. I actually ate off the tray of my patient who wasn't eating it. I was dying. I had to miss lunch today 'cause I went to give that speech and this guy was like, I don't want this, and I was like, I'm gonna eat that.

**Alie:** [*laughing*] Am I allowed to put that in? Is that illegal?

**Dr. N:** That's fine. I asked his permission.

**Aside:** And how was Dr. Natter's blood glucose on this day? Well, with all the running around, it was low. It was dipping into the 60s. And the 60s, at least in blood sugar terms, are not groovy.

**Alie:** Did you find that stress definitely impacts it?

**Dr. N:** Stress does impact it. For most people, including myself, stress usually makes it go high because when you're stressed out, you activate your HPA axis. Oh my god, we can do one of these, like, harken back to your neurobiology talks with that wonderful woman whose name is escaping me.

**Alie:** Dr. Crystal Dilworth.

**Dr. N:** Oh my god. Dr Dilworth is *awesome*. I *love* her. So when you have your hypothalamic pituitary adrenal axis kicked in, you are spitting out... Well, from your hypothalamus, your hypothalamus is like, "*BLEH!* Fight or flight!" And then it goes to the pituitary, specifically the anterior pituitary because the anterior pituitary is the master endocrine gland, and in terms of this fight or flight, your anterior pituitary is spitting out ACTH specifically. And that guy goes downstairs to your... there's like this little beret that sits on top of your kidneys called the adrenal gland. And the beret has a crusty outer part called the cortex, and then a gooey center called the medulla. And the gooey center secretes adrenaline, but we call it either norepinephrine or epinephrine.

And then those two hormones spin around the body and make everything go superfast. So they make your heart go [*rapid*] bup, bup, bup, bup, bup, and they make your blood flow and all that stuff. But the other thing they do is they kind of kick in a lot of glycogen breakdown. Glycogen is the storage form of sugar and your liver and your skeletal muscle have most of it — mostly the liver. And so then you start breaking the glycogen down, which turns into glucose, and glucose is basically sugar, and that goes into your bloodstream. For you, if you're running away from the bear, great, 'cause it's good for your muscles. For me, if I'm stressed out, I don't have insulin to then take that sugar that's in the blood and put it into the cells, so I go high.

**Aside:** So, thank you adrenaline, for reaching into our liver, and muscles, and cracking open that emergency sugar stash. So just think, your body hides glycogen like a Snickers in a glove compartment, and stress essentially screams, "Bust that sucker open! It's freakout time, and I need to get juiced up!"

**Dr. N:** Anyway, that was an aside. We went into an aside.

**Alie:** No, I loved it. I loved it. And so for you, because you don't have insulin to escort it into the cells, then it goes high and then it can do damage to your tissues.

**Dr. N:** Correct. Well, long term damage.

**Aside:** So in the short term, you just feel like hot, sweaty garbage. But Dr. Natter reminds us that in the long term, there are complications like blood vessel damage that can impact everything from your eyes, to your kidneys, to your feet — it's serious stuff. But you can avoid it or stay on top of it. So let's learn how, via your questions.

**Alie:** Jess Flowers wants to know: Is it pronounced dia-bee-tus or dia-bee-tees?

**Dr. N:** I feel like it depends on your mood. I mean, Wilford Brimley would go with dia-beet-us. It feels good to say dia-beet-us. I say dia-bee-tees. Sometimes I call it the 'betes, or affectionately, [*derived from "sugar"*] the *shugahs*, or the *shugs*, but it's, you know, however you want to do it.

**Aside:** P.S. I always figured [*Wilford Brimley saying: 'dia-bee-tus'*] a pronunciation popularized by diabetic actor, legend, and human walrus, Wilford Brimley must be southern in origin, like some kind of Ozark's lilt. But I just read it might be less regional, and more temporal. So in the post-war of the 1950s, Americans apparently pronounced it dia-bee-tus, but in the 1970s, alongside wide ties and sideburns, it shifted to dia-bee-tees. So Wilford, who was born vintage, and has been playing lovable geezers since the 1985 ripper *Cocoon*, is just saying it old school. But he's a good sport about people getting tattoos of his mustachioed face, alongside the word 'betus. He retweets body art in his image — and yes, he has a Twitter, it's @RealWilford.

And to Patrons who asked about his impact — I'm looking at you Ruth Anthony Vernotico, McCall Edwards, Anna Sutheim, and Jess Flowers — this gentle mocking of his pronunciation has only upped the profile of the disease. He's cool with it. And he said, about diabetes:

*I would encourage people, especially people over 50 years old, to be examined to see if they've got [Wilford Brimely saying: 'dia-bee-tus'] and, not to be afraid of it. It's not something that needs to scare you. It's not a death sentence, necessarily, but that's up to you. You can learn about your body if you just pay attention, and keep a log of blood glucose tests and carbohydrate intake like I do. And mainly, do not be afraid.*

The dude's had it for decades and he's going strong. He's 85 right now. So, follow the walrus.

**Alie:** Shea Littlepage says: My dad has type 1 diabetes and wants to know what's the highest and lowest blood sugar ever recorded in a living person? He promises not to use this information to live on the edge. Do we have any idea? Like, yours when you were hospitalized was staggeringly high.

**Dr. N:** I have to admit ignorance. I don't know what the record holder is for highest and lowest. The problem with lowest is that, you know, someone can technically... Typically, like, in the hospital during what's called a code, when someone's actively dying, we get a lot of labs to see what's going wrong with them. And so we might get a sugar back that's like, you know, in the single digits, but they're technically dead. [*clip of Jim from the Office: "Oh man, that's a bummer."*] So I don't know what the lowest would be that you could still be alive. I mean, I've seen people go into the twenties and then recover. And then the highest, like you said, I think, personally, when I was diagnosed I was at 1600, which is just like disgustingly high. And I think at the time at the hospital I was diagnosed in in New York city, that I held the

record, at least in the pediatric ER for some time. I don't know if that's still the case. It's not a proud record to have.

But yeah, I don't know. I've seen some A1Cs where I work. A1C is a three-month average of your blood sugar. A normal person's A1C is between like 4% and 5.5-ish%, and what that really is, is it's measuring the glycosylation of your red blood cells. Sugar is sticky and so it's going to stick to your red blood cells and you can kind of get an average. The reason it's every few months is because your blood cells turnover in about 120 days or so. What that does is that kind of gives you an idea of what your blood sugars are throughout those last three months. It's kind of like a report card. *[clip from The Simpsons: "Here are your grades," followed by dramatic music: Dun Dun Dun!]*

When you have diabetes, you're usually... Technically, diabetes is in A1C of above 6.5%. If you're in, technically, "good control" as a diabetic, you're less than 7%. If you're not doing so hot, you're 8% or 9%, even in the tens, it's not *good*, but I've seen folks in the 19%, 18%, and that kind of correlates to an average blood sugar of, like, 500-all-day kind of thing.

**Alie:** I had so many Patrons, Kelly King, Heather Densmore, Deanne, Karen Burnham, Megan Johnson, Andria Marsh, Ashley Hamer, Shea Littlepage, April Perry, also first-time question-asker Amanda Mercer, who says: Is diabetes genetic? My great grandfather and my grandfather were both diagnosed later in life and I was wondering how much of a chance I have in been diagnosed. So, all those people are like, "What's the deal? How genetic is it?"

**Dr. N:** It's a really good question, and it's not perfectly worked out yet, but the data suggests... Obviously there's numerous types of diabetes, and there's type 1 and type 2. And in type 1 diabetes it's most commonly thought... laymen assume that type 1 is the genetic kind and type 2 is 'cause you ate too much crap. And it's actually much more complicated than that. So, what the studies are kind of finding out is that in terms of the genetics, there's a stronger genetic component with type 2, surprisingly, than type 1.

But it's multifactorial and it's not like an autosomal dominance type thing, where you're automatically passing on this dominant trait. It's much more complicated. So, the data basically pares out that in type 2, if you have a first degree relative, then you just have a higher chance of having type 2 at some point in your life, not necessarily at all, but it's also environmentally triggered. There's this saying that I learned in... it might've been undergrad that genetics will load the gun and environment pulls the trigger. So they're kind of intimately involved. In type 1 - and this sucks for me 'cause I'm a dude, although I don't have kids yet, so maybe it won't be the case - but apparently there is an interesting correlation with type 1 fathers who have sons have a higher likelihood of getting type 1, but there's no sex-linked trait that we know. Like, it's not a sex-linked trait, but we just happen to see epidemiologically that type 1 fathers have more of a chance of having a type 1 son.

**Alie:** Oh wow. Did anyone in your family have it that you know of?

**Dr. N:** No, no one in my family had it that I know of. The other thing is that type 1 is considered an autoimmune disease. So autoimmune diseases, they get lonely, they come in clusters and pairs and things. So, if you have a first-degree relative that has any autoimmune disease, it does put you at a slightly higher risk of having an autoimmune disease yourself. There's an interesting geographic component too. In the Netherlands, that part of the world: *very* high predominance of type 1 diabetes.

**Aside:** So in part 1 we talked about how folks in cold climates and in cold seasons tend to get diagnosed with type 1 more often, but could there be anything else at play? Like just bad luck? Or a witch's curse?

**Alie:** Do you think that has anything to do with the hygiene hypothesis, and immune systems, and autoimmune issues?

**Dr. N:** It's not known. So it's a really interesting theory, and just in case your listeners aren't familiar with it, it's a really fascinating theory. The idea is that back in the day, you know, my mom and dad would eat dirt and they'd roll around in the mud. And anytime you introduce pathogens or any type of 'foreign invader' into your system as a kid, your body then has a chance to have its immune system developed so that it creates plenty of antibodies and defense systems. The theory is that, you know, us little snowflakes are growing up in this very clean world where you've never put, like, a twig in your mouth or a bug in your ear. Your immune system has not been kind of trained to be recognizing things that aren't foreign. And so then all of a sudden it starts looking at your own cells as foreign invaders. And so you start having autoimmune - auto meaning self, immune meaning your immune system - kind of attacking things. It's interesting. I don't know.

**Alie:** Yeah, I'm sure in the future we'll know way more about it and think, "Holy smokes, we should have been eating more turnips straight from the ground."

**Dr. N:** Oh, I was thinking just like worms and dirt, but turnips too. [*clip from 1987 film Roxanne, exasperated: "Worms??"*]

**Alie:** So many people had prediabetic questions like Lauren Krupens, Dominika Dec, Christian Buettner and Rachel Ames. Lauren Krupens wants to know: At what point does a prediabetic *become* a diabetic? And Dominika wanted to know: How concerned should you be if you can be considered prediabetic, in terms of how to change your diet? That's a hard question to ask. But in general, prediabetes, at what point are you super screwed?

**Dr. N:** Yeah. Well, let me just put a little preface in here. I am a physician. I treat patients. I am a diabetic, but I cannot give individual medical advice, like in this setting. So I will speak in generalities. [*clip from Buffy the Vampire Slayer, Principal Snyder: "Don't sue."*]

Let's first back up. So what is prediabetes? Prediabetes obviously comes, it's like *the before* diabetes. And what that is, is it's kind of like a little bit of a warning sign. It's like, "Hey, you're heading in a really not-so-hot direction. Let's take a good gander at what we can possibly do." So what does it mean to be pre-diabetic? If you go by the guidelines of the A1C that we mentioned before, the hemoglobin A1C, as I mentioned before, a normal range is 4% to 5.6%. So between 5.7% and 6.4%, in America, we call that the prediabetic range. That's most commonly how I, and I think most clinicians, will diagnose a prediabetic.

Once you get into the 6.5% and above range, you're technically considered diabetic. There are other ways to diagnose diabetes. For instance, a fasting blood glucose, so like a finger stick glucose, of above 126, is also considered... I think it has to be twice though, I think not just one time, but twice above 126 in a fasting state, I think, is also considered diabetes. And then you can also do like an oral glucose tolerance test where they make you drink this way too sweet, syrupy liquid and then check your venous blood sugar at different hours to see if you're metabolizing everything and making sure that you're dropping your sugars as they should.

But I think the A1C is the most common and easiest way to do it. So once you're in that 5.7%, 6.4% range, you're technically pre-diabetic. And then what you have to do is you have to look at why. The first thing I would want to say is, is this prediabetes for type 2? Most commonly that's the case. But if someone's young and otherwise well, or maybe has a family history of autoimmunity or whatever, I'd want to get a couple of lab tests to make sure that they're not actually type 1 diabetics because that's something you can't miss, because they can get very sick, very quick and you don't want to miss that. So you might want to get something called an anti-GAD65, or a C-peptide or an anti-zinc transporter. These are, basically, markers for autoimmunity amongst insulin or some of the beta cells. And not every type 1 will be positive for those, but at the very least it's good to screen for them because if they are positive, then you know that they are going to be insulin dependent and are type 1.

**Aside:** Okay, so to recap. Fasting glucose over 126, a hemoglobin A1C, which counts how much sugar is sticking to your blood cells, over 5.7% is pre-diabetic. Over 6.5% is diabetic. But there are also tests to see if your hyperactive immune system is [*breathy voice like excitement*] helping you too much and accidentally killing the insulin or beta cells in your pancreas. Dr. Natter has also had to counsel patients who might be most statistically at risk for type 2. And as a diabetic diabetologist, he wants to help them avoid the beast of the 'betus.

**Dr. N:** Alternatively, if a patient is overweight, a little bit older, you know, has first degree relatives with type 2 diabetes, has what's called the metabolic syndrome where a large waist size, overweight, obese, usually hypertensive, hyperlipidemic or high cholesterol, usually these are folks that are going to be type 2. And so the first thing to do is you could say, "We need to lose weight," but that's not good enough to tell someone to lose weight. You have to talk to them and say, "Okay, let's get granular here. What are you eating for breakfast? What are you eating for lunch? What are you snacking on? How can we intervene? Small steps. How can we get you exercising?" And then if they are morbidly obese and they can't lose the weight, it's actually been found that weight loss surgery can halt, and in many cases reverse, type 2 diabetes.

**Alie:** Wow. How is that? How does that happen?

**Dr. N:** There's a lot of theories, and I think if someone tells you they know how, I think they're lying, because I don't think we know 100%. Part of it certainly has to do with the losing of weight for sure, and then I think part of it has to do with the brain-gut connection. I think there's a lot of feedback and connections that are happening there, and I think we're still, kind of, not quite there in understanding all of it. But I mean, the easy, low-hanging fruit is, "Well, you just lost 100 pounds and so therefore it's... You've taken off all that weight, it's going to be easier for you to regulate the glucose."

But it kind of gets into the idea of the pathogenesis of type 2, and we all assumed... in laymen and in popular culture it's thought that, "Well, you ate too much candy, you ate too many carbohydrates..." But we're learning, actually very recently, that it has less to do... at least the pathogenesis - the etiology, the beginning stages of type 2, or why we get it - have a little bit less to do with the carbohydrates up front and more to do with the saturated fats, and the processed meats, and all the thing that are processed, and deep fried, and high saturated fats, and meats.

And what's happening is those chemicals are causing what's called a lipotoxicity; 'lipo' meaning fat, and 'toxicity' meaning toxic. We're getting this, kind of, accumulation, or deposition, of this adipose tissue in places that it shouldn't be, like the liver, the pancreas, the skeletal muscle, and it's gumming up the works. It's causing mitochondrial dysfunction, oxidative stress, and all these fancy words. That's going to, in turn, cause an insulin resistance picture, and what's insulin resistance essentially is, it's kind of three categories. It's a dysregulation of glucose regulation, it's an impaired postprandial absorption - postprandial, 'post' meaning after, 'prandial' meaning a meal - of sugar into the skeletal muscle, and then impaired pancreatic gluco-regulation of the beta cells.

**Aside:** So yes, those saturated fats and the lipotoxicity are messing up how your food is absorbed, and how insulin - the hormonal key that let's sugar out of the blood and into the cells - is able to work in the locks of those cells. But why do fats fudge up the works? Why are they such glucose goblins?

**Dr. N:** So, all of those is happening because of inflammation, lipotoxicity, and it kind of spirals into this cycle of inflammation, high blood sugar, less insulin secretion, less insulin sensitivity to the secretion, and you spiral into type 2.

**Alie:** So eating, like, a deep-fried hot dog with aioli, it's a bad idea.

**Dr. N:** Well, it's delicious, but... You know, it's funny because... I think about this a lot, because currently I'm on an oncology rotation in the hospital and I see a lot of terrible stuff, and it makes me think about quality of life. I think everything in moderation is good. So you don't get type 2 diabetes and you live to 120, but like, maybe you didn't really live, you know? If you eat a hot dog with aioli once a month, enjoy it. Do your thing. But maybe the rest of the month you're eating your salads, you know? A give and a take.

**Aside:** Imagine your pancreas in tense negotiations with your mouth, offering to trade, like, 4,000 salads for one Luther Burger, which is a dish I just learned about when I googled, 'what's the least healthy thing you can eat?' The Luther Burger, sidenote, it's named for R&B legend Luther Vandross, who LOVED these cheeseburgers squished between two Krispy Kreme donuts. Also, not to make this too real, but diabetes ran in the Vandross family and Luther himself perished from a stroke related to diabetes at the very young age of 54. So, when Natter says avoiding insulin resistance in type 2 is worth the salad balance, he means it.

**Alie:** What the hell is insulin resistance? A ton of people had this question, including Shea Murphy, Madelyn Winter, Rose Presby, Samantha Galbraith, Moses Bibi, and Lynn Perry. Rose Presby said: Can you explain insulin resistance and how it may differ between type 1 and type 2? What the hell is it?

**Dr. N:** There's insulin receptors that are typically found on adipose tissue, so like fat cells, and skeletal muscle, and a few other places. When the beta cells of the pancreas secrete insulin in response to an elevation in blood sugar, those little insulin pieces, they're kind of like keys. I'm oversimplifying but they're kind of like keys. And the receptors on the adipose and the skeletal muscle are kind of like locks, they go in and they unlock the doors of those cells, and the glucose goes in, everything is wonderful. Insulin resistance or insulin insensitivity is a broken lock, and we think this is because of this fat deposition, and this mitochondrial dysfunction, and the oxidative stress that a lot of people lump into the term lipotoxicity.

**Aside:** Again, type 1, you're out of insulin, which acts like a key, so you inject yourself with keys to open the locks on your cells and let sugar in. Now, type 2, your locks are wonky.

**Alie:** And when it comes to advising a patient, and it comes to adipose tissue, and BMI, there's such a difference between weight, and an unhealthy weight. Where do you as a doctor advise people in a way that isn't, like, moral or judgmental, or... that actually addresses the physical problem instead of something that we're used to being aesthetic, or a certain aesthetic is frowned upon? You know what I mean?

**Dr. N:** Yes, I think that's an excellent question. I think medicine is getting more and more... it's called precision medicine, or precise and individual. You can't just lump someone into a one-size-fits all anymore, and in medicine that's very true. BMI is a great example of how... The way we calculate BMI is very crude. Basically you look at someone's height and their weight, and the best example of why it doesn't make sense is because if you've got a very fit body builder with a big muscle mass who's maybe not that tall, they would technically be morbidly obese based on BMI, and yet that have no body fat. You're not taking into account a lot of factors. But those folks aside, BMI can be helpful in steering a conversation because sometimes you need the objective data to say... You can always tie back in medicine to, "This is not reflective of a judgement. It's not reflective of an aesthetic. This is me being concerned about what's going on *inside*."

And we know that where you carry the fat is also important. Central adiposity, the beer belly, is far more dangerous than carrying your fat on your butt or your thighs. That's because the central adiposity is actually a surrogate marker for the fat that's inside, and that is when you have your lipotoxicities, your inflammation, your metabolic syndrome. And we know from years of data, and from seeing patients even in the short term, that those folks that fall into those categories have far higher risk of heart attacks, strokes, hypertension, diabetes, and all the horrible comorbidities that come with those things, especially diabetes. I've seen terrible things from that. So I'm very keen to help my folks lose the weight but not for any other reason than... and I tell them, because I want them to live longer, and healthier, and feel good.

**Alie:** A lot of folks asked about exercise and type 1 and type 2. Michelle Phillips, Meryl Stark, Euan Munro. Elize asked: What is a mechanism that lowers the blood sugar of type 1 diabetics when they exercise without taking exogenous insulin? So, how does exercise and blood sugar work?

**Dr. N:** That's a very good question. Very complicated physiology. My understanding of it is a little bit crude, and I don't know if it's been fully worked out. But the basic idea is that when you're exercising, you're using skeletal muscle. We can get really granular. Typically, if there's a rise in blood glucose the beta cells sense that, they secrete their insulin, the insulin sits into the insulin receptor, and it actually stimulates something called the GLUT4 transporter to come intercalate into a membrane, and ferry the glucose across intracellularly.

**Aside:** Okay, if you're like, "Huh? What?" just think of GLUT4 as the friend who gets a text from insulin, and insulin is like, "Hey, can you get my cousin glucose into this party or what?" And GLUT4 shows up at the door and is like, "Heh, yeah. Come in Glucose, you seem cool."



A sidenote, skeletal muscles and adipose, or fat tissue, needs a bunch of glucose, and hence needs insulin to text about getting the glucose in. In type 1 it's kind of like your phone died, but your phone is your beta cells. Insulin can't text to get glucose in. But in type 2 insulin is, like, texting, and texting, but the cell is like, "eehh... I don't wanna let more glucoses in. I'm just over it." Also, if you use this flimsy metaphor on any entrance exams and you don't get in, I'm truly sorry.

**Dr. N:** I don't know if it's been worked out or not that the GLUT4 transporter actually still intercalates in the membrane in the absence of insulin. Or more likely what happens is because you're using skeletal muscle while you're exercising, and there's a higher demand of glucose because you need the ATP (because once the glucose comes into the cell you go through all the glycolysis, you break things down so you get ATP which is kind of like the currency of the cell, to have energy). There's a need for that energy, therefore the insulin receptors may just be much more sensitive, and therefore whatever circulating insulin, however little it is, is just going to stimulate the GLUT4 receptors. That more likely what's going on. So I don't know if it's necessarily in the absence of insulin. It might just be in the presence of very little insulin you're going to get a robust response of those receptors.

**Aside:** So when you exercise, the glucose party in your cells thins out. So when insulin says, "Hey! Get my cousin into this party," the cells are really responsive. They're like, "Heck yeah! This party's dead, man. We'll let him in," which is why moving our booties is great for staying healthy and also just for keeping parties lively.

**Alie:** Does it kind of retrain your body in terms of how it handles insulin?

**Dr. N:** That's a good question. I think retraining would imply that then in the absence of exercise you're just going to always be sensitive, and I think if you exercise enough, then yes, your exogenous insulin requirement... We should talk about that. Exogenous means the stuff you're injecting. Endogenous means the stuff you make on your own. Just in case folks don't know. So, people that are very fit, that are marathon runners, and they exercise all the time, their insulin requirements are probably a fraction of what someone who just sits on the couch all day would be as a type 1 diabetic, or even as a type 2. I think in that sense you can train it, but I think if you ran a mile today, next week I don't think you're going to need less insulin. The next day you might, but not next week.

**Alie:** Let's talk about hypoglycemia. Jordan wants to know: What is the deal with reactive hypoglycemia? And Christina Shuy says: Does hypoglycemia mean you'll get diabetes later in life? Asking for me.

I'm also asking for me as someone with reactive hypoglycemia. I've taken that five-hour insulin test and I was a \*\*\*\*show. Started at, like, 70, rose to maybe 90, 110, and then crashed to 40. And I was, like, shaking, crying.

**Dr. N:** Wow. To 40?

**Alie:** Yeah, it was not good.

**Aside:** In reactive hypoglycemia, when you have sugar or carbs you put out too much insulin, and then too much glucose floods into your cells, leaving the glucose party in your blood stream a little sleepy, which is why *you* can feel sleepy, or cranky, or have blurry

vision, or have a voracious craving for more carbs. It's not your fault (I'm talking to myself here).

So, what do you *dooooo*, doc?

**Dr. N:** My understanding for treatment is, a lot of frequent, small meals that are made up primarily of complex carbohydrates, like quinoa, brown rice, those types of things, but mixing in vegetables, fiber, proteins, and good fats like avocado and that kind of stuff.

[clip from *The Sopranos*: "Oooh I love a mixed salad. I could stare at it for hours."]

**Alie:** Let's talk about how babies can ruin your blood sugar. What about gestational diabetes? Let's say you're cookin' a baby... Evan Jude, Maren Mossman, Jessica Chamberlain, Michelle Lee all want to know... Evan just asked: What causes gestational diabetes? How is it transient while regular diabetes is not?

**Dr. N:** Gestational diabetes is often co-managed by a lot of the OBGYNs as well as endocrinologists. It's super important that when someone has gestational, or just type 1, diabetes while they're pregnant to keep their blood sugars in *extremely*, extremely tight control, because any kind of unfortunate high or low blood sugar is going to have potential really bad impacts on the child, significant if the blood sugars are really out of whack. So the endocrinologists and the OBGYNs tend to be very on top of their diabetic pregnant ladies.

But the understanding I have of why this is going on is because the placenta is a mofo. It spits out, like, so much hormonal stuff. One of which is a placental growth hormone called LPN. It creates a really hyperglycemic state in the mom and it makes it very difficult for insulin sensitivity, constantly having sugar around in the stream, because the idea is that... My understanding is that hypo, or low, blood sugar for anyone in the acute setting is far more dangerous than a little bit of hypERGlycemia.

I think the idea is that evolutionarily you never want the child to be without a source of glucose, so it's really scary if the mom were to become hypOglycemic. I think that's maybe why these hormones are being secreted and wreaking havoc. It's not understood exactly why some women are more prone to getting gestational than others. If you are diagnosed with gestational diabetes that may be transient, but you are at a significantly higher risk of getting type 2 diabetes later in life.

**Aside:** If you are a person carrying a baby in your body, listen to your doctor. Gestational diabetes can become unhealthy for you and your little one, and if that is not incentive enough, untreated it may lead to, just, a real whopper of a huge baby that you have to push out of your groin. So, no thank you.

Also, as long as we're talking about children, each week we donate to a cause of the ologist's choosing, and for Part 2 this week, Dr. Natter would like a donation to go to JDRF.org, formerly known as the Juvenile Diabetes Research Foundation, which works with researchers from all over the world to fund more than 100 grants each year to reach more new breakthroughs. Their mission is very simple: to find a cure for type 1 diabetes.

Thank you, Dr. Natter, for pointing us in that direction. *Ologies* will be making a donation in your name for that. Thank you to sponsors of the show that make that donation possible. You may be hearing about them right now.

[Ad Break]

Okay, let's get back to chewing the fat. What about chewing some fat?

**Alie:** A ton of people... Not a ton. A handful of people; Chris Brewer, Michelle Phillips wanted to know about the keto diet and if it's good for treating diabetes.

**Dr. N:** That's a tough one. You can go on any blog and anecdotally there's going to be people that will swear by that. I think right now, in terms of the data, if I'm going to speak from the empirical side, or the evidence-based side, I think the plant-based diet is far better, not only for diabetics but for everyone. I think anytime you do an extreme diet where you cut out one major food group, I do think that's dangerous. I'm not a big proponent of that. I think it's also difficult to sustain doing that, and if you do a really strict keto diet or the Atkins-type diet, or the paleo diet, you end up eating a lot of meats and a lot of saturated fats. And if the data that's come out recently holds true, then you could actually be predisposing yourself to type 2 diabetes. So, I think a plant-based diet, if it grows from the ground, greens, you want salads, beans, and lentils, those things have shown again and again that they're good for not only your diabetic health but for cardiovascular health, stroke prevention, weight loss, and overall healthier.

**Alie:** It's also really healthy for animals.

**Dr. N:** I agree. *[laughs]*

**Alie:** Speaking of animal diabetes, Sid, Derrick Allen, AliceMouse, and Tara McNee asked: Is there diabetes in cats and dogs? And Tara McNee wants to know: How do diabetes service dogs work? What are they smelling? What's happening?

**Dr. N:** Yes, dogs and cats can get diabetes. I am not a vet so I don't know the details about it. I've heard about a lot of fat cats who get diabetes. I haven't heard of too many dogs getting diabetes, and then, ironically, my sister's poor dog was diagnosed with diabetes, so she's giving him little insulin shots. Poor guy. It's really sad.

**Alie:** Aww! Both of you guys.

**Dr. N:** Yeah, we're diabetes buddies. Diabetic alert dogs are awesome. Have you seen these?

**Alie:** I've heard about them, yeah. Tell me everything.

**Dr. N:** Oh my god, they're so cool. I want to get one really bad but I live in New York so my apartment is the size of a shoebox, so it probably wouldn't work out. I'm not entirely sure... They're trained... It's a scent. My best guess is, dogs have these phenomenal olfactory bulbs, and they're just so amazing at what they can pick up that is outside the realm of what we can sense, and I think your breath changes odor when your blood sugar is either very high or very low. I know for a fact that when you go into what's called diabetic ketoacidosis, which means you're at the very other end, you're very, very high and you're going into a coma state, your body is breaking down... because there's no insulin, your body starts breaking down alternate forms of fuel, which typically is fats and lipids. When those lipids are broken down the byproducts are acidic, called ketones, specifically called beta-hydroxybutyrate and acetic acetone.

Your blood, which likes to live at a very neutral pH of 7.4, with all of these ketone bodies being dumped into the blood, it drops the pH down to much less than that, so you become acidic or acidemic, which is bad and you don't like that. When your blood is acidemic, your enzymes, your proteins denature, things don't work and you can die. [*OH! NO! No thank*

you.”] Your body tries to compensate by blowing off the acid through your breath, so you breathe these... what's called Kussmaul breathing, you breathe very rapidly and shallow, and you're trying to literally exhale acetyl acetone. And acetyl acetone is nail polish remover, and so it smells, like, sweet. They call it ‘the sweet breath’, it's like a fruity sweetness, but it's nail polish remover. Humans can smell it, so I imagine that if you're even just a little bit high, maybe something has changed in your biology where your breathing something that might be different, whether a little low or a little high. Maybe that's what they're smelling. That's my best guess. I don't really know.

**Aside:** Two things: Your nose has about 5 million scent receptors, but dogs have up to 60 times that, and they use those olfactory talents to gather info about their environment, and their friends' butts. Now, what are DADs smelling when they're protecting their owners, though? Scientists aren't totally sure. It might be those ketones, or they may also be observing these subtle body cues like sweating or shaking. But in a 2016 University of Cambridge study they found that hypoglycemic patients exhaled two times the amount of this compound called isoprene, which means that a low-sugar breathalyzer could be in the works in the future.

Will we still need DADs? Well, studies have shown that diabetic alert dogs, which can cost up to \$20 Gs fully trained, were slower and less reliable than a continuous glucose monitor like Dr. Natter has. But patients who had diabetic service dogs were overwhelmingly happy with the help that they provided, even if it means some false-positives, and being nudged awake when their glucose was actually fine. So, CGMs, continuous glucose monitors, are cheaper, more reliable, they don't require belly rubs. But on the downside, they are less fuzzy, which sucks.

**Alie:** What about artificial sweeteners and insulin? Karyn Molines, Lynn Perry, and Todd Peterson asked this: Can you explain the dangers of diet soda? Todd Peterson said: I heard that aspartame really screws with your insulin levels. And Karyn Molines wants to know about Stevia and artificial sweeteners, what that does to your insulin response. What's the deal with that?

**Dr. N:** First of all, sodas, diet or regular, both are really terrible for you. There's a lot of phosphates, and the carbonation, and all of that stuff in the dyes, and the synthetic stuff, it's just bad for you. It's bad for your bones. It's just bad for everything. There's a lot of not-goodness in there. [*“Mmm... You deserve a cold, refreshing can of Not-Goodness!”*] So, the most interesting way that people have been hypothesizing that it can cause harm is that most people drink diet sodas because they're trying to be fit and they don't want the calories. One theory is that when your tongue tastes the sweetness, it then predisposes your brain to expect the caloric impact of that.

So when you end up, just like, pooping all of that out and not actually getting the caloric impact, your brain's like, “Wait... Hey, I need more. I didn't get the calories, so give me more. Give me more. Give me more.” So you end up becoming kind of addicted or looking for more sweetness, so you either continue to drink the gallons of Diet Coke, or you go searching for that donut that you told yourself you wouldn't have because you are now craving it. I think there's something interesting about that. I don't know if that's panned out in the literature or not, so that's one theory.

In terms of what it does to your insulin and glucose, my understanding is that it actually shouldn't have too much of an impact at all, in terms of diabetics. Technically it shouldn't raise your blood sugar. Things that raise your blood sugar are typically carbohydrates or pure sugars. Those technically don't have any and it shouldn't necessarily affect your blood sugars.

**Alie:** This one is tricky, folks, because few studies have been done and it's hard to separate the metabolic factors that cause folks to drink diet soda, like a predisposition to weight gain, with the affects of the diet soda. There was one 2017 Oklahoma State Medical Association paper that cited a meta-analysis of a bunch of other studies, and: Other than causing low blood sugar from the big bamboozle of zero-carb sweetness, nobody knows what the heck artificial sweeteners do to blood sugar.

Now, what if you don't have blood sugar issues, but somebody around you does?

**Alie:** Langley Bradley, Madelyn Dunkle, and Hanna M Childers wanted to know: What can you do if someone's in diabetic shock? If someone's hypoglycemic or hyperglycemic, if there's a bystander, a loved one, how can you support them? What can you do in an emergency?

**Dr. N:** That's a really good question. I love diabetes awareness, and obviously saving lives is a good thing. There's two real diabetic emergencies, and this is where it can get tricky and you have to tease out which one's which. First and foremost, call 911. That is always, always the first thing you do. Call 911, 'my friend's diabetic, he's unresponsive,' and you get the ambulance. That's always the first thing.

The next thing you can do is, if you know that their blood sugar is low... It's either going to be very low or it's going to be very high. If you know which one that is, if you happen to be with that person and they tell you, "I don't feel good. I think I'm low," and they're not responsive, then we can say, "Okay, they're low." And what you would do in that case is, you never ever, ever want to, like, pour juice down their mouth or any of that. There's two things. Most diabetics have something with them called a glucagon kit. Glucagon, it goes back to what we talked about with the pancreas. The pancreas is this magical organ that wears two hats. Its wears the endocrine hat and the exocrine hat...

**Aside:** Those exocrine cells don't make insulin but they make acids and enzymes that break down your salad, or Luther burger.

**Dr. N:** But then there's these little islands of cells that make hormones. There's alpha cells, beta cells, delta cells, gamma cells... The alpha cells are making glucagon. Glucagon is a hormone that is kind of like the opposite, the yin to the yang, of insulin. If you're not eating, if you're fasting, and you are in fight-or-flight, or you're starving, your glucagon's going to be very active. What that's doing is it's telling the stores of sugar in your body to say, "Hey, let's release these and spit some glucose into the bloodstream because we need it now." And that usually happens in the liver. If you're going to give exogenous glucagon, you're trying to utilize and mobilize that sugar that's already in the body. You can draw up the syringic glucagon and give it to that person. It's kind of difficult because you're giving them a pretty big intramuscular injection, and some people, not a big fan of the needles. I get it. That might be tricky, they might not have the kit on them.

The next best thing, and probably even better, if you're a bystander, is cake frosting.

[*"Pardon?!"*] If you can take some cake frosting, and you put it on your finger, and then you

put it on the mucosal side inside the cheek, and you just rub it into their cheek. The mucosal layer is actually very... You can really absorb a lot of sugar that way, and that might just be enough to keep them alive until the paramedics come, and that could save someone's life.

Now, I need to preface this. This is only if you're pretty sure that this person is low, hypoglycemic. If by chance they've passed out because they have DKA, or because they have super high blood sugar, and you're certain of that... again, you should not ever really administer insulin to someone in that case. You should just get them to the emergency room as fast as possible.

**Alie:** And now let's talk about how you're bionic. You have a pump. You have a meter. Essentially you have an external pancreas. Jessie-Zoe Robertson, Meryl Stark, Tal, Elize, and Robert Bourne [phonetic] all had questions about monitors and pumps. What are your thoughts on it?

**Dr. N:** Yes. I was diagnosed in 1994. In 1994 the technology for diabetes at the time was, like, super '80s, very archaic. I had this, what looked like, a brick of a glucometer. When you're diabetic you have to do a few things. You have to take your insulin, and you have to prick your finger and test your blood sugar on these little meters. And at the time when I was diagnosed, the meter was little at all. It was kind of the size of an old school Gameboy. [*'90s video game tune*] And it took a decent amount of blood from your finger, and it took a full 60 seconds to count down and tell you where you were. The thing was pretty big. In addition to that, you have vials of insulin, and you needed to have insulin syringes, and you needed to keep the insulin cold. So if you were going somewhere you had a little cooler and you'd roll with the cooler and the insulin, and the syringes, and it was a whole mess.

Things have come a long way since then. From there they have these insulin pens that are little disposable pens with little tiny needle caps that you screw on, and it's great. It's very convenient. The glucometers have become really teeny tiny, it takes five seconds to count down, and it takes a very small sample of blood. And then things got really cool.

Insulin pumps have always been around but the technology has gotten better, and better, and better. Now these insulin pumps, they kind of look like a little bit of a pager. I typically get asked why I have a pager, and it makes sense because I actually have a pager for work, but now I also have my insulin pump. Insulin pumps only take one kind of insulin, it's a rapid-acting insulin as opposed to what are known as basal insulins, which are these long-acting insulins with no peak. This is a rapid-acting insulin, and so once it gets into your system it works pretty quickly, and it peaks, and it comes out of your system. And you load up a reservoir of insulin into the pump, and you basically program what are known as basal rates into the pump.

So you say, "Okay, from the hour to this hour I want you to give me this fraction of a unit," and you can get very granular in fine tuning it. Once that's programmed, you're done. That will, basically, pump it into you for the 24 hours as your background insulin. You don't have to think about it. And there's a canula that you push in under the skin with a needle, and the needle comes out, and it's a subcutaneous – just beneath the skin – infusion then. So you have a little tube – some of them are tubeless but mine has a little tube – and you have a little plastic canula that kind of sits just under the skin. It doesn't hurt while it's in. To put it in, you know, it's a little pinch and that's it. It's really not that bad. It'll give me that basal insulin throughout the day.

When I go to eat something I have to say to myself, “How many carbohydrates am I about to eat? What is my blood sugar right now? And how much insulin should I bolus – or give a large amount at once – in order to cover the amount of carbohydrates my body is about to see?” It's kind of a little guess-and-check, but the technology has gotten even better, because when you're testing your blood sugar, it's a datapoint in time. It's a fixed datapoint in time, so you could test your blood sugar right now and it could be 100, but it is 100 and hanging out and chilling there? Is it 100 and dropping? Is it 100 and rising? You don't know. You're in the dark.

Now we have something called a continuous glucose monitor, CGM. And that CGM, I wear it on my arm. A lot of people like to wear it on their arm. And it is a small strip of platinum that sits beneath the skin, and it sits in the interstitial space, which is the space between cells. What it's doing is detecting flux of glucose. As the glucose is going across it, it picks that up, and so you're actually picking up a derivative, or the rate of change, which is exactly what you aren't getting when you prick your finger.

Now you have all of this data. Now you know, “I'm 100,” and there's arrows pointing down, “I'm dropping,” or there's arrows pointing up, “I'm rising.” They've taken that data and used shortwave radio waves, so now it talks to my pump. That's called a closed loop. This is kind of brand-new technology now. What this is doing is taking a cognitive load off of me the patient and it's saying, “Oh, your blood sugar is rising, but it's not quite high, technically, but it's about to be. I'm going to give Mike a little bit more insulin, I'm going to increase his basal rate,” on its own. So overall, when you look at it from the 1,000-foot view, you're saying, “I'm going to spend more time ‘in range’, my blood sugar's going to be less high and less low because of this system.” And what that does overall is it drops my A1C into a better range, and what that does in turn is it makes me, essentially, live a longer, healthier life with less likelihood of complications.

**Aside:** So, let's say you have some activities that you'd like to not be wearing a small, dangling machine off your body. Let's just say hot tubbing, or nude racquetball. Dr. Natter says you could feasibly remove it for an hour or so without any dire consequences. And you don't have to take them off for airport screening. I just checked the TSA website and found a guideline that, “attached medical devices in sensitive areas are subject to careful and gentle inspection,” which sound awkwardly romantic.

**Alie:** A lot of people had this question. Emma Hoch-Schneider, Christopher Rougeux, Hanna M Childers, Andria Marsh, Lacy Gilbert, Monster Cat, and Fiesels wants to know what Andrea Marsh asked: Why can't the US get it together and make insulin affordable? Why is it so \*\*\*\*ing expensive?

Monster Cat says: I recently heard a local news story about how a young man died trying to ration his insulin. And Fiesels said: I've heard that due to the price of insulin there are loopholes that people can use and you can get animal insulin for a lot cheaper than the human insulin and use it for yourself. Which, probably doctors don't recommend, but what is happening with insulin?? Why is it so expensive?

**Dr. N:** It's really a problem. It's really sad. It's actually ironic that we're talking today, because today is World Diabetes Day.

**Aside:** By total happenstance we recorded this on November 14<sup>th</sup>, which is the birthday of Canadian scientist Dr. Frederick Banting.

**Dr. N:** And it's World Diabetes Day because today is when Dr. Banting, he discovered the therapeutic use for insulin. He was able to distill it from, I believe, a dog's pancreas and use it in a young diabetic boy, and save his life. He sold the patent to the University of Toronto. Do you know how much he sold the patent for?

**Alie:** How much?

**Dr. N:** A single dollar. [*DJ airhorn*]

**Alie:** Oh my god!

**Dr. N:** And he said, "Insulin does not belong to me," 'it belongs to the people that need it, diabetics, and it should always be that way.' And so now we've come into this very unfortunate and corrupted place of capitalism where in America there are only three major pharmaceutical companies that manufacture insulin, and they have very proprietary patents and uses on their specific insulins. Through a series of, kind of, really messed up, capitalistic, greedy situations, insulin has risen more than 400% of inflation over the last decade, maybe less. Not too long ago insulin was about \$35 a vial, out of pocket, like with cash. And it is now closer to \$300 a vial.

**Alie:** How many vials does a diabetic person need per month? What the monthly cost that people are looking at?

**Dr. N:** It depends on their insulin requirements. I'd say on average about 1-2 vials a month.

**Alie:** So \$600 a month.

**Dr. N:** A month. Now, what you have to understand is, currently, we are living in a country where most young people living with type 1 diabetes are otherwise healthy, so these people may not have insurance, they may not have good insurance, and they may not have a job that offers them insurance, or a job that pays them enough where they can afford \$600 a month. What we're seeing now is insulin rationing, where people are taking less insulin than they're supposed to be taking so they have at least a little bit on board throughout the month. We've seen people die. We've seen significant rises in preventable type 1 deaths because of this problem. It's horrible.

Before the human insulins came out, I actually used pork insulin because that was the standard, to use either pork insulin or some other type of animal-based insulin. Since those are no longer in use, people are still trying to get those and they're cheaper. But as of today in the New York Times, the WHO, the World Health Organization, just put out a statement saying they are going to somehow allow a generic push, to allow some pharmaceutical company to make a cheaper insulin to therefore undercut these three big pharma companies and try to drive the price down by using competition. It needs to happen now, like yesterday, because there has been just a horrible response.

I was really fortunate. I was able to dip out of the hospital for an hour today and run downtown to Wall Street for a rally to talk about what it's like, A, to be a patient, but also to be a physician and see family members needing to decide if they're going to feed their family for the month or take the amount of insulin they need. It's sickening. It's really sickening.



**Alie:** What can the general public do? Who can we yell at?

**Dr. N:** I think lawmakers. I think it needs to come from a government intervention at this point, is I think the best way to go about it. We need to rein in this inflation that just continues to go up, and up, and up. When you think about it, type 1 diabetics did nothing. They didn't smoke cigarettes and get cancer. This is not anything they did to themselves. Very often these are children that are diagnosed that just happen to be inflicted for reasons that are outside their own doing. They are now dependent, not on a medication, but literally on a hormone that they would otherwise be making themselves that they don't, and so you are restricting someone from... I wouldn't even call it medication, I would call replacing the hormone that their body stopped making, that we have and know how to make cheaply for about 100 years. And you're making it inaccessible and letting people die from that because of money.

**Alie:** What about people who are trying to access medications that would be used for pets on themselves? I've heard of people who have taken, literally, fish antibiotics because they don't have insurance to get, you know, medication for strep throat. Are people doing that?

**Dr. N:** I don't know, personally. I wouldn't be surprised if people are doing that. I would, as a physician, certainly not recommend doing that. Right now the best option is, Wal-Mart has probably the cheapest insulin you can get, which is very reasonably priced. It's not the top-of-the-line stuff, it's still... I believe you have to use syringes for it. I believe it's not the most rapid-acting, or the best basal insulins out there, but if nothing else that's probably what you should be going for because it's better than getting black market stuff.

**Alie:** In terms of type 2, if you're not insulin dependent yet, or if you're type 2 and maybe you can take some measures that aren't exogenous insulin, like Kat, Tyler Q, Colin Croft, Lynn Perry, Roxanne Parker, Shea Murphy, and Jessica Davis asked: What can you do to try to reverse type 2?

**Dr. N:** It's kind of what we spoke about. Basically, the idea is diet, exercise, losing weight, that's key. In more extreme cases, these weight loss surgeries do see really dramatic results. Anecdotally, I have a patient who's, like, the most amazing human being. I saw him first when I was an intern, so two-and-a-half years ago, this gentleman was wildly overweight, he wasn't taking care of himself, he wasn't taking his insulin, and one day last year he came to see me and he just looked terrible. I had to admit him to the hospital. I said, "You're really sick. I need to admit you to the hospital." And when he came out of the hospital I had to talk to him and I said, "Your kidneys are failing. I need to put you on dialysis." And we had a real come to Jesus moment, and I said, you know, "This is because of the diabetes. We need to figure this out."

More recently I saw him, and I saw him on my list on the computer, and I went to the waiting room to grab him, and I called his name, and I don't see him anywhere. And this guy is walking up to me and I was like, "Oh, no sir, you're not next." And I'm trying to find this guy.

He had lost 230 pounds! And he was a totally different man. You saw the life in his eyes. He no longer had diabetes. His A1C went from 16%, which is extremely high, to less than 6%, which is normal. That's because he gave up all the things he was eating that he knew were no good for him. He exercised, and he had a new lease on life. Granted, he had to be on dialysis, which is not easy, but that's the wake-up call he needed.

So, weight loss is huge, and a significant amount of weight loss can definitely help. And it's not easy to do it, and this guy is really on another level. But any kind of weight loss is going to help, and exercise is also very, very helpful.

**Alie:** Do you have any strategies that you give to your patients if they have tried weight loss, they've tried exercise, and they've tried eating differently, and it's just really hard? Are there any places to start?

**Dr. N:** It's tough. Everyone's so individualistic. There are some medications that have been proven to be somewhat helpful in weight loss. I don't like using medications, ideally, for anything. You can consider what you eat a medication. That's really the first place to start. But you have to find out what about someone's life... So, what is it that they can't give up? If there's a guy and he needs to have his morning donut no matter what, like you can't give that up, he's pre-contemplated, meaning he's not even ready to think about giving that up. You say, "Okay, so you eat that donut, but then where can we trim the fat elsewhere? Can you not have the fries with your meal? And can you get rid of this bun and trade it out for brown rice?"

You look for substitutions, you look for small things, and then you make these small steps that hopefully add up, but you want to make these small steps because those are the ones they can continue to do. Can you get off the subway a stop early and walk? Can you take the stairs instead of the elevator? Can you park your car a little farther away from where you need to go so you can walk? These things, in folks that are otherwise sedentary and overweight, you actually see a really, really big production from that. They'll shed pounds, and if they give up the sweetened drinks, and the sodas, and those things, you'll see a huge difference. Those are the first places to start.

I think you break a cycle, because there's an addictive quality to some of these beverages, and sweetened drinks, and foods. I've seen it in myself. I used to drink a lot of diet soda, and when I read about how horrible it was I stopped drinking it. I didn't drink it for years, and then I had to... I didn't have to, but I was thirsty and that's what was in the hospital at the time so I had some, and it tasted terrible. It felt... It just didn't taste good. I realized that I had an addiction to it, and when I stopped drinking it I realized how awful I actually felt when I drank it.

**Alie:** It's the same thing with breaking up with people, and you look at them later and you're like, "Wow, what was I thinking?"

**Dr. N:** Well, I have the opposite problem with that. "Why did we break up??" It's terrible.

**Alie:** I know, you're a softy. A ton of people wanted to know about importing a pancreas, essentially. Dana MS, Bob Carleton, and Robert Bourne, and Madelyn Dunkle want to know: Will we ever get to a point where we can do pancreas transplants? What's up with that?

**Dr. N:** We do them now.

**Alie:** WHAT??

**Dr. N:** But we don't typically do them for diabetes, because you have to understand, when we do these pancreas transplants, and really with any transplant, there's so much anti-rejection medication that you need to take, which in and of itself is, like, horrible. So, you're on a lot of these steroids, you're on a lot of... Tacrolimus, and all these things that are suppressing your

immune system. So, you're kind of trading one malady for another, oftentimes. But we're getting closer. A lot of folks that have pancreatic cancer, oftentimes... A lot of stuff is going on at Hopkin's, actually. This is actually a really amazing thing that they do.

What they do is something called a Whipple procedure, where they're basically cutting out the pancreas, because there's cancer there, but the parts of the pancreas that they cut out that aren't cancerous, they digest out the beta cells, and the hormone-producing cells. And they then re-inject them through the portal vein, in the hope that they'll take homage in the liver and just, kind of, hang out in the liver and do their thing. What they're doing is... Because otherwise they would've made these people diabetic, and they're basically making them cancer-free and not diabetic all in one fell swoop, which is really impressive.

**Alie:** A ton of people had questions about the future. Steph, Meryl Stark, Dawn Ewald, Megan King, Daniel Tipton, Helen Pang, and David M Williams want to know: What technology, like CRISPR, is on the horizon for treatment of type 1 and 2 diabetes? Is there going to be a cure? What about vaccine-as-cure trials? What's coming up?

**Dr. N:** There's a lot of really exciting research. I don't think that there's a silver bullet because I still don't think that we truly understand the multi-factorial etiology, but I think we're getting close. Right now, I would say, we have as close to a mechanical cure as you can get with a closed loop system. We're getting closer and closer to fine-tuning those. There's something called the Bionic Pancreas Project, where.... If you think about insulin as a gas pedal, an insulin pump only has insulin in it. But a pancreas has insulin and glucagon, and there's data to suggest that we, as type 1 diabetics, over time, don't have the same glucagon response.

So, they're making this dual-chambered pump that has both insulin and glucagon, that has a gas pedal and a brake pedal, which is the glucagon. And that's going to be a lot of physiologic, and I think that's going to be coming in the near future. That's coming out of Boston.

**Aside:** To the folks working on the iLet for Beta Bionics, we see you. We love you. Also, Dr. Natter asked me to add that clinical care of diabetes is a team sport. It includes clinical diabetes educators, nurses, dieticians, nutritionists, therapists, and they all rock.

What else is on the horizon?

**Dr. N:** There's going to be an implantable CGM that's coming out soon, which is going to be... Right now I have to change out the CGM every five days. I have to change out my pump every three or four days. There's going to be an implantable CGM that will last for six months to a year, and that is, kind of, similar to the Nexplanon, which is a birth control rod, progesterone that they put in the arm for a period of time. A very similar procedure. That's exciting.

There's always a lot of stem cell research. Stem cells are what are known as pluri-potent cells, meaning they could become any cell in the body. If I took a little swath of Alie Ward's stem cells and I put them in a petri dish, and I put growth factors around them, and coerced them, and whispered to them at night and said, [*whispering*] "Hey, you should become beta cells. Let's be beta cells," and I grew your own beta cells, then here we go, we have functional beta cells, which we've been able to do in the lab.

Then the problem becomes, if your type 1 diabetes is because of an autoimmune disease, then how do I put back your beta cells I just grew in this petri dish and make sure they don't get attacked by your immune system again? There's a lot of research looking into that. There's some research trying to hermetically seal them in these, like, capsules, what I would describe as like a Trojan horse. They're invisible, like an invisibility cloak to the immune system. There's a lot of really interesting stuff going on.

CRISPR is interesting. The problem is, we don't have one specific gene, or chunk of DNA, or protein that's really effing things up. It's multi-factorial, and in some cases it might be mostly environmental. So, we can't necessarily use CRISPR per se, but I'm optimistic that in my lifetime I will be put out of business because there will be a cure for diabetes.

**Alie:** [*with relief*] Ah! And then what are you going to do?

**Dr. N:** I'll draw books. [*laughs*]

**Alie:** Cool! [*laughs*] I thought there was going to be something on a beach. You'll draw books on a beach.

**Dr. N:** Yeah. I often fantasize in residency, if I were to quit what would I do? And I thought about maybe being a mailman in Hawaii. I thought that'd be fun. You get these cool shorts with the stripes on the side, you know?

**Alie:** I'll take it. I'll take a pith helmet.

**Aside:** So what does Dr. Natter like the least about being a diabetic diabetologist?

**Dr. N:** Okay, there's a lot. I'm going to be real with you. Diabetes sucks. It really sucks. I wouldn't wish it on my worst enemy.

**Aside:** And what about being a doctor?

**Dr. N:** I don't like how much of it is a business. I don't like treating my patients like customers. I don't like rushing them out of my office, or in the emergency room, or in the hospital. I don't like discharging them because we have to turnover beds for money. I don't like that.

I don't like that most of my day, unfortunately... Maybe 10% of it is doing real medicine, and the rest of it is doing what feels like bureaucratic nonsense. I know I'm a resident, but I think a lot of that's still the case as an attending. And that bothers me a lot. That sucks about medicine as a whole. Obviously, the finances and the business of it, and the insurance sucks, and the access to insulin and other medications that my patients need and are struggling to get really sucks.

Diabetes sucks. So, diabetes sucks because this is a 24/7, constantly on your mind, constantly needing attention thing. And at any moment you are worried about, "Oh I'm going on this date with this cute girl... Uh oh, my sugar's low." And when your sugar's low you act really wonky, and you stumble, and you stutter your words, and you feel the cold sweats. That's not very sexy. Or your blood sugar's high, and it stays high, and no matter what you're doing, and you're doing everything right, it's high and you don't understand it. And you know that if it stays high you might get complications, and you worry about having kids and passing it on, and you worry about going blind, and losing limbs, and losing fingers, and losing your kidneys. It's a lot to deal with. So, that sucks.

**Alie:** Yeah. Understood. It's like your pancreas is out to lunch and in its place you have a screaming baby that needs your attention at all times.

**Dr. N:** That's exactly what it is.

**Alie:** "We took out your pancreas. We replaced it with a screaming infant. Go about your life."

**Dr. N:** "Oh, thank you. So kind" *[laughs]*

**Alie:** What is your favorite thing about being a physician, or about talking to patients who have diabetes?

**Dr. N:** So, this is the flipside. This is why I still do it, and this is why I went into it, is because I like people. And I think when you wake up in the morning to go to work and know that you have the potential to help someone at the very least, and at the very best you can save someone's life. That's some powerful stuff, and it makes these long days, and these 24-hour shifts, and all this stuff, all the decades of schooling, it makes you feel like this is worth it. I like connecting with people, and I like connecting with people on a deep level, and I like being able to help people.

**Alie:** How do you not cry on the job?

**Dr. N:** I cry so often.

**Alie:** You do??

**Dr. N:** I cry so... I mean, I am an emotional, sensitive man, maybe more so than most. As we were chatting before, I'm currently on an oncology rotation, so it's cancer. And it is heavy. It is really heavy. It's this weird dichotomy of... you have this weird privilege and this weird honor to be, literally, at the bedside with someone who's dying, and talking to their family, and walking them through it, and you just met them an hour ago. And here you are, kind of, guiding them through the most human process that anyone and everyone goes through. So, it's really something special, which I love. But I then take it home with me, which is not healthy. So then, you know, you go and you cry. I definitely cried more this rotation than I think any other.

But usually... like, you learn as an intern, you become very efficient at crying. Because what you do is you used to come home, cry, then shower, then have a drink. Now what I do is I cry *in* the shower while having a drink and just kind of get it all done at once. You learn efficiency.

**Alie:** *[laughs]* Is there a good place in the hospital that you cry? Like, do you know that there's a supply closet that's always good for it?

**Dr. N:** Oh, Alie. Intern year I scoped out all of the cry spots. Don't you worry. In one of the hospitals I work, there are these great single bathroom where you can do the ugly cry, because you have all the time and the space to do it, and then when you try and clean yourself up you have, like, all the utensils you need. You've got a sink and... But then, there's the emergency cries where you're like, "Oh, I didn't think this was going to happen!" and it's just coming out like waterworks. Then you usually have to go to the top of the stairwell, because if you go to the very top then the likelihood of people coming down from there is slim, so you can, like.... But that echoes so you can't ugly cry there, you've got to muffle it a little bit.

**Alie:** *[suffering laugh]* No...

**Dr. N:** Most of the times I cry it's not out of, like, pain. It's more emotional, like... It's not really my own either, it's more like seeing other people... I guess I happy cry like in the sense if I'm watching something sweet, I'll get the single Obama tear. That's how I like to cry, that very manly one tear and stone faced. But more recently I've had the, like, crumpled up, snot, you know, heaving cry. That's been...

**Alie:** Been there. Done it. Well, I'm going to cross my fingers for a cheaper generic alternative, and when that day happens we will FaceTime and we will happy cry about it together.

**Dr. N:** I like that plan.

**Aside:** But Dr. Natter wanted to leave us on a high note, so...

**Dr. N:** Without diabetes I don't think I would've gone into medicine. So, I think there's a silver lining in that respect. I think it helped me find my calling, so I'm... If I could be appreciative to diabetes for anything I think it's that.

**Alie:** Has it brought you closer to other people who have it?

**Dr. N:** Yes, and I think... As I alluded to before, when my patients are struggling with any chronic illness but especially diabetes, I love when they catch a glimpse of my pump and then we have that moment of, like, "Oh wait a minute! You get it!" I had a patient recently who was admitted to my service for an infection but she happened to have type 1 diabetes, and being in the hospital... She was young, and being in the hospital is scary, and she was admitted overnight, and happened to have been there at ungodly hours.

And she said she immediately felt comforted knowing - because she wore the pump and the CGM - that I got it, because not everyone in medicine understands how these things work. As a diabetic you're very, kind of, protective and know your diabetic care better than anyone else. So for you to get admitted to a hospital and all of a sudden someone who you just met, who doesn't really understand diabetes that well is saying, "We're taking your pump off and I'm going to give you insulin how I decide," is jarring. So, we... It was really nice to be able to share that with her and make her feel really comfortable.

**Alie:** Fake redheads have the same nod.

**Dr. N:** *[laughs]*

**Alie:** It's like, "I see you." Happens all the time.

**Dr. N:** *[still laughing]*

**Alie:** So, essentially, I've lived your life, and I get it. Thank you so much for doing this.

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So once again, ask nice, sweet doctors stupid questions, because we're all going to die eventually, but you can delay that by asking questions. To follow Dr. Natter, he's [Mike.Natter](#) on Instagram, or [Mike Natter](#) on Twitter. We are [Ologies](#) at [both](#), I'm [@AlieWard](#) on [both](#). Links to [JDRF.org](#) and the sponsors are in the show notes, and they're also up at [AlieWard.com/Ologies/Diabetology](#).

Ologies Merch is at [OlogiesMerch.com](#) or at [AlieWard.com](#). Thank you to Shannon Feltus and Boni Dutch, two wonderfully sassy sisters who run that and host the comedy podcast *You Are That*, so check that out. And Happy slightly belated Birthday to Erin Talbert, who runs the Ologies Facebook Group, which is a job in and of itself. Thanks so much Hannah Lipow for all of your volunteer efforts

over the last several years. And to Emily White who organizes all the transcriptions. Thank you, Patrons, for allowing me to pay them for that hard work. There are links to bleeped episodes, including Part 1 of this episode in the show notes. Jarrett Sleeper of the mental health podcast *My Good Bad Brain* did assistant editing. Thanks of course to the man and the mustache, Steven Ray Morris, who hosts the kitty-themed *Purrrcast* and the dino pod, *See Jurassic Right*, for putting all the parts of this episode together. Nick Thorburn wrote and performed the theme music. He's in a band called Islands, a very good band.

And if you stick around to the end of the episode, you know I tell you a secret, and this week, as long as we're talking hormones, I have to take a bunch of hormones because my ovaries are just, like, "Buh-bye, we're outta here." And one of them I take is, like, a progesterone, and it bums me out so much. I'm supposed to take it regularly but I just get so Eeyore on it, and I'm only telling you this because, A, the first few times I took it I had no idea what was going on and I thought I was losing my marbles fully. I didn't know that that can happen to some people when they take it.

And also, because as long as we're talking about the wonders of the American healthcare system, I told my latest doctor about it and she said, "Well, I have to put you on it again and feel like you want a crevasse of the earth to open up and swallow you, and *then* your insurance will approve something that doesn't do that to you." Anyway, so progesterone, dudes, and ladies, and everyone who's neither. Thank you for ducking into my secret hut and listening to these things. Please take care of yourselves. Do you promise? Yes? Okay. Berbye.

*Transcribed by your eastern European cousin with the confusing surname, who lives in beautiful British Columbia with her rescued senior furball Len — Aska Djikia*

*And by Emily White, who never makes her bed until immediately before getting in it.*

### **Some links which may be of use:**

[Shockingly, Gwyneth is not drinking her pee](#)

[Don't drink your pee!](#)

[The Golden Fountain: pee won't help you](#)

[Army Field Manual: just go thirsty](#)

[CDC Diabetes fact sheet](#)

[Type 1.5 diabetes](#)

[Drink your juice, Shelby!](#)

[Types of Diabetes](#)

[Coxsackie and Type 1 Diabetes](#)

[Generalized Anxiety Disorder and blood sugar](#)

[Coxsackie New York and its cute viruses](#)

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