Diet Doctor Podcast
with Dr. Casey Means
Episode 59

Dr. Bret Scher: Welcome back to the diet podcast. I'm your host Dr. Bret Scher. Today I'm joined by Dr. Casey Means. Now, Dr. Means has a pretty unique story on how she got into being on the forefront of metabolic health and continuous glucose monitoring.

She actually started as a surgery resident in ear, nose and throat, ENT and from that realized, as you're going to hear, that most of what she was treating was probably preventable with proper nutrition and lifestyle, which is pretty different for most surgeons to think.

So, from there she went on to get trained in functional medicine, started her own medical practice focusing on the sort of deeper dives and bigger discussions about what's at the root cause of inflammatory problems, and now has gone on to be a cofounder and chief medical officer of Levels Health.

And through this whole process has really focused on continuous glucose monitors and the amazing amount of data and information we can get from them and how that affects behavioral change. Because that's really what it comes down to. We could have all the data in the world, but if we're not using it to motivate ourselves and to change our behaviors and improve our health, then what good is it, right?

So, she sees CGM as such a powerful tool and she clearly has a wealth of information. So, we're going to talk about a lot of the data, a lot of the concepts about CGMs and sort of bring it back towards how that affects inflammation and metabolic health and near the end we get into some... we try to get into rapid-fire, but you can see she's got too much information for rapid-fire, but we're getting some real practical tips on what you can do, you can take away, of how to use the CGM, how to talk to your doctors about it and what some of the nuances are that you need to know.

So, hopefully this will be a great introduction and deep dive at the same time into continuous glucose monitors and metabolic health and what it can mean for you.

Dr. Casey Means, thank you so much for joining me on the Diet Doctor podcast today.

Dr. Casey Means: Thank you for having me, Dr. Sher. So happy to be here.

Bret: Yeah, there's a lot I want to get into today with you about metabolic health and CGMs. But first, I want to talk about your journey, because I find it so interesting. I mean here you are, a resident in ear, nose and throat surgery at a prestigious institution at Stanford University, spending

your days in the operating room and somehow you got from there to focusing on metabolic health and blood sugar and nutrition.

Because usually when people make that transition, it's from like internal medicine, or endocrinology, or some sort of certain metabolic focus specialty. But yours was totally different. It was from a surgical specialty into metabolic health. So, give us a little bit about how you made that kind of unusual transition.

Casey: Yeah, absolutely. So, like you said, I was practicing year, nose and throat and I had trained fully in the conventional system. You know, I had been an undergrad at Stanford, I had been a medical student at Stanford and then gone to Oregon Health and Science University for my surgical training. And I am five years in and I'm treating a lot of the same conditions over and over every day.

I'm doing you know, chronic sinusitis, I'm doing ear tubes for chronic ear infections, treating Hashimoto's thyroiditis, I am treating vocal cord granulomas... And what was so interesting to me is that, fundamentally, all these conditions are inflammatory in nature. These are all foundational inflammatory conditions.

And that was really interesting to me because the main modalities we're using to treat many of these conditions were steroids, antibiotics and surgery. And certainly steroids take a big hit on, you know, inflammation and the immune system, but surgery isn't actually really a tool that affects our inflammation or our immune systems. It's kind of felt like fighting a battle with the wrong weapons.

And so this was quite interesting to me. I started thinking, why are my patients so inflamed? And why is it that everyone's got these revved up immune systems? And it was especially interesting to me, in light of what I was learning about other chronic conditions, so things like obesity, diabetes, even things like cancer, depression, Alzheimer's disease, you start reading the literature on these things, and it all also stems back to inflammation.

And so, sort of started to put these Venn diagrams together, thinking, you know, this is fascinating that cytokines like TNF alpha and IL-6, they're kind of upregulated in all of these diseases. What's going on here? And what is this threat that all of our bodies or immune systems are responding to?

And ultimately that got me really digging deep and thinking about the root causes of inflammation and really sort of transitioned from being someone who was very passionate about surgery and about helping people in the way to someone who really became laser-focused on how do we keep people out of operating room? How do we impact these inflammatory pathways to keep all healthy?

And if we can affect those core fundamental underlying physiologic perturbations, we may be able to have multifarious benefits on health. Not just helping an ENT condition, or you know, depression or Alzheimer's or heart disease or stroke, but actually kind of help quite a bit with one fell swoop.

So that was really a journey for me away from the operating room and into trying to help patients identify the root cause of their inflammation that affects the that and I think what we're learning more and more these days is that a lot of that inflammation is stemming from diet and lifestyle.

It's stemming from the exposures and the choices that we're making every single day about what we eat, when we eat, how we respond to stress, the quality and quantity of our sleep, the quality and quantity of our physical activity and exercise, the toxins we're exposing ourselves to, our micronutrients for consuming... All of these things have an impact-- and microbiome, of course. How we are treating our microbiome.

All these things translate into our bodies' fundamental level of health and so that became a real focus in my career. And I got out of the operating room, opened up really a more metabolic health focused private practice where I was really digging into the root cause of people's underlying health conditions, trying to draw lines between a lot of the different seemingly disparate symptoms and conditions they had and helping them make the behavior change choices, that were ultimately going to generate conditions in the body that would generate wide-ranging good health and health improvement.

And a key to that was really behavior change. It was how do we make these choices every day that are going to lead to conditions in the body that generate health. And so behavior change became a huge, huge focus for me. And as doctors we're actually not really that well-trained -in being agents on behavior change.

Bret: We're not.

Casey: It's not really in our curriculum and what's more, as much as we want to be our patients shoulder every day, we're not there every day. We can't be there for the hundreds of micro decisions that people make every day. And so I got really fascinated with what can we leverage to scale our efforts.

And that led me to digital health and to trying to really partner with companies who are thinking innovatively about tools to get people to make the lasting personalized sustainable choices that generate health. And so that's sort of the core of my focus now is supporting companies that do that and then practicing in this really high touch clinical practice where I focus on the root cause of health conditions.

Bret: Yes, so let's rewind for a second. There's a lot there to unpack. So, when you're going through your surgery training, I mean there's no mantra in surgery, like there's no problem you can't fix by cutting it out. I mean you can fix anything by cutting it out. So, to have sort of the opposite mentality as you're still in training, is kind of heresy.

I mean were people looking at you like you had two heads and sort of thinking you're a little crazy for your thought process? Or did people sort of get it and say like, yeah, you're right, there is like an underlying problem here that we need to address? What was that like?

Casey: I would say people did not fully get it. I think now a few years out people definitely get it, but at the time, no, it did feel a little bit like heresy. There is quite a few fine adages in surgery like, "When in doubt, cut it out". And there's also one that's a little darker, said sometimes, which is almost embarrassing to share, but it is, "You eat what you kill".

And what that means is that you make money and you generate revenue when you book surgeries. And so there is sort of this underlying push towards, you know, doing this intervention that is both good for the patient, but also extremely lucrative for the system. Surgeries are very high paying, high reimbursement and do you know what doesn't get much reimbursement?

It's a 30 minute counseling session about diet and lifestyle. Or really digging into the core realities of patients' lives that lead to the health behavior is that ultimately underlie chronic disease. So there is interesting stuff going on there.

And so when you come guns blazing, saying hey, you know, I want to spend a bunch of time talking to my chronic sinusitis patients about food sensitivities and about their exposures and about these things that maybe really jacking up their inflammation, I want to talk about food as medicine, I want to talk about how certain food compounds may be helpful for their anti-inflammatory effects. And just there's not a lot of space or time for that in conventional medicine.

So, that was a little bit tough, but I really blame a lot of the authors in this space for being my motivators. So I was reading, you know, Jason Fung, I was reading the Obesity Code and the Diabetes Code. I was reading the Mark Hyman, The Ultramind Solution and The Blood Sugar Solution.

I was reading Joel Fuhrman, I was reading Sarah Gottfried, I was reading all-- you know, I was listening to Rhonda Patrick and Peter Attia and just really once I think you start going down that pathway and you got these audiobooks going on your headphones as you are walking down the hospital wards it starts to plant a seed that's really hard to undo that we need to be thinking bigger about how we are managing chronic disease.

And in the face of sort of the realities, which is that you know 88% of Americans are metabolically dysfunctional, a UNC study two years ago, that 72% of Americans are overweight or obese, there's 128 million Americans with diabetes or pre-diabetes... and the pre-diabetes there is about 90 million Americans, 90% of which don't know they are pre-diabetic.

So, we are dealing with like this is not fringe, it's astronomical and pretty much everything I just mentioned is preventable and it's driving up our chronic morbidity, mortality and our health care costs. So, you got these incredible forward thinkers in one ear, you got these stats in the other ear and it's really hard to just walk into the operating with a scalpel thinking that you're making impact at scale. Surgeries are beautiful art and it's important I think for acute conditions, but for chronic disease management I don't think it's the best tools we've got.

Bret: Yeah, I think that's a great assessment, especially when you talk about, you know, "you eat, what you kill" that actually is a disincentive to getting to the root cause of problems and solving the problems. And whether it's conscious or not, that's the way the system is. And so, there is a disincentive there that you went past.

And I can just see your surgery attendees eyes rolling back into their head, if you are talking about these things and wanting to spend more time with your patients. So, that's right, I think is important for people to understand where you came from, that you had to come from sort of the exact opposite mindset, which just shows how powerful of a motivator it is for you and how much you truly believe in this.

And then you went and started your own practice and from there are now trying to scale it through technology to use CGMs to help people understand the glucose to metabolic response to different foods and lifestyle changes. So, first before we get into that, have you always been sort of techie and wanting to get into the sort of technology sector or is this like totally new for you?

Casey: I would say somewhat, yes. So I was so fortunate to be in the Bay Area and Silicon Valley at Stanford for my entire medical training, from undergrad to medical school. And there you can't help, but drink the water, drink the Kool-Aid. We can't say Kool-Aid, because that's full of refined

sugar, but drink the water, drink the Kombucha, of digital health and of the real beauty that can come from interdisciplinary collaboration.

And so by that I mean physicians engaging with business so as to really leverage their efforts. Medicine has so traditionally been we've really glorified this one to one interpersonal interaction, between the doctor and the patient, which is a beautiful and can be a transcendent relationship.

But with the challenges that we're facing today in healthcare, so much of which are related to chronic disease and so much of that chronic disease is related to diet and lifestyle and ultimately behavioral choices, I do think the paradigm needs to shift a little bit, because the one-to-one conversations are actually not extremely effective at moving the needle on behavior change.

There's been quite a bit of research to support this, to say that while patients do enjoy having that conversation with their doctor, when a doctor makes a recommendation about diet and lifestyle, it's pretty unlikely that it's actually going to be carried out by a patient, not to say that it never does, but in terms of the statistics, they're not great.

So, you got to think, how can we pair that really powerful conversation with the doctor and the high level thinking that a doctor can do with tools that a patient can have day in and day out to really personalize and empower that advice?

And make it actually really practical. So, that's where I see the future of medicine; is pairing, you know, the wisdom and the real cognitive beauty of the physicians or the healthcare practitioner's knowledge with tools that make it a day in and day out situation. Because this isn't a decision about encouraging someone to take a pill, it's not about encouraging someone to have a procedure. It's about encouraging someone to make decisions, these hundreds of times a day that are ultimately going to move the needle in health.

And what's so interesting is that the decisions for each person are going to be completely different. What you and I both need to eat for optimal metabolic help may actually be very, very different. And one example of that is that, you know, recent research has suggested that we could eat the exact same meal of carbohydrates, the exact same standardized meal and you and I have could have a completely different glucose response to that.

Same exact cookie, I could go up to a glucose of 150 mg/dL, you could stay at 75 mg/dL. So, for one of us that's a potentially good metabolic choice and for one it's not. So that's where you can really see how the one-to-one relationship between the doctor and patient without supportive personalized tools can actually fall apart, because we need this really, you know, personalized direction for each body.

So that just one example of where tools that can give a little bit more personalize feedback in real time can help be synergistic with the physician interaction and really scale the efforts, so—

Bret: Which is a perfect segue to start talking about CGMs or continuous glucometers, which are probably the best tool we have right now certainly for blood sugar control. Because the others, you do a finger prick a few times a day, which gives you a one-point-in-time measurement or you get a hemoglobin A1c as a blood test every three months, which gives you a retrospective, backward looking, three month average of your blood sugar.

But CGM is totally different. So for people who may not know, give us just a brief introduction of what a CGM is and then about how you are using it to really help patients make decisions.

Casey: Yeah, absolutely. So, continuous glucose monitor, otherwise known as a CGM, is a small wearable device. They can go on the back of the upper arm and they are worn generally for around two weeks at a time. And what they do is they have a small micro filament that goes right under the skin into the interstitial fluid, which is the fluid between cells and samples glucose automatically every 15 minutes, 24 hours a day and then sends that information to a smart phone or a reader.

So instead of having to prick your finger, get a drop of blood, use a glucometer and get those readings maybe 3 to 4 times a day on a good day for the average person with diabetes, this is actually giving you, you know, dozens and dozens of data points in the background and you can really see a much more high fidelity high granularity curve of what's happening to your glucose in real time.

And so the beauty of this is that, as opposed to just getting a single snapshot of what's happening to your glucose levels in response to dietary and lifestyle choices, you are seeing the really dynamic action of the body and you're actually getting much more granularity into your overall metabolic health.

So, just to step back, this technology has been traditionally used for the treatment-- it's FDA approved for the treatment of type 1 and type 2 diabetes. So this has been a game changer for those populations and making, you know, fewer fingerpricks and higher data resolution and for allowing people to dose their medications properly and more safely.

But what's really neat to think about is, how could this technology that's already existed for over 10 years actually benefit a wider population than just the type 1 and type 2 diabetic community.

This is essentially a biofeedback tool that finally for the first time can actually close the loop between any nutritional choice and what's happening to our health in real time. It's one of the only continuous biomarkers we can track at home and fortunately it tracks the core metabolic substrate of our body that has huge implications for health.

And what's more, we know the metabolic disease and metabolic dysfunctions, so like over conditions like type 2 diabetes, that these are not these conditions that one day you don't have it and one day you do. It's not like a light switch. These are diseases that are spectrums where you are likely progressing along this metabolic dysfunctions spectrum over the course of years if not decades from the repeated choices and exposures that lead us towards insulin resistance.

And so you can imagine how having this information about glucose far earlier, you know, years and decades before we get that slam of a diagnosis or that fasting glucose in the doctor's office that finally says we have reached the diabetic level... You can have this way, way before and actually tailor your diet and your lifestyle to minimize the glucose spikes that ultimately start pushing us down the path of insulin resistance, towards overt dysfunctions.

So it's sort of this beautiful tool that can really prevent us from ever having to walk into the doctor's office and get a surprise about our metabolic health. And that I think is really empowering. And secondarily I think it's an antidote, a welcome antidote, to just the mass confusion about nutrition that we're dealing with right now.

There's data that suggest that 80% of people are confused about nutrition advice. And I feel that in my own practice and in my own social community like everyone it's-- You know, nutrition has become essentially tribal warfare and to be able to cut through some of that noise with an objec-

tive data stream that gives us continuous information about our key metabolic biomarker is so exciting.

So that's really how I use this technology is in a more mainstream populations, so not just for patients with clinically diagnosed metabolic conditions, but in in really all patients as a precision nutrition and lifestyle tool and much more as a prevention tool.

Bret: Yes, I think that's definitely where the future is going. I mean, hopefully more mainstream medical practitioners are going to catch on to see the utility of this in the general population, not just people with diagnosed type 2 diabetes or type 1 diabetes.

But, you know, it's sort of like a catchphrase to say oh everybody's individualized, oh everybody responds differently. And while it may be true, there are certain underlying consistencies that apply to just about everybody. Like not eating too much sugar, not eating overly processed foods. I mean, we can sort of get all that stuff out of the way, but then you're actually right.

Then there is a very personalized response that people have to foods and when we live in a society that puts out a dietary guideline that says we all need to eat whole grains and more grains and more fruits, it becomes confusing and something like a CGM though can be a wonderful tool to show how maybe that's not the case for everybody.

So, is that something that you are finding that these so-called expert recommendations really can get a lot of people into trouble with the CGM or do you not see that so much?

Casey: I would say I see that so much, yes, I think it's a really great point. I think there's two aspects that are very, very helpful. One is certainly the personalized, not really refinement piece that really can take people to the next level of picking the perfect foods for them. But then there's the much broader brush stroke of just really having this tool of insight and almost recourse to a very loud food marketing environment.

So take for example something like instant oats. If you go look at a box of instant oats at the store, it will say all over it, excellent source of whole grains, this is a heart healthy food... there's pictures of hearts all over it. This gives you X grams of whole grains per day, this is a good source of fiber.

So, it has a lot of very compelling marketing on the package. And of course, the good consumer will say, I'm making a really great choice for my health by buying this food. And one of the most interesting things we've seen in using continuous glucose monitors in a lot of healthy patients is that instant oatmeal for most people that I have seen spikes them well into what we would call sort of diabetic or really unhealthy levels.

So I'm talking like 170 to 210 with just plain instant oatmeal. What's more, if you actually go to some of the websites of these companies, they will actually show the instant oatmeal with some brown sugar fruit, a glass of orange juice, toast... And I actually, I fear what that glucose response would be for the average person.

But just instant oats alone can send people up to 170, 180. Different between each person, I know some people who haven't spiked very much on it, but for those people who are spiking that high, they are almost guaranteed having an astronomical insulin response.

They are exposed in their whole body to a very large glucose and insulin burden and if that's happening every morning, they are starting their day that way, you are likely putting yourself on a glucose roller coaster, that insulin is likely to cause a profound reactive hypoglycemic dip after

breakfast. So, a lot of you walk around thinking, yeah, I always kind of have this like midmorning energy slump and I'm feeling a little moody today and oh, my energy is a little off.

And you pair that with this data, showing your wild roller coaster of your glucose and all of a sudden you put together the subjective experience you are having with this objective data and realize that this might not be the best choice for you.

And so it's a way to I think one, really move past food marketing and understand what foods are actually best for your own physiology and then two, to really gain an amazing sense of body awareness by pairing subjective experiences that you are having throughout the day with objective data.

And I think as you do that over and over and over again and realize how these little things that are happening throughout the day are especially related to cognition, mood and energy and athletic performance and sort of our physical vigor and see how that relates to your data, I think you really build this beautiful sense of somatic awareness of starting to understand how the choices you're making are impacting objective metrics, and how that's leading to a subjective experience.

And that trifecta is really somatic awareness and I think digital tools can help us get back in touch with those inner workings of our body. And there's a really cool term for this, called interoception, which is a sense of people understanding and sensing what is going on inside their body. And so, an example of this would be heartbeats.

Many people have the ability to sit still and actually really feel their heartbeat. And other people really struggle with that. And the people who are good at that, or who can do that, tend to have much better mental health outcomes, anxiety, cardiovascular outcomes. It's good to know what's going on inside your body.

And we live in a culture right now where it's actually hard to feel what's going on inside our bodies. There's a lot of stimuli, there's hyper palatable foods, we live in a very addictive digital world and we can become I think a little bit numb to how we are feeling and our internal cues. And I think there's a potential for biofeedback tools, especially ones that are measuring internal biomarkers to get us back into that loop of really correlating these experiences with our objective metrics.

So, yes, definitely to just circle back to your question, definitely see that there are foods that are putting people on roller coasters with their glucose and unquestionably putting people, if repeated, down the path of insulin resistance, that are marketed as healthy. And I like to say to people, a carb in the mouth is not glucose in the bloodstream.

It's not necessarily a one-to-one relationship. It's different for every person. And that comes down to our microbiome composition, our insulin sensitivity, how much exercise or sleep you got, a number of factors. But we really have to know for ourselves what that relationship is. We can't assume it, we can't use glycemic index charts. We are learning it's much more complex than that.

Bret: Yeah, I am really glad you brought up the food marketing, because that is such a problem, especially if you take an already pretty confused public and then throw them in the midst of very talented marketers, whose goal is not your health, right? Their goal is to sell you product.

And when you can get the American Heart Association a heart seal on honey nut Cheerios, or, you know, some highly sugary type food source, that's not actual real food, but to get like a seal of approval and all the marketing... just leads to more confusion. So, a CGM cuts through all that

and gives you the feedback exactly like you're saying.

But one thing that is so interesting though is how do you correlate saying, okay some people are eating oats or eating fruit or eating whole grains, get these huge spikes in their blood sugar, but yet we have observational scientific data that say eating whole grains and eating whole fruit is healthy in general for people.

Like that's sort of a cognitive dissonance or disconnect that most doctors might not be able to reconcile. So how could you help doctors or just the general public to sort of reconcile those two things?

Casey: It's a really, really good point and I think there's a lot there. So, first of all I think the foods we are eating today are not necessarily traditional foods that we have been exposed to throughout history. An apple today is very different than an apple 20, 30, 40 years ago. So that's just one place to start, you know.

The fructose level in some of these foods that we're seeing is just... These are sugar bombs, a lot of them, and we're eating portions that are really high. So I think on the one hand, it's that. It's that we're eating different food and we're eating really large portions and we're also much less physically active than we were historically. So there's other mitigating factors there.

With the whole grains piece, I think that's also a tough one, because a lot of whole grains now we're seeing paired with refined products in them, like refined sugars and, you know, just pair it with other unhealthy-- You can still label something whole grain, even if it's got a lot of other stuff in it that we don't want to be eating.

So there's some confounders there. I think also, within food groups like fruit or like whole grains, there can be a lot of variability between how you respond to different foods. So I know for myself personally, I actually respond pretty high to most fruits and so I actually have had to learn how to pair fruits properly so that I actually can blunt my glucose spike a little bit when I them.

And I think that's something that you can really develop, some skill and some intuition about, as you use biofeedback regularly. So, here's an example. I ate a small pint of blueberries and my glucose went to 150. I never want to go to 150. I like to stay between 70 and 90 almost all the time, at most go up to 110. So, 150 is really for me like not where I want to be. But if I take that same kind of blueberries and I dump it in a cashew unsweetened yogurt that has 15 g of fat.

Maybe add a little bit of almond butter, a bunch of Chia seeds, which have protein and fat and fiber, all of those things actually will completely change the glucose responses to those berries. Many research sites have shown that fiber and protein in conjunction with a high carbohydrate food can minimize the glucose response.

There's a number of different mechanisms involved there... gastric motility, insulin sensitivity, a number of things. And so, pairing fruits properly is I think a big key piece to this. I don't necessarily know if we're meant to eat a huge apple or a pint of blueberries completely by itself late in the evening. You know, that's another pieces foods timing. We become more insulin resistant as the day goes on.

Melatonin, which is released in anticipation of bed time has an impact on our beta cells and on our insulin both secretion and insulin sensitivity. And so we generally are going to have a higher glucose response to the same food eaten later in the evening than if we ate it first thing in the

morning.

So all of a sudden I take that pint of blueberries and I pair it, I eat at a different time, I maybe tackle a little exercise on it before or after, make sure I'm eating a big carb load, after a good night of sleep. All of these factors, food timing, food combining, exercise, sleep, even how stressed we are that day have an impact on how we process carbs into glucose.

So it's really about thinking bigger picture about the context of those carbs we are going into and that's where nutrition research-- we don't have that type of granularity in these population studies and where I really want to see the research go. And ultimately the goal being that people build these metabolic toolboxes that they can grab from to make sure that they're eating healthy nutrient rich foods without the collateral damage. That's really my goal.

Bret: Yeah, that's a great point about how there are so many variables to factor in. And the food pairing is certainly one of them and sleep and stress and exercise also very important variables. Because your response after eight hours of sleep to the same meal after four hours of sleep can be completely different. Which at first doesn't make sense, you know, like it's the same food. It's the same food, you should have the exact same response.

But no, it's almost like two different people are eating it, based on your sleep, based on your stress. So I think that's such a powerful motivator, but also something that can be confusing, even with a CGM. You could take a look at a food and say oh I can tolerate that just fine, but then, if you eat it without the same amount of exercise you had that day or with less sleep, often is not going to be so fine, so you can't be so confident about that.

So, that seems like a very important behavioral learning tool as well from CGM. So, do you see that a lot in your patients?

Casey: This... the confusion about some of these modifiers?

Bret: Yeah.

Casey: Yeah, I do... and I think-- And this is where I think digital health really has an amazing opportunity, because the hardware and the glucose sensors are available. And they are generating a raw data stream that like you just mentioned can be a little confusing, because there are so many mitigating factors of that glucose like we talked about. The really big ones that have been studied in detail is food timing, food combination, stress, sleep, exercise, but there's also other things.

There's our micronutrient status... you know, our zinc, magnesium, carnitine levels, there's our microbiome, you know, we know that our bacteroidetes and our firmicutes ratio and how much of those particular bugs we have in our microbiome, have an impact. We, of course, got genetics and epigenetics.

There's many, many factors that feed into this. So, off course it could feel very, very confusing, but my feeling is that the lowest hanging fruit is these four main pillars of the food, sleep, exercise, and stress. And that's where I think software that is overlaid on top of that raw glucose stream and really integrating data sources so the raw glucose data stream with other data streams like objective measures; exercise, sleep and stress.

So, we think about heart rate variability, other noninvasive biomarkers we can track at home. When we start merging some of those data streams, you can actually really start to pick up really interesting trends and help people parse out and wait how these different lifestyle and dietary

factors are affecting that glucose readout essentially.

So it is really a multivariate thing. But that's where I think machine learning, AI, software is going to revolutionize this. And sort of hand to a person on a silver platter like, every time you eat those apples with peanut butter, you'll have a 15 point lower glucose response. And you know every time that you don't eat these foods, X, Y, and Z, after 6 PM your sleep, your deep sleep is 20% better.

That's where I think we're going to see people being able to have those actionable insights. But certainly parsing on your own is a challenge and I help my patients that are in my practice, but I think that that's where software, machine learning and integrated data streams is just really the future of metabolic health.

Bret: So, for the data junkies it seems like there's a limitless amount of data that you can get and some people are going to love that and some people, it's going to make them want to crawl under a rock and never come out because they get so overwhelmed with the data which is why I like you can also sort of boil it down to the four major pillars with the food pairing, sleep, stress and exercise. I think those are so important.

Now, I want to get back to another thing that you said. You mentioned some specific numbers of where you want to stay under. Now traditionally our diagnosis or our use of blood sugar numbers are so poor... like 126 for fasting blood sugar or 140 after a two hour glucose tolerance test, like these are the magic goals and as long as you're under that, you're fine. But it's really not.

I mean it's just the unfortunate way that our medical society has diagnosed things. But when it comes to this term of "optimal" and I'm using air quotes for the people who are watching on YouTube, the "optimal" blood sugar response, do we really know what that is at this point or are we sort of making up and defining it as we go?

Casey: We 100% do not know. And this is where we need to make progress in the next five years. And I know that there are many people thinking about this deeply, people like Dom D'Agostino, people like Ben Bikman, people like Peter Attia, people like Sarah Gottfried, Mark Hyman, all of those individuals I've just mentioned are thinking deeply about the question of what is the optimal glucose level.

We know we want to stay below a fasting glucose of 100 not to be labeled pre-diabetic, but that doesn't actually tell us what to shoot for, what's going to keep us thriving in our current day-to-day lives and also out of trouble down the road. So, this is where we really need to do some research. And I think part of the reason we haven't done that research is because our medical system is very much a reactive system.

We wait until diseases and symptoms have manifested before we intervene. And we are certainly moving I think more towards prevention, there's efforts with value-based care to really focus on the front end of health and I think that's great. But we need to be thinking about glucose when people are not pre-diabetic or diabetic, because that's where we can really move the needle on keeping people out of trouble down the road.

And so, you know, I think the more CGMs and data we can produce in a non-diabetic population, the more we're going to start to understand some of these trends.

There's a lot of people doing great like hard-core research on this... there's Michael Schneider out

of Stanford who wrote a paper last year or the year before about glucotypes, which was putting CGMs on a bunch of non-diabetic individuals and seeing all these different patterns and sort of subtypes of normal within the normal population and being able to start to predict which of those patterns responses to food, responses to different lifestyle variables, which of those are most predictive of problems down the road, how can we look at this glucose curve on a CGM data and actually make inferences about the future. Eran Segal's lab at the Weizmann Institute is doing similar stuff like that as well, looking at these patterns of glucose.

So we're not just focusing on these single time point measurements, like once a year fasting glucose, maybe once a year HbA1c if your doctor orders that and rarely a non-diabetic individual get an oral glucose tolerance test. So, we maybe have an A1c and a fasting glucose and that's just not enough to know the full picture of metabolic health.

So, some of these labs are trying to figure out how can this continuous glucose data stream maybe be predictive about the future outcome. So, there's super exciting stuff there. But optimal, bottom line optimal glucose levels is likely much, much lower than what we're seeing in terms of standard diagnostic criteria for a non-diabetic.

Bret: So, I think it's pretty clear that lower is better. Obviously as long as you're not symptomatically hypoglycemic. But lower is better. But then the question becomes, how hard do you fight to get it lower? So, is, you know, a postprandial response to 110 vs 99 a big deal? Is that a big deal? Like I guess, we don't really know. So, what kind of criteria do you give to your patients to say, this is what you should shoot for?

Do you give them hard numbers or do you tell them to focus more on just trends and patterns? Like how are you going to help your patients practically process this and define a goal?

Casey: Yeah, I think your first point about like how do we determine the difference between 110 and 99, that's a question that I would love for us to understand the answer to. And I think that some of the research we need to do to figure that out is to pair those glucose readings with other readings like insulin levels after meals, inflammatory markers after meals. What are the other actually downstream physiologic effects of those numbers?

Because it's going to be hard to just take those numbers and say one is good one is bad. But if we understand what they are generating in terms of maybe our stress response, an inflammatory response, an oxidative stress response and insulin response, this can get us farther down the road. So, I know that people are thinking about doing this research and I really, fully support that, because if you go to 110 and your insulin is shooting up to 30s, 40s versus a lower number, it's a totally different physiologic landscape. So--

Bret: Yeah. So that's a great point, so, sorry... Just a follow-up on that point then... I guess the next question then is, is glucose enough? Like is this even good enough for us if we don't have the insulin response? Because that's such an important part, but we don't have on demand insulin testing. So, is it even good enough as it is, or is it not quite there yet?

Casey: I think it's an excellent start, because it is so much more than we've ever had. The average person you walk down the street, ask them to predict what their metabolic health is or their glucose is, no one's going to have any idea. And you can go from that to essentially being an absolute expert in your glucose very quickly by using CGM and I think you actually can make some inferences about the underlying downstream stuff by tracking your glucose long-term.

So, for instance you might go to a post-meal glucose level of 110 and go up and come immediately back down and then stabilize the rest of the day. Or you might go up to 110 and stay elevated for an hour and then come down. Or you might go up instantly after a meal or you might actually not peak for an hour after your meal.

All of those little extra pieces of data actually tell us something about our insulin sensitivity and our insulin response. So, this is where these labs are really trying to figure out how does a glucose curve and the patterns within that curve tell us about the bigger picture? So, we actually translating that to simple, easy to understand information, we're not there yet, but I think as we do research pairing insulin levels to glucose curves and we're going to actually be able to use glucose as a much more viable predictive marker.

So, that's what I would say on that front; is we're not there yet, but glucose is a really amazing start. And I would just hope, for most people, what I'd like to see is that everyone is getting a fasting insulin level at least a few times a year and then pairing that with their glucose monitoring experience.

Because if you start with a really low fasting insulin of like two, three, four, five, versus a fasting insulin of 25, you know right off the bat, you're probably on a very different part of metabolic spectrum.

And I think your listeners are all very familiar with insulin, but just the basic concept there being that as we spike our glucose over and over again throughout our lives, produce insulin spikes over and over and over again throughout our lives, ourselves become numb to that insulin and our pancreas has to produce more insulin to get the same amount of glucose into the cells.

So, at baseline that fasting insulin will look higher if you're sort of farther down that spectrum. So we want to shoot for those lower levels and so by pairing that one piece of data with CGM, I think you can actually open up even more insight.

Bret: Yeah, I agree that it's so much better than anything we've had and I think it's so useful. And I want to emphasize the point you made that is not just the absolute number, but it's also the curve and the steepness of the curve and the tale, the length of the tail before coming to normal.

And that's what sort of highlights the importance of working with someone who knows how to interpret the data or working with a technology platform that can help you interpret the data, because it's not just all cut and dried. And one concept is this degree of glucose variability versus short of the area under the curve, meaning your average glucose.

And just to fine that a little bit... traditionally hemoglobin A1c has been used as a marker for danger of blood sugar and diagnosis of diabetes and that's an average of your glucose. But what it doesn't tell you is how high are the spikes and how steeper the curves. So, there's some evidence now that regardless of your average glucose, the high spikes may be more dangerous than chronically elevated but not high spikes.

So, how strong would you say is that evidence and is that something we absolutely need to pay more attention to rather than just our average glucose?

Casey: Yeah, absolutely. I think glycemic variability is going to be a term that is going to make its way into the zeitgeist and we're to be talking about it, on the tip of our tongues in five years. We haven't been able to talk about glycemic variability in the past because we haven't been checking

our glucose levels 24 hours a day.

We've just been pricking our fingers. You cannot assess glycemic variability by pricking your finger. Unless you are doing it 50 to 60 times a day, which my cofounder, my business partner has done in the past because he couldn't get access to a CGM. And so you can basically graph your own continuous glucose score if you're pricking your finger 50 or 60 times a day, but no one wants to do that.

Bret: Did he have to start using his toes if he ran out of fingers?

Casey: So many bruised fingers, yeah. So, glycemic variability refers to these up-and-down swings in the glucose throughout the day. And they can be from food, they can be from having a high spike and then crashing down and then having sort of like a bunch of bumps after that, as the body kind of plays tennis with insulin and glucose, insulin and glucose.

It can be from stress, you know, having a stressful conversation can give you a glucose spike. There's a lot of things that can do it, but primarily refined carbohydrates and refined sugars are going to be the big culprits there. So glycemic variability is an independent predictor of increased cardiovascular mortality and an independent predictor of developing diabetes down the road. So, in itself just having those swings is problematic.

And there's a number of physiologic mechanisms for this. Having a giant spike and drop of glucose is going to cause a lot of downstream issues. It's going to potentially cause inflammation, it's going to generate oxidative stress and free radical burn in the body, it's going to potentially lead to glycation; so sugar in the bloodstream sticking to other proteins and fats and structures in the body and actually sticking to those molecules causing dysfunction in interactivity.

So, glycation, oxidative stress, inflammation and then of course that high glucose spike is likely going to generate a much higher insulin spike as well and be just putting more gas on that pedal of pushing you towards insulin resistance if this is repeated over and over. And it also has pretty massive implications I think for the weight loss community in ways that we don't recognize yet. Of course people who listen to your podcast probably do it and anyone who's read Jason Fung's books.

But you can imagine if your glucose curve throughout the day kind of looks like a radio static wave or is just up and down, up and down all day, because let's say you got up and you had coffee with some milk, then had some sugar, you know, skim milk, a bunch of sugar, you added sugar to your coffee, then you had oatmeal, then you an apple later in the morning, then you had a white bread sandwich for lunch.

Then you had, you know, let's say we're trying to be healthy in the afternoon and had a bean salad, but beans really affect you, and then for dinner you have a white potato with a small piece of chicken and some ice cream, you have probably--

Bret: My blood sugar is going up just listening to this.

Casey: That is a totally normal, borderline someone might say "healthy day" of food. You know, coffee, salad, fruit, potatoes, you know, oatmeal. People might think they're really winning there, but what you might see on your glucose is just this up down, up down, up down. And from the weight loss perspective this is really interesting, because you're almost invariably spiking your insulin with each of those spikes.

And so, you can imagine your average insulin throughout the day is probably much higher than someone's who's eating a low glycemic impact diet, a personalized diet. And when that insulin is on, it's blocking fat oxidation. It's essentially saying you can't burn fat because the body registers that as, oh, insulin's around, which means you got tons of glucose for energy.

So why would we ever burn fat for energy? So, that is just thwarting weight loss efforts. So, glycemic variability for all those reasons, inflammation, oxidative stress, glycation, insulin resistance and just blocking fat oxidation, it's not what you want. You don't want the ups and downs.

Bret: You won't learn that unless you have a tool like a CGM. So I agree, that's so powerful.

Casey: Yeah, and one other just interesting factoid, you know, they've done some studies basically giving two different populations the exact same set of calories throughout the day, the same standardized meal and had some people eat it in a short window like 8 AM to 2 PM and then some people ate the exact same meals between 8 AM and 8 PM.

And the people who ate it in the shorter window had better overall metabolic parameters. And you can imagine thinking about glycemic variability, if you're compressing it, you're keeping that variability into a much shorter window versus like spreading it throughout the day. Every time you spike your glucose, your insulin has to go up and down.

So, if you're just spreading out those calories, you are just exposing the body to more time with that. So that's kind of, you know, another one-- There's many, many studies that really highlight this, but that's one that I always kind of come back to, of really trying to just tighten up the window that you are exposing your body to all these... molecules.

Bret: Yeah, and along those lines, one study that I thought was really interesting was when they looked at either having dinner at like 6 PM or having dinner at 10 PM with the same dinner. And when they woke up the next morning, their blood sugars were the same when they woke up, but their response to the same breakfast was totally different.

Which just shows there was like this carryover insulin resistance even for the group that had dinner at 10 PM. That they had a much higher blood sugar spike to the same breakfast the next day, which I think is so interesting. How that is not just affecting you in the moment, but is affecting you over time, which is so interesting.

And I really like about what you said, how you sort of brought it back to the inflammation, because we sort of started this whole conversation with you noticing these chronic inflammatory conditions. And then we kind of started talking about metabolic health and glucose.

But what we just talked about there, with the glycemic variability, brought it right back to the close circle of how that leads to the chronic inflammation and I think that's such an important point to make that it may seem disconnected. We're talking about glucose, we're talking about inflammation, but they are-- not always but many times, especially when it's in a dis-regulated system, they are absolutely related, so that was a great summary there.

Casey: Yeah, absolutely.

Bret: So, now moving on, I want to make sure we get into some really practical advice and some specific questions. So, are you ready for a little rapid-fire question and answer here?

Casey: Let's do it.

Bret: All right. So, what do you tell patients are your goal blood sugars and what's the number one advice that they need to pay attention to when they're checking their blood sugars?

Casey: Yeah, so my goal ranges... so these are really based on my review of the literature. I will caveat this by saying these are not standardized. This is what I shoot for and my interpretation of the research out there. And most of this is coming from reviewing the six or seven main papers where they put continuous glucose monitors on healthy individuals, tracked their glucose over time and saw what the glucose does.

And when you look at the-- no intervention, just observational studies. And when you look at these studies, what you find is that for healthy populations who do not have pre-diabetes or diabetes, people tend to spend about 90% to 95% of their day between a glucose of 70 and 120. In some studies that's a little bit more liberal and you'll see 70 to 140, but people are spending less than 1% to 2% a day above 140, or below about 60 or 70.

So, really just to start, we're tightening up that range of just stick below 140 after meals. We're tightening it now to 70 to 120. So, that sort of one thing I'll start with. The second thing is there's been some interesting research showing that as fasting glucose increases even in the normal non-diabetic range, which is a fasting glucose less than 100, you actually see that as your glucose goes up from 70 to 100 in the normal fasting glucose range, you actually increase your risk for multiple diseases.

So, as you get closer to that 100 threshold, you increase your risk for diabetes, you increase your risk for ischemic or hemorrhagic stroke and a number of other conditions. So, there's evidence that being in a much lower, tighter fasting glucose range, probably in the 70s to 80s, is going to be where you want to be for reducing your risk for chronic conditions down the road.

And then knowing what we know about glycemic variability, we also want to keep those post-meal spikes pretty tight. So, I tend to recommend to people that they want to have a fasting glucose between 72 and 85 mg/dL, want to keep their glucose between 70 and 120, ideally 70 and 110, because when you sub-stratify some of these studies and look at the healthiest people in those studies, it's really more between 70 and 110.

So, sticking between 70 and 110 pretty much for the whole day and I don't really like to see excursions, so post-meal glucose spikes, more than about 15 to 20. So, really solidly under 110 for the day, ideally in the 80s at baseline and getting your morning waking fasting glucose and you haven't eaten any calories about eight hours between 72 and 85.

For me personally I like to be a fasting glucose low 70s, I keep my average glucose height, so 24-hour glucose, in the high 70s to low 80s and rarely trying to go above 100. And that's just from years of experimenting with this.

Bret: So, that was a terrible answer for a rapid-fire Q&A. But it was a great answer, but it was a fantastic answer. So it was my fault for even trying to do a rapid-fire, because you just have too much knowledge and that was a wonderful answer and I want that details. So, forget the rapid-fire.

Casey: No, no, we'll get back to rapid-fire, sorry.

Bret: No, because that was a great answer. And my next question might be even harder for rapid-fire. So, the next question is people, especially if they're following a low-carb diet, will find that they wake up with blood sugars of 100, 105, 110 and think, oh my goodness, based on these

definitions I am pre-diabetic, based on my waking blood sugar.

But then they may find that that's their highest blood sugar of the day, and then you look at that the literature, though, and the literature says if you wake up with elevated blood sugar and have a dawn phenomenon, you are more likely to go on to develop type 2 diabetes. But those studies weren't done in anybody following a low-carb diet. So, what is your take on this specific situation that has some people very worried?

Casey: This is such an interesting question and I wish I had Ben Bikman here to back me up, because he thinks about this really, really deeply and he has a term that he talks about, what is called reverse metabolic inflexibility, where you see sort of a paradoxical glucose rise in people who are on a low-carb diet.

And we really don't know if that's-- what the clinical implications of that are, but I suspect that it may ultimately has to do with glucagon and sort of changing other-- glucagon has an impact on our glucose levels and it's sort of an antagonistic way to what insulin does. And so, low-carb diets may affect some of our other hormones to keep that morning insulin, that baseline insulin a little bit higher, but it's hard to know... these people are likely keeping their insulin levels very, very low.

And we know that insulin is really... insulin is really the devil in the details here. Glucose certainly has its own problematic effects, but insulin, the downstream effect of high glucose, is what I think is causing the majority of the damage that we're seeing in chronic disease. So, the bottom line is really hard to know.

I suspect that there is some different physiology going on with our hormones that makes it probably not something to be a huge cause for alarm, but we have to do more research in that population, this paradoxical sort of glucose elevation in the context of low-carb diet. Study the hormones, study the inflammatory cytokines, study the oxidative stress and see whether it's a problem or not. But we just don't know.

Bret: Yeah and I think that's a great point you brought up about the difference between, say, a fasting blood sugar of 108 with an insulin of 35 and a fasting blood sugar of 108 and an insulin of two. Those are completely different physiologic circumstances that, like you said, we don't have perfect evidence to say that they have different implications, but, gosh, it sure makes sense that they would have absolutely different implications.

And that also goes back to the glucose variability, because if that's one of your highest blood sugars in a day and you're not having postprandial glucose spikes, hard to imagine that that signifies anything concerning from a glucose standpoint, at least from my standpoint. So even in the absence of literature, would you disagree with that or agree with that?

Casey: I agree completely. And with that type of patient in my own practice what I would be doing is I'd be ordering some of these other tests. I'd be definitely ordering a fasting and a postprandial insulin levels, I'd be ordering potentially glucagon levels, I'd be ordering oxidized LDL, I'd want to see is there any downstream oxidative stress we need to be worrying about.

I'd be ordering some inflammatory markers, CRP, maybe an inflammatory cytokine marker, but that would be a little extreme, but just seeing like what's the other context of these numbers. It's very hard to interpret them in the context of an unique diet in their own right.

And so, there's just a lot of physiology there, and the nice thing is that we can probe a lot of that.

There's other things, you know, uric acid... There is not a lot you can look at.

Bret: So, if someone's listening to this podcast and writing these labs down and they bring them to their doctor and say, doctor, I want these labs... They are going to just look at them like they had two heads and they're not going to know what to do with it. So, what kind of advice can you give to patients if they are in that type of situation?

Casey: Totally, yeah... I think if someone is at home checking their glucose levels on a low-carb diet, which is the finger prick, which I know a lot of people are starting to do now, just check even a fasting glucose or a post-meal glucose, and let's say you're seeing some concerning numbers... the things I'd probably recommend for like low hanging fruit would be to potentially check ketone levels, see what's going on with the ketones...

And things that I think a doctor would potentially order is a fasting insulin level and a CRP, which is C-reactive protein, which is an inflammatory marker. And maybe a cholesterol panel, take a look at triglycerides, LDL, and if you're lucky maybe an advanced lipid panel, which is going to look at some more complex markers. But CRP, fasting insulin, maybe check some ketones and kind of get a picture of where you're at in the fat oxidation, you know, insulin inflammatory realm.

And I think most doctors would order an insulin and a CRP and that will give you a lot of information. Because I do think if your insulin is quite low in the context of those slightly elevated glucose, you have a lot more information there, that certain pathways are-- I'd be curious from your perspective if you have any others that you might probe.

Bret: Yeah, I think for the person going to their general doctor, it's so easy to get them confused and frustrated with asking for too many things that they feel like they can't order. So, I think the ones you mentioned are perfect to get started.

Definitely the fasting insulin and a CRP I think would be helpful, and correlating that with your blood sugar check if you can like at the same time will be so helpful, yeah. So, next rapid question. Are these devices good enough to really give us the level of detail and granularity that we're looking to get?

Because like you said, they were started for patients with type 1 diabetes and basically to make sure you're not 60 and going to have a hypoglycemic coma, which can happen at a level of 60 for people with type 1 diabetes or 300 and going to get DKA. They weren't really meant from the beginning to tell the difference between 90 and 85. So, is the technology good enough to really inform us to this level?

Casey: Yeah, it's a great question. I mean this technology is FDA approved for treatment of diabetes and so it is deemed by the FDA to be precise enough for the management of these conditions, in times when this can be, you know, a life or death situation. So, I certainly I have faith in the hardware.

There are interesting intricacies about the hardware that is important to know about. And you can look up some of the validation data for the hardware itself actually online; it's all published. And you can go to the FDA; there's is this SSED documents, which is a summaries of safety and advocacy documents.

And they are fascinating reads... Of course, because I'm passionate about this, dug deep into them, but on page 16 of the one for the Freestyle Libre, which is one of the three hardware man-

ufacturers, it's a continuous glucose monitor, it will show you the exact accuracy of these sensors at different ranges.

And what you'll find is that these devices are optimized for more of a diabetic glucose profile. So, for between about 120 and 200, you're going to have the most accurate readings. And as you get below 120 you're actually going to see more variance between the interstitial CGM monitor glucose and the blood glucose.

And there's going to be the lowest overlap at very low numbers, like 50s and 60s of glucose. That's where you can sometimes see a 20 point delta between actual glucose and interstitial glucose. So, at lower levels they tend to be slightly more inaccurate, but what you'll find is that the delta, so a pre-meal and a post-meal... that difference between the two will generally be quite accurate and that delta I think is very important to know.

So, the key points are they are increasingly inaccurate at lower values, they are really primed to that like 120 to 200 range. That's where they're going to be most accurate. And there are sensors like the Dexcom, which is another piece of hardware, that allow you to calibrate with finger sticks.

You can get the most accurate... So, the Abbott is not calibrated, it auto-calibrates. The Dexcom, which is another brand allows you to finger stick and calibrate. So, there's a lot of ways to get it as close as possible. And I think the future generations of hardware are just going to get more and more accurate.

From what I've heard, the new Libre, which is Libre 2, which was FDA approved in June, their SSED I don't think is out yet with all this data, but from what I've heard in the pipeline it's going to be more accurate at lower values. So a lot of progress on the hardware front, but those are some of the key things to be aware of.

Bret: And I think just a simple advice can be when you're first starting out, maybe it is worth checking your finger sticks with the more accurate monitor just to see what the variance is and see if there's a consistent variance so you can know to make adjustments in your brain based on the findings. I think that could be good advice sometimes.

Casey: Definitely.

Bret: We are sort of near the end of our time, but I have another question here and then we can wrap it up. So post exercise, or during exercise rather, a number of people can see their blood sugar go to 120, 130 during a hard interval training session and they're concerned about that as well.

As the high blood sugar is something you want to avoid and here it is doing something that's supposed to be good for me. Is this something I need to worry about? So, what's your advice there?

Casey: Yeah, it's a really interesting mechanism that's going on, which is that high-intensity exercises, so heart rate or VO2 max above the sort of 70% and 80% range, people will see this odd paradoxical rise in their glucose levels that can sometimes be big, like 40 points, 50 points. And this can even be in fasted states.

So no power bar or drink, you know, protein drink before the workout. The mechanism of this is that when you start doing that high-intensity workout, your body senses physical stress, so your body will release catecholamines and cortisol and those hormones, those stress hormones are

telling your body there is some stressor, we probably need energy for our muscles.

Let's dump it out of our stored bank of glucose, which is the liver, get into the bloodstream so that we can feed those muscles. And so this is actually a physiologic adaptation to what our body perceives, as a physical stress that we need energy for. So it is not likely that those exercise-induced spikes are going to be detrimental for metabolic health in the way that food related spikes are.

They are going to have a different impact on insulin and the muscles are primed and ready to be a sink for that glucose. And so there's just this sort of temporary mismatch in the bloodstream where you are producing a lot of liver glucose and then, you know, there's some time before your muscles use it, but the muscles are able to take up that glucose rapidly and even in an insulin independent way.

So, just the contraction of the muscles can allow you to actually take up that glucose without the insulin by mean to bring it in. So it's a very different physiologic process. And the research on high intensity interval training powerlifting, these activities actually can rapidly improve our insulin sensitivity.

And people who even do a single hit workout can see an improvement in insulin sensitivity over the next 24 hours. And so those effects are only compounding over time. So, it appears that these activities are net-net positive for metabolic health. And sort of hormetic types stressors that are putting our body under this acute stressor, but ultimately with advantageous adaptive downstream effects.

Bret: Yeah, great answer. And it again goes back to the elevated blood sugar with elevated insulin or elevated blood sugar with lower insulin and a completely different physiologic response. So, such an important caveat to understand that there are different circumstances where you need to pay more attention or less attention to it.

But this has been sort of a whirlwind tour of metabolic health, CGMs, how people can use it and what literature is behind it. You clearly are passionate about this and have so much knowledge about it. So, how would you summarize any last advice to people and then of course where can they find you if they want to read more about you?

Casey: Yeah absolutely. So, I would just summarize it by saying, you know, metabolic health is a spectrum. We can all move in the right direction on that spectrum. Research shows that most of us are probably not in the best place on that spectrum and we may not be seeing the overt signs of that, but it still can be brewing under the surface.

Then I guess one last thing I would kind of leave people with is that that glucose variability and that moving along the spectrum can be related to a lot of pain points in our life that we don't typically associate with blood sugar... so, things like mood lability, brain fog, low energy, poor exercise fatigue, even things like acne and things like infertility, these are conditions that we know are related to glucose even though we're not diabetic.

And so there is just a whole host of things that we can improve in our lives by tightening up glucose and of course the downstream effects of chronic disease, the heart disease, stroke, diabetes, obesity, nonalcoholic fatty liver disease, etc. cancer, dementia.

So, really it's worth thinking about and learning more about and in that vein, I write a lot about this

on our website www.levelshealth.com/blog I write all about metabolic health for the non-diabetic student, the person who wants to learn about this, from the perspective of why we should think about it now. And I also write a lot about this on Instagram and Twitter, @drcaseyskitchen

And there I talk about metabolic health and using glucose biofeedback to personalize our diet and lifestyle. And so, yeah, I would like to connect with anyone on those platforms.

Bret: Great, well, I am very excited to see what the future is going to bring for CGMs and how much people are going to learn from it and how it's going to change the whole concept of how we view nutrition and metabolic health. So, thank you for all you're doing to help further the information behind this and really push this cause and I really appreciate your passion. Thanks for joining me today.

Casey: Thank you for having me.