MIGRAINE WORLD SUMMIT

TRANSCRIPT

INTERVIEWS WITH WORLD-LEADING EXPERTS

IS MIGRAINE A BRAIN ENERGY PROBLEM?

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Introduction (00:05): Now there's actually one common denominator for basically every single migraine trigger that I can think of, and that is oxidative stress. Even perfumes, bright lights, loud noises, altitude, alcohol, exercise. All of these have negative impacts on these oxidative stress molecules, so the “bombs.” And the bombs, in turn, impair energy metabolism. So that is the common link on all of these.

Carl Cincinnato (00:31): Migraine is often described as a neurological disorder or disease, but not so long ago, researchers believed it was a vascular disorder. Today, emerging research suggests an entirely new theory for some people: Could migraine be a metabolic disorder due to energy deficits in the brain? And if true, what implications does it have for treatment and management? Today we have the author of several research papers that discuss this hypothesis and the potentially groundbreaking approach. Her work was also featured at the most recent International Headache Conference. Dr. Elena Gross, welcome to the Migraine World Summit.

Dr. Gross (01:06): Hey, Carl, it's great to be here. An honor and a pleasure. Looking forward to talking to you.

Carl Cincinnato (01:12): What is our metabolism?

Dr. Gross (01:14): Well, metabolism, in very simple terms, is how you turn what you eat into energy. Plants are using oxygen and light to make energy. Humans need to get energy from foods, as you know, right? And metabolism is more than that. But in very simple terms, it's how you ingest, digest, and then transport those micronutrients — so the fats, the sugars or carbohydrates, the protein — and turn that into the energy currency of the body that is called ATP [adenosine triphosphate]. And ATP, or energy currency, is basically what makes everything you do possible — whether you move your hands, whether you talk, whether you think. Anything you do in the body requires this ATP, and metabolism is basically how we get from the foods to this energy currency that can be used in all of the body to support living.

Carl Cincinnato (02:04): What is a metabolic disorder?

Dr. Gross (02:06): So, it's a problem with either turning the food into energy — or the energy, the powerhouses in the cells that are turning — that are basically making energy. Metabolic disorders, for example, are mitochondrial dysfunction diseases, right? Inborn disorders of metabolism can be either in how you digest the food — for example, you do not have certain enzymes, you cannot digest or burn fatty acids well — these are disorders of metabolism. You have a problem in turning the food into energy in one of those intricate, very complicated stages. Now, when you get into the cell, now you have your macronutrients — you have your proteins, your fats, your glucose — that now gets into the cell. Now it needs to be manufactured into the ATP energy currency. Now this requires powerhouses — a bit like making electricity — and these are called mitochondria. And with mitochondria, a lot can go wrong, as well. Mitochondria are responsible for making the energy in a very efficient way.

Carl Cincinnato (03:08): So, it sounds like it can get very complicated very quickly when it comes to metabolic disorders because it's such an intricate process that it has so many different steps. But essentially, it's converting what we eat into energy, and that energy then supplying the essential functions that the body has to perform. And you mentioned the mitochondria. This is something that comes up in other contexts, in other conditions, as well. Can you tell us — I know you define mitochondria for us — but can you tell us again what is mitochondria and glucose, and how do they kind of relate to each other?

Dr. Gross (03:44): The mitochondria are these ancient bacteria that are now in our cells, and they're the powerhouses that make the energy. Now they can make energy from different so-called substrates. So, one thing that I was taught all the time is that especially brain cells use primarily glucose as a fuel. So, glucose is one fuel source that can be fed in the mitochondria and then by various steps be converted into this ATP currency. But they can also use other substrates. For example, ketone bodies, which is another fuel source that the brain can use. Short-chain fatty acids (SCFA): So, these are not derived from the carbohydrates, but from this other source of energy-dense molecule group — the fats — they can turn into ketone bodies. And fats directly can also be so-called oxidized to go into the mitochondria and provide energy. So, glucose or fats, those are basically the fuel, the coal, the sun rays, the water energy that goes into the powerhouses to then make energy.

Carl Cincinnato (04:47): Right. And so glucose comes in the food that we eat?

Dr. Gross (04:51): Yes, glucose comes in the food that we eat. Or actually, when it comes to glucose, the body can also make its own glucose, which is very interesting.

Carl Cincinnato (04:58): So, we've got this complex process in our body called the metabolism. How might it relate to migraine?

Dr. Gross (05:05): When you look at how we have looked at neurological diseases, we kind of always think that the brain is somewhat separate from the body, which is to a degree, true. But the brain also needs to eat; the brain also needs energy to function. The brain is protected by something called the blood-brain barrier (BBB). Only very few selected small substances can get in there so that we don't have pathogens coming in as easily, or toxins. It is shielded, which is great, but that means only glucose, small energy molecules, ketone bodies, and lactate can make it into the brain. So this is what makes the brain special. And the other thing that makes the brain special when it comes to metabolism is that it is dependent mostly on energy supply. So, it cannot really store energy. So the energy has to come from outside. The brain is very vulnerable to any energy shortcomings.

Dr. Gross (05:56): Now, how are metabolism and migraine connected? There's a lot of different evidence that suggests that migraine could be a warning signal. In a large proportion of people, I believe it's warning you from too much oxidative stress, too many free radicals, or an energy deficit in the brain —that metabolism mitochondrial dysfunction is not functioning well in migraine. And we know that [people with migraine] have a hyperexcitable brain — a brain that doesn't habituate — a brain that has a lot of energy demand because it is spending more energy, paired with a malfunctioning or suboptimal metabolism.

Carl Cincinnato (06:31): So, there was a lot in that response. I'll see if we can play it back for the audience. So, the potential link between the metabolism and migraine has to do with the amount of energy that's produced. And the migraine brain may require more energy than the average brain because of the way we interpret stimuli, or there may be some dysfunction within our metabolism. Either way, there's an imbalance of energy that can occur. But your hypothesis is that a migraine attack may be the brain's way — the body's way — of resetting the system to rebalance the energy. You said homeostasis, which is the balance of the energy within the body.

Dr. Gross (07:09): And interestingly also what has been shown is that during a migraine attack, if you trigger an attack, for example, with a lot of glucose, you can trigger an attack as much as with fasting or lack of oxygen — all of which are kind of metabolic triggers — even exercise,

right? These are ways we know that we can trigger a migraine attack. So if you look at the whole cycle of the migraine attack, it fits very nicely with those different pathways that the migraine is actually trying to protect us rather than being this nuisance that is trying to harm us.

Carl Cincinnato (07:41): So, you mentioned oxidative stress. Can you tell us what that term refers to?

Dr. Gross (07:44): Oxidative stress is also necessary in some degree. When you are producing energy, you are always making some degree of oxidative stress. And as long as you have antioxidant enzymes — which are like the catchers of the bombs or the bomb neutralizers — as long as you have enough of those, it is good to have around, right? When you do exercise, that increases oxidative stress. When you produce energy, that increases oxidative stress — it increases the bombs. As long as you can catch the bombs, you're good. Now, with a migraine patient, the problem is that very often the antioxidant capacity — the bomb neutralizers are not as plentiful as the actual bombs or the free radicals, the oxidative stress. So oxidative stress are small bombs that are destroying even the powerhouses themselves. So the more oxidative stress you have, the less energy you're making. So it's a vicious circle, really, and that's an important term to understand if you are a migraine patient.

Carl Cincinnato (08:41): So, how much of this sort of scientific appraisal that you've given us is hypothesis versus what's been researched and has been demonstrated as evidence? So, how much support is there for this hypothesis that migraine could be considered a metabolic disorder?

Dr. Gross (08:58): So, I'm going to be hesitant to say that migraine is a metabolic disorder, period. I would be saying that for a larger proportion of [people with migraine] — for a subgroup of [people with migraine] — a malfunctioning metabolism can be at the root cause of the problem. Not that it's the only thing that matters for them — for maybe a smaller proportion, it will. But malfunctioning metabolism in migraine — I think there's a lot of evidence already, and this was published in *Nature Reviews Neurology* in 2019 with Jean Schoenen, who is the No. 1 expert on migraine and metabolism. He's published about a thousand papers on the topic. So there's quite a lot of research. But migraine is a very, very complex multigenic disease, meaning that my migraine is completely different from yours; it's completely different to you who are watching online. There's a lot of small polymorphisms — small changes in genes — lots and lots of genes that together are leading to the phenotype of migraine.

Dr. Gross (09:56): So for you, it might be that your glucose uptake into the brain is not very good. For me, it's my mitochondria that are broken. For somebody else, it might be their female hormones that are “off-wrack,” right? So it's not a one pathway problem for everyone. Now, is migraine at least partially a metabolic disease? Is that only a hypothesis? I would say it's between a strong hypothesis and evidence-based right now, just because it's not yet in the diagnostic guidelines. And there is a lot of research, but it's not something that is common knowledge just yet, and it hasn't been entirely accepted, but I think it will be in maybe a decade or so. And I strongly believe that there has to be a subgroup of migraine — an official one that we can diagnose based on biomarkers in the blood — possibly that is metabolic migraine. And it will be in two-digit percent — maybe around 50% of people — that may profit from such an intervention, in my opinion. But that also needs to be validated by more research.

Carl Cincinnato (11:06): So even though the research is fairly in its early stages, some of your research was presented at a conference in September 2023, the International Headache

Conference. How has your research or this hypothesis been received by professionals in the field and medical societies?

Dr. Gross (11:23): I must say I was very surprised that *Nature Reviews Neurology* published this already in 2019 because it is one of the highest-ranking journals that has a lot of scrutiny. And that was a surprise to me, honestly. Until then, of course, experts are skeptical because it is new, not as accepted. But I think the more people read into the science, the more surprised they are that this was actually fairly established, let's say 70 years back. Even in 1935, migraine was referred to as the "hypoglycemic headache." As you already summarized, the whole field shifted towards it's a neurovascular issue, and now it's a neurogenic issue, and it's just whatever is kind of fashionable right now. So, a lot of the research we're now coming up with, or digging up, for the review was 50, 70, 100 years old. So, we're kind of reigniting the interest of metabolism in migraine.

Carl Cincinnato (12:18): What are some of the signs of having an insufficient supply of energy to the brain? Is there a way that we can tell?

Dr. Gross (12:25): Yeah, so I guess one way to tell is if you're constantly fatigued and tired; if exercise makes you feel worse, not better; if you have frequent food cravings, especially for sweet, salty, or fatty foods; if you wake up in the morning and you feel like a truck has run over you, that's another good sign; if you have very frequent migraine attacks as well, [that] can be a sign.

Carl Cincinnato (12:46): Hypoglycemia is something that you mentioned earlier. That occurs in diabetes when the blood sugar and glucose levels fall too low. Is hypoglycemia common in people with migraine?

Dr. Gross (12:58): I would say yes. So especially if you look at premonitory symptoms, which are cognitive difficulties, cold hands and feet, yawning, fatigue, thirst, craving for sweet things, all these things that we know are happening in the premonitory [phase] — the phase that precedes the headache phase — that is, basically, one-to-one, the symptoms of hypoglycemia. And the problem with migraine, I believe, is reactive hyperinsulinemia —that is a complex term again. It basically means that if you have a lot of sugar at once, your glucose spikes. Now, in migraine, the insulin that is required to get the glucose into the cells — so the insulin being the taxi driver that brings the glucose into the cells — is coming very late, and then there's too much of it. So then, after that high glucose meal, you dip into hypoglycemia — too little blood sugar — because there's an overreaction — I think in a fraction of migraines at least that is a very common problem. And it's also I believe why, for example, with a glucose tolerance test, if you give 150, 100 grams of pure glucose, you can trigger migraine in certain migraine patients.

Carl Cincinnato (14:06): How do migraine triggers, such as certain foods, or fasting relate to our metabolic processes?

Dr. Gross (14:13): Now there's actually one common denominator for basically every single migraine trigger that I can think of, and that is oxidative stress. Even perfumes, bright lights, loud noises, altitude, alcohol, exercise. All of these have negative impacts on these oxidative stress molecules, so the bombs. And the bombs, in turn, impair energy metabolism. So that is the common link on all of these.

Carl Cincinnato (14:40): Are there any metabolic markers or tests that can predict or correlate with migraine occurrence or severity? I mean, you mentioned biomarkers before. Is that something that we know?

Dr. Gross (14:50): Yeah, so there's only very little research gone into this. We did one study: a small study that suggests that elevated inflammatory markers such as a marker called CRP [C-reactive protein] and then the long-term blood sugar — how much blood sugar you have over a three-month period in your blood [hemoglobin A1C or HbA1c] — as well as phosphorus, can predict in our small study in Basel in Switzerland, who is responding to this ketogenic metabolic intervention and who is not. But this needs to be validated.

Carl Cincinnato (15:20): Are there any genetic links between metabolic disorders and migraine?

Dr. Gross (15:23): I'm sure there are. So, for example, in this MELAS syndrome [mitochondrial encephalopathy, lactic acidosis, and stroke-like episodes], which is a metabolic and inborn mitochondrial disorder, there you have 30% of them [also] have migraine. So whenever there's mitochondrial dysfunction, migraine increases, and in turn, in migraine, we do see some mutations in genes. For example, with antioxidant enzymes. So SOD2 (superoxide dismutase 2), for example, has come up. There [are] also mitochondrial genes [that] have come up clustered in the brain that could play a role, as well in migraine — so this mitochondrial piece. And then there are also enzymes that tend to be more mutated in migraine. And neuroimaging studies — that's not genetic, but neuroimaging studies have shown less energy in the brain, as well, in migraine, even between attacks.

Carl Cincinnato (16:12): Are there any specific populations or demographics that tend to show more of an inclination to this type of metabolic aspect of migraine?

Dr. Gross (16:22): Well, for one, mitochondria — your powerhouses — are inherited [from] your mother. So whenever you got migraine from your mom's side of the family, I believe it's more likely that you have metabolic migraine or a metabolic issue.

Carl Cincinnato (16:35): So, let's talk about something you've mentioned a few times: the ketogenic diet and ketosis. For people that have never heard of these terms before, can you explain what they are?

Dr. Gross (16:45): Yeah, so let's start with what is ketosis. Ketosis is the state in the body where ketone bodies in the blood are elevated. Ketone bodies are [short]-chain fatty acids that are produced, for example, with your fasting, from your fat tissue in the liver. The liver breaks down the [long]-chain fatty acids (LCFAs) and makes small molecules — ketone bodies — to sustain the metabolism of the brain and the heart when glucose is sparse because we're not eating, we're fasting. A fasting-mimicking diet is today called a ketogenic diet. Here, you basically mimic what the body is doing when you're metabolizing, when you're eating your own fat stores. So it is 75% to 80% of your calories are coming from fats. Then you have 15% or so coming from protein. So that is a ketogenic diet. It's a diet that severely limits carbohydrates, moderates protein, and increases fats to meet your caloric needs, to mimic fasting without having to fast in that sense. And that will then increase the production of ketone bodies in the liver. So it will just make ketone bodies out of the fat that you're eating, rather than your own fat stores.

Carl Cincinnato (17:53): How does it link to our metabolism? And how does it potentially help address people with migraine who may have a metabolic disorder?

Dr. Gross (18:01): Yeah, so why are they even relevant? So there [are] several mechanisms [that might explain why] ketone bodies could be relevant for migraine. These ketone bodies are actually also a signaling molecule, a bit like a hormone. You might've heard of a hormone that is transferring a message from one part to the other part of the body. Ketone bodies are anti-inflammatory, so that means they reduce inflammation in the body. They can change gene expression — which genes are read and which are not, which genes are turned on and off. Ketone bodies can influence that. They increase so-called mitochondrial biogenesis, just meaning that they can increase the number of powerhouses you have in your cells, which in turn means more energy. But also very relevant for migraine is that they seem to be reducing the excitability of the brain. So they reduce the likelihood of neurons to fire — so your brain becomes calmer in a sense, which is super relevant for epilepsy, which is overfiring of neurons, but also for migraine, which is also overfiring of the neurons.

Dr. Gross (18:57): And then they can also, for example, [produce] d-beta-hydroxybutyrate [D-BHB]. That ketone body — one ketone body — is very close to butyrate, [which] our gut is producing, so they can potentially even help with gut function. And all of these mechanisms together, because there are so many potentially migraine-protective mechanisms of ketones — ketone bodies — means that even though migraine is a very complex disease and I might only have three of those mechanisms and you have a completely different, four or maybe two or whatever, it means that ketone bodies have such many pathways they can influence that it may be a good tool for quite a lot of migraine patients.

Carl Cincinnato (19:40): There's been a lot of discussion about the ketogenic diet. It's been around for a little while. It's not an easy diet to [follow]. Is that something that is sustainable for people with migraine?

Dr. Gross (19:50): I know that some people are actually really successful at it. I also know that not everybody has to be ketogenic. So there is another way: So more recently, there's the possibility to add these ketone bodies, exogenously — add them via a supplement or a medical food — and sparing your liver in that sense, at least for a while until it has recovered. That may be an easier solution for quite — some people.

Carl Cincinnato (20:16): I know that there are a lot of people with migraine that have taken a lot of medication over the years because we've tried to find something that helps, and we've had to take a lot because we've had a lot of pain. So I don't think we're to blame for that. But it does mean our liver has been working pretty hard for a pretty long time, for many of us. And so the ketogenic diet puts a little bit of extra strain on the body. But what you are saying is that we can get these ketones exogenously without having to go through the strain of a ketogenic diet. And one way to do that is through these exogenous ketones.

Dr. Gross (20:46): Exactly. I want to say a bit of caution when you talk about liquids. There are different forms of how you can get those exogenous ketone bodies. Exogenous just means it's not your liver making it — it's made in the lab — but there can be forms that are bound to an alcohol, butanediol. So, a lot of those ketone esters are bound to an alcohol, which means that your liver is back in the picture, needing to metabolize the alcohol into a ketone body. So that puts extra stress again on an already stressed, potentially stressed liver. So I would personally not recommend using ketone esters in a migraine [context]. Also, not butanediol, just because, again, the liver needs to put in work and the liver might already be struggling. Better for me always is to use something that is human-identical, that is the substance that your liver would make directly, which is the d-beta-hydroxybutyrate.

Carl Cincinnato (21:36): If we're taking an exogenous ketone that is hopefully a high-quality one —if we are exploring this option — does eating a regular diet that has carbs reduce the benefit of having these ketones?

Dr. Gross (21:53): That's a very good question. Now, what I would always recommend is no matter what you do, no supplement, drug, or whatever can outdo the bad consequences of a bad lifestyle diet. So, a whole-foods — at least a low GI [glycemic index] — diet is something that I would recommend. We don't have the data to see what happens long-term. In our trial, people have been on their standard Western diet, so they were not even reducing sugar or anything, and we gave the ketone bodies on top of just their normal mixed diet, and that still had a positive effect. So, the question is really: What is worse? Is it worse to have no ketone bodies and high glucose? Is it better to have ketone bodies and high glucose? Or, I guess we all know the best would probably be to have no sugar and ketones. But maybe not for always, right? So, one thing to keep in mind is you always have glucose in your system. Your brain always needs its energy — 30%, 40% —from glucose; otherwise, you're dead. So having glucose and ketone bodies elevated or around at the same time is the normal state.

Carl Cincinnato (22:58): In your research that was published in the [*Nature Reviews Neurology*], you outlined four steps that you mentioned to improve mitochondrial function and energy metabolism in migraine. One of them was to individualize supplementations and micronutrients; reduce oxidative stress and increase antioxidants — we've spoken about that with diet and lifestyle factors; stabilize blood glucose, which we've also spoken about; and provide an alternative energy substrate for the brain, which is what ketone bodies and [D-]BHB is. So, coming back to individualized supplementation and micronutrients, are there specific minerals or supplements that we can take to help regulate metabolic imbalance and reduce potentially migraine attacks?

Dr. Gross (23:43): Yeah, great question. So, ideally, it's the individualized piece, right? You would go to a functional medical doctor who is checking your blood for any deficiencies in trace minerals, minerals, fat-soluble, water-soluble vitamins, as well as antioxidants such as CoQ10 [coenzyme Q10], or omega-3 fatty acids, and so on. And then you tailor what you're taking towards that. Now, that costs money. It needs availability of functional medical doctors and all these lab tests. So that may not be available for everyone. So, if you cannot do this, I would try to take a multivitamin with antioxidants — the very complex formulation that also tries to use human-identical versions, again, bioactive versions of those vitamins and minerals, so that you don't just make expensive pee. Because 95% of supplements actually have inactive versions of those substances because the consumer doesn't know — I didn't know — and they're then cheaper, and then they just make expensive pee because a patient doesn't have the energy in the enzymes oftentimes to convert most of these nutrients into a form that we can use. So that would be my tip.

Carl Cincinnato (24:47): And we spoke about lifestyle to some extent. Beyond the diet, are there any lifestyle changes that we can make that can help address the metabolic aspects of migraine?

Dr. Gross (24:58): Yeah, fantastic question. It's actually so much more than diet. For example, there are so many things that can increase this oxidative stress — those bombs — free radicals out there in our world currently. One is blue light. Blue light that we have on screens and phones — and everybody's on a screen, on the phone all the time — increases oxidative stress in the eye and through the skin, even. So blue light glasses in the evening and is an absolute must — an absolute must for people with migraine, in my perspective. Everybody should get [a

pair]. It will put a lot less strain on the eyes and metabolism in general. Then we have toxins: toxins in cleaning products, toxins in makeup for women, toxins in perfume. Perfumes are unregulated; they have all sorts of crappy stuff in there, and these odorants go directly into the brain via the nose because the blood-brain barrier is broken in the nose; otherwise, we couldn't smell. So chemicals can go directly in there, which I believe is also why perfumes are such a potent migraine trigger — and cigarette smoke. So getting rid of toxins, try more organic, more natural products in the household, in cosmetics, and also in food.

Dr. Gross (26:00): And then it comes to a psychological stress reduction because psychological stress also increases oxidative stress. Chemical, physical, and psychological stress on a cellular basis can be very similar — something that I would've never thought — it's OK to say goodbye or [let] things go that are no longer benefiting you. So as a migraine patient, one tends to be very selfless, but in the end, it's very important also to clean up all your psychological or relationship stressors — saying "no" at work, and so on. Maybe psychotherapy if it helps, if you have some things that are unresolved. Getting your eight hours or whatever you need of sleep to restore and give your body some time to catch those bombs and free radicals and clean up the waste. And air and water. Again, making sure you have mineralized, high-quality, toxin-free water. Water isn't just water. That's something that I didn't know, as well, especially if you're living in the U.S. — very important. And air — if you're living right next to [the] street like I do, maybe an air purifier will do you good, as well. Mold — I can go on and on. There are so many things in the world currently — artificial lights; it's more than diets. It is a whole lifestyle around trying to fix your metabolism, for sure.

Carl Cincinnato (27:13): There's a question I'd like to ask you about the potential risks and drawbacks of approaching migraine from a metabolic perspective. We've mentioned two things that stood out for me. One was the fact that there are some supplements that can be very helpful in addressing micronutrients and imbalances there, but the supplements themselves are not regulated in the same way that medicines are. The other one is something that affected me personally was when I had a liver that was likely already strained from a lot of the medication I was taking and had an elevated liver enzyme when I was doing the ketogenic diet. And so, if we are going to be doing a ketogenic diet or trying it, to do so under medical supervision and make sure that you get your liver tested as you go through that process. Are there any other potential risks or drawbacks that you would want to warn the audience about?

Dr. Gross (28:02): When it comes to supplements, be wary [of] where the stuff is coming from. Is it controlled? Does it have certain third-party labels or quality checks on it? That is something I would recommend. All the other things that are discussed in the lifestyle, changing to a whole-foods diet, which is also not containing a lot of processed foods, right? That's essential because, again, processed foods will increase free radicals, oxidative stress. So we have again, a stressor on that front. So, anything we do to reduce or anything that we do that is actually reducing oxidative stress in our environment will not do you harm. That is only a plus. But with anything else, I don't think you can do something wrong with one exception: You need to be careful with weight loss. Many people say fasting as a [person with migraine] — in general, fasting, anybody can fast and for long, whatever. But in the current world we live in — for me, at least, that was the case, and I know that is true for quite a few people — toxins accumulate in the fat tissue, so I would not encourage anybody to do rapid weight loss stuff. Like, if you introduce fasting or go on a very strict ketogenic diet and you're dropping the pounds by the day: Be careful. Because you will also be releasing a lot of toxins, which will again increase your oxidative stress. So keep your stress at bay and be careful. The No. 1 thing —always, no matter what — listen to your body. You have a very sensitive body that is sending you warning signals via the migraine, but

also the fatigue. Your body knows best. We just have to start listening to it again, and it will protect us.

Carl Cincinnato (29:28): Dr. Gross, where can people follow your work or learn more about what you're doing?

Dr. Gross (29:32): Well, on Dr. Elena Gross, I can be found on Instagram, where I try to explain what migraine is, what metabolism is, and what you can do about it. The same on Facebook — Dr. Elena Gross. Now maybe soon, TikTok — still playing around with that a little bit. On YouTube, I'm making a full course, "Migraine and Metabolism," a course that you can watch in your own time. I'm releasing a book as well, *How to Master Migraine With Mastering Metabolism.*

Carl Cincinnato (29:56): Fantastic. Well, we'll make sure we link to that in the show notes beneath this video. It's been an absolute pleasure and very interesting to hear about your hypothesis. Thank you so much for joining us on the Migraine World Summit.

Dr. Gross (30:08): Thank you so much, Carl. It was great.