Speaker 1: Bulletproof Radio, a state of high performance.

Dave: You're listening to Bulletproof Radio with Dave Asprey. Today's cool fact of the day is that the brain chemical that's missing in Parkinson's disease is probably responsible for its own demise. I'm talking about dopamine. It's a neurotransmitter that keeps your body movements fluid. It can kick off a toxic chain reaction that kills the nerve cells that make dopamine, at least according to some new research.

What the scientist who did this discovered is that there may be a way of treating the estimated 10 million people with Parkinson's. Those are the diagnosed ones. There's a lot of people who are on the way to Parkinson's who aren't diagnosed yet. What they are proposing is that if you can make less cellular damage in the brain by treating the neurons early on with antioxidants, you can probably prevent the damage from too much dopamine.

The scary part about this, too, is that if you're doing things that spike your dopamine a lot, and very frequently, then you may be actually wearing these cells out more, so this may be a reason to think about porn, gambling, high-sugar diets, cocaine, and all the other bad habits that you may, or may not, have that affect your dopamine systems. You want to be a low dopamine person because if you have no dopamine you hate your life, but if you spike your dopamine all the time, you might not have as long of a life as you'd probably like, unless, of course, you hack that with the right selective use of antioxidants.

Now, speaking of antioxidants, the number one antioxidant in the brain, and certainly in the liver is something called glutathione, and Bulletproof makes something called Glutathione Force, and we like to call this the body's master antioxidant, and it's something that doesn't absorb through the gut very well, and after several years of making bad-tasting syringes of this stuff we actually got it into a form that can absorb through the gut using capsules. It's called Glutathione Force. I take it when I travel, and I take it several times a week. You can check it out at bulletproof.com. It's called Glutathione Force, real super-amazing name there.

All right, if you like today's podcast, or any other podcast, if you go to bulletproof.com/iTunes you can leave a review, which would make me exceptionally happy, because, hey, people pay attention to reviews quite a lot, actually, so thank you if you take a second to do that.

Today's guest is a guy I met more than a year ago at the American Academy of Antiaging Medicine where I was giving a keynote presentation as a nonphysician talking to 3000 physicians. I might have been batting outside my normal whatever you say that when you're batting, outside my normal zone. I was punching outside my weight class. There we go. Anyway, it was amazing to talk with a lot of physicians about mitochondrial stuff, and the guy who impressed me the most was actually on the floor there by the Bulletproof booth. Tyler came up and this guy just knew everything there was to know about what I like to call the next nitric oxide. Nitric oxide, it wasn't known as a gas that mattered in the human body til about 10-15 years ago, and now it's a huge thing. We

talk about healthy arteries, and blood flow, and one of the mechanisms why Viagra, and its natural alternatives, also work.

There's a new gas that's coming out for biohacking. It turns it's always been important, but it's so ephemeral in the body that, basically, science missed it, especially science in the U.S., but not in Japan. Tyler is like a walking dictionary of everything ever known about hydrogen and, in fact, I just mention his first name. Tyler LeBaron is his name, and, Tyler, welcome to the show.

Tyler: Well, thank you, Dave, for having me be here. This is a great opportunity.

Dave: When I met you, you said, "I'm the Executive Director of the Molecular Hydrogen Foundation," and I'm like, "Oh, great, like this guy is probably a little bit out there," but you actually worked in Japan at Nagoya University, Department of Neurogenetics to look at cell signaling pathways, and you're a Director of the International Hydrogen Standards Association, and you actually know everything you're talking about, and I would say there's about zero mysticism in your work, and a huge amount of science. Why do you care so much about hydrogen? Like, how did you get into this?

Tyler: You know, thank you, yeah, a great question. My background is biochemistry, and so I went to Japan to research the mechanisms of how hydrogen is actually working, because we're seeing in all these studies, whether they be cell studies, or animal studies, or the human studies, that hydrogen is really having this therapeutic effect, but the mechanism of exactly how has always been very interesting to me.

I actually came across this in 2009. I've always been interested in health, and wellness, exercise performance, just the next thing, and read a lot of different books and things, and then I came across molecular hydrogen. Actually, I came across an article published in Nature Medicine in 2007, which showed that hydrogen was therapeutic and you could suppress brain damage, and I was, "Wow, this is very interesting." Ever since, 2009, I read all the articles, and then had the opportunity to go to Japan and actually do research. Since then I have continued my research and collaboration with universities and different groups, institutes, all throughout the world, and throughout China, and Europe, and then elsewhere.

Dave: You got into it because you care a lot about biochemistry, and you found this kind of unknown thing. When you met you, you said, "Dave, there's 800 studies in Japan about hydrogen gas." I consider myself reasonably well educated as a biohacker and I hang out with these antiaging guys who are always 10 plus years ahead of everything else, and I had not come across anything to do with hydrogen as an antioxidant, or as a signaling molecule. Can you tell our listeners, why does it matter? Why is this so revolutionary?

Tyler: Absolutely, and that's the thing. It is strange at first at least, when you consider that hydrogen gas could exert any of these therapeutic effects, and we're seeing the anti inflammatory effects, antiology-type effects, antioxidant-like effects. A number of the clinical trials very positive effects, but just going back to this idea from the standpoint that hydrogen, the first element in existence, right, this neutral diatomic gas that is so

prevalent, and is so simple, and is essentially biologically inert, would have a therapeutic effect. It's strange.

You mentioned nitric oxide just earlier, and those decades ago, in the 1980s, 1970s, there was this idea that there was this endothelial-derived releasing factor, relaxing factor, was responsible for all these benefits, and then it was suggested it was nitric oxide, a gas, and that was met with some pretty harsh skepticism. How could a gas do this? Well, nitric oxide is a gas and it could do that, and we know the mechanisms of how it works, well a lot of them anyways. It's a free radical. It's very reactive so it can do this. Other gases, like carbon monoxide, a very polar, a very strong molecule, or hydrogen sulfide, another gaseous molecule, but then when you look at hydrogen gas, this is just a neutral, simple molecule, and yet it exerts these therapeutic effects, it is very curious, very strange to biologists, to biologists, to biochemists, how can this have this effect? That really is why I have been so interested in understanding and researching the mechanism behind hydrogen.

Dave: What does hydrogen do in our biology?

Tyler: Okay, great. As mentioned, hydrogen has many effects. The effects are multiple. First we can talk about say the antiinflammatory effects. In order to understand this, we need to talk a little bit about what causes inflammation, and inflammation can be caused from various pro-inflammatory mediators, such as pro-inflammatory cytokines, those like interleukin 6, interleukin 2, interleukin 12. These are various cytokines that promote inflammation, and that's the swelling, that's the pain, that's the slowing of recovery, and different things.

Of course, the same information is also important for mediating the benefits of say exercise training, or the healing, or recovery. We need a small amount of inflammation in order to cause this healing effect, so we need base levels of inflammation. When we have a dysregulation of that inflammation, such as what happens with aging, or various diseases, you get into a state where you have chronic basal levels, or chronic low levels, of inflammation, and that's when you have like arthritis and a lot of swelling and just problems, but yet you also have a slow inflammatory response to say some sickness, so you get sick easier, or you don't heal very fast, and so you have that dysregulation of inflammation. Hydrogen really shines in its ability to bring back the inflammation to homeostasis, so it can help to dow regular these pro-inflammatory mediators that are excessive and bring them back into the normal range.

Perhaps in other cases, in the initial stage it can actually increase or enhance the pro-inflammatory mediators. We've seen this from several studies. For example, hydrogen can indirectly activate NF-κB, which is a transcription factor. When NF-κB binds to the DNA in the nucleus, then NF-κB induces the transcription of various cytokines. Well, some of these studies have shown that hydrogen can, in the initial stage, actually activate NF-κB, and then you have a slight mild transient increase in inflammation followed by a decrease in inflammation that is systemic, and now you have improved benefits for many of these various diseases that we're talking about.

Dave: Don't we all breathe hydrogen everyday anyway?

Tyler: You're right. Hydrogen is already in the atmosphere, but at a very low concentration, about 0.0000055% of the atmosphere is composed of hydrogen gas, so not enough to be therapeutic. But, it also is natural in our body, because of our intestinal bacteria. Our intestinal bacteria actually produce hydrogen gas, and as we metabolize the fibers, the nondigestible carbohydrates, the bacteria produces hydrogen gas and that, in turn, dissolves into our blood. It's in our breath, so we always have base levels of hydrogen gas all the time, but small amounts of additional hydrogen gas are effective, are therapeutic.

Dave: When you say effective and therapeutic, okay so my NF-kappa beta levels go down, right? What does that mean?

Tyler: So, if we look at some of the clinical studies, and some of the animal studies, again hydrogen is still very much in its infancy. We don't have, you know, 20-30 years of clinical research with hundreds and hundreds of studies. It's in its infancy. There's just over a 1000 publications on molecular hydrogen and its medical benefits. But, what we're seeing, for example we look at the human studies, for example I mentioned inflammation and its connection with arthritis, rheumatoid arthritis. Well, there was a study published in 2012, and some other ones in 2013 and 2014 where they showed in a double-blinded, placebo-controlled, randomized fashion that the ingestion of hydrogen-rich water was very significant at improving the symptoms of rheumatoid arthritis, and decreasing the markers of oxidative stress, like OHdG, which is a marker of DNA damage, insomuch that some of the patients with early-stage rheumatoid arthritis they actually had a complete remission of the disease. Their markers of the acetylated proteins, for example, that are markers of the rheumatoid arthritis disease, were back to a normal level, as though they did not have the disease anymore. This is very powerful, and it's being followed up right now with another study with near 170 or so patients to really show the effects in the rheumatoid arthritis.

We see other ones. For example, you mentioned Parkinson's disease at the beginning of this podcast, well one of the very first diseases that hydrogen was shown to be effective was in Parkinson's disease in an animal model. In fact, that is how Dr. Kinji Ohno, one of our advisors on Molecular Hydrogen Foundation Institute, got started was because he saw the effects of hydrogen gas in Parkinson's disease.

Let me tell you what happened. He was approached about this idea of hydrogen gas being therapeutic, and you could dissolve it in water, and it could be therapeutic. Of course, Nagoya University is the fifth most prestigious University throughout Japan, so it's very reputable. He was very skeptical of the biologist about this, but he wanted to try it, and so he did a study and he found, and then published in 2012, that ingestion of hydrogen-rich water prevented the development of Parkinson's disease. This was also found by Dr. Noda, also one of our advisors. She found and published, actually in 2009, as she induced a Parkinson's disease in an animal model using a toxin, 6-hydroxydopamine, and the benefits of the hydrogen are very clear. Ingestion of hydrogen-rich water completely prevented the development of Parkinson's disease in this animal model, and this was a powerful article. She's a great researcher at Kyushu University. She used to research at Rockefeller University, for example.

These animal studies, and several others then spawned a pilot study. It was a small study, about 100 patients. It was double-blinded, placebo-controlled, randomized trial, and similarly they found those patients who were drinking hydrogen-rich water had a lower disease rating of the Parkinson's disease. They showed improvements, and they did decrease as much as those in control. Now they are finalizing nearly a three-year clinical trial with a few hundred patients on Parkinson's disease, and looking at the effects of drinking hydrogen-rich water in that study, as well. The clinical studies are really starting to catch up and show that what we see in these animal studies really is showing promise in humans, as well. That's just a few of the diseases that have been shown so far to be effective in clinical studies.

Dave: What about the rest of us who don't have Parkinson's or arthritis?

Tyler: That is probably even more important, if you want to talk about hydrogen from a standpoint of total biohacking and prevention, if you will. If you remember what I said about those studies, they induced Parkinson's disease, and they were drinking hydrogen-rich water, so the drinking of hydrogen-rich water as a pretreatment prevented the development of the Parkinson's disease. We need to remember that many of the diseases are multifactorial, not only genetic and not only environmental, and as we have these epigenetic changes that occur, that can induce the genesis, or the initiation of various diseases, and potentially by drinking hydrogen-rich water the idea, anyway, and this received some evidence from animal studies, could lead to the prevention, or the prolonging the inevitable, if you will, in developing of these diseases, so hydrogen is a great way to go if you're talking about ways of prevention.

We also just did a study for autism, so we took and induced autism disease in an animal model with a toxin, valproic acid, and we showed that the drinking of hydrogen-rich water was also effective at ameliorating the autism-type symptoms. We see in many studies where this is a prevention-type idea. Another way we can look at it. If we consider a stress as a factor that can initiate many diseases ... Well, we also published an article that just recently in Scientific Reports, just a couple months ago, and we showed that drinking of hydrogen-rich water helped to prevent the anxiety and depressive-like behavior of the animals that were suffering acute and chronic stress. Again, hydrogen-rich water just helping in the daily life, with the daily stresses that we all face.

Dave: All right, so then how would you go about getting more hydrogen into your life?

Tyler: Well, there's a number of ways to do it. There's quite a few ways. In fact, one of the first ways was done using hyperbaric hydrogen therapy. Of course, we're familiar with the hyperbaric oxygen, but you could do the same with a hyperbaric hydrogen. One of the first studies to report its beneficial effects was actually published in the Journal of Science in 1975 by Texas A&M with Bailey University. They found that transplanted melanoma tumors could be greatly reduced by the treatment of hyperbaric hydrogen therapy. That didn't really come to practice at the clinical side of things, because little difficult to do hyperbaric therapy, because hydrogen is exclusive, and you need to be very careful, so it didn't really catch on so quickly. When that article was published in 2007, and they showed the inhalation of hydrogen gas at only a 2-4% concentration was also therapeutic, that's when the research really started to increase a lot. So, inhalation,

of course, is one of them, and also, like I mentioned, simply drinking hydrogen-rich water.

Dave: How much atmospheric pressure were they using in the tank when they were doing hyperbaric hydrogen?

Tyler: They, in that animal study, I believe there were around 8 atmospheric pressure at 97.3% hydrogen, and the rest oxygen, so if you do the molar ratio, you're still at the same amount of oxygen, but, yeah, very high concentration.

Dave: That's like four times what the hard-sided tanks that we use for treating Alzheimer's and brain injury are, so this is something that pretty much isn't going to be happening at a mall near you anytime soon.

Tyler: Not at that concentration; however, I was in Japan earlier this year, and they actually do have a hyperbaric hydrogen tank. You can buy it for your clinic, and it does about 2 or 3% hydrogen, maybe 1.5 atmospheric pressure, so it's a new thing. I'm not sure how effective it is. I haven't seen any clinical studies with that method yet.

Actually, I was in Poland earlier this year, also, and one of the doctors he converted his house into a hyperbaric hydrogen home, so you go in and have the chambers and the different doors, and you can close one of them and you feel all the pressure changes, and the differential, and they walk into the other one, and his home was converted to about a 1-2% hydrogen gas.

Dave: I want to visit this guy. That is the coolest thing I have ever heard of.

Tyler: Yeah, it's pretty sweet.

Dave: Are there clinics now taking just normal hyperbaric oxygen chambers and pumping hydrogen in, like I have a couple of hyperbaric chambers floating around Bulletproof labs here at my house. I have a hydrogen concentrator, because after meeting you I'm like, "I need to get one of these things, a hydrogen inhaler that makes about 6% hydrogen gas."

By the way, if you're listening to this, you're like, "What the heck, what all is Dave doing?" Well, I do all sorts of weird stuff, but one of them is when I'm working on my next book late at night I'm breathing hydrogen gas through my nose, because, hey, who doesn't do that late at night, right, under red lights. So, can I do this in my hyperbaric? A lot of people listening, actually have access to these things.

Tyler: You know, you may be able to. I'm not sure of any clinics that are already doing this. Again, you have to be careful because hydrogen gas is explosive when it gets above the 4.6% concentration, but hydrogen does have a very high rated ... The [inaudible 00:20:40] is very high so there is some safety with that. The other thing is, is that going to, for example, if your whole house is hyperbaric hydrogen it may not be as effective as say drinking hydrogen-rich water, or intermittent inhalation, because, really, hydrogen

works more as a gaseous signal modulator than it does as an antioxidant, and because of that, a continuous exposure of molecular hydrogen may not be as effective, because you get attenuation or habituation of the signal, which is common with many gaseous, or other, signal modulators in general.

Dave: So, maybe we don't want to all live in houses that are pressurized like space ships full of hydrogen gas. Plus, that's kind of inconvenient, and certainly you wouldn't want to smoke or ... I guess at those levels you're not going to have flammability. Okay, so we have these we'll call them innovators and biohackers who are doing some interesting stuff there, but for the rest of us, you can get a hydrogen inhaler. I have a machine over here, I've been playing around with different stuff, that makes hydrogen-rich water. You can buy cans of hydrogen water. You get tablets you put in water and drink, so this is essentially a next-generation of a type of supplement, but when you take it what do people feel after they, say, drink hydrogen-rich water.

Tyler: Well, because hydrogen is so light, they usually feel lighter. They start to float up in the air.

Dave: Nice. They talk in a squeaky voice, too. This is [crosstalk 00:22:04]

Tyler: Right. You know, if you inhale pure hydrogen you do get that change in the voice.

Dave: If it's pure, of course, that makes sense. But, this isn't pure. This is 6% hydrogen, at most, in the air, and in the water is what 2-4% hydrogen?

Tyler: Well, it's difficult, because you can't necessarily compare a 6% from the air and then a 6% to the ... because your units are totally different, right, so really it's best to refer to hydrogen in terms of milligrams per liter in water, and when people drink it, of course, everybody is different. For some people they really do report anecdotally they feel a rush of mental clarity, a energy, being able to continue like with exercise performance.

There's some studies on exercise performance we could talk about, but everybody is different. Some people may not experience anything at all. Other people they may need to take hydrogen for a few months, especially if talking about like a chronic disease. Hydrogen as a signal modulator alters gene expression, and it takes time to induce like PGC-1alpha, and a number of different changes, and those small changes over time lead to very significant improvements. Because hydrogen is so mild, it's nontoxic. Most people may not see a dramatic change in their feeling, or their behavior. If you are, maybe, out of homeostasis, maybe you are suffering from some type of disease, or your body's out of homeostasis for whatever reason, and hydrogen really helps to bring things back into homeostasis, whether it be your levels of free radicals and antioxidants, or your levels of inflammation, they are more susceptible, in my opinion, to experience something from hydrogen therapy.

Dave: I can say I do feel like a kind of a subtle boost of energy, but it's not like drinking a cup of coffee, that's for sure, when I play around with hydrogen, but I like to use it after I come back from a trip, or if I'm under, basically, just a higher oxidation load, because when I

read through some of the papers you sent, one of the most harmful free radicals is called peroxynitrite, and this forms inside your cells, inside your mitochondria, as you're turning food and air into electrons to use in the body.

High levels of peroxynitrite cause all sorts of problems, and hydrogen, whether you're breathing it or drinking it, goes in and selectively turns off that oxidative free radical, but it doesn't turn off the other oxidative radicals that you actually need to tell your cells to keep growing. If you were to take like a blanket antioxidant, and take it regularly, it's gonna suppress your ability to essentially burn food for fuel, but if you turn off the most harmful things it's kind of like having a smoke scrubber, tell me if you like this analogy or not, like a smoke scrubber on your chimney that takes out the worst parts of the smoke but doesn't put out clean air entirely. You like that? Am I onto something here?

Tyler: Yeah, yeah, yeah, we're working on it.

Dave: Okay, that would be a no.

Tyler: But, you're right, that's the really neat thing about hydrogen, it's selective. It's able to help attenuate the excessive oxidation without attenuating the important free radicals, so the hydroxyl radical, peroxynitrite, those are very dangerous oxidants. Peroxynitrite is not actually a radical, it's a very oxidizing molecule. The hydroxyl radical is similarly ... It's actually the most cytotoxic and most reactive radical, and because hydrogen is so small it's able to diffuse through the biomembranes of the cell into the mitochondria, the nucleus, really easier than anything else. It's the smallest molecule. It's smaller than oxygen is, and it's able to selectively reduce, or decrease, those levels. It's likely not done via direct radical scavenging. In other words, it may not be through a direct reaction if you look at the rate constants of the hydrogen gas and hydroxy radicals, but its selective reduction of those radicals is very critical, and that was shown in the 2007 Nature Medicine publication, that hydrogen was selective in its ability to simply only decrease those types of ROS, Reactive Oxygen Species, and not the other ones.

Nitric oxide, that is a free radical. That's how the Viagra works. It's all these things that you mentioned earlier. We don't want to neutralize that. A superoxide anion radical, hydrogen peroxide, these are all very important assimilating molecules and, in fact, when we exercise we increase our levels of these Reactive Oxygen Species, and these Reactive Oxygen Species and these Reactive Oxygen Species are, in turn, what mediate a lot of the benefits of exercise training. They are what induce mitochondrial biogenesis, and increase vascularization. Some various reports have shown that ingestion of high levels of exogenous antioxidants can actually negate the benefits of exercise training and, perhaps, some of that is due to the scavenging or neutralization of these critical stimulating molecules.

When it comes to hydrogen, it doesn't do that. It's only going to bring things back to that homeostasis that we need. In fact, in some cases, hydrogen can act as a pro-oxidant. One article published recently showed that ACE2 acts as a mito hormetic effector. In other words, mito meaning mitochondria, and it actually showed that it transly increased superoxide production in the mitochondria, as measured through mitoSOX. I guess we don't need to go into all that, but it [transly 00:27:40] increased the

superoxide production, just initially, and a little bit of hydrogen peroxide, and then you quickly saw an up regulation of the Nrf2 pathway, which is a transcription factor that you get higher levels of glutathione, which is the master antioxidant that you mentioned earlier.

Dave: In fact, hacking Nrf2 is a big part of what's in Headstrong and in the Bulletproof diet, something you can do with coffee, something you can do with ketosis. A lot of the practices out there raise Nrf2. If you want to live a long time you want more Nrf2. There is probably an upper limit where you don't want that, but I haven't discovered it.

Tyler: There is. That's a good point. There is. One great way to up regulate Nrf2 is just to start smoking, or something. If you have strong toxins, you're going to up regulate things, and you could do it too much, and you could have problems. You can have a reductive stress just as you can have oxidative stress, so taking very powerful, potent molecules that can constitutively up regulate Nrf2 pathway could be bad. Taking things more mild, things that are found in food, of course hydrogen, for example, that is going to only increase the Nrf2 pathway to the levels it's supposed to be, to that homeostatic level where it's supposed to be, and that's when you talk about antiaging and longevity, it's because you're staying in the homeostasis.

Dave: Very well put. Now, I mentioned earlier, there's all these different form factors. You breathe it, you can drink it, tablets, and all that stuff, how would someone listening, who's interested in "trying hydrogen," how the heck do you know what works? I know hydrogen is a small molecule. It seems like it's going to essentially escape from most containers I can think of. If you were to buy a bottle of hydrogen water that's already out there, does it need to be in glass? Does it need to be in aluminum? Does it need like a special space ship force field around it? I'm kidding, but ... How do they keep it in there, and should we consider maybe tablets? How do you know if those are good? Walk me through the decision tree that I would go through if I was saying, "All right, I want to try this. I don't want to spend thousands of dollars and convert my house into a space ship."

Tyler: Sure, so here's some general guidelines. We don't represent, or sell, or promote, or recommend any specific products, but there are some general guidelines you should be cognizant of. First off, you're right, hydrogen gas is the smallest molecule, so it's going to diffuse quite quickly through your plastic container, so if you see in a store hydrogen water in a plastic bottle, rest assured by the time it gets to the shelf it's not going to have any more hydrogen gas in it. You can do it with CO2 gas, but CO2's a lot bigger than hydrogen gas. So, plastic is not going to work. You do actually require some sort of aluminum container. There are some pouches, cans, also, and now with the regulations and different things, typically everything will have some sort of a liner so you don't have the direct contact of the water, or the beverage onto the aluminum itself, but the aluminum, the physiochemical properties of aluminum are such that it prevents the hydrogen gas from escaping out of the container.

There are options for ready-to-drink hydrogen products. Then, of course, there are the hydrogen-producing tablets that they can work great, as well, and there's other ways.

Now, as far as to know, is this a real product, or not, you can also test it. You can buy the H2 blue, which is a redox titration reagent, and from h2sciencesinc.com.

Dave: Yeah, I've got a bottle over there, right, so you could test whether what you get works, if you want to be geeky about it, okay.

Tyler: Exactly. It's a titration reagent. It's methylene blue with some colloidal platinum as a catalyst, and it will actually, you can use it to measure the concentration of hydrogen.

Dave: Very cool. I don't know that I'm a position to recommend, you know, go out and buy something right now. I can tell you that breathing the gas seems to work from, the name of the inhaler, it's like MiZ, I think, and we had eight of these at the Bulletproof conference, so a lot of people who came to the Bulletproof conference in Pasadena in October got to actually experience breathing some hydrogen for a little while, so who needs oxygen bars when you're got a hydrogen bar, right? There's always an upgrade.

Tyler: Inhalation, it's very interesting when you want to compare what's better, for example, is it inhalation, or is it drinking hydrogen-rich water, and the research is still debatable, but I wanted to mention a couple of things about inhalation that's pretty cool. First off, so you understand, the Japanese government is actually very strict, more strict than our government, and so for them to do anything they need approvals every step of the way.

Well, the Japanese government recently gave the approval for hydrogen inhalation as an advanced medicine to treat post-cardiac arrest patients, so they can use this in hospitals, and they are doing a major study right now, about 360 patient study, maybe 20 different hospitals, and they're using hydrogen gas to treat postcardiac arrest, because what they're finding is ... Okay, if you have a heart attack, when you restart the heart and the blood goes to the brain, you get the ischemia reperfusion injury, you get all the oxygen rich blood goes to the brain and you end up causing lots of free radicals and damage, and inflammation. Hydrogen in animal studies have shown to be superior to even hypothermia and other conventional treatments. Hydrogen, of course, is very safe. There's no toxicity with it. It's very easy to administer, and so this has now being applied to humans. So far the clinical results are very positive. That's an ongoing study right now. It's a very major advancement in the research.

Another really great one is with cerebral infarction, like a stroke. There was a study published a few months ago with 50 patients. It's double-blinded, randomized, and 25 in each group, and they compared inhalation of hydrogen to the control. What was the control. It wasn't placebo, it was the currently-approved medicine. Okay, they actually got the approval to compare it head-to-head with an approved medicine in Japan. The results were quite clear. Hydrogen was significantly more effective.

Dave: What was the medicine it was going up against?

Tyler: I don't remember. I think it was [Adaravil 00:34:19], if I remember correctly.

Dave: Wow. Does this mean that maybe people doing head impact sports like football should be sniffing hydrogen, especially if they whack their head?

Tyler: Well, in my opinion, because hydrogen is safe, I absolutely think so. Dr. Banks, one of our [inaudible 00:34:39] advisors from the University of Washington, he published a study in 2012, oh no, I think it was a little more recent, maybe 2014, but it was on traumatic brain injury. They used drinking hydrogen-rich water. It was an animal study, but very powerful results with decrease in the markers of apoptosis, the increased energy production, the ATP, so you are able to attenuate the damage a lot faster. It's quite powerful in what they show, and there's several studies showing this area.

When it comes to the high-impact sports, and the brain damage, not only maybe good idea to inhale hydrogen, or drink hydrogen-rich water after it happens, but if it were me, I would be drinking, or taking, the hydrogen before as a preventive measure, as this pre-treatment, I think, is the way to go. I think it's with everything. There's another article talking about cellular senescence, or basically premature cell death. In this study they found that the environmental toxin was a type of plastic, a very common plastic we're exposed to all the time, but it increases cell death, and cellular senescence, apoptosis, it decreases the ratio of NAD, plus NADH, all these things that are very bad for your health.

Well, they showed that pretreatment with hydrogen-rich water totally prevented the negative effects, and to put this in perspective, again there's no clinical trial on this, this is animal and cell culture, but I think the results are somewhat transferable, according to the other studies. If you drink, or take your hydrogen in the morning before you go out into the bustling city of exhaust and pollution, and all the environmental contaminants you're going to exposure yourself to, maybe that molecular hydrogen is going to prevent some of those pathological changes to your DNA epigenetically, or your cells in other ways, and really help benefit you.

Dave: I know there's a lot of NFL teams who listen to Bulletproof Radio. I've had the fortune to chat with some of them just about what they're doing, and if I was going to go out there and potentially get hit in the head in a sport, I would be pre-treating with hydrogen, because it doesn't really cost you anything, like the risk is very, very low. I'd also make sure I have ketones present, because there's really clear evidence that ketosis is going to be very helpful if you have an injury in the brain, and I'd up regulate the crap out of my mitochondrial function, things like KetoPrime, things like Unfair Advantage. Those are Bulletproof products I make for that. I'd be on a high polyphenol diet, things like that, just so that you have everything that you need to have highly functioning mitochondria without huge amounts of free radical damage, if you do take a hit.

The same thing goes for an MMA fighter. Why wouldn't you do this before you go out there, because if you can inhibit that first inflammatory response, you're probably, even if you do injure your brain, it's probably going to be less of an injury. There no guarantee, and this isn't like a treatment, it's just like, okay, you put your seat belt on before you go for a drive in your car. It doesn't mean you're not going to get injured. It doesn't mean it will prevent an accident, but it, hopefully, reduces the damage. I think we might all want to do this. What would you do, Tyler, and you fly all over the world. I

know you're really doing a lot of work to put hydrogen on the map. What would you do before, or after a long flight?

Tyler: Again, when you're exposed to the radiation, and to different things, it may be a good idea to take hydrogen. Maybe some of the radiation is hormetic, little beneficial for you. Maybe we need more research on that, but assuming that there are toxicities, especially from chronic prolonged exposure, maybe for pilots, and different things, that potentially could end up being problematic. Some people are likely more sensitive than others, so when we look at the studies on hydrogen preventing against the damage from radiation, there's a lot of them. In fact, that's why NASA had been interested in, not NASA but some people at NASA, for example, who were in this field, very interested in looking at hydrogen to help protect the astronauts during their space travel, to help mitigate the toxic effects of the radiation.

Taking hydrogen-rich water, or inhalation, before your flight, before you get up in the air, could be a potential way to help mitigate that radiation-induced damage, mitigate the decrease in 8-OHdG, the marker of DNA damage.

Dave: All right, we're talking about radiation. We're talking about hydrogen. There is a dark side of hydrogen, so-called heavy hydrogen, or deuterium. One of, actually both of my grandparents spent time working on nuclear power. My grandmother has an advanced degree in nuclear engineering. So, like this is the kind of dinner table conversation that would have happened at family reunions. Yes, I have a weird family. But, what's your take on the fact that the hydrogen we breathe, the hydrogen we're exposed to ... I guess we breathe lots of it, but hydrogen we're exposed to, particularly when we're drinking water, or eating food, can have heavy hydrogen isotopes in it?

Tyler: You know, it's not my area of expertise. It is interesting. When you consider the fact that the isotopic effect of hydrogen is significant, because hydrogen is already the lightest molecule element there is, we can actually use the kinetic differences of deuterium to preferentially produce certain organic compounds versus another one, and so you can imagine, hypothetically, again there's probably more research on this, I'm not sure, but if more deuterium atoms are utilized in DNA, then that can alter the ability to transcribe, or translate, our DNA, and maybe has other issues with the entire transcription in general of our DNA. I know it had been suggested that perhaps the mitochondria can be considered a deuterium-depleting organelle. In other words, when we eat good food, such as our good fats, then most of those actually have Low deuterium content as opposed to your refined sugars, due to the process of making the food from the water in the first place. If it's a preferential discharge, it's the electron transfer, in the making in general, and then in the initial states. The point is the mitochondria may help to deplete the cell of the deuterium, and then the use through the pentose phosphate pathway you may be able to have more of the substrates that are also deuterium free and those that, in turn, are used for substrates for DNA production.

Now, is there a correlation relation with hydrogen? Maybe. Maybe if for example hydrogen gas did react with the hydroxyl radical, you're by product would simply be water, and all of that would be protium in the form of non-heavy water. Secondly, hydrogen gas has great effects on the mitochondria, and so if we're talking about

improving the mitochondria, as well as increasing the number of mitochondrial biogenesis, then we're also talking about that benefit. Just going to that athlete thing really quick about the concussion and traumatic brain injury, not only should they be taking it to help prevent those potential problems, but hydrogen appears to be rather ergogenic when we look at the human studies, and animal studies, on hydrogen as an ergogenic aid.

Dave: I would think for people who are looking to recover more quickly from a heavy workout, like breathing some hydrogen just seems like a really good idea. I've been investigating that heavy hydrogen isotope thing. I looked at a bottled water back in 2014. I'm not certain that there is a lot to be done there biologically. You eat fat, it generally doesn't have that stuff in it, and you drink low-quality water, or eat a lot of sugar, you're going to get more of it, which is one of the probably 5% difference mechanisms in a high-fat diet where you get more calories from burning fat that is naturally depleted by plants or animals versus eating a lot of sugar, but it's a small thing, probably smaller than just breathing hydrogen, which is, I think, a much bigger thing that no one really talked about, apparently until 1974 when they started these crazy things, and really no one has talked about until the last couple of years, and that's really been, at least in the West.

Japan's been looking at it, but you're the first guy who has really taken this and said, "All right, let's look at the core biology about what's going on with hydrogen gas. What can we do with it?" I am to the point where I think there's convincing evidence, really stuff you sent me, that says, you know, if you can find a way to incorporate it into your supplement regimen at least some of the time when you're in high stress, or high radiation, or high injury-prone environments, there's almost no downside. There's probably a reasonable upside in that maybe more research will come out. Is there more research that you can talk about, stuff you're aware of, or ideas that our listeners might be interested in?

Tyler: One thing that I think could be interested in is with mild cognitive impairments, like Alzheimer's disease. This is quite significant. There's an article just published. This was significant. It was a one-year double-blind clinical trial, placebo-controlled, and just to put this in context, it's very difficult to treat Alzheimer's disease. In fact, there really is no approved medication to treat this. Nothing really actually works. This study was a one-year, it was small, maybe around 100 patients, but what they found was hydrogen was very effective at preventing or slowing down the decrease in the memory recall and the different assessments used for these patients and, specifically, those with the genotype APOE4, and those genotype APOE4 are more susceptible to Alzheimer's disease. In fact, about 50% of everybody who has Alzheimer's disease have that genotype or are a carrier.

If we consider on a grand scale, again we need a larger trial, which is now we're talking about making a very big study, and to really see the effects, but if we consider how significant these effects were with those people who had APOE4, we're talking about helping half of the people with Alzheimer's disease in a very significant way that no current medication can do.

Dave: That seems like it might matter. This is early stage. They'll be more evidence, and with all biohacks, when you decide, "Look, I'm going to take control of my biology. I could wait 20 years until there's even more evidence, or given that the downside is low and the upside is high, maybe I'll just do it now," especially if I am at high risk for Alzheimer's. This is one of those things that drives regulators nuts. "You can't do it, it might not work." You're like, "Hold on a second. I know what's likely to happen if I don't do it, and the fact that it might not work, I'm okay with that risk, because it's not like hydrogen gas is going to cause harm in any way that we've seen so far," so it's that risk/reward on a personal basis that's the foundation of being able to be in charge of yourself. I like the way you think about that, Tyler.

Tyler: Yeah. That's the thing, the downsides are still low, and it's very rare. It's very rare you can come across a molecule, or anything, that has such prominent therapeutic potential with such a low toxicity. Hydrogen is already natural, so whether you're a child of one month old, or you're pregnant, or you're really old, there is no evidence, at this point, I'm not saying there isn't any toxic effects, maybe, but we have not seen any clear evidence of contraindications or toxic effects, and we're already exposed to it. All the time we eat good, healthy meals with fiber, we make more hydrogen gas. I do think it's something we should really investigate and do the clinical studies, and I kind of laugh a little bit about we need a bigger clinical study, and the reason it reminded me, I just got back from speaking at the Fourth Chinese Biomedical Symposium in China. We were talking about doing clinical studies.

We need to start doing these clinical studies here in America. One of the reasons why is because in America people don't know about hydrogen water as much, so we can actually find people to do the study. In Japan it's estimated, there was a report, it is estimated that over 50% of the Japanese population do use, or have used, in some way or other, hydrogen. If you want to do a study, they're looking at about 400 people for the study. How are you going to find 200 people who don't take hydrogen, and it's got be for three years, right. You can't take any hydrogen, and you're going to be in either the placebo group or the hydrogen group, and with all the research coming out, I'm sure they're thinking to themselves, "Hey, what if I'm in the placebo group. I'm not going to risk this. I'm gonna take hydrogen."

It may be more and more difficult to do some of these double-blinded studies in the future and, thus, the need to come here to America, so that study that's in discussion right now with the International Academic Society of Hydrogen Medicine Biology, which actually we just formed this organization amongst the European researchers, Chinese, Japanese, and here, but we may actually try to do that study here in the USA simply because we have access to patients.

Dave: Just a quick shout out to Japan. I was there recently. The Bulletproof diet actually sold more copies in Japan than in the U.S., I think, or at least an equal number. The Japanese are definitely willing to try new things. I was totally blown away, so I went out there to sign some books and meet Bulletproof fans. At the airport I saw four or five different hydrogen water flasks, USB powered, just at the airport at the little tech stands, so it's definitely become something over there that you see. Here it's just kind of not a part of our awareness yet and, hopefully, this show and work, Tyler, is going to get the word

out so we can start paying attention to low-risk, potentially high reward, maybe different rewards for different people in different situations.

You're a relatively young guy. You latched onto this idea with just rabid curiosity, dug in, read all the papers. You travel internationally, allover the place to learn more, and work with the world's best people, so you're totally moving the needle on this, and I want to ask you, if someone came to you tomorrow and said, I want to perform at that level. I want to perform better as a human being, like what are the most important things I should know about if I want to kick ass and move the needle in a field as much as you have? Give me some advice, or give our listeners some advice. The three most important things to pay attention to for yourself if you want to have whatever you have that makes you do this.

Tyler: That's a great question. Put me on the spot a little bit. I don't consider myself to be ... I wouldn't use the same words to describe myself as you have, and so ...

Dave: I just call it like I see it, man. You're kicking ass, and you are moving the needle, and I choose people for the show specifically because they're changing the game in their field, because they've done something that's noteworthy, and I want to know what makes you tick, and what advice would you have as to what you've learned about learning how to do this that other people can use.

Tyler: I guess I can try some things that work for me, and perhaps the principle of what I say can be applied to other areas.

Dave: There you go.

Tyler: I must mention hydrogen. Whether that is you actually use hydrogen on a daily basis, or the principle of ... As you may tell, I'm really quite passionate about hydrogen, and it's something I really enjoy studying. I want to learn about it. I want to educate people. I want to do all I can to better the human race, and there's a principle in there, and I think that perhaps that principle as a driving force could potentially be just as, or even more beneficial, than the hydrogen molecule itself.

Another one, I am a very strong believer in exercise. Of course, sometimes I can be an exercise fanatic and I really push myself to see what the human body can actually do, but you don't need to go that far, and I think just getting out and getting some exercise, making some free radicles at a small level I think is so important, and I think exercise is medicine.

Maybe a third one to kind of balance things out, with the secular learning, and the physical things is think there should be a spiritual balance to everyone's life, whether that is just a belief in God, or just the understanding of the quantum implications of there is so much then our mortal tiny self. There's so much more out there, and that's something that we should recognize that should induce reflection, meditation, and to put things in perspective, and I think as we do that it may allow us to have better focus,

to do better in all other aspects of our life, and just keep ourselves grateful, and humble, and helping other people. I think maybe those three things play a large role in my life.

Dave: Well, thank you for sharing that, and I'm basically hearing passion for what you do, exercise, and have some spiritual balance, or faith, and that includes a practice of gratitude. What a fantastic list. It's funny, there are patterns that come out from having interviewed almost 500 people, like people who change the world, those are quite often on their list, and you're working to change the world in your own way. Taking a set of knowledge that's in some part of a thing something that you believe is important and then taking it and spreading it out, which is a huge act of service, because I fundamentally believe that when people understand what they can do to be better people that they'll actually do it, especially if it's not that much work, and that when you do a little bit to make yourself better, we're all wired to be nice to each other, at least if our basic stuff works.

Anytime someone makes you stuff work better, you're naturally, as a by product, nicer to the people around you, which makes it easier to practice the other pieces of advice you just had there. Thanks for doing what you're doing, Tyler. I appreciate just the amazing focus and passion you have on this body of research that very few of us in the U.S. have heard about, so you are doing an act of service by sharing this, and I'm grateful for it. There you go, I practiced two of your things right there. I'll work out later, and then I'm good for the day.

Tyler: That's right.

Dave: Where can people find out more about your work, Tyler?

Tyler: You can visit us on it's molecularhydrogenfoundation.org. Soon to be molecularhydrogeninstitute.org. Again, we are a science-based nonprofit. We don't sell products, or make recommendations on products, but we really try to advance the research, and the education, and the awareness of hydrogen but, again, right now molecularhydrogenfoundation.org. You can read about some of the studies, some of the information on hydrogen, and stay up-to-date.

Dave: All right. Thanks your work. Have an awesome day.

Tyler: Thank you, Dave.

Dave: If you liked today's episode, you know what to do. Head on over to iTunes, bulletproof.com/iTunes will take you there, and if you're not a subscriber to the show, subscribe, because you hear more cool stuff from people like Tyler, and leave a rating while you're there, just leave a review, which is a way you can express gratitude, and just achieve one of those three goals that Tyler just shared with you. You could head on over to Tyler's website, and since it's a nonprofit I'm sure he's accepting donations, and if you're in a position where you can donate to the kind of research that might change your own life, or change someone else's life, little donation to people like Tyler who are working to do core research on our biology that isn't driven by pharmaceutical stuff can

make a huge difference, so consider supporting scientific research with your donation dollars. I think that's something worth doing, and something that I certainly do by supporting Gerald Pollack's work with water at the University of Washington, for example. Thank you very much. For listening today and I'll see you on the next episode.