Episode Transcript

Danny Lennon: A big welcome to the podcast to Dr. Pete Peeling. Thank you for joining me on the podcast today. How are you doing?

Peter Peeling: I'm well. Thanks for having me.

Danny Lennon: I'm very excited to talk to you today and I think, as I've mentioned to you, I've been incredibly impressed with. The, both the extensive and informative nature of your work. So I'm very keen to talk about some of the topics I've planned, but before getting to any of that, maybe for people listening to give them some context about your work, can you walk us through a bit of your background in academia and your current research interests?

Peter Peeling: Yeah, definitely. So I guess I started out at uni studying sports science and exercise physiology. As an undergrad and I was a bit of a hack runner myself and always had issues with my iron. So as I went through undergrad and honors degree, it took me down the path of trying to think about how to solve my own problem. So I ended up doing a PhD at the University of Western Australia with my supervisors at the time, which were Professor Brian Dawson and Dr. Carmel Goodman. He's a medical doctor and

together we hatched a plan to see if we could investigate iron metabolism a little further.

Spent a few years looking at that in, in my PhD and then ended up working in industry with the Australian sports system at one of our state institutes as a physiologist, working with a number of sports. I think I had about seven sports at the time that I was working with, but mainly with kayakers in that group. I think five of the group we were working with at the time ended up going to the Olympics, so it was a really cool period working in the trenches, if you like. And whilst I was doing that I tried to maintain my hand at doing some research in the field and that led me back to university land to do some teaching and pick up the research a bit more. And then through the help of a number of grad students over time we started to build, I guess a lot more on this area of iron deficiency because it the work I initially was able to do, intrigued a lot more questions and I guess that's what led me back to academia was wanting to answer those questions with the help of some really good students who if anyone looks at the literature that they're the guys that have done a lot of the work since my original work, but have been fortunate enough to help them along the way. Collectively we've all been able to put together some good work in the area, I think.

But then also, I guess I been able to, or fortunate enough to work with lots of other people in other areas of sports science. So I guess you'd say, Is my main area, but have a lot of work on inogenic aids heat altitude, environmental stress, and then some work with some professional teams looking at player loads through GPS analysis and that sort of thing.

And that's led me to be able to look after the research center in our institute where I used to work. So I kind keep moving back and forward between the two organizations and over there we have 11 PhD students now looking at a wide variety of things from nutrition all the way through to, we've got one student looking at computational fluid dynamics in swimming trying to maximize the use of the dynamic wave that a swimmer produces when they swim.

So I've got a really broad research interest that spans across sports sciences. But my niche, if you like, or my probably pet area of interest is this work in iron that seems to be ongoing and it's never ending. Questions keep popping up.

Danny Lennon: And certainly that will be our focus for today's conversation. And I think maybe a good way to start this when we're thinking about the impact of iron status and sports performance, or at least for athletes specifically, is to maybe put on people's radar why this is something that is so crucial or why we have this connection. Because people have probably heard of the importance of iron as a nutrient generally for health, but specifically in the context of what athletes care about and this area that you're involved in, can you maybe connect the dots for people of why iron is such a crucial nutrient in this context?

Peter Peeling: Yeah it's a funny one. So with all minerals and vitamins, the body's dependent on the diet to replace them. So we have no innate process of producing iron yet. The irony is iron is so important in pretty much all of the processes that occur in the body. So if we draw that back to an exercise specific domain and you go where are the key areas that iron are useful in that setting to carry oxygen around the body? And our red blood cells requires our red blood cells to house iron so that the oxygen is actually bound to iron in the red blood cell.

So without iron, we wouldn't actually be able to transport oxygen to the muscles. In that context it becomes critical for our ability to move and then at a more cellular level from an energy metabolism and ATP production perspective. So right in the mitochondria iron plays a role in some of those processes that catalyze ATP as well.

So if you think about getting oxygen to the muscle and then being able to produce energy irons involved in both of those processes fundamentally function to allow us to move and therefore from a sport perspective, allow us to compete. And then iron plays a role in other things like cognition and immune function.

So when we are making decisions that could be implicated if we have iron deficiency, some of the symptoms become brain fog and fatigue and lethargy. So having healthy iron stores helping decision making process. And then immune function is about minimizing day's loss to illness, right? So if we can maintain a healthy immune function, which is reliant upon us having healthy iron stores, then certainly we might be able to reduce the day's lost to training from injury and illness. So collectively, I think if you look at the whole experience of an athlete and the things that you need to tick boxes to

make sure that you can train consistently and iron has a role in there. And so making sure that you can maintain healthy iron stores becomes important when you're trying to optimize the function of the system.

Danny Lennon: When we think about iron status, and when we start trying to think "okay, what levels are adequate? What level levels are optimal?" For lack of a better term... At what levels do we start seeing symptoms emerge?

How do we typically classify iron status or what are some at least benchmarks we can put in people's minds for the rest of this conversation?

Peter Peeling: Formally and clinically, if you like, there's probably three levels of iron deficiency that we speak of. So we tend to talk of three stages of iron deficiency.

So that first stage is really just a depletion of iron stores. And the way that we currently measure iron stores in athletes, and most of your listeners would know this, is we send athletes for a blood test. And in that blood test we test a few things, but if you were to boil it right down, what the doctors would look at the moment would be a serum ferritin level and a hemoglobin level.

And so if the serum ferritin level is below 35 micrograms per liter, and your hemoglobin was normal, then you might say that an athlete could be iron deplete so that their iron stores are somewhat compromised. This doesn't mean that you'd start getting symptoms, but it's a good point to red flag an athlete to say, "hey, look, you're on the borderline or on the cusp of this likely becoming a problem". So we classify that as stage one.

And then so using those two, same two measures, if we work our way down in the stages of severity, stage two creeps in when serum ferritin levels start to drop below about 20 micrograms per liter. But in this instance, hemoglobin is still somewhat normal. So you've got deficient iron stores, but they're not yet impacting your ability to produce red blood cells or your hemoglobin. So the hemoglobin stays above about that 120-130 grams per liter mark.

And then as the progression of the issue gets worse, we then talk about stage three iron deficiency, which is actually anemia, and that's where both the, so the serum ferritin is now probably below 12 to 15 micrograms per liter. But

the differentiating factor here is that hemoglobin is now starting to be impacted. So not only do you have a depleted iron pool, but you're not able to produce or adapt from a hematological perspective. And so the key symptoms of lethargy and fatigue will probably creep in around stage two. And then in stage three you start to get compromised function.

So we talk about three stages because it's ideal to try and catch it in stage one and. And apply some sort of strategic approach to fixing the problem before it gets worse. But we have a number of strategies that we've been looking at that you address each stage at, so if you didn't really get to the problem until stage three, there's some more extreme measures you can go to fix the problem, which I'm sure we'll talk about as we get through the podcast. But the point really is that if we can monitor athletes appropriately, then we might be able to catch this early and try and fix it with a more food first approach, then have to go down the route of oral supplements, which are pretty common anyway, or more intravenous type approaches to fixing an iron deficiency, which is where you'd end up in the most severe stages.

So that's how we define it at this point in time. And there is some conjecture around how good those measures are, because as we probably know hemoglobin is impacted by plasma volume, and in athletes that can change quite a bit. And serum ferritin is an acute phase reactant, so if there's inflammation around, then you may get an elevated ferritin level as a result of that inflammatory process. So we've come up with some guidelines in the literature that suggest how athletes should present and when they should present for this screening to make sure that the data's as good as.

Danny Lennon: Yeah, so there's a couple of elements just to want to touch back on, and at the risk of oversimplification, one of the things that might be highlighted there is that we could have a situation at stage one that you've outlined, where ideally we'd want to try and catch that and address that issue before it progresses any further.

But at that point, the athlete may, to some degree, be asymptomatic or at least not presenting any major problems in stage two, we may see other symptoms like lethargy and fatigue; indirectly what you would see would have an impact for an athlete of negatively impacting their performance or recovery.

And then at stage three, as things get progressively worse, there's even more direct impact on actual.Performance would that be to some degree accurate representation of what's happening with some of those?

Peter Peeling: Absolutely. And so that at stage two, when you mentioned it might not be as direct, it might be the lethargy and fatigue is not allowing you to train consistently and therefore you, that starts to have knock-on effects to your ability to adapt anyway because training hasn't been as consistent or as regular as it normally would be.

But then yeah, you're right. In stage three, that's when okay, now we've got compromised hematological outcomes and therefore our actual performance whilst we're exercising is reduced as well. So we get a reduction in physical capacity when we get down to the more severe stages of iron deficiency.

Danny Lennon: And just to touch back on the second point you made in relation to assessing iron status in athletes, and this is something many clinicians will maybe be aware of, but for athletes themselves or people working with them who are looking at blood tests, particularly in this age now of consumer testing, which has its pitfalls when people try and interpret that, there are some big challenges if someone is looking at a blood test, particularly if it's one individual blood test at a point in time. And you've outlined that there are a number of factors that could impact those test results or at least need to be factored into that decision making.

You mentioned some things around inflammation and training and maybe the timing of those tests. Could you maybe just speak to that a bit more and clarify for people, the importance of accounting for such factors.

Peter Peeling: So there are a number of factors that can affect the variables we currently use to assess iron status. And like I said, the key ones are serum ferritin and hemoglobin. But because we know that there are various factors that can influence them, we've written out some guidelines, which are published in the European Journal of Applied Physiology. I think the paper was published back in 2019 now.

So the first author on that paper is Mark Sim. And other contributors, I think were Laura Garvican-Lewis, Gregory Cox, Andrew Govus, Alannah McKay and

Trent Stellingwerf. And all of those people have published quite a bit in this space. And as a reflection on when people were getting their iron status taken. So if you think in a practical sense, my time in the institute setting, whereas an athlete would be lethargic, they'd go to the medical provider, they'd get a blood screening for iron studies and they would go to the phlebotomist whenever it's suited, which was likely after training or in the middle of the day or at the end of the day when they could get there. They'd get it done and then the results would come back and you'd be like those results vary quite a lot over between screenings and is that just the result of when you went what you did before it and those sorts of things? So in our guidelines, we wrote down some standardization protocols. So one of those being the time of day can influence those measures. So preferably the athlete would go and get their blood taken in the morning before they've done any training or on a rest day when there is no training on. And we'd also written things around making sure that you're well hydrated because plasma volume can be impacted by dehydration, which is why going after training isn't necessarily a great idea because you're likely dehydrated when you go and get your blood taken.

So in the morning, on a rest day in a well hydrated state, at those minimum guidelines that we think you should try and adhere to when going to get your blood taken. And of course, not having any signs of illness. So if you feel sick or if you're injured and there's high levels of inflammation in the body, there's no point in getting your blood screened for iron status in those states because you're going to get elevated markers that aren't representative of a true baseline, as to where you're at.

Yeah, is there a better time? We think there is and it's certainly on those, the rest days. In the morning in well hydrated state and presenting as a healthy individual, not sick or injured

Danny Lennon: In athletes, what are some of the factors that would increase risk of iron deficiency? Some of course are going to probably apply. General population folks as well, but there are probably additional ones in relation to athletes. So what are some to be wary of?

Peter Peeling: Yeah, so we, we tend to say there are probably four high risk groups. I used to say three, but my thinking is evolving over time.

One of those high risk groups is female athletes. And the reason that females are at a greater risk than males is the menstrual cycle. So any way that we lose blood is obviously a way that we also lose iron. So if you look into clinical medicine when an individual has a hemorrhage, they generally need some high end treatment if they recover from that because they've lost a lot of blood. So female athletes in the menstrual cycle put you in one high risk group.

We tend to say distance runners are in another high risk group or distance athletes, endurance based athletes. And the reason... it's somewhat related to the amount of time they're exercising. And I'll get into some other mechanisms that make sense there in a second. But it's also about their ability to replenish food or their energy that they've used between sessions. And we know that endurance athletes, that train multiple times per day have limited times to re-feed and therefore tend to sit in an energy deficit. And what comes along with an energy deficit is a reduction in the amount of vitamins and minerals that you're consuming in your overall food load; replenishing what you've, what you need. So that endurance athlete link is really around the ability to refuel.

And then we think that that energy compromised athletes from an aesthetics, perspective or a weight restricted perspective maybe at risk. Again, that's around total energy intake. So if you think rowers for instance may have weight restrictions around weight classes similar with jockey, similar with boxing. Similarly, there's the aesthetic type sports, like dancing. So we've just finished a study in ballet and contemporary dancers, and the prevalence of iron deficiency in that group is super high because it's an aesthetic sport, but they're training a lot so they have reduced time for them to actually get the energy intake that they need.

And then the fourth group would be special dietary type consideration groups. So vegetarians and vegans, for instance. And the reason why they're at a higher risk is vegetarians have to eat more foods with iron in them than what they normally would. So our ability to absorb iron from leafy greens, for instance, is about half that, what we would get if we were to eat red meat. So we know we can absorb about 35% of the heme in red meat, but we only absorb up to about 20% of the non-heme in leafy green vegetables. So you have to eat a lot more of that sort of food to be able to meet your iron requirements.

So they're our high risk groups, and then specifically athletes. The ways that we lose iron during exercise are related to a number of ways, but one of those is sweating. So we store some iron in our sweat pores, and when we sweat we lose minerals. But we also lose iron in our sweat. And if we're exercising more, then we need to replace that iron. Also, if we're exercising a lot in hot conditions we can become dehydrated. That dehydration can cause small lesions in the bowel, and therefore we can have micro blood loss, which can lead to over time to iron deficiency.

And then we also have red blood cells senescence. So when we're exercising, If we have older red blood cells in the system, just the impact of exercise itself can cause those red blood cells to to break down and therefore we lose the iron to the system of those red blood cells. Now, in a healthy individual, we would recover that and recycle it but there are, it is a means of iron loss of that recycling process breaks down. And then lots of our work has looked at the impact of hormone elevations from exercise. So we know that when we exercise, we get an increase in a hormone called hepcidin.

And interestingly, hepcidin is the master regulator of iron absorption from the gut. So when we have high levels of hepcidin, we have lower levels of iron absorption because hepcidin sits on the gut transporter that gets iron from our gut into our system, and it downregulates that process. And so we know that there's a transient period post-exercise where there's a reduction in iron absorption as a result of elevations in hepcidin.

And so lots of our work has become about the timing or strategic timing of when to consume iron to try and absorb that. That iron before you get elevations or sparks in the hep and hormone. So they're probably holistically all the reasons why athletes are at risk from high risk groups to the actual mechanisms behind what's causing it.

Danny Lennon: So to maybe recap on a couple and to dig in a bit further, first on the. Specific scenarios you describe whether there's a situation of low energy availability, is that causing the issues simply due to the reduction in overall iron tank iron intake because they're under consuming? Or is there something else going on that has this additional detrimental impact of having a low energy availability state with low iron intake?

Peter Peeling: It's probably multifaceted. I don't think there's any one simple answer and I think they're so interconnected that it would be hard to dissociate them. But if you took that as an example, there is certainly so if you think about the athlete who is undernourished, they're probably training a lot, which means they're probably sweating more and there's probably more of these chances of these mechanisms, culminating in an iron deficiency, right? So there's that bit.

And so they're losing more iron and we know that the general person will lose between one and two milligrams of iron per day, but an athlete will lose between three and four milligrams per day. So there's increased losses and that's from the exercise.

And then you are not refueling appropriately, so you're not putting back in the increased losses. So the energy deficit part becomes about the fact there's not enough iron to replenish what's been lost, but the mechanism is really the mechanics of how we are losing it. So combined they're creating an issue and then there's the other parts of that is that an undernourished athlete is probably not recovering well. So there's this elevation and inflammation, and the elevation and inflammation can also cause an increase in hepcidin, which means there's a reduction of absorption when we do put the iron in. So you can start to see how all these things intertwined and they create a complex problem rather than a simple "it's A or B". It's A, B, C, X, Y, Z sort of thing, right?

Danny Lennon: So yeah, maybe let's focus in on hep that in there for a moment, because part of. What you notice is when we get this transient increase in hep and when that's elevated, this can have an impact then on our absorption. And so being mindful of when this increase can occur is quite useful. One example you just gave a moment ago is when there's an inflammatory response due to exercise that can cause this transient increase. Are there other instances then when we also get this transient increase of hepcidin? And as second part to that question can that go beyond a normal response we'd see in hepcidin? Can something become almost dysregulated to the point where hepcidin is staying higher than we would like for longer periods?

Peter Peeling: That's an interest question. So if you look back into the clinical research, so hepcidin hasn't been known of for a long period of time. It was

discovered in 2001. And then was in that period from 2001 to 2005 was well researched in clinical populations. And what was discovered there was that people with high inflammatory states had really high hepcidin levels tended to present as iron proficient, which was a problem of anemia, of inflammation in clinical settings.

But they also found at that time that people with hemochromatosis which is a disease where the body has no regulation of iron, so you absorb all of the iron. That you are eating and too much iron is toxic. So you start to store that in your organs, which is really negative for the body. Those people weren't producing any hepcidin at all.

So they're the dysregulated settings at the extreme ends in a health model that you would look to. So then that, that research progressed to looking at what are the primary causes in the inflammatory setting. And they, there was a lot of mouse model research done at the time where they could take mice that were knockout mice of certain cytokines. So they didn't produce a certain type of cytokine. And in some of the key research that found this association, they took a IL-6 knockout mice. So that's mouse, so that's interleukin six. And they compared that to a normal mouse model. And what they saw was that the IL-6 knockout mice didn't produce any hepcidin.

There was this key process where when they induced an inflammatory response and increased IL-6 levels, they saw a con contaminant increase in, in hepcidin. But when they did that with the IL-6 knockout mice, they got no response. So we know that IL-6 is a key driver in in hepcidin.

But then you also get the converse where there are, have subsequently been found some ways to suppress hepcidin levels. And one way to do that is when you go to altitude the body produces a different hormone, which she's known as erythroferrone. And erythroferrone seems to attenuate the elevation in hepcidin, and so why would that be useful?

When we go to altitude, the stimulus is causing us to produce more red blood cells to be able to deal with the altered environment and altitude. So the body's response is to suppress hepcidin so that we can absorb more iron so that we can start to make the new red blood cells that are required to survive at that altitude.

So I may have gone off track there, but they're the underlying ways that hepcidin functions and regulates in the body. And so exercise is a primary stimulus of interleukin six. So we know that when we exercise, we get these transient increases in interleukin six. And What tends to happen following that is about three hours after the exercise period, because we've got this immediate increase in IL-6, the body responds to that, and at that three to six hour period post exercise, we get our peak periods of hep concentration in the body. And that's generally related to the exercise and transient increase in inflammatory response.

Danny Lennon: Super interesting. So with that, we can start maybe thinking about some of these potential treatment strategies for an iron deficient athlete. One of the interesting elements you've already noted has been this timing potentially of iron consumption relative to this hepcidin response that we know about. First can you maybe speak a bit more to that? And I think then there's some interesting follow-ups in relation to some of the oral supplementation stuff too.

Peter Peeling: Yeah, so my original PhD study was literally super simple. It was get people into the lab and get them to sit around for a couple hours and just monitor their blood and see what happened when they were doing nothing and control all the things that they did before and after that, and then we recreated the same thing, all the same controls, same conditions, except we had them for an hour and we simply monitored IL-6 and hepcidin in the post exercise period. And so we saw that transient increase in IL-6 and then three and six hours post exercise. We saw these elevations in hepcidin. So that made us think, oh, obviously exercise creates this transient increase in hepcidin, so there must be a period of reduced iron absorption.

And similarly then there must be better times to consume iron around that reduction in iron absorption. And actually there's some research that just came out by Stephen Hennigar at Florida State University who showed specifically with iron isotopes that yes, that increase in hepcidin after exercise transiently reduces our ability to absorb iron.

And so one of our graduate students, Rachel McCormick, ran a study that looked to see what the impact on absorption would be in the morning and the afternoon, because we also know that your hepcidin levels in the morning will be lower than they are in the afternoon. Simply a factor of the

day. It's not by a large amount, but there is certainly a diurnal impact where you get greater hepcidin levels in the afternoon.

So Rachel wanted to see whether iron absorption would improve in the morning versus the afternoon with exercise or without exercise. What Rachel did was she got people in the lab, she fed them an iron isotope. She traced how much of that iron ended up in a red blood cell, 14 days after she gave it to them, and obviously the more in the red blood cell would suggest them more that they absorb. And what Rachel saw was that when she fed athletes the isotope and they exercised in the morning, she fed them the isotope within 30 minutes of finishing exercise.

So what she was trying to do was to see whether you would still absorb iron if you had it in close proximity to exercise. And what she saw was that in the morning group, when they exercised in the morning, you improve the amount of iron they absorbed if they consume the iron within 30 minutes of finishing exercise.

But that didn't happen in the afternoon group. So if you exercise in the afternoon, you were provided the isotope, you didn't absorb any more of that iron, likely a result of that diurnal increase in hepcidin levels. So Rachel set the scene for well morning exercise or morning consumption of iron seems to be a better approach than afternoon consumption of exercise of iron. And if you can consume that iron in close proximity of the exercise, given that we know that you don't absorb as much at that three-hour time point, which was confirmed by Stephen Hennigar's work, then consuming it in close proximity of exercise or even before exercise will likely improve your chances of absorbing more iron.

So it seems the strategy there would be if you're going to consume high iron containing foods, maybe consume it in the morning and try to consume it in close proximity exercise to avoid the peak in hep and levels that occur three to six hours post exercise.

Danny Lennon: And so with that, in a maybe slightly related point, and please correct me if any of what I'm about to say is incorrect, but it reminds me of some of the work looking at oral supplementation of iron, where for a variety of reasons, different strategies have been looked at, for example, alternate

day supplementation rather than daily. One reason being because it results in maybe less upset stomach for people who don't tolerate it.

But it seems that there's also this additional potential benefit around when there's high dose taken daily, there tends to be maybe a drop off in some of that iron absorption and potentially that is down to this transient increase in hepcidin and caused by that high iron dose if I'm remembering correctly, but you can rephrase it incorrect. Has that played out in some of the iron supplementation literature of looking at different strategies and different timings, alternative versus daily. What is the state of the evidence there and is some of that decreased absorption with high daily doses down to the hepcidin response?

Peter Peeling: Yep, definitely. So you've done your research, which is great. So there's a group in in Switzerland who have done a lot of work on this. They travel to Africa and the incidence of iron deficiency is really high in African children. So their work is about trying to improve the status of those those individuals, which is really cool work. And they did some really good studies. The key collaborator that I know is Diego Moretti, who has worked with us with Rachel's stuff as well, and the work that Diego was part of they, they looked at this relative versus absolute absorption problem and they showed that with high doses exactly as you said; when you get consecutive high doses of iron, you tend to absorb less of the consecutive doses as a result of the hepcidin spike that comes from the first dose. And so then they started to drop the dose and they found that from a relative perspective, they were absorbing individuals, were absorbing more of the iron from a lower dose, relatively relative to the amount from the higher dose over time. So it paints the picture of the benefit of lower doses for absorption. Probably the catch with that is that in the absolute sense, more iron was still absorbed from the higher dose, but from a relative perspective, it was better as a percentage of the total iron consumed.

So more is more, but less is more, if that makes sense. So the way to leverage that is if you can tolerate iron at a hundred milligrams per day every day, or even up to 200 milligrams per day every day from an oral supplement. Then go ahead if you are iron deficient because you're going to absorb more of it and you'll get more overall.

But lots of people struggle to do that because oral iron supplements, one of their biggest downfalls is that they give you lots of GI distress. So there's not many people that can tolerate that, that amount of iron over time for the eight weeks, it's required to get you back to healthy iron stores.

So Rachel actually did a study in athletes where she for eight weeks supplemented a group with a hundred milligrams of iron every day. And she compared that to a second group who were doing all the same training, where she gave them 100 milligrams every second day. And the overall eight week outcome on serum ferritin levels was the same.

It was very slightly lower in the alternate day. But it wasn't significantly lower. And probably upshot of that approach was that she had, I think it was about a 30% decrease in in GI upset. Please don't quote me on that 30% number, but she a significant decrease in the incidence of GI upset in the alternate group.

Which is good in two ways because one, if you can reduce the GI upset, then you increase the compliance. People are more likely to do the eight weeks if they're not feeling sick or have GI upset from taking the supplement. And the second upshot of that is you've used 50% of the supplement and they're not cheap, right?

They're a bottle in Australia costs us $25. And that lasts a month, whereas now you're spending $25 for two months. And from an athlete perspective, there's a financial upside of that too. So you're ticking a couple of boxes with the alternate day approach, which seems to be effective over the long term.

Danny Lennon: So maybe to finally round out on some of these treatment strategies. The iron deficiency has progressed to a certain stage. It's probably unlikely that just some simple dietary changes is going to do the job. We can then look to something like oral supplementation. There we may run into issues either where an athlete can tolerate enough for whatever reason or another sense maybe is not responding appropriately to that type of treatment. What other options have been looked at in relation to increasing iron status in athletes, and maybe particularly in the case where that needs to be done relatively quickly?

Peter Peeling: Yeah and you're alluding to the more anemic type states where you need a rapid response to treatment. And so the way that we go about that is from an intravenous approach. And so we used to go down the path of intramuscular eye injections but they're quite traumatic in a sense.

And that the process has evolved over time to become more an IV infusion of iron in straight into the bloodstream. And the benefit of that approach is that you bypass the gut. So all of the issue in athletes or individuals being iron efficient comes down to the gut, whether it's you're not putting enough through the gut to absorb it or your gut is, has some issues where it's not absorbing it or you get malabsorption of what you are putting through.

If you can bypass the problem by putting the iron directly into the where you want it to go, which is the bloodstream. So then it's taken around the body and to where it needs to be. The problem with that is if you have healthy iron stores and you're doing that because you think more iron is better, that's actually quite dangerous.

That, because as I mentioned before, in cases individuals with hemochromatosis, they start to store that iron in their organs. Having a quick response when you've already got high iron levels to get more iron probably my first caveat is, don't do that because it's a really bad idea. So iron, the iron isn't such a mineral where it's more, is better, more is actually worse.

There's a really finite balance of what is good and what is healthy, but in individuals that really need it and that have malabsorption at the gut. You can completely bypass that by putting it directly into the system. But what the research would show is that the impact of doing that is effectively nothing unless the individual's hemoglobin is severely compromised, which is why we save it for those individuals in the anemic state of iron deficiency rather than those that are just depleted iron stores. So there's lots of literature out there that shows if you put intravenous iron infused into an athlete that just has low serum ferritin. Yep, you'll increase their serum ferritin, but it won't do anything for their physical performance. Whereas if you take an athlete who has compromised serum ferritin and also a reduced hemoglobin or a better measure still is hemoglobin mass.

So the total amount of hemoglobin in the body, if you give those individuals an iv iron, they increase their ferritin stores really quickly and they improve

their hemoglobin or hemoglobin mass quite quickly as well. So it's almost that they're ready to adapt, their body wants to adapt, but they don't really have the toolkit to do that.

And what iron does, the infusion does is it provides the toolkit for their hematology to adapt back to where it should be. So it seems to be really effective in those groups. And not so effective in the other groups in terms of improving physical capacity, but it will certainly increase ferritin levels very quickly.

Danny Lennon: So in, in relation to some of this work Pete, what are some of the upcoming research questions that either you. Your group is currently exploring or that you hope to explore in the next couple of years that you think are particularly interesting?

Peter Peeling: We just finished a study where we looked in contemporary and ballet dancers at the impact of a long-term supplementation, so eight weeks. Either all in the morning or all in the afternoon to play that out, the acute stuff that we'd seen over the longer term. So we're looking through the results of that now, which will be interesting. And then where we are probably taking this is we want to look a bit more at periodized approaches to iron supplementation and periodized in the sense that we know that in menstruating females that there's going to be a period where they have a significant hemorrhage if you like.

And as a result of that, they'll get a suppression of hepcidin levels in the body because the body will be craving iron. So we are wondering if there's a better time across the menstrual cycle that females should be. Increasing their overall iron intake or supplementation where you get a bigger bang for your buck from a maintaining iron stores during that period, and then maybe taper off through the menstrual cycle.

What we do know is when estrogen levels are really high, hepcidin levels will also increase. So towards the back end of that cycle, there might be little benefit from consuming lots of iron or iron supplements at that point. But there might be a big upswing in the amount of iron that's absorbed at the point of menses.

So periodizing iron intake around the menstrual cycle would be of interest to our group. And then also looking at that concept at periods of high training load versus lower training load or different training focuses and whether there's a more individualized or periodized approach as to how you might think about consuming iron in your diet.

Danny Lennon: For anyone listening who is interested in diving more into your work, is there any places online you would send their attention? Either social media, university websites, et cetera? Where are some places they can go and check that stuff out?

Peter Peeling: Oh, yeah. Usually if you jump on PubMed and search any of our group's names, Mark Sim, Trent Stellingwerf, Alannah McKay, Louise Burke. If you search any of our work you'll lots of things will pop up on PubMed and most of us are on Twitter and usually put out something when we've done something semi-interesting, so that they're always good research resources to, to keep up with.

Danny Lennon: Perfect. And to finish off today this final question can be to do with anything completely, even outside of what we've discussed. If you could advise people to do one thing each day that would have a positive impact on any area of their life, what might that one thing be?

Peter Peeling: Oh, I would say maybe a couple things. One, would be every day try and say yes to something that challenges you, because you'll be surprised that at what you can do if you just say yes and take the plunge. I think lots of the things that, that I've been offered the opportunity to do has been a result of just saying yes and simply figuring out where it ends up along the way. And then my other one would be to try and help someone else every day. I think that's always important. It's handy having a five year old because you can sometimes feel like you can try and help them every day as much as they're helping you as well. But yeah, you can go outta your way to try and help someone else every day.

That's probably not a bad way to improve everyone's life. But if you bring it back to the settings that we are in here, sports science, nutrition, if it's just mentoring someone else to learn something or help them do something, then you know that's always going to be good for the area to help progress people.

Danny Lennon: Fantastic. And with that professor Peter Peeling, thank you so much for taking the time, number one to come and talk to me today. It's been an honor to talk through some of this with you and then also for the continued work you do in the field.

Peter Peeling: It's very much appreciated. Awesome. Thanks for having me. And probably just to reiterate at the end here, that certainly work that I'm interested in, but we have a really good team of people that, that do a lot of that work. So certainly not all my stuff definitely are collect. Approach to this work.