**Ischemic Heart Disease (Coronary Artery Disease)**

00:00 Dr Mike

Welcome everybody to another episode of Dr. Matt and Dr. Mike's medical podcast. I am your host Dr. Mike Todorovic. I'm joined by my co-host Dr. Matthew Barton. Matt. Good day. Good day. Good day, mate. How are you? I'm well, thank you.

00:41 Dr Matt

What's new? Not a lot. No, nothing. Fighting fires? I did that on Sunday. I'm not sure I should say this, but the it was a hazard reduction burn. Yeah. Which is preparing for the fire season. So we're currently in winter in Australia. Big thing in Australia. Fire season. Summer. And it got a bit out of control. So it probably went from a hazard reduction

01:08 Dr Mike

into a wildfire into a hazard itself. Yes. So have you? No, right. Happened on the Saturday. I was there on the Sunday. Right. And so you were only supposed to be there for a couple of hours doing a little bit of burning off. Yeah. And it turned into saving 14 hours of trying to stop houses being burnt down. That's right. Great. Well, and it is in the middle winter here. So yeah, it's Australia though, too. That's true. And we live in Queensland. So it was a 24 degree Celsius day. Probably more. It was probably 26, 27. Well, there you go. What would that be in Fahrenheit? Oh, seventies? No way. Mid sixties? No, probably like 90. Oh, I have no idea how Fahrenheit works. There you go. And that's a winter day. There we go. Well, I wasn't fighting fires on the weekend. I was running the open day while running it. But the whole university, Griffith University, had their open day. I was supposed to, but I got my dates wrong. Okay. Well, you were fighting fires. You were saving lives. So you, but just in different form. That's right. I was, I was saving the educational status of many, many aspiring health professionals. So I was at the uni. I was in the labs. The labs were used to teach anatomy and physiology. And I was just there bringing all these new students in, showing them what we do, showing them the models, some of the experiments that we perform. It was exciting. The students liked it. I think I recruited probably thousands of new students for next year. Really? That's how, yeah, I'm pretty good at influential. You were that's very convincing. A lot of impact, a lot of Alright, Matt, we're going to jump into what we're talking about today, which is ischemic heart disease, sometimes termed coronary artery disease or CAD. And look, it's got like many interchangeable names, which I'll get to a bit later. Okay. So we'll call it ischemic heart disease. Yeah, both both ischemic heart disease or CAD or coronary artery disease. So we might use them interchangeably. But basically the same thing. Yes. All right.

03:21 Dr Matt

Now, this is a this is a topic that's very close to your heart. Hey, hey. Oh, right. Okay, God. Jesus. All right. I was gonna screw that up. Why is ischemic heart disease close to your heart? What's going on? Well, it's in my family history, I guess you'd say. Right. And so I'll give you so my father, maybe 2018. So it was definitely pre COVID. I'm pretty sure it's 2018. I remember. Is that correct? I don't remember if it was pre COVID. No, it's definitely pre COVID. It was a while ago. Yeah, it was definitely pre COVID. Anyway, he had a double bypass. What does that mean? Basically means that the surgeon has to go in and put two vessels that aren't normally in that location there to bypass a clot in the coronary vessels of the heart. So there's two alternate routes to feed because there's a

04:23 Dr Mike

blockage blockage in his coronary arteries. Yes. Right. And two blockages to blockages. Right. Now, I know your dad, he is a tall, lean, fit, healthy by all standards, you know, individual,

04:39 Dr Matt

like I wouldn't think he ticks the boxes of being at risk for coronary artery disease. No, very low risk. So what's going on? Why did he need this? So basically, what happened was, he's very active, like you said, and he does a lot of bushwalking or hiking, I guess you'd say. And he's a well known bush basher. He was out. I think it was happened over a couple of times that he reported, but essentially he was out bushwalking one day and noticed that didn't get any pain, but he just was out of breath. And when he particularly going up hills, he just wasn't as, you know, his ability to power on was diminished. And that was odd for him? Yeah. Yeah. And in retrospect, because I did go bushwalking with him before this, and I do recall going up a steep hill once and he

05:36 Dr Mike

had to stop a few times. But he's a tough dude, right? So he would have not wanted to show that he didn't, that he needed to stop, right? So I assume it was a lot worse than what he was making out to be as well. Possibly. Yeah. But there's a couple of times. And you're a terrible son,

05:55 Dr Matt

so you probably said, come on, hurry up, you lazy old bastard, get up the hill. But I just remember, and I thought, oh, that's a bit out of character for dad, because he is very fit. And I just thought, oh, he might be just getting a bit old on. And so I think this event, he was about 68. Years of age. Yeah. Okay. Maybe a bit younger 67. Anyway, so he went to ease. So it's a couple of times where it was just out of breath. I guess you'd say shortness of breath with exertion. We went to the GP and the GP said, Oh, look, there's no chest pain, but it sounds like it's

06:32 Dr Mike

an exertional, you know, heart thing. Right. So even though he didn't tick the other boxes, because I would think a lot of GPS would go, look, I wouldn't think it's anything to do with your

06:42 Dr Matt

heart looking at you. So I mean, that's a good GP to be. Yeah. And I think this is also important to note here, because the classic signs and symptoms of this condition, and we're talking about today doesn't always present as we think it should. Yes. And so some people when they think of heart attacks, or it's giving heart disease, they should have the classic radiating chest pain, clutching your chest, falling down and collapsing, which it doesn't necessarily have that. It could even be a silent. So you may not even know you're having it. You may have other symptoms, but they're not the classic, you know, kind of crushing chest pain. Yeah. So that's important to know. So he so his GP said, Look, go get it checked out, gave him a referral to a cardiologist. Yeah. And in in the town where my parents live, there isn't a cardiologist available all the time. So he was referred to Newcastle, which is about two hours away. And again, the cardiologist said, Look, there's no point me doing a stress test on you. And I can talk in a second what that means. I think it's pretty classic angina. Right. So what we'll do is I'll just get you straight in. Since it's hard to see me essentially from where you live. I'll just schedule angioplasty. Really? Yeah. So they'll just do a I thought they always required a stress test. Well, he said, you've done the stress test that was walking up the hill. That was it. Like you're it's indicative to me that when you do exertion, you become out of breath. And that's probably some form of schemic heart disease. So didn't even do a echo. No, not that I can recall. Not that I reckon. Dad may have not told me everything, but I don't I don't recall him telling me this. Okay. Because this was all very quite sudden. And so it was either the same visit or very close to it. He then did an angiogram. Did I say angioplasty or angiogram? You said angioplasty. Sorry, angiogram. Okay. Yeah, sorry. Because I was thinking, no, and joking him straight into surgery is sorry, angiogram, angiogram. So okay, so explain that. So basically, they put a cannula in one of your arteries, arm or leg, they go up right where the coronaries begin the aorta and then they shoot contrast guy into it whilst x rating your heart. Yeah. And they can see if there's any blockages,

09:19 Dr Mike

sure, or narrow ins. Right. And so they did that. So it's another test. No test. Right. So it's another test you can perform before you start to open people up. All right. I mean, it's an invasive test. Relatively invasive. Yeah. So they did that. And immediately they said, well, this is getting this is quite bad. We all have to do a bypass straight off the bat. So they saw that of one or more coronary arteries. Excuse me. These are the arteries that feed the heart muscle itself. That if they are blocked, or the term we use is occluded, which we'll be using from here on out. If they're blocked, occluded, it means that tissue doesn't get oxygen or nutrients, and that tissue can ultimately die. Yep. So they saw that. And they go, let's so they can't just

10:09 Dr Matt

open it up. They can do that. But they couldn't for him because they said or the cardiologist said it's in a very awkward location of where the occlusion is. Yeah. Maybe on certain vessel bends, the way that it's kind of bending around and it's not stentable. Right. So that's the stent. That's like the umbrella that can be used to hold the walls open, scaffolding. So they said, it's either too calcified or it's kind of in a bad position that we can't put a stent in. So we'll have to put a bypass. So what do you mean by calcified? Well, that would be a longer. So at some point today, we'll talk about the steps of atherosclerosis, which is the plaque formation in the blood vessels. Yeah. But the calcification is more an advanced form of, I guess you'd say chronic inflammation, where the blood vessel gets infiltrated with calcium. And that's kind of a form of chronic inflammation. So is that more of a genetic based? No, I don't think so. But I think in his case, and then you'll find out mine, that that may be the genetic risk that you are more predisposed to having this form of atherosclerosis. So regardless of the additional risk factors you'd have in your lifestyle, you're still predisposed to getting a type of atherosclerosis, which you really can't avoid. So we had to go into surgery, what would have been the next day, a few days later? Not long. Okay. So then we were told family were told that you need a double bypass. And so this was all very acute. What vessels did they use? One from the arm and I think they use then, there's a vessel internal amillary, I think. And that's kind of at the back of the sternum. And they just kind of loop that in. But then they bring I think they brought a stripped of a vein from his arm, and did that. And now so that was obviously successful because your dad's pretty good now. So the cardiologist actually said your type of genetic risk, we will see the patients in their early 40s. Oh, but the fact that you had such a low risk profile, so like a healthy lifestyle didn't smoke, not not obese, you know, as you said, thin, on top of his blood pressure doesn't have diabetes, doesn't have any cholesterol, drinks very minimal. So all these lifestyle risks he doesn't have,

12:41 Dr Mike

he extended his life span. Yeah, so that he also delayed the pathophysiology of all the pathogenesis of that disease long enough so that they saw it two decades later than they normally would. That's right. Right. That's right. But not for you, because you're very, and then just to finish off,

13:01 Dr Matt

and this kind of illustrates dad as a, you know, like you said, a, what did you say, not a battler,

13:07 Dr Mike

but a, I said is more of a stoic. Yeah, there we go. That's that that sums up dad very well. He's very much a stoic. He's very much his, his mindful, but he doesn't burden others with his

13:18 Dr Matt

emotion. Very much like Matthew. Very true. Very true. But because he's had a physical job all his life, he, you know, would get injuries and then just shut up about deal with it. I mean, even once he had lost his leg and never told his family, he's a diesel mechanic, but he had, he was on working on a tractor and the tractor rolled onto his leg. Oh, so it was close. Crushed it. He pushed it off and then drove to hospital. Oh God. And so it indicates how dad is. But after the bypass surgery, which is essentially they'll cut up in your sternum and open your chest and then do all the plumbing. I think he was out of hospital in like four days. Well, they try and get them up and moving immediately. Now, I think he was out of the coronary unit in about 24 hours. And then, wow, because they used to keep people still for a long time. And then they realized that the best evidence is to get them moving, get them up and going. I think that's what a lot of things now. I think so. Um, it makes total sense. So now what's happening with you though? So the cardiologist said, look, because it's a genetic underpinning of your atherosclerosis, it's likely that your children will have it. So how did he know it was genetic? Simply because he didn't tick the other risk factors or they did a test. Didn't do the test, but I think it's just the type of atherosclerosis that he had. I guess he could tell from looking at it through the angiogram. But also the lack of risk factors too. I'll assume. So what test did they do for you in your sister? My sister hasn't had it yet because she is considered basically if you are as a female, still premenopause, you're at a low risk because estrogen is protective. Right. So as soon as females hit menopause, then their risks go up dramatically and they catch up to men pretty quickly. So what test did you have to do? So I had to do, I think this was the first thing I had to do was a calcium score CT, which is basically a CT scan of my heart with contrast. And then they would do a like a rating score on percentiles to see of the plaque that's currently in your vessel,

15:44 Dr Mike

how kind of advanced it is. And so they would do that for anybody who they suspect is having atherosclerosis. Who's at risk. Yes. So this is now a fairly, it's not modern anymore, but it's a newish form of non-invasive test. I mean, it's still got a bit invasive because it's a lot of radiation. But what was your score? I was in like the 97 percentile. Oh, congratulations. Oh, no, that's bad. That's bad. Okay. So for my age. Usually when someone's in the 97th percentile, you have to throw a party for them, but not in this case. Not in this case. This is a bad case. In this case, you throw statins at them. Basically. That's correct. All right. So 97 percentile. So what does that mean? Does that just mean that you've got a relatively occluded vessel or you're in the 97th percentile to being at risk for something? So what was it that they saw? What that told them

16:42 Dr Matt

that? I think it's, I haven't been given a perfect answer in what this is actually measuring. Right. It's not occlusion, but I think it's the form of calcification within collectively in the vascular chair of my heart. So the remodeling that has occurred thus far, it's sort of an algorithm. So for my age, sex, I'm in the, I guess you would say bottom three percent of or the high three

17:09 Dr Mike

percent of risk. Right. So that then means you need to do what? What was the information on the back end of that? So that was all you don't drink. You don't smoke. You're a vegetarian.

17:23 Dr Matt

You eat extremely well. You exercise. You are ugly, but in a redhead and you're going to bring that in. So there's those two things that are held against you. But I mean, I assume the cardiologist is like, keep doing what you're doing. At this point, it wasn't a cardiologist. It was a GP. But then the GP after that result, they'd refer you to a cardiologist,

17:47 Dr Mike

which then I've been seen for the last three years, I guess. And you guys say every six months, three to six months. Yeah, it was every six months. So initially what they did was functional assessments. So that would be a stress test. Yeah. So ejection fraction or more ECG. It was actually both. So the ECG and then an echo. So they would do it. So the ECG is measuring the electrical activity of the heart to see if there's any changes to the way your heart conducts, because that's an indication of mechanical change or potential mechanical change of your heart working as a pump. But then you can do an echo, which can directly measure your heart's ability to work as a pump. So whether the appropriate amount of blood entering or leaving, if there's any regurgitation, if there's any size changes, if there's any remodeling of the actual muscle of the heart. So they did those two tests and did they find anything? So resting and then after the 10 minutes of exercise on the treadmill. Yeah. And then how'd you go with that? Fine. It's not the most enjoyable experience because they kind of want you to hold on to the handles. Yeah. Whilst not trying to run. Yeah. Whilst going uphill. So it's just what my wife does. My wife does this for a living, right? So she's a cardiac technician. And so she gets every day people in to do these stress tests. And a lot of them are older. Yeah. And a lot of them, if they have a heart condition, have never done exercise. So she said, it's, you know, it can be quite scary when you have somebody in there, 80 and you put them on a treadmill and you push them to exertion and they've probably never exerted themselves before in their life. Or for a long time. Or for a very long time. She goes, it gets scary. She said sometimes within 30 seconds, people like you need to stop. So, you know, and she said it can be quite worrying,

19:42 Dr Matt

especially when you start seeing these arrhythmias occurring. And yeah, so you did that. So I think they try to push you up to about 80% heart rate max. Yeah. And so for me, I just hit that and they

19:57 Dr Mike

pull you off the treadmill. But no arrhythmias? No. So conduction's cool. What about echo? Echo is good. Great. So it's just the fact that you are at risk genetically. So what does that mean

20:10 Dr Matt

on the back end? The cardiologist says, what do you need to do? Well, at the moment, well, pretty much straight away, they, as you said, put me on a statin. So that's a cholesterol lowering

20:20 Dr Mike

drug. So just reducing your risk of depositing cholesterol into the walls of your blood vessels. That's right. Okay. And initially it was every six months, but now I think it's gone back to once every one year, maybe even two years now. Because you're at such a reduced risk. Yeah, the cardiologist is not really concerned now because they've done a whole lot of functional assessments. They've done. You'd probably be at a more reduced risk than me now considering you're on statin so early in your life. I'm probably at a greater risk than you are. The fact that you identify that. Possibly. I don't know the long-term evidence of statins. I also live a less healthier diet. And you exercise a lot though. So, all right. Now this is 20 minutes of preamble talking about you as always, as we always do, never focus on me. It's just you and your dad. Anyway, should we start to actually jump into what people are after? Yes, definitely. And what they're after is obviously the information. And the information is going to include what? What are we going to cover today?

21:25 Dr Matt

All right. So what I thought we could discuss is firstly, when we were referring to a Scheming heart disease or coronary artery disease, see how prevalent it is in our society. Australia or globally? We can do both. All right. A bit of medical history. And this is where we've had a special researcher do some work for us, which we'll talk to in a second. Then we'll define essentially what it is, what the cause of it is, the risk factors associated with it, brief pathophysiology. And then within the definition, we'll explain that this is an umbrella term that is actually the subtypes that fit underneath it. And just we'll discuss how they are slightly different to each other. And with the clinical presentation, we'll talk the mechanics for why you would see those typical symptoms. So what's the mechanisms behind each one of these classic presentation symptoms? Yep. And then complications? The complications. So this would be more in reference to a heart attack. If you were to

22:31 Dr Mike

survive, what would be the likely ramifications that it would potentially lead to? So an MI or a myocardial infarction or a heart attack will be one of the primary outcomes of ischemic heart disease, one of the primary negative outcomes, obviously, of ischemic heart disease. And therefore that will also lead to other potential downstream issues, which we can

22:53 Dr Matt

focus on. That's right. Anything else? Then just quickly how the, this is kind of diagnosed. Yeah. We've already kind of alluded to it with my dad, but we'll just briefly expand on that and then

23:06 Dr Mike

treatments. All right. So to begin, we do need to flag the fact that we did have a special researcher helping us with this. So we had Ben Zaxson. Now, Ben Zaxson is a high school student in Connecticut, in the US. And he just sent us an email and said, Hey guys, love what you do. I'm very interested in biology, doing a couple of college courses on physiology. Is there any chance I can help you with some of the work that you're doing? And so Ben is basically a virtual research assistant for us. And he helped us do a little bit of the background research for the ischemic heart disease topic today. So we do just want to thank Ben and thank him for his help. And you know, if anyone out there is interested in doing a virtual internship or research assistant role with us, feel free to pop us an email and have a chat and we will see what there is that can be done. So without further ado, nearly 30 minutes into the podcast, which is typical Dr. Matt, Dr. Mike fashion, we're going to start talking about ischemic heart disease, coronary artery disease, and we're going to start with a bit of a background or a history.

24:18 Dr Matt

We'll just do the prevalence first. So in terms of how common this is. All right. So there are two kind of subgroups to ischemic heart disease. Yep. There is something called angina or engine. Do you say engine? Does anyone say engine? Again, I think it's an Americans pronounce it like that. Angina. But I could be wrong. Once I put the accent on it, it's an engine. Angina, Angina, Angina. I don't know. So here in Australia, Angina. So we're going to talk about angina. So there's two kind of subcategories of ischemic heart disease or coronary artery disease. There are the engine is or engine is just say engine. Okay. And then there's the infarctions, the myocardial infarctions. Okay. Okay. So when we refer to and enjoy it now, you can say engine. I prefer engine. I've just never heard you say engine. So in terms of the whole, the global population, right as of 2010, this is a stat that I could find. That's quite a while ago. About. Yeah, it is a bit old. It'd be interesting to see the effect of COVID now on heart disease because it seems like it's a vascular disease. It's now dramatically increasing this. Right. That's a good point. But anyway, about 1.6% of the whole population has angina at any one time. Wow. Now in the American context, that's about 10.2 million individuals that have angina and about half a million cases per year, new cases per year. So individuals being diagnosed with angina every year. Okay. Now in Australia, this is a more recent stat, 2020, 21. And so this is kind of within COVID. Yeah. About 2.9% of our population will be living with ischemic heart disease. Okay. So that's not insignificant. That's based on reported data. So with the latest survey, what do we call that? Census. Yeah. That would be reported data. So about 2.9% of the population. So we're higher than the global average. Right. Okay. But most Western countries would be, I assume? Yes. And that's going to be interesting because it's been traditionally thought as a affluent disease, I guess you should say.

26:46 Dr Mike

So- Because of environment and lifestyle. Yeah. Which tends to be overindulgence in, when it comes to diet. Correct. But also sedentary lifestyle. Possibly, yes. So more sitting, more eating tends to correlate with increased risk of ischemic heart disease. That's right.

27:04 Dr Matt

All right. So about 2.9% of Australians have ischemic heart disease. But once you get over the age of 70, it goes up to about one in nine individuals. So- I think it's at 3%. 2.9%. 2.9. Sorry. Yeah. And then as you get up to 70 years old, what? It's about 11%. Right. So it correlates with age too. That's right. So diet, sedentary lifestyle and age. Okay. Correlates with those factors. That's right. All right. Now, in terms of an acute event, so this would be, we'll get to these categories again, but this would be probably the more severe end of those categories in ischemic heart disease. So this would be heart attack or something called unstable angina. People would, about 50, 60,000 Australians would be having these per year. And about terms of heart attacks, about 155 events per day. Right. And of these, about 12% are fatal.

28:08 Dr Mike

So, you know, forgive me, Matt, but what is ischemic heart disease and coronary artery disease? So you're saying, you know, it's common. People are experiencing it. People are experiencing the effects of it in a multitude of ways, whether that be angina or myocardial infarction. But what is it?

28:27 Dr Matt

So let's just first do the first one, which is ischemic heart disease. What does ischemia mean? Okay. Ischemia just means a reduction in blood to a tissue, usually a region of the body, a tissue area. So if it's, if we're referring to the heart, it would just mean there's a reduction in blood

28:46 Dr Mike

flow to the heart muscle. And that's important because the blood has oxygen and nutrients. Correct. So then off the back of that, you impute that means that that tissue, so in ischemic heart disease, no oxygen and nutrients are getting to the heart muscle. It doesn't get fed.

29:02 Dr Matt

It doesn't work. It's no longer a pump. Is that right? Not, there's not no, but a reduction in. If you're talking that there's no blood, that's now changed in a term from ischemia to an

29:17 Dr Mike

infarction. So ischemia is just an alteration reduction in blood flow, but it may not be so significant that it results in cell death. Correct. But if it is so much so that it results in cell death, that's now called an infarct. Correct. Right. So ischemia and infarct reduction

29:35 Dr Matt

in blood flow and a result in cell death from reduction in blood flow. Yep. And so that's the big distinction here because ischemic heart disease is the umbrella that would encapsulate both the anginas and the myocardial infarctions, which now I'll just call the MIs. Yep. That

29:54 Dr Mike

all right. Yep. But before we jump into that, just very quickly, the other word or descriptor that's used is coronary artery disease. And so the coronary arteries are the blood vessels that specifically feed the heart muscle. And so the disease aspect then I assume refers to

30:10 Dr Matt

alterations in those coronaries that lead to ischemia. Yep. So since you've brought this up, I'm going to give you all the interchangeable terms that are used for this condition. All right. Go through everyone. Okay. This is what I could find. Coronary artery disease, coronary heart disease or CHD. Okay. Okay. That's not very good because sometimes the CHD also means congestive heart disease. I was just gonna say that. So it's not great. Yep.

30:37 Dr Mike

Atherosclerotic heart disease. Okay. But that's very specific and doesn't encompass everything. But we'll get to that. Coronary vascular disease. All right. Ischemic cardiovascular disease. Okay. Ischemic cardiomyopathy. All right. Ischemic heart syndrome. Yep. Myocardial ischemia. Yep. Cardiac ischemia and then angina pectoris. See, I think the thing here that I'm, they do sound synonymous and interchangeable, but some are more descriptive than others. Some will describe only a couple of categories of ischemic heart disease. Some will only describe the outcomes of ischemic heart disease. So I think ischemic heart disease is the better term and those others, like the myopathies, that's now specifically referring to the musculature of the heart. Right. So, and then some of those, I think there was one that was just something like ischemic vascular disease or something, which could be peripheral. Yeah, that's true. That's true. So it could be systemic peripheral, maybe not heart specifically, but vascular. Sure. Yeah. Anyway. All right. So there are a number of different terms. So let's just say ischemic heart disease, coronary artery disease, reduction in blood flow. So this is where you have the big split. You have the anginas and the MIs. And the difference is what we were defining before where ischemia versus infarct. That's right. So in the ischemic events, where there's a reduction in blood flow, there are the anginas. Angina. And then the blood flow that's reduced so significantly that the tissue dies,

32:13 Dr Matt

that's the infarct. That's a myocardial infarct. And so by definition, now you're having deaths of tissue. So you could theoretically. Which generally means myocardium, so muscle heart cells

32:24 Dr Mike

have now died. Not all of them, but some. And that's what the heart basically is. It's just thick muscular tissue that contracts to work as a pump to move blood in and out. Right. Correct. All right. So by using that split, right, my thought would be it's more of a a flow on effect in which ischemia must occur before infarct. So my thoughts would be that angina would by definition have to proceed. Am I? Is that correct? Well, I couldn't give you a definite answer. Okay, let me change the phrasing of that because it's a loaded question because I know the answer. Ischemia will proceed infarct. If the infarct is caused due to ischemia that's lasting too long. So you could argue that you can have a blood vessel, a coronary artery that is ischemic or there's a reduction in blood flow and it can be remedied or reversed and it doesn't lead to cell death or the infarct. But you can have that ischemia that lasts too long and it does result in cell death. So you can have ischemia that leads to cell death ultimately, but you could also have ischemia that's reversible. But I think the difference comes in with the definition of what angina actually is because angina isn't by definition necessarily ischemia. Angina pectoralis by definition is simply chest pain or chest discomfort. Is it like a clinical symptom? Yeah, it doesn't actually say ischemia. It doesn't. You sort of impute ischemia, but it doesn't necessarily mean ischemia. It just means chest

34:09 Dr Matt

pain or chest discomfort or chest strangulation or something like that. Correct. And I believe you've got a quote on the first use of this term clinically. Was this the first use of it? Of it clinically. I mean the term was already in use or had been used to mean like pain of strangling effect. But then I think angina with pectoris meaning the strangling pain.

34:37 Dr Mike

Is it pectoris or pectoralis? Pectoris. Pectoris. Okay. That I'm sorry. Associated with chest. Yep. All right. So this is by William Heberden from 1802. Where was he from? Britain. Okay. So I'll do a British accent. Okay. But there is a disorder of the breast marked with strong and peculiar symptoms considerable for the kind of danger belonging to it and not extremely rare, which deserves to be mentioned more at length. The seat of it and sense of strangling and anxiety with which it is attended may make it not improperly be called angina pectoris. Those who are afflicted with it are seized while they are walking. More especially if it be uphill and soon after eating with a painful and most disagreeable sensation in the breast, which seems as if it would extinguish life if it were to increase or to continue. But the moment they stand still, all this uneasiness vanishes. It wasn't very British. But there was a combination of like, it was a bit of Dracula in there. But that is a disorder of the breast. So William Heberden. So this is 1802. And I think this describes angina. Stable angina. Stable. Okay. Now we're introducing more categories of angina. So are we now going to focus in on, in on and are we going to focus in on angina

36:15 Dr Matt

for a little bit now? Soon, soon. So what are we doing? Well, I still have to read out another interesting fact that Ben found. Okay. So the first documented evidence of probably a heart attack was uncovered by a group of researchers that found a princess in ancient Egypt. Oh, they called princesses then? I don't know. Were they just pharaohs? Or was it just part of the royal lineage? Let's call it that. Okay. So she lived between 1580 and 1550 BC. All right. So 2500 years ago. Yep. So 3500 years ago. Yep. 35. Yep. And so she died fairly early in her 40s. Yeah. 3500 years ago. Oh, in her 40s she died. Okay. That might be a ripe old age for ancient Egypt. Could be. And again, this goes back to what we're talking about. That, you know, typically ischemic heart disease was thought to be a more of a western, you know, diet-induced, eating bad foods, not doing much exercise. But these researchers had a look at a whole lot of mummies from ancient Egypt. So they, well, wait, so how did they know that this person had a heart attack? They did CT scans on them and they did scans of their heart and they looked at their blood vessels and they- Because they didn't take the heart out, did they? That's the thing. With the mummies, they took everything else but the heart out. Is that right? Or did they take the heart out and

37:49 Dr Mike

preserve that separately in like a jar or something or a pot next to it? I could be wrong, but I'm quite confident that they leave the heart in. Okay. As one of the few, because I think they thought the heart played the role of the brain.

38:01 Dr Matt

Yeah. Or- Could have made that up entirely. I think it was something to do with the spirit. They thought that's the spirit of the person in the heart. Anyway. You keep going. So from the mummies, I think they did 50 odd. They did CT scans on 50 odd mummies and they found that at least half of them had evidence of coronary artery disease.

38:25 Dr Mike

Really? So atherosclerotic plaques. That's right. 50%? 50% of them. So you're saying it's not just a Western recent current, because there has been an argument that I've heard, you know, things like, oh, cancers are a recent disease. Heart disease is a recent disease. But this isn't the case.

38:44 Dr Matt

We never died of these things in ancient times because we were much healthier. But we did. But I think I sent something to the other day on what the common diseases were in London in like 1800s or something. And there were things that we just wouldn't even be afflicted with now. Right?

39:02 Dr Mike

Yes. A lot of them were just infectious disease or disease of incidents or accident that would for us today would just be fixed. No problem in ED.

39:12 Dr Matt

Some of them were amusing in some ways, like deaths from being bitten by a rabid dog.

39:19 Dr Mike

Yeah. Well, luckily we don't have rabies in Australia. But I'm sure people still die of rabies even in the US. Yeah. So, all right. So, so it's not a recent disease. And they saw that there were atherosclerotic plaques or at least maybe modifications or changes within the vessels that indicate that there was possibly heart disease occurring 3500 years ago. And so should we start talking about angina?

39:49 Dr Matt

Before that, let's just quickly introduce the idea of what the coronaries do. Really? If we understand what they do, then we can talk to what happens when they're not doing what they should do.

40:01 Dr Mike

Yeah. That's a great idea. Well, this is where I jump in. So the word, okay. Okay. No. So you do it. So I'll say this is where I jump in and then you just.

40:08 Dr Matt

Oh, I'll just quickly just introduce what the term means. Coronary means crown, like a coronation. That's the process of crowning someone. Right? That's right. Like the King recently, a King of England, or Britain, England, Britain, Britain, recently. You need to be careful here, Matt. Britain recently got coronated. Yeah. And that was the process of crowning them. Yes. So the coronaries, I guess, were named because they look like they're a group of blood vessels that go around the heart. The base of the heart, which is the top, which is coronate. That's right. The base of the.

40:48 Dr Mike

Corona is the crown is referring to the sun, but it's also that the corona is that sort of glow you get around the sun. Right. Okay. So that's the corona. All right. So with these coronary arteries, I mean, they're super interesting arteries in many ways. And I think the most interesting piece of information to understand about the coronaries is that I think early on students don't understand the fact that while the heart may be a pump for blood, that the heart doesn't just take the blood that it's pumping in the ventricles and just absorb it through diffusion or osmosis to get its own oxygen and nutrients. It, like every other tissue in the body needs its own dedicated blood supply. Right. So this is the coronary arteries. And as we know, all of the oxygenated vessels come off the aorta, right? The aorta will have oxygen and nutrient rich blood that it delivers toward the tissues of the body. The coronaries are no different. They also come off the aorta, but they can be the first branch straight away. Interestingly, they come off the aorta at a very interesting place at the aorta. So as the aorta leaves the left ventricle and a sense up, you know, like the, like the trunk of a tree moving up and that's what the aorta means to hang to hang. So it looks like the hearts hanging in from the aorta. So we've, that's right. So we've got the trunk of the aorta as it leaves the left ventricle, but because it's going up and you know, it's hanging, it means that when the left ventricle relaxes, blood is going to want to fall back down the aorta into the left ventricle. So all of these large vessels that leave the ventricles, so the aorta, but also the pulmonary arteries, they have valves in them that are called semilunar valves that just catch that, but they're like nets that catch the blood that's falling back into the heart when the heart's relaxing, also known as diastole. That's right. Or diastole. Do you say diastole or diastole? Diastole. Okay. Does it matter? No. Yeah. Well, good. So we'll say diastole. So as that blood's falling down, it gets captured by the aortic semilunar valve. Now here's the thing or valves. As it gets captured just above the valve on either side of the aorta are two little exit points and these little exit points are the left and right coronary arteries. And as they exit the aorta, so think about this, the left ventricle contracts, pumps the blood up into the aorta to feed the tissues of the body. Then the left ventricle relaxes and the blood falls back down wanting to go back into the left ventricle, but it can't because the aortic semilunar valves close. But as they close, the blood then gets to drain into the left and right coronary arteries to feed the heart muscle itself. So unlike other tissues of the heart, the heart actually gets fed

43:46 Dr Matt

when it relaxes, not when it contracts. Yeah, that's cool. It is. Right. But I wonder here, I haven't looked into this. I probably should have. But I wonder also, another point to add here is when you talk about the heart, if you were looking at the layers of the heart, you have the layer that's closest to the blood within the chambers, endocardium, endocardium, and then you have the thickest layer, which is the myocardium, which is all just muscle to do the pumping. And then you have the outer wrapping of the heart, epicardium, which one aspect of it is also known as the pericardium. Yep, the visceral pericardium. That's right. So you would think in most tissue, the blood vessel should be probably in the middle of the tissue, right? Right. But in terms of the heart, it's actually on the outer surface. So if you were to pull the heart out of a person or just look at their heart whilst in situ, you actually can see these vessels generally, and sometimes they are kind of covered in fat. But generally, you'll see them on the outside

44:48 Dr Mike

of the heart itself. That's important clinically, right? So they are epicardial vessels. They are epicardial vessels. And the importance of the that is if that so, okay, let's think about it. Actually, let's talk about the vessels. And then let's think about how it feeds the tissue. And then we can talk about what that means the fact that the epicardial vessels. So as the left and right leave the aorta, the left will feed the left hand side of the heart, the right will feed the right hand side of the heart. There are multiple branches that each of the left and right coronary arteries have. So some of the most important ones would be that when the left exits the aorta, that it has two main branches. So one that basically just goes straight down the middle of the heart to the apex of the point goes down an area that's probably termed the interventricular septum, which is the septum that unsurprisingly separates the ventricles, hence the name. But then there's another artery, which is split off from the left coronary that wraps around the heart circumnavigates, it's circumnavigates. That's right. And hence, it's called the circumflex circumflex artery. So you've got the left circumflex artery. And then

46:01 Dr Matt

you've got the one that goes all the way down the front, which is called the left anterior descending artery. So that's sometimes shortened to be the lat the lad. Yes, was more correct anatomically would be called the anterior interventricular artery. But that's right, mostly it'll be called the lad. Maybe inappropriately sometimes called the widow maker. Yes, that's right. Because that's

46:24 Dr Mike

the one that usually gets blocked in a heart attack. And that leads to death. Yeah. There's also another branch, which comes off, you could argue either, you know, the main aspect of the left coronary or the circumflex, which could the marginal, and it simply just goes down the left margin of the heart. So if you're just looking at the heart from front on, you can have the left and right boundaries of, you know, the side of the heart, it just goes down that left sort of border of the heart. So they're the three main, I would say, on the left, right? Then you look at the right, it's similar in the sense that there's branches that come off. And so from the right coronary, you're going to have a branch, which is going to be the right marginal. So it goes down the right margin of the heart. But the right coronary also moves behind the heart as well, and then has another branch, which is the opposing version of the lad. So the end point rather than a branch, it's probably this is just where it ends. Yeah, you're probably right. So the right basically, as it curves around the back of the heart, begins to descend around the back. Hence, it's called the posterior descending artery. And for some people, that post that posterior descending as it goes towards the apex can actually meet up with the anterior descending or the lad who's going down the front. And they can meet at around about the apex or a little bit behind and connect together called an anastomosis, which is one of my favourite terms in anatomy, which is actually something that would be, you know, theoretically beneficial, because it leads to redundancies of blood flow. So if the lad may be blocked, which we'll be talking about, maybe there's an opportunity for the posterior descending to feed at least some parts that the lad would be feeding, at least

48:07 Dr Matt

around the apex of the heart. Any other aspects there? Well, not in terms of the arrangement, the vessel, but the point I was going to make is, as you said, when the heart is in systole, and the blood is getting pushed out of the left ventricle into the aorta, and the force is such at a high speed, like you're talking 120 millimetres of mercury, that would be very hard to fill those two pipes in systole. But when the heart is relaxing, or the ventricles are relaxing, it's kind of sucking back to shape, it would almost try to siphon the blood back into it. Yes. But these valves or the aortic valve pops open, and then blood enters the coronaries.

48:50 Dr Mike

So what do you mean the valves pop open, the valves would shut? Yeah, sorry, I mean, when I say pop open, I mean, just let's say pop close. I think what you mean is that the valves close the blood vessel. It almost is like a parachute opening. Yes, that's what you meant. It opens up like a parachute closing the aorta, so it doesn't regurgitate back to the left ventricle, but remains

49:13 Dr Matt

open to catch the blood to drain it through in diastole into the coronaries. So this was my thought, and I haven't investigated and I should have. But as the vessels fill in diastole, I just wonder if they're just kind of filling to be filled with blood, but when it goes into its next systolic phase, and the heart's being squeezed, if it's actually that squeezing, it would be that does the perfusion. I'm sure. So it's kind of like one step behind. Yeah,

49:47 Dr Mike

does that make sense? I'm confident. I've always thought that and I haven't checked it either, but that was my assumption was that the change in pressures and forces due to the contraction relaxation of the heart muscle would, like you said, I like the word siphon in a way sort of lead to some maybe suctioning effect or pressure gradient changes that increase the perfusion rate of the coronaries. So I would agree with that. I think another important point to highlight here is the fact that you said that these coronary arteries are epicardial. So they sit on the outside of the heart, meaning they feed those parts first and then they feed the endocardium last. Yes. And the reason why that's important is because if you have a reduction in the blood flow in the coronaries, the part that's going to be most affected first would be the endocardium.

50:42 Dr Matt

Or the sub endocardium, technically. I think the endocardium by definition will get its nutrients through diffusion, but it's so minimal, it would just get to that. Yeah, you're right. On the other side is the first that will become death.

51:00 Dr Mike

Yeah. But for all intents and purposes, we can say endocardium just to make it easier. But yes, it's because obviously the oxygen and nutrients will need to diffuse to the endocardium or sub endocardium. And if there's less, then it's going to be less available for diffusion. And so that's an important point because when we start talking about ischemia, the first parts of the tissue to become ischemic will be the endocardium or sub endocardium. Yes, that's important. That's very important. Particularly when it comes to MIs, the first part to undergo infarct and

51:37 Dr Matt

cell death will be the endocardium. And then that can spread through. Right? So when we look at blood vessels and the coronaries, and we talk about issues in regards to like angina and MI, are we talking about angina now? One final thing I'm putting forward is just really quickly. So we've spoken about their branches, how they're arranged, how they're filled in diastole versus systole. But finally, just an interesting point that I came across is how is the blood vessel diameter controlled? Okay. And so there's going to be effects from the autonomic nervous system. So sympathetic nervous system in particular, once it's activated. So this is in the fight and flight response when you do want the heart to be working hard and blood pressure to be up and more breathing, etc. You want the coronaries to dilate so they can bring more blood to it. Sure. But there's also its own intrinsic control. So whatever the heart's doing, from a workload point of view, would locally signal to the blood vessels to tell it, we need some more blood. Can you dilate for us? Yeah, so there's local control and more systemic or peripheral control. And so one of the ways that would do this is if the heart is being working harder, it needs more ATP. Therefore, it needs more oxygen, right? And so that's a relationship that is strongly connected. So ATP dilates coronaries? Not quite. Right. But as the ATP is being utilized, so as ATP is being pulled apart by the phosphates being pulled off it, their byproduct being ADP or AMP gets degraded into adenosine. And adenosine then signals to the blood vessel through calcium to dilate, not contract.

53:39 Dr Mike

Which makes sense because it's saying we're low on energy, because we're a byproduct of having used that energy, we need more. How do we get more? Dilate the blood vessels, bring more oxygen. So that would then mean from that, and this is why I like physiology, is the fact that you can sort of take from fundamentals and then have some pretty good educated guesses. So using that logic, I could say, okay, then there's probably a number of other metabolic byproducts that would also vasodilate the coronaries. For example, maybe lactate and maybe hydrogen ions would also vasodilate the coronaries. And the reason why I would think that is because they're byproducts of metabolism with less oxygen. Right. And they do, they do vasodilate the coronaries because of that. So you can say ADP, adenosine, hydrogen ions, lactate, carbon dioxide, these are all local factors that can vasodilate the coronaries. Right. But you can also have cells in that area, which could be either stimulated directly by those chemicals or through changes, or maybe there's been ischemic events where the cells might think they're damaged and they release chemicals. And these chemicals could be things like nitric oxide or prostaglandins or bradykinins. And they can also vasodilate as well locally. Yes. And with nitric oxide, that would be a gas that's released by the endothelium. Yes. And that actually can be used by clinicians artificially to dilate them. In the form of nitroglycerin. That's right. Yeah. All right. I'm not going to ask if we're going to angina now.

55:24 Dr Matt

What are we doing next? Well, now it's time to go into the condition now. All right. So we've done what the physiology is. Yep. We've kind of introduced the terms. Yep. So we know what

55:36 Dr Mike

ischemic heart disease is. Now we can start to look at how it comes about. So the thing that I find tricky to at least in the front end when I didn't fully understand ischemic heart disease is that ischemic heart disease is basically just saying there's a reduced blood flow, right? Going through the coronaries to the heart muscle. That is not always caused by atherosclerotic plaques. No. Now what we've spoken about so far is pretty much just, it's just been that, right? We spoke about the case study with you and your dad. The fact that your dad has had occlusions due to atherosclerotic plaques, calcium buildup. You are at risk for that as well. But probably 50% of cases aren't necessarily atherosclerotic. And I mean, that's what the evidence also states is that if you have a look at the evidence, 50% of angina patients don't have coronary obstruction. Okay. Right. And so there are other things happening to the coronaries or at the level of the coronaries that are leading to ischemia. Right. So let's then talk about angina because angina is simply telling you that the person is presenting with some degree of chest discomfort or chest pain, which is an indication of something happening

56:56 Dr Matt

to the coronaries. Right. Where do you want to go from there? Well, firstly, let's introduce, if you're going to, if we're going to focus on angina, is that what you're suggesting? What do you think? Do you think it's the, where we should go to now? Yeah, we can, we can. Okay. Well, as you said, if we can't, we don't have to. We've spoke that ischemic heart disease is just an umbrella term that's suggesting that the heart muscle is running out of blood. Okay. And it's almost like a spectrum. You could have some at one end that the ischemia is predictable, as in you can pretty much guess what is going to lead to the ischemia. And then as we go to the other end of the spectrum, it becomes very unpredictable. And these are generally now termed acute coronary syndromes. So that would be the MIs and the unstable angina. Okay. When we can talk about what, but both from the predict predictable and unpredictable, that is the stable. So that is the unstable and MI. That's right. So unstable angina and the two classifications of MI, which would be a STEMI or ST elevation MI or non ST elevation MI, which we call it non STEMI. They form in a cluster of acute coronary syndromes, which are very unstable. So where do they fit in the predictable to unpredictable? Yeah, unpredictable. So the pain, the angina that is brought on comes about with a, in a very unpredictable nature that you can't be confident of what the things that predispose or what's the other word?

58:44 Dr Mike

To bring it on. So what about the predictable? So that would be the stable angina. All right. So you're saying that we've got ischemic heart disease. And when we look at it and we, and we talk about chest pain or chest discomfort, there is predictable and unpredictable, like this spectrum. Yep. And that if it's predictable, we sort of know what's causing it and probably can reverse it to some degree, or at least in that stage, right in that stage. That's right. It might still be progressive, but in that stage, we could possibly reverse it, but we know what's causing it. And

59:17 Dr Matt

that's what we call stable angina. That's right. And then on the other end, that's would be the definition that you read. All right. Gotcha. So the real William, that's right. The real classic presentation of stable angina is the pain comes on with exertion. Yep. Generally that's going to be a physical exertion, but it can also be emotional, like a stressful event. And it will

59:39 Dr Mike

be relieved by rest. Right. And then the unpredictable you said is unstable angina and myocardial infarction. Correct. All right. So where should we start at stable? We can do. And then move, move down. Yep. So we've got, so angina first of all is chest pain or chest discomfort

01:00:01 Dr Matt

lasting a certain period of time. Yep. Right. Again, it's, it's tricky because it really depends on the situation. But if you, if we're using stable angina as the, the base point, then it would be really a short term degree of chest pain that's brought on with exertion. Yep. That then dissipates with rest. Right. Now the, the crux of it, the baseline of it is going to be an atherosclerotic lesion. Not always. Well, once you start to go to close to the unstable, that's where you're going to bring all another form being the Prince metal or vasogenic, maybe I think it's cause where there are spasms associated with blood vessel that then becomes an unpredictable form. It's not so much stable because it can come on with rest and doesn't go. So you, you're not exerting yourself and it'll come on and it doesn't necessarily go away with say the nitroglycerine. Yeah. But when we talk about stable, the classic stable, it would have a, an occlusion to the vessel that would reduce blood flow. And it's only when the heart's working harder that then that reduction in blood flow isn't it to a certain level that the heart is now running out of blood. Yep. But when you go to the acute coronary syndromes, then they have a whole lot

01:01:19 Dr Mike

of other things that could be superimposed onto it. Yeah. Because I was reading a paper that came out, I think it was a year or two ago that was basically stating 50% of angina patients don't any coronary obstruction at all. And that many have microvascular changes or vasospastic angina. And so they, they highlighted that there's these three different areas that you look at in regards to angina. So the systemic, so you've got this myocardial supply demand ratio, which is off. And that could be due to a multitude of things, right? It could simply be due to a problem with the blood pressure, heightened sympathetic activation, pulse rate. So those types of things could, could affect that. You could have cardiac based causes. So this could be heart failure, left ventricular hypertrophy, whatever that may, those types of things. Or we could have coronary induced, right? Coronary specific. So this could be obstructive, like you were saying. It could be microvascular dysfunction. It could be artery spasm, myocardial bridging, endothelial dysfunction, a range of things. But I think that what you were saying is broadly the best way to look at it, because it makes total sense in the fact that in stable angina, you have some existing degree of occlusion. May or may not necessarily be atherosclerotic, but probably is. But you've got some degree of occlusion that's there. And it is occluded, limiting the amount of blood getting through. But at rest, that's enough to feed the heart muscle. But once you start doing exercise and exertion, then what we're saying just before that the supply demand ratio is off. So it can't, um, there's a mismatch. You know, the oxygen demand exceeds the supply. And therefore you're like, well, it was brought up by exertion because the heart's now pumping harder. And as a muscle, it just needs more oxygen because it's working as a muscle more, you know, more vigorously. Let's just tell that person to stop exerting. And when they do, it might relieve itself. So that's what you were saying about the stable sort of at rest, it sort of resolves, at least the chest pain resolves, the angina resolves. I mean, they've still got some form of issue in the vasculature or the coronary. Or maybe you give them nitroglycerin and it just relaxes the blood vessels to sort of open it up a little bit. And then that lets more in. And that is also predictable as in that will go away with this intervention. So both of those interventions for stable angina tend to resolve the angina. And when we say, and again, this is why we keep saying that angina is simply just chest pain or chest discomfort. It resolves the angina. It doesn't resolve the issue. Right. And the issue with some degree of occlusion in the, in the coronary. Right. And that could be microvascular a microvascular issue. It could be an atherosclerotic plaque. You know, it could be endothelial dysfunction. It could be any of those particular things that might be leading to that.

01:04:36 Dr Matt

So then we go down to the unstable. Do you want to talk before we go there, just the basis of how plaque comes about? Yeah, good idea. Good idea. Because this is going to be also underpinning all the risk factors that are generally associated with this disease cluster. Yeah. I mean, pretty much all the risk factors come about from atherosclerotic disease. Yep. Because even if you think about if you, if we go out of the heart and go to another area of the body, let's say if you look at peripheral arterial disease, which is usually legs, patients who have these, so this would be an occlusion in a vessel in their legs, they would get their pain, their ischemic pain on exertion as well. So when they start walking, they get their calf pain, which is called intermittent claudication pain. Yep. And again, that's brought on by exertion.

01:05:28 Dr Mike

But it's the same event. Yes, that's right. Right. Yep. So and I think that's important because it's just a different muscle, the same event. Correct. Correct. One's peripheral as

01:05:38 Dr Matt

opposed to coronary. Yep. So I won't go into too much depth with it. But pretty much atherosclerosis, you've done a whole podcast. Yeah, that's right. You could make the argument that it's a form of acute, well, probably chronic inflammation. Yeah, that's fair. Now it's the inflammation is in the blood vessel. So that's where the problem is. Okay. So essentially, you need something that initiates the injury to begin with. Yep. And this is the first step of atherosclerosis. And all of us would have this in parts of our body. Sure. So this is generally termed the fatty

01:06:13 Dr Mike

streak stage. So just quickly to jump in, correct me. You've got, because if you think about the vessels as a hose, and you've got the internal lining of it, that's epithelia. So it's endothelium, that's what we call epithelia within blood vessels. And endothelia is arranged in a way that just tries to make it this frictionless, smooth environment. Because we know that any time you've got disparity or some sort of anything protruding out from the blood vessel, platelets are very sticky. They'll stick to anything that's not smooth. Right? And platelets are floating through your bloodstream all the time. But just like with a hose, you can damage the inside of that tube a number of different ways. And one of the probably prominent ways is through continual high force being placed on the wall of the endothelium. And that can lead to damage. And like you said, over time, you know, tends to be this over time thing, but it's still damage.

01:07:16 Dr Matt

So are you saying that the fatty streak happens once the endothelia is damaged? Generally, that'd have to be an agent that leads to endothelial injury. That's right. And the biggest one's probably hypertension. Yes, I would agree. I think that is true, that high blood pressure or high shear force on a blood vessel is an initiating factor for

01:07:41 Dr Mike

endothelial injury. And in the atherosclerosis podcast episode, which I will link in the description of this episode, we talk about those shear forces and where the vessel is most likely to be damaged when we talk about hypertension. So we do go through this in a lot of detail.

01:07:59 Dr Matt

Usually speaking, where there's a vessel with the greatest turbulence, just like a river that has high flow, where you see rocks sticking out or things that are blocking it, that's where it changes the still water into white water. It's similar to blood vessels. Wherever you see white

01:08:18 Dr Mike

water, there's turbulence that can smash on the side of the wall. Bufocations are usually bifocations. Those types of locations. All right, so we've got damage to the endothelium.

01:08:27 Dr Matt

Now many things can do that. So smoking is a huge thing that would cause toxins in the blood. Toxins from the tobacco smoke would cause injury to the endothelium. So would byproducts of diabetes. Certain fats can also be toxic to the vessel wall. Alcohol. I don't know exactly how alcohol comes into the mix, but alcohol is a risk factor. Well, nearly everything. But that may not be… Look, I'm probably wrong, but it could be more the way that it changes your lipid profile in. Probably right. Than ethanol itself. But who knows? I mean, there's millions of things that could have effects on endothelium. So what happens is basically, you've now got a disturbance to the endothelium. And what can happen is the blood vessel says, got a problem here. What's going to happen is these LDLs, low density lipoproteins, can start to go into the wall and kind of deposit just on the other side of the endothelium. So on the intima, just on the deeper side of it. Connective tissue. And just start to kind of accumulate there. Right. And this then leads to the next phase where because we've got an injury, we bring in some white blood cells to try to clean up the problem. And some of the things that will, some of the blood, sorry, the blood cells that will come in, the white blood cells would be things like monocytes, neutrophils, lymphocytes that try to clean up the mess. But because of the nature of the fat, they try to faggous our toes, so eat it, but they can't clear it overly well and they become oxidized. And these are, this is called foam cells. And so if you were to look at the blood vessel in histological or through a microscope, it would look foamy, like foam, like seafoam. That's right. And so these cells are just becoming, there we go, like shaving foam. So they start to kind of build up in nature. Now this happens over decades. So now we're talking again, most of us in society would have this process in our vessels somewhere. And this is kind of moving between a fatty streak to a more of a advanced plaque.

01:10:53 Dr Mike

Quick interruption. Are these happening in all types of blood vessels or only blood vessels of

01:11:00 Dr Matt

certain size and type? Good question. From the best of my knowledge, it will only happen in arteries, not in veins. Yep. And generally larger arteries, right? Yeah. Not, yeah, I think in theory, all the kind of muscular based arteries, I don't know, they will affect the aorta, which are more elastic based, right? Yeah. Once we get right down to the smaller end,

01:11:26 Dr Mike

maybe just because they don't have such a big pressure, they may not develop as… That was always my thought. The fact that it was generally the larger arteries because of the pressure

01:11:37 Dr Matt

gradients. But the classic locations would be, you know, your carotids, your renal, your abdominal aorta, your coronaries, your cerebrals. It's generally larger arteries. Yeah. So now we kind of go into a long term. So this is why age comes into the mix. Okay. Just because it's long term. That's right. Allowing this process to continue. And what starts to happen is the fat cells, so the foam cells start to become necrotic and you get this inner core that dies off and it starts to get filled with other things like so smooth muscle starts to migrate up into that. And then

01:12:13 Dr Mike

we try to… Is that just because it's trying to remodel it? It's trying to fix it. And so fibroblasts or maybe there's other types of stem cells moving through to go, oh, let's just try and heal it up.

01:12:23 Dr Matt

That could be right. Any way possible. That could be right. But then the fibroblasts kind of come up to the top of the actual… Because now all this foam cells and all these lipids that are filling up the blood vessel in that location is starting to bulge into the lumen. Yeah. And so you're wanting to support, you want to make it secure. And so the fibroblasts kind of lay a cap over the top of it. Right. This thin cap. And that makes it instead of a… It's still probably going to have endothelium

01:12:55 Dr Mike

on it, but it wants to reinforce it and make it safe. So it puts a fibrous cap over the top. All right. Now stop. Because in stable angina, we've probably undergone this entire process up until this point. And now you've got an occluded to some degree vessel. So this vessel might be 20% occluded, 50% occluded, 90% occluded, but it's occluded and it's capped. And so you now know that you've got a vessel of a narrowed diameter. And so when you try to increase through the pumping motion of the heart through exercise, again, there's now a mismatch in the oxygen demand and oxygen supply. And again, if it remains capped off and unchanging more or less in that moment, then you've got stable angina. Right. Correct. But if the next phase occurs, which is what?

01:13:54 Dr Matt

Well, again, it's hard to say this because I don't think it necessarily just goes from stable to unstable to now MI. No, it doesn't. You may have the first known case of your ischemic event. Maybe straight into an MI. Sure. Sure. And it could just come about from any of the things that you mentioned earlier. It could just be it's been an embolism that's broken off. And now it's just

01:14:16 Dr Mike

blocked the vessel. But it's needed to talk about like this. Okay, so it's capped off, right? You now undergo some degree of exertion possibly, okay, where you've increased the blood pressure inside of this artery. It's because of the pressure, you know, blood pressure is the force that the blood places on the walls of the vessels. It might damage that cap a little bit, right? Might knock that cap off. Right. And now you're just exposing all this underlying tissue that's there. It's like these flags that are now waving to the inside of the blood vessel. As the blood moves through, platelets are like, Hello, what do we got here? Stick to them. Because it's like, there's a damaged side here. Let's try and block it up. But now the blood now the platelets accumulate. Now this might further occlude this vessel, leading to further angina and further occlusion and ischemia.

01:15:14 Dr Matt

Or maybe it pops off. And this is now a. Yeah, so now what you're talking about is we've now left the stable. Yeah, and we're going to the acute coronary syndrome. The horses have left the stable. That's right. And so what we're looking at here is either the unstable angina. Yep. Or now the MIs. Yes. And so I think you've presented the classic progression of a stable plaque, which would be the

01:15:43 Dr Mike

primary cause with now an additional thing on top. Yes, literally. Yeah, which is a thrombus. So that thrombus, because if you think about all arteries where these atherosclerotic plaques are forming, they go from wider to more branched and narrow. So if you've created this clot or embolism,

01:16:07 Dr Matt

it's an embolism if it's produced in the heart, right? Embolism is where it's gone from a thrombus and it's broken off. Yep. So any time usually heart produced, isn't it? No, no, you could have

01:16:17 Dr Mike

a palmar embolism, which comes off from a DVT in your leg. Yep, of course. Yep. So it's popped off and as it travels down the artery, it's going through more narrow spaces until blocked, until it's just stuck. And that means anything distal or further away from that doesn't get fed. Correct. And so if this is happening in the coronary, then whatever's further away from that blockage, that tissue isn't just becoming ischemic now. It's not reversible. You can't just stop exercising and then that tissue gets fed because it's blocked regardless. So the supply to demand is even worse. Even at rest, you can't supply the oxygen to that tissue because it's fully blocked it. And so this could then lead from ischemia to infarct. Yeah. But let's first talk

01:17:11 Dr Matt

about that unstable angina. What is the difference between unstable angina and a myocardial infarction? Okay. So the big difference is if you're talking about unstable being the primary cause being atherosclerosis and now something additional to that, that's now pushing the ischemia into an unpredictable fashion. And so like you said, which I think is important, is there could be a whole host of reasons what leads to the reduction in blood flow, which is not just atherosclerosis. And this could be, like you said, it could be anything from your blood has just become thicker than it normally is. So it's more viscous. So you can't get it past that occlusion. Now it becomes unpredictable. Yeah. Or the vessel starts spasm. And that's now becoming unpredictable. And I think this is important because or just the demand that the heart has now, which is not from something that you would think is typical. Like even if you all of a sudden developed anemia, the heart is now working hard at a baseline because you are having less oxygen in your blood because you've got iron deficient anemia. So your heart is at rest beating harder

01:18:36 Dr Mike

now. Yes. But that's enough now to go into an angina state. Yes. So I think it's important to say that the stable angina, because we're just talking angina at the moment, remember angina is just the chest pain. So the stable is like you said, it's known predictable, predictable, can be reversible in that moment. And the unstable is, oh, not sure what's happening here. It may lead to an impact. Right. But I would say clinically, the main difference between unstable angina and an MI is that, you know, the pathophysiology and symptomatology is the same. It's just that the biomarkers are different in regards to troponin. Yeah. So it just hasn't. So for an unstable angina, it just hasn't got to the degree where cells are dying. Exactly. Exactly. And so one of the things that I've heard medical professors say is that an MI is unstable angina that's just gone too long. Right. So that so in regards to unstable angina and MI, the difference is simply time. Yeah, that's probably a good point. And so the reason why, you know, because again, the pathophysiology and symptomatology, it's the same, right. But an MI is telling you that tissue is dead. And an angina is telling you you've just got chest pain. So at least by definition. But it's likely due to an ischemic event of some sort leading to the impact. So I think the thing I was saying about the biomarkers is different is without going into detail here, that the troponin is released when muscle cells die. Right. So it's a byproduct of muscle metabolism. And so if you've got no death muscle, yes, sorry, it's a byproduct of muscle death. And when the muscle dies, it releases troponin. Right. And so if you've got troponin levels going up, it's telling you muscles dead. If the troponin levels aren't elevated, well, the muscle hasn't died yet, but you've still got the chest pain. It's unstable. It's unstable angina. Right. Now there's other things you can do to check all this, which is an ECG. Right.

01:20:50 Dr Matt

Do you want to talk about that now or not yet? The only thing I'll just mention before we get into the diagnostics is just the main risk factors for ischemic heart disease. So this kind of puts it all together. So the risk factors kind of come to, I guess you'd say behavioral risk factors.

01:21:11 Dr Mike

And those that are more biomedical risk factors. So would you say behavioral or lifestyle? Yeah. Okay. Either, either or. Okay. But I get your point. So I like, I like lifestyle because behavior makes it seem as though it's a choice when it probably is in many aspects, but also

01:21:29 Dr Matt

sometimes it could be a product of circumstance. Okay. Right. So the classic risk factors and you would say these are the model, at least the big modifiable risk factors associated with ischemic heart disease would be smoking, the diet related. So poor diet, that's a hard thing to know what that means. Insufficient physical activity and alcohol consumption. They would be the big four that if you were considered to have a high risk profile, those are the ones you'd need to kind of consider to get into check. Yes. Now the ones that you would say biomedical, these are things that could be modifiable, but they're additional to the lifestyle. So these would be high blood pressure, right? Abnormal blood lipids. Now sometimes these are termed hypercholesteroid, but I think a better term is dyslipidemia. I think that's better because often it's about ratios, right? So that would suggest that you've got, if you just say you've got hypercholesteroid, that just means you've got high amounts of lipids in your blood. Yes. But you could have a really high good fat, which is the HDL, right? And also increased LDL, but that ratio- Terrible term to use good fat, but yes. Good, good lipid fat? I wouldn't even say good. No? No. Protective? Probably protective. Okay. Again, it's ratio-based, right? But I'm just saying the ratio to each other, but I'm just saying HDL is typically termed the good blood lipid, right? Compared to. Opposed to the LDL, which is more harmful, I guess you'd say. But if you just say hyperlipidemia, that just means raised. But if you say dyslipidemia, it kind of means the HDL is low and the LDL is high. Yes. Which is a poor ratio to have. So how do you remedy that? I'll get to that. Diabetes is another one. And then finally, obesity or being overweight. So they are the biomedical risk factors. Okay. So just a couple of side clinical points. Probably in the last, if we're talking in the Australian context, the way that maybe primary health physicians like GPs would try to assess their patient's risk for scheming heart disease, they would, a lot of the information that they would be basing their clinical predictions on was from a study that was done in a town in Massachusetts called Framingham, I think. And so this would be called the Framingham study, which I believe was around the 50s. And they kind of looked at individuals in this town long term to see what parameters within their life increase the likelihood of ischemic heart disease. And then based on these, there's a longitudinal study. Yep. Based on these parameters that would stratify risk for individuals developing ischemic heart disease. But that was, you know, 70 years ago. Right. And so the profile of individuals back then is different to how they are now. Oh, good point. So have they done an updated study of this? Yes. So at least what I've come across in Australia, the Australian Heart Foundation has implemented a recent New Zealand study that I can't remember the name of it, that has updated the risk scoring. Okay. And this takes into different, so the, you can actually use this cardiovascular risk. So it's called the Australian cardiovascular disease risk calculator. This would typically be done by a GP, but it brings into a whole host of other things. Now, the first thing they would do to kind of calculate your risk of developing ischemic heart disease would they would look at on age. So there's kind of three categories that they would look at. So you go to cvdcheck.org.au? Yeah, that's right. So this would look in terms of individuals that are over the age of 45. Yep. So that would be something that a GP would want to do a score on, but also individuals who have diabetes. So this would probably be more so type two diabetes, but not exclusive, exclusive to. If you were to have type two diabetes, your age of risk may start a bit earlier and that would be 35. Yep. But also first nation people of Australia, that would also be a higher risk. So their age, the start of their age risk would be at 30 years of age. Okay. So these are the age groups that would be

01:26:33 Dr Mike

wanted to bring in to do this assessment. Yeah. Okay. And so this, by the look of this assessment, you obviously need a couple of measurements taken prior to doing this. So you need to know family history about hypercholesterolemia or chronic kidney disease. You need your systolic blood pressure, your ratio of total cholesterol to HDL, and whether you're taking any cardiovascular disease modifying medicines over the past six months, history of atrial fibrillation and diabetes. And so it takes all this into consideration. Don't know what the algorithm is

01:27:14 Dr Matt

that they use and then they calculate a risk in a way. Yeah. And that's right. And so I think where it's updated from the Framingham study is they historically would have said diabetes is a risk full stop. Yeah. But here they would say, well, diabetes could be, but how well has it been regulated? And so if you have type two diabetes, but you're really well on top of your management, that it may not be a great deal more of a risk. So that's why they want to look at your kidney function because that's indicative. If your kidney function is dropping, that's an indication that your diabetes hasn't been well managed. But also other things like HB1C, which is a three month ratio of how well your blood sugars are being managed. So it's diabetes, yes, but it's poorly managed diabetes, which is the real risk, not just diabetes flat. So these are just some of the preventable things that an individual could look at to down, not downplay, but diminish. Reduce their risk. That's right. That's right. Okay. So they're the risk factors. So what now? So what did you ask before I came in with the risk factors? I don't know. 30 minutes ago. We were going to talk about. Diagnostics. Were we? Yeah. Okay. So no, that's, oh, that's right. ECG. Yeah. Okay. So like, I think you were alluding to when we, because ischemic heart disease is that umbrella term that encapsulates both the angina's and the infarctions, we've got two clusters of a group that is the ischemics and those that are infarction. Yeah. Okay. So by definition, infarction, we said, there's there's been cell death ischemics. There haven't been. And as you spoke about, we could take a blood test. So you could have an individual that presents to AD with chest pain. And if you're wanting to see if they've had an infarction event, you could take blood and look for these markers that you said, troponin, but also creatine kinase, which would be indicative that heart muscle has died, ruptured and spilled its contents into the blood, which you can then measure. Yeah. But the other thing you could do is an ECG. And an ECG is essentially the electrical activity of the heart. And so if there has been a change in the oxygenation status, then the way that the heart depolarizes and

01:30:01 Dr Mike

repolarizes is going to be altered. Right. Yeah. What about so before we jump into that, I'm going to do what you do to me, the symptomatology of ischemic heart disease, right? Because now we're going, you know, somebody's presenting an AD, but usually you only present if you have symptoms. Right. So we all think like you spoke about earlier about the chest pain, you know, you watch on TV, somebody, you know, sort of clutching at their chest and then collapsing. But that's probably not even the most common way it's presented necessarily. It's not a very, well, I won't say predictable, but it's not the best or most accurate method of human severity either. Because it's not uncommon for people to go to the emergency department with chest pain and they've just got gastric reflux. Correct. Right. So there could be or lung disease or, you know, there could

01:30:59 Dr Matt

be a number of things, costochondritis, but there could be a number of things that lead to chest pain. That's very good because I actually did this with my students. I'll say here's a patient with chest pain. If you're the nurse, the triage nurse, and you're trying to figure out what the source of the chest pain is, let's not assume that it's a heart attack, but you just try to figure out what it could be. You know, a typical assessment of pain is you do the PQRST scale, right? Being P, what precipitates the pain? What brings on the pain? What palliates the pain? What takes it away? Q, what's the quality of the pain? What's the severity of the pain? What's the time profile of the pain? All these questions are important. So heart pain, if you're saying from ischemia, that's visceral pain. It's not a very well localized pain. It's very kind of diffuse in nature, and it's not very well, it can radiate, it can move. That's right. It can go to the shoulders, it can go to the back, it can go to neck, jaw. So the question, a good question to ask is, this is the P of the PQRST. What were you doing? Like what brought on the pain? And the classic, that's the classic heart pain is exertion. But like you said, if it's reflux pain, well, what brings on reflux? Well, did they just eat? Did they get it while they're lying down? Or they just had a chili meal or an Indian meal, right? Or did the pain go, this is the palliation, did it go away when you had an antacid? Because if it did, then it's not a heart attack. Good indication. Well, I shouldn't be definitive like that. But you know what I mean? It's a good indication. It's less likely because that's taken it away. Taking an antacid with having a heart attack pain, it's not going to take the pain away. Yes. And like you said, if it's pulmonary derived,

01:32:58 Dr Mike

it's going to be worsened by breathing. Yes. If it's- Which is tricky because shortness of breath is also a symptom of ischemic heart disease. So chest pain, maybe. Shortness of breath, maybe. But you might also have fatigue, right? You might also have nausea. Yeah. So some people do feel

01:33:19 Dr Matt

like they feel sick, dizziness, lightheadedness. These are very nonspecific symptoms, aren't they? So because if you're saying presented with chest pain or chest discomfort, we're working in the context of ischemic heart disease here. The heart is not keeping up with demand here, right? So the heart's not working well because it's running out of blood itself. So its efficiency is dropping. So therefore the body's going, well, why aren't you doing what you're supposed to do? That's right. We'll better tell you or tell the fight and flight system to speed up. So this is where you have a sympathetic drive and this is where you're starting to see the, I guess I should say, nonspecific symptoms of it. So you would get cold, clammy, whitish skin, right? So they look pale. Their hands, they're a bit sweaty, they're cold. That's the sympathetic drive. Nausea, it's a harder one. It could be part of that, but it also could be an irritation to the vagus nerve. And so if you have a vagal irritation, that can cause the feeling of nausea and vomiting and vomit.

01:34:36 Dr Mike

Absolutely. So the point we're trying to get across is that the symptomatology is varied and individual specific. And like I said, my wife working as a cardiac tech, she tells me all the time of the symptoms that people ought, no symptoms at all that people state when they've had an MI, right? She said there's people who have obviously had, in fact, of some degree in their myocardium, they've had no idea. Now they probably did have some symptomatology, but maybe on the background of probably generally feeling pretty crappy on an everyday basis may not have necessarily

01:35:11 Dr Matt

been that bad for them. Yeah, I had a close family friend who had an MI the whole day. And he just felt like he had just a bit of discomfort, like, you know, how you have that muscle pain after a gym workout, that kind of uncomfortable pain. And he was doing just walks down the street, right to the, you know, just around the street to the park or something to try to get rid of the pain because he thought that what he needed. Yeah. Well, little did he

01:35:43 Dr Mike

know that he was having an MI a big part of the day. Geez. See, so we just wanted to flag that as well, because I think that is important. So regardless, somebody's coming to ED, and you're going to have the physician going to go, well, look, they've got what could possibly be ischemic heart disease. Maybe they've got angina, maybe they're having a heart attack. Let's do the basic tests, the gold standard tests to figure this out. And one of those in addition to doing bloods, like you said before, for troponin and creatine kinase, for example, would just be to chuck them on an ECG. You know, it's not invasive, it's super quick, and it shows you what's happening in the heart. And from experience, we know that changes, specific changes in the ECG readout can be indicative of ischemic heart disease and specific types. So for example, there is often something called a STEMI and a non STEMI, and a STEMI is ST elevated myocardial infarction.

01:36:44 Dr Matt

However, I think you can have STEMI for unstable angina too. I think it's more with Prim's Metal. Right. Because we haven't really spoke about this. But essentially what that is, is a vasogenic or a vasospasmodic artery. Yeah. And so that becomes very unpredictable, because it could be a multitude of why the blood vessels go in constricting, dilating, constricting, dilating. So the big difference here is, if you're getting a reduction in blood flow from the whole thickness, so from the endocardium all the way to the epicardium, called a transmural, is that right? Yep. If you can get that whole strip that's running out of oxygen, that would lead to an ST elevated change. That's right. Whereas the non STEMIs and the unstable is more to be a partial thickness, and they're more likely to be a depression. But you're going to explain this. But the big difference here between a STEMI and a Prim's Metal is the Prim's Metal will reverse. Right. Whereas the STEMI is now a full thickness, infarct or necrosis.

01:37:54 Dr Mike

Do you think Prim's Metal would also have the elevated biomarkers? No, because it's not death. There you go. All right. So you could have an ST elevation and not elevated biomarkers could be an indication it's just another unstable angina.

01:38:07 Dr Matt

Correct. And that's where I think you got your stat where if you clustered all your anginas together, that would be the stable Prim's Metal unstable. A big part of the cluster would be a

01:38:21 Dr Mike

non atherosclerotic basis. Right. That's right. Yeah. So look, this could be a whole topic and it has been a whole video on the YouTube page. I will provide a link in the description to this video which describes exactly because I'm drawing out on the whiteboard what happens in ST elevated and non ST elevated myocardial infarction. So a STEMI and a non STEMI. But to basically summarise what's happening in these situations is if you understand an ECG and if you don't understand an ECG, Google what a lead to or ECG trace looks like and you've got various bumps, dips associated with it. You've got what's called the P wave, the Q wave, the R wave, the S wave and the T wave. Generally, it's they're representative of the electrical conduction within the heart and throughout the myocardium, the heart muscle. And simply put, it's about whether depolarisation happens in the direction of the lead or away from the lead that you're looking at or repolarisation repolarisation happens in the direction of the lead or away from the lead that you're looking at. Generally speaking, depolarisation which is basically the movement and this is a gross oversimplification but it just makes sense. The movement of positive ions in the direction of the lead. Sorry, depolarisation is simply the movement of positive ions into the cell. But generally because one muscle cell is connected to the next, is connected to the next, is connected to the next, this wave of depolarisation or wave of positive ion influx spreads through the muscle, right? And if this spread of positive ions moves in the direction of the lead, you get a bump up on the ECG. If it moves away from the lead, it dips down on the ECG and that's why, you know, the major reasons why you see peaks and troughs on the ECG readout. So if you have death of the myocardium, so these cells are dying and they're dying in, let's say, the left ventricular wall, right at the apex, but it's not going all the way through, it's just going halfway through, right? So remember we said that the tissue will die from the endocardium out towards the epicardium, the outside of the heart muscle, simply because of the way that the coronary arteries are situated. You've got these cells dying, these myocardia cells, and we know as, you know, biochemists that inside of a cell you've got heaps of potassium and outside of the cell you've got heaps of sodium. Cells are bags of potassium, that's all they are. They're floating in a sea of salt, which is sodium and chloride. Now, what we have in this situation is, in order to depolarise a muscle cell, it needs to begin as being negative inside the muscle cell. And the way this happens is, because you probably go, wait, we've got positive sodium outside, but we've also got positive potassium inside. But it's about the movement of these ions and which side is more positive or more negative compared to the other side. Generally speaking, all these ions want to move down their own concentration gradient. So if sodium is in high concentration outside the cell, it wants to get into the cell. If potassium is in high concentration in the cell, it wants to get out of the cell. Now, there's no doorways or channels for sodium to get in at the moment at rest. So sodium is stuck outside. But potassium, there is a channel and it's cracked open a little bit. So potassium tends to leak out of the myocardium, which means these positive potassium go outside, making it slightly more negative inside the muscle cell compared to outside. This is what we call the resting membrane potential, where it's negative inside compared to outside. So it's just a comparison. And the negativity compared to the outside is about negative 90 millivolts. That's the resting membrane potential. This is what we call the isoelectric point. When nothing's happening in the myocardium, it is at this baseline. Right? But now think of this.

01:42:39 Dr Matt

So is that on an ECG, the baseline is the flat point? That's right. So in a typical cardiac cycle, there are actually points where there's a flat line

01:42:48 Dr Mike

happening. Yes. And so isoelectric simply means there's no change in conductivity. Right? Now, it doesn't mean that it is of zero charge. It's just no change in conductivity. Right? So if you have myocardium cells dying, right, halfway through the ventricular wall,

01:43:10 Dr Matt

the cells are dying, which means no ATP is being made by the mitochondria. Now, the thing is that- So is it dying or is it just running out of oxygen?

01:43:19 Dr Mike

Well, it's running out of oxygen to the point- There's not enough ATP. There's not enough ATP being made. And here's the thing. These muscle cells don't just have these leaky potassium channels. They've also got other potassium channels present in their walls that ATP keeps shut. And so when we've got heaps of oxygen, so when we've got a good blood supply and heaps of oxygen, we're making heaps of ATP and these potassium channels are closed. So the potassium remains inside and you only get that leaking out of the potassium and you have the normal resting membrane potential of negative 90 millivolts. But if the cells aren't getting enough oxygen due to a blockage of the coronaries, no ATP, there's no ATP to keep the channel shut. So these potassium channels are open and potassium leaks out in a higher abundance than the leaky channel. So what this means is that you've now got an accumulation of potassium outside of these muscle cells. Now for the dead muscle cells, doesn't matter. But now for the surrounding living muscle cells, there is a concentration gradient where the potassium that generally would want to leak outside because it's going down its gradient- Can't.

01:44:36 Dr Matt

Doesn't want to. So in a way it becomes hyperkalemic. Yes, hyperkalemia occurs. But minus the emic because that's blood, but you know what I mean? Yes.

01:44:44 Dr Mike

Hypotassium in that area. Yeah, you get hyperkalemia in that area, right? So you get high potassium sitting outside the cells and the healthy cells, the ones that are remaining, the potassium doesn't want to leak outside. Because the gradient's lost. That's right. So now the resting membrane potential isn't negative 90. It's going to be more positive. So it might be like negative 50, for example. But what that means now is that it's easier to depolarize and that the isoelectric point at baseline is higher. Okay. So that now when you get an EC- Because if you think about this, right, the depolarization, because it's these dead cells are leaking potassium out, right? It's causing an early depolarization event. But because there's a gap in the muscle wall that's living, the depolarization event can still happen in the direction of the lead, right? Okay. So this lead picks up an early depolarization event and interprets it as an higher isoelectric point. So the isoelectric point begins higher, which now means when you get this depolarization of the rest of the ventricle, the QRS complex, that's higher up, right? But then you get the T wave from the end of the QRS complex, the S to the T, that represents repolarization. So resetting of the heart. This happens normally, which means it then drops back down to its normal resting point. And so what it looks like on an ECG is that you have this ST depression. And this happens when you have death of the muscle tissue that

01:46:26 Dr Matt

doesn't go the full width of the muscle wall. Okay. That would typically be the N stemming. But you can also have this in the unstable. Exactly right. So the unstable and the non-stemmy

01:46:42 Dr Mike

could look similar in an ECG. Yes. And it's called ST depression, but in actual fact, it's QRS elevation. PQRS elevation. That's right. It's everything else elevation. But when we look at a transmural death, so an infarct that's killed the muscle tissue that goes the full width of that myocardium, what now happens is the same thing, potassium leaks out and the early depolarization event cannot happen in the direction of the lead. It happens away from the lead because that's the only other direction for it to go. We're talking lead two here, which means that now if it's going away from the lead, depolarization is happening away from the lead. So you get a drop down. So the baseline isoelectric point begins lower. So now what you get reverses it exactly. So now the ST segment looks elevated, but it's really everything else has been depression. Sorry. Yeah, that's right. So the ST elevation. So the STEMI is not a true STEMI. It's actually an everything else depression, but it looks like ST elevation. Great. Does that make sense? Yes. All right. So it has to do in a big part with potassium,

01:47:57 Dr Matt

but it also has to do with a big part with what degree of the cell wall has died off. Well, not only died off, but just not enough ATP. Yeah. Just enough reduction in oxygen and blood supply to cause lack of ATP. Because the real important point here is if you were just to do, let's just say a person had chest pain and you were just to do an ECG, you could get ST elevation, but we have to use this term because this is what it's used, right? Yeah. We could get ST elevation with a STEMI, but also the Prim's metal angina, but we would get an ST depression with the unstable angina and the non STEMI. Yes, that's right. That's right. Hence why the biomarkers are also an important thing to do concurrently. Now with the stable angina, technically if you had a person at rest, because it's predictable, there's enough myocardial oxygen, they would probably have normal ECG. But if you put them on a treadmill and you've stressed them, then they're likely to go into a ST depression like an unstable or an angina STEMI. But the point, which is important here, you do have two groups now in ECG changes. Yes, you have the ST, or we'll just call it STEMI. We'll call it STEMI and the Prim's metal in one group. Yep. And then we'll have the unstables and the non STEMI is another group. Yeah. And so now the final test that will separate them all is the serum markers. Yes. And so once you take the blood and you look for troponins, you now can in those that have ST elevations, you can now separate the STEMIs from the Prim's metal. Yeah. Because Prim's metal won't have any troponin changes because there's no infarction. And then you can go across to the non STEMIs or the non ST elevated

01:49:55 Dr Mike

changes and you would only see troponin changes in the non STEMIs. Yeah. So you're basically saying that the troponins tell you whether it's ischemia or infarct. Correct. Right. So and that's a big

01:50:09 Dr Matt

group separation. It is. Yeah. Now would they, I don't know if they, do they also give aspirin? Yeah. So we'll get into management, but just before we do that, I know you're rolling your eyes. With all those things that you mentioned, so potassium is leaking out. Yep. Okay. We've got changes in ATP. Yes. So that means we've got more ADP and AMP, which has been degraded to adenosine. We've also got the heart trying to make ATP without oxygen, which is lactate. That's right. Which it's fine with using. It's not, it's right. And we've now got the area, not only high in potassium, but high in acid or hydrogen ions, all these things. So adenosine, hydrogen, potassium, said something else. I can't remember. All irritating the nerves. Yeah. So the nerves.

01:51:03 Dr Mike

Also, sorry to interrupt, they're also trying to vasodilate the coronaries as well. So it's

01:51:09 Dr Matt

sort of a homeostatic response. It's trying to help fix itself, but still not enough. But if you've got a full clot that's now blocked, plugged in the blood vessel, nothing's going to do anything.

01:51:20 Dr Mike

That's right. So you're saying that these are now irritants to the nervous supply.

01:51:25 Dr Matt

Correct. And so what does that mean? Now that the nerves that are so the sensory nerves that are supplying the visceral sensory nerves that are supplying the heart are now being irritated to cause a noxious stimulus, which now exits the heart. Now, because the heart and then going into the spinal cord, because the heart is a visceral organ, it's not low. It's not well localized like somatic muscle. It's visceral muscle, just like all your gut or your gallbladder or your kidney. It gets thrown into the spinal cord at multiple levels. Now the heart gets thrown in at T1 to T4. So it's over a diffuse part of the spinal cord. It's not well localized. Do other parts of the body enter a T1 and T4 as well, Matt? So the bottom part of your break your plexus come in at that point. So from the arms? From the arms. And that's why it refers sometimes to the lower part demotone of the left arm. Right. But it can also go into your high thorax. So it can be chest, neck, jaw. Got you. And that's why it kind of confuses. I guess this is in some way part of the gate theory that it kind of confuses with other somatic areas. Yes. And the brain or the central system get confused where this stimulus is coming from. Yeah.

01:52:44 Dr Mike

So this is the reason for why some individuals will get referredness to their pain. And that is important. I mean, it's important anatomically and physiologically and clinically as part of that symptomatology.

01:52:58 Dr Matt

So now it's treatment? Treatment. Treatment management. Okay. So straight up, do they give aspirin still? I think from the last time I checked, the one intervention that has the greatest impact on mortality is aspirin. Why? Well, aspirin, it goes back to if we're going to generalize the most likely reason for the, if we're talking acute coronary syndrome now, so this is going to be the unstable to the MIs, the most common reason for it is a superimposed thrombus.

01:53:35 Dr Mike

Now, like you said, what's that? What's that?

01:53:37 Dr Matt

So that goes to again, a stable plaque, which the individual has now gone through an event that has bumped up their blood pressure. So they've got a stable plaque. I didn't know of, let's say they've just overexerted themselves. So they've carried furniture for their child because they're moving house, carried a bed up the stairs. So this is the greatest exertion they've done for some time. And it's a big exertion. Sure. All of a sudden they've got a huge spike in blood pressure. The blood pressure in their coronary is as high. There's a huge amount of force that's flying over the top of that hill, which is the plaque in your blood vessel in the coronary. And it's ripped off the top of the hill. So it's like a low flying plane. The cap's off. It's took the cap off the top of the fibrous cap, off the top of the atherosclerotic plaque. That's ripped the top off. Now, as far as the things in your blood that try to stop blood vessels having holes in it, they think, oh, there's a hole in the blood vessel here. We better patch it up, which is great when you have cuts and abrasions and all those kind of things, but not when it's in a blood vessel. Sure. So all of a sudden these platelets come along and go, hey, there's a hole in the blood vessel. Let's hang out here and start holding hands. And this is called platelet aggregation. Right. So all of a sudden platelets will start to join and get bigger and get bigger and get bigger. And then all of a sudden most of the blood vessels now are occluded.

01:55:08 Dr Mike

So what's that got to do with aspirin? So aspirin is a drug that stops platelet aggregation. Hold hand in. There you go. So it reduces the risk of clot and further embolism.

01:55:19 Dr Matt

That's right. So it prevents the clot progressing. Okay. Okay. But you can also bring in other anticoagulants here. So this is also why heparin is good. It stops the stabilization of the clot. So it makes the clot less stable and more likely to be broken down. I'm not really sure the evidence in giving the clot busters here. So breaking the clot up. Yeah. Thrombolitics. Thrombolitics. I don't know how well that's utilizing clinical practice. They may do it in more kind of remote settings when they can't get the ability to get in there and take the clot out. Sure. But I don't really know how well that is done. But they also give nitroglycerin. So that would be a good one to try to get the blood vessels open. So nitroglycerin is a good one. Depending on how the patient is, if they have a low oxygen saturation, so I think under 90, they would give oxygen. But I think oxygen is not routinely given anymore because there is concern that if the person was to survive from the MI, they can get a reperfusion injury with too much oxygen, which becomes like a free radical damage to the surviving tissue. Okay. So I think oxygen is only given when they're desatting. Gotcha.

01:56:45 Dr Mike

Now, not just because they used to just chuck every time they come in.

01:56:49 Dr Matt

Yeah. The other thing they can do is they can take the stress away from-

01:56:55 Dr Mike

I also thought that oxygen can lead to further vasoconstriction in certain vessels too.

01:57:01 Dr Matt

Well, in most cases, hypoxia does result in vasodilation. Yeah, that's what I was thinking.

01:57:10 Dr Mike

Maybe giving the oxygen might also further exacerbate the constrictive effect because it thinks everything's okay.

01:57:17 Dr Matt

Maybe not. Because they're in pain and because they're highly anxious, they also sometimes give morphine, to kind of quiet them down a bit. Not quiet them down, but just take the anxiety away, which takes the pressure off the heart. Talking about taking the pressure off the heart, they can give beta blockers, which makes the heart kind of work less hard. Therefore, they need less myocardial oxygen. Yep. And then the statins, which I don't know how, obviously in the short term, how useful that will be. Yep. I have heard that it can stabilize the plaque, but I don't know if that would be really that useful in the acute setting.

01:58:01 Dr Mike

Because you can sort of give those blood volume alterating- Alterating. Altering meds as well as a secondary sort of intervention or prevention to reduce further endothelial damage. You're trying to reduce hypertension basically. Right? So you can sort of, things like ACE inhibitors. But yeah, I think angina pharmacotherapy would include probably beta blockers.

01:58:30 Dr Matt

What about calcium-based meds? Calcium channel antagonists, I think, are one of the main states for the prims metal.

01:58:41 Dr Mike

Because you have the spasms in the artery wall, which would be the main concern. All right. Okay, so they're the various meds. And obviously there's other interventions like surgical. And we spoke about- Oh yeah, so the surgical- Stenting, right?

01:58:54 Dr Matt

That's great. So if then the treatment management would be, you would go to the cath lab. Yep. And that would then try to unblock the blockage. Right. And so that's where you'd do what I spoke about at the start with my dad. Go up there, look for where the blockage is. You could put a balloon in there to try and widen the wall.

01:59:16 Dr Mike

Just like a party balloon? Like one that you could fold into a sausage dog or-

01:59:19 Dr Matt

Not quite, but along those lines. All right. Just small. So you blow it up in the- Like a water balloon. In the- there we go. Blow up the water balloon. Actually, I think they do use water. I think they inject water. Okay. And it pushes it out. Anyway, that- But it's not a water balloon. It pushes the wall open and hopefully gets the occlusion out of the way. Yep. They could use a stent and then if that doesn't work, then they did the bypass, which we already spoke to.

01:59:46 Dr Mike

Yep. So is that cabbage? Cabbage. What's cabbage?

01:59:50 Dr Matt

Oh, I can never remember. Coronary, artery, bypass, graft.

01:59:54 Dr Mike

Yeah. And yeah, and that's what you were talking about before. Okay, cool. So- If you were to survive? Yeah. So if somebody- let's just say, because obviously at the very end, worst case scenario of ischemic heart disease, at least in the acute phase, is an MI. So somebody has a heart attack, but it doesn't just- If somebody survives a heart attack, it doesn't just finish there necessarily. No. So there could be these various complications of experiencing the MI, the heart attack. And so there's a number of them. And I know that you said to me that you had done as good a job as you possibly could to create a mnemonic because you love creating mnemonics to help people. Because you're always student focused, right? That's right.

02:00:45 Dr Matt

Memory tools, I call them.

02:00:46 Dr Mike

Yeah, yeah. And I mean, that's what I call you as well. So you're just here to help the students. And so Matt, tell me, what have you worked hard on? What mnemonic have you worked really hard on to develop for the students today? Okay.

02:00:58 Dr Matt

So this mnemonic underpins all the possible complications that could come after an MI. Right. All of them. Oh, okay. I'm not going to do that. No, okay.

02:01:08 Dr Mike

I apologize for doing that, but most? Most. All right. The most common. Okay. So what's the mnemonic?

02:01:12 Dr Matt

I tried to come up with- actually, I threw it through chat GBT to begin with. And the best I could get initially was two words. Yeah. But then I've narrowed it down to one word. Great. Now the one word is? Yes. Sharted.

02:01:27 Dr Mike

Wait a minute. Sorry?

02:01:29 Dr Matt

Sharted.

02:01:31 Dr Mike

Sharted. Are you familiar with that term? Well, I am not only familiar with the term, Matthew, but I'm familiar with the action. Sharted, my friend, is a verb. Okay. So doing word. Yes, it's a doing word. It's past tense, so the shart has occurred. And I would say that in the unfortunate circumstance in which you want to pass bodily gas, which is a normal physiological process, might I add. Yeah. But sometimes you may have gone to Taco Bell or maybe not to disparage particular fast food organizations. Um, you may have eaten maybe something that disagreed with your tummy a little bit earlier. Blue stool. Well, you, uh, which was my nickname in high school. And so what happens is you think you need to fart, but you actually poop. Now it's not called a part. It's called a shot. So it's another word for poop. Um, it's a bit of a wet fart. Okay. So in saying that, what does it stand for? Does it stand for? Okay. What does each letter stand for?

02:02:51 Dr Matt

Now, remember, an MI is resulted in the death of myocardium. Yes. Okay. So this is where it's going to potentially, I mean, one of them isn't a recovery, but all the rest is the body trying to recover from the MI. Okay. So charted S I had to have a look on the board because I won't be able to spell it. I'll read it out for you. So S is shock shock. So that'd be cardiogenic shock. So that would be basically means you've lost probably significant amount of myocardium and now you have a degree of pump dysfunction or pump failure. So the heart just can't pump enough blood out to keep up with the demands of the body. So you would get a perfusion is shock, right? That's right. So you'd get cardiogenic shock opposed to the other forms of shock, but this is just heart driven shock. Yeah.

02:03:41 Dr Mike

So cardiogenic means from the heart. Yeah. The cause is the heart. Genic is, you know, Genesis, the cause of. So cardiogenic shock. So shock is the S of charted.

02:03:52 Dr Matt

H would be heart failure. Heart failure. That's right.

02:03:54 Dr Mike

Yeah. Which I think is self-explanatory and no longer works as a pump. Correct.

02:03:59 Dr Matt

The A is aneurysm. Yes. That then means what happens is as the walls are now died, so myocardium is died, doesn't matter really where in the body, if you have any kind of death of tissue, the body tries to come in, clean it up, infuse it with white blood cells, eat all the dead stuff up and lay down a new basis of tissue to try to repair it. Now that's fine in some locations where you can remake the tissue to how it should have been. So if this was in your skin and you had an injury, you cleaned it up or your immune system clean it up. Lay down new fibers and then the epithelium grows over it and you've got a nice healed wound. Sure. Can't even notice it where it was. But in your heart, the big problem is the myocardium doesn't really recover, so it becomes more of a scar tissue than new muscle. So where's the aneurysm part? So what's happened is it hasn't repaired well enough and the sidewall has bulged out and formed an aneurysm, which is just like a weakening pouch. Gotcha. And so that's kind of bulged out the side of the ventricle, let's say.

02:05:11 Dr Mike

Which probably can then lead to the R in charted, which is rupture. Rupture, that's right. So you can have a rupturing of the ventricular wall or the interventricular septum or even the papillary muscle. So you can have various aspects of the heart tissue rupturing. Yeah.

02:05:25 Dr Matt

Then the T is a tamponade. Tamponade. So that basically goes to the basis of you've had an injury, you've now got inflammation. We know that one side of inflammation is edema or swelling. Now in this case, because it's going to be on the outer part of the heart, that inflammation can go off into the pericardium. Right. And cause fluid accumulation. And then that starts to push against the heart itself. So when it's trying to beat, it's having this tamponade, which is kind of resistance. Resistance against it.

02:05:56 Dr Mike

Yeah. And that can lead to obviously issues with heart working as a pump,

02:05:59 Dr Matt

but also a significant amount of pain. Yes. And just the ability of the heart to feel because it's been restricted. So it's not filling in diastole.

02:06:07 Dr Mike

Therefore you can't get as much blood out. And the E is embolism. No, we did embolism. No, we didn't.

02:06:12 Dr Matt

Embolism. Embolism. So because you're getting maybe a poor efficiency of filling and beating, you can get stagnation within the ventricle. And then that can lead to the blood clotting. Yeah. Similar to what you sometimes see in the atrium with AF. You can get stagnation and blood clot formation, and then you can get embolism.

02:06:35 Dr Mike

Gotcha. So a thrombus versus an embolism. And D. Wait, a thrombus versus an embolism. This is what I was saying earlier. Isn't an embolism begins in the heart?

02:06:47 Dr Matt

Embolism is just basically meaning something's breaking off from something else. So you could have a clot, a thrombus in your veins and your lower leg, but as soon as it breaks off from the original point and it's moving, it's now an embolism. Okay, cool. But you could also have an embolism which is fat. Right. So from a broken bone or an air embolism. What's the difference between that and a thrombus? Thrombus is fixed.

02:07:11 Dr Mike

It's staying where it formed. Cool. And then D is dysrhythmia, which do we call it dysrhythmia or do we say arrhythmia now?

02:07:20 Dr Matt

Well, didn't you, I'm sure you did a video on that. It was years ago. And you said arrhythmia means technically no rhythm. Yes, that's true. Whereas dysrhythmia is a disordered. Agree. I think dys is the better term. I agree too. So it's disordered rhythm. But really arrhythmia is going to be the one you'll see more frequently in textbooks.

02:07:37 Dr Mike

Yeah, I agree. And so that could be, you know, a range of things, you know, heart block, atrial, ventricular. It really depends on where it happens.

02:07:44 Dr Matt

Yeah. So- And the other rupture you could put there would be the rupture of papillary muscles. So if you have papillary muscles that die. I said that in my video. Did you? Yeah. Therefore, the strings that are holding on the- On to the-

02:07:57 Dr Mike

Quartotendinae, heartstrings. Release and you get mitral valve regurgitation. There is another way that you can sort of classify all these. So another D is death. Okay. Well, that's a pretty bad complication. So you can classify it differently. I like yours better. Sharded is far easier to remember. But you can have the- You can have arrhythmic, ischemic, mechanical, inflammatory, and systemic. Complications. So the arrhythmic are the conduction. So heart block, atrial, ventricular arrhythmias. You can have ischemic, which can be a reinfact. So you can actually have a reinfact or you can have an extension of the existing infact.

02:08:38 Dr Matt

I think reinfacts are fairly common. And one of the way they know that is between the time profiles of the two blood markers. So creatine kinase versus troponins. I think creatine kinase has a shorter half life. Yep. So it will disappear. I think it's 48 hours. It almost goes back to baseline. Yeah. Whereas other one takes a lot longer. I might have that wrong. But essentially, if you have another peak of the creatine kinase, that will tell you you just had another infact. Yes. Whereas the troponins are still coming down.

02:09:10 Dr Mike

So you don't necessarily know going off troponins. Well, exactly right. And I think it's important to understand that this is usually going to happen within a couple of days of having the original infact. Then you've got, in addition to that, mechanical. So these are the mechanical complications. Martial valve, caudal ruptures, septal, ventricular, tamponade, aneurysms, right? Inflammatory, pericarditis. Yeah. Which is tamponade. Which is part of that tamponade. Well, tamponade is the result of the pericarditis. Yep. And then you can have systemic. So that's the cardiogenic shock. That's the heart failure. That's the lower extremity embolism. Whatever it may be.

02:09:51 Dr Matt

Right. And interestingly, and this goes back to maybe what Ben sent at the start with some of his research that he sent us, is historically the way that a survival and a heart attack would have been was six weeks to eight weeks in bed. Wow. To stay in bed. Yeah. And in a way, without having all the modern medicine, it makes sense because all these complications just by staying in bed and not making your heart work hard could reduce the risk of these worsening. Yes. Because if you're not stressing your heart out after the infarct, you're less likely to get maybe some of the downstream effects like aneurysms, ruptures. So it makes sense.

02:10:35 Dr Mike

It doesn't do anything. But we now know that your body is dynamic and responds to stressors, those stresses that we can overcome. The thing is you don't want to overly stress the heart after MI, but you want it to do its job as a pump as well.

02:10:54 Dr Matt

So have we hit the end, Matt? Yeah. And so the only other thing that I will put here, but that really goes back to the risk factors. Let me just pull that slide up because I've got the CVD risk calculator, is that the management, well, technically how you would want to manage this whole umbrella term would be preventative. Yes. You don't want it to begin with. Yes. So you really want to do your best. And this is the point of this cardiovascular risk to get it through to choose your parents wisely. That's right. You really want to prevent all this happening. And so when we spoke about all the risks, you want to minimize those as best you can. But if you were to survive an ischemic event, even if it's the angina or the MI, and the clinicians would be working with the patient to reduce all those risks and lifestyle management to try to get the likelihood of another event happening to be very low. Yeah. So there would be blood pressure, lipids, stop your smoking, better nutrition, get moving. Healthy weight. Don't drink alcohol.

02:12:12 Dr Mike

Yeah. Beautiful. There we have it.

02:12:14 Dr Matt

So this is, as we said at the start, this is the most common cause of death in the Western world. So it's a disease that is very common. Yeah. And you'll have a lot of patients.

02:12:25 Dr Mike

But predominantly preventable. Yes. Super important. Predominantly preventable. Now I know it's two hours and 12 minutes into the podcast. You've got some emails. Yeah. I just want to read. Whoops. I just nearly smashed my iPad then. I just want to read a couple of emails out because we love those that contact us. And I especially love those that say how great I am. Just you. Well, who wants to hear anything about you? So here we go. This is from Roman. Roman says, hey, fellas, firstly, love your work. Thank you, Roman. Secondly, I have a suggestion for a course or content. So Roman is saying that in Australia, at least, we've got the GAMSAT, which is the medical entrance exam to get into medicine at university. And he's said- Postgraduate medicine. Post-grad medicine. Very good. So you've already done a bachelor's of something else. Good point. So he's basically said that there's one section of that that scares a lot of students. And he thinks that we are more than capable of putting together content for that particular section, which is section three. Is that the science section? This is science, bio, organic chemistry, physics, maths. You can do the physics side of it, Matt. And he said that there are various preparation companies that just charge a ridiculous amount of money. And he thinks that we could do a better job for cheaper. And you know what? I agree. And so Matt and I will sit down and have a chat. And maybe this is something that we move to in the future. Maybe helping students prepare for the GAMSAT, at least the science aspect of the GAMSAT. Roman is a second year nursing undergraduate student and an aspiring future med student. Roman, please keep in touch and let us know how you get on your journey. Here is one from Braden. So Braden, thank you so much for your email. Braden says, look, I don't need anything. I just wanted to let you guys know that I just discovered your podcast and you're both freaking hilarious. Thank you, Braden. I know that he means one of us is hilarious and it's me. And I truly appreciate that. I know that you didn't want to disparage Matt. Hurt my feelings. Yes, because obviously I'm the bully in the podcast here. And so Matt, even though we are the closest of friends, we high five all the time. So? Colleagues. Colleagues. Oh, so there is a distinction that you'd like to make? Of course, of course. Not just acquaintances. Oh, look. So we're beyond being acquaintances.

02:15:00 Dr Matt

We're colleagues at least. With colleagues. Friends?

02:15:04 Dr Mike

No, don't stretch it. Best friends. Okay, maybe not. All right. Thank you, Braden. We've got another email here from Kevin. Kevin says, for some topics to be covered, would you please come up with more biochemistry lectures like nucleotides and nucleosides? And didn't you do these in the short form? I did, but they probably need redoing. No, the short form was in like the A to Zs. Oh, well, we spoke about we haven't got to end yet, but we have spoken about adenosine and adenine and the difference in regards to whether it's a nucleotide or a nucleoside. Okay. So in saying that, please listen to our A to Z podcasts. We will get to that. Two per week. Nucleotides and nucleosides. We release two per week. I forgot to upload Monday's one, but that's, I was busy. But that doesn't, that's not an excuse, Mike. All right. Last one by Sally. Hi, Sally. Sally says in the topic of breathing and ventilation, I've just watched your amazing video, brackets, Dr. Mike, because I'm sure it's my video. She hasn't actually explicitly stated that, but I've just watched your amazing video on the mechanics of normal breathing and wondered how normal breathing is different with positive pressure ventilation. Is it sort of the opposite with pressures?

02:16:28 Dr Matt

Any insight here, Matt? So positive airway pressure would be used when you're trying to improve inflation of the lung. How that would impact. So if you were to have situations, actually, I got asked this other day in class, and they were talking about high flow ventilation. Yeah. Where you don't necessarily want to add oxygenation levels, but you just want to help the ventilation of lung tissue where there may be poorly ventilated regions. Yeah. Or collapse.

02:17:03 Dr Mike

How that would impact breathing mechanics. Yeah. So the way I think about it is that ventilation is obviously simply just getting air into and out of the lungs. Respiration is gas exchange across the membranes, and gas exchange across the membranes only occur when there is a partial pressure gradient. So the oxygen is higher once of the gas. Oxygen is higher on one side of the membrane compared to the other. Same with carbon dioxide, one side to the other. So if you've got a positive pressure gradient that you're introducing in, you're not just introducing more into the lung itself, but you're probably facilitating an increase in gas exchange at the respiratory tissue. If you're just trying to facilitate ventilation, because there's probably maybe there's an issue with the respiratory muscles, or maybe there's an issue with the lung tissue itself, but there's not a problem with gas exchange occurring. All you need to do is facilitate ventilation. And so that's when you'd probably utilize one.

02:18:04 Dr Matt

That's where they would use, say, CPAP, which would be a continuous positive pressure. And that could be in obstructive cases where people's airways are closing in during sleep. But then by level where they're trying to regulate that in other situations. In and out with a positive peep or a peep where they're kind of holding the lung open at the end of expiration. I can't remember now. But that would be how that would impact normal respiration mechanics. I don't exactly know. Yeah, look, I don't think it would alter it in any particular way apart from facilitating it. Right? Yeah, that's right. I think it's highly utilized within the acute management situations like ICU, where you really wanted to have that higher peep to keep the airways more inflated.

02:18:57 Dr Mike

Yeah, that's right. And that was the last email for today. We have more emails coming through and we will read them. And again, thank you, Ben, for your research excellence. Yeah, Ben, thank you, mate. We very much appreciate it. If you would like to contact us, send us an email, gubiosciences.gmail.com. Or you can go to our website, which is drmat.doctormike.com.au. And you can send us an email from the website. But you can also contact us on social media at drmiketadorovic.com. Go to our YouTube channel, hit subscribe, give us a five-star rating on the podcasts. And you know, tell your teachers that you listen and watch Dr. Matt and Dr. Mike and send all of your positive feedback across. If there's something that you think you don't like the way we do, for example, you don't like the way that I… Matt talks. Matt talks or the fact that I rib on him all the time. Well, let us know. I probably won't change that because part of… That's just our relationship. That's right. Matt, does it bother you? That you're disparaging of me? That I give you a hard time sometimes. Look, I know you don't mean it. You know I love you. Well, that's subjective. We're best friends, remember? Best friends forced to do battle. Was that… What's that off? Is that ThunderCats? No, it's off Jim Carrey and Cable Guy. Yeah, but he got that from something else. Oh, I don't know. I don't know. All right. Hey, if you know the answer to that and you decide to stay two hours and 20 minutes into a podcast, let me know. And we love you. That's right. Thank you, dear listener. Your commitment. Cheers. Look after your heart. Please do.