Airing Pain Programme 136

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Paul Evans This is Airing Pain, the programme brought to you by Pain Concern, the UK charity providing information and support for those of us living with pain, our family and supporters, and the health professionals who care for us. I'm Paul Evans, and we're grateful for the support of the British Pain Society in the making of this edition of Airing Pain.

Dr Simon Thomson It is a very exciting new thing which has got a long way to go and it's just really a matter of giving hope to people with secondary back pain, so it's not a primary pain disorder. It really is one of those game changers.

Dr Timothy Deer Doctors who use the same exact device on every patient will be out of the mainstream. You'll come in, you'll meet a doctor who's open-minded and they'll look at some markers whether it be your imaging, your blood test, your urine biomarkers, with some factors. We'll look at those and then we'll get on the table and put the small wire in and the wire will measure your spinal cord and tell us how your spinal cord responds to different types of electrical current. Based on that, we'll choose to put in a certain device or a certain waveform that day and we'll have probably a 95% or more predictability, and we're seeing this already.

Dr Owen Williamson People who have osteoarthritis in their fingers tend to perceive their hands as smaller than they actually are, and if you put them in a virtual environment and stretch the hands so they perceive them as normal, the pain goes away.

Evans: In the spring of 2022, we at Pain Concern attended the British Pain Society's annual scientific meeting. It's an event we always like to go to, to hear internationally recognised clinicians and researchers from around the globe exploring and sharing new developments and ground-breaking research in the pain community. And through Airing Pain, we share that with you. Dr Stephen Ward is chair of the Scientific Programme Committee, which sets the agenda of the meeting. He's a consultant in pain medicine at Saint Thomas' Hospital in London, which is probably Europe's largest pain clinic.

Dr Stephen Ward: Pain management is a specialty. It's pretty small and we only get to see each other probably on this one occasion per year as a group of individuals. You know, a lot of the discussion is not held in the auditorium, it's afterwards in restaurants and bars and so on, so it's a chance to catch up, but also education.

Evans: For people with chronic pain, we don't all know what is going on behind the scenes. I mean, some people with chronic pain, they never get further than their GP practice and can feel very, very isolated

Ward: Of course.

Evans: So, it's important for people to know that actually all this stuff, all the science, is being talked about seriously.

Ward: Quite so. A great example of that is in fibromyalgia. You know, there's just reams of stuff out there about latest research and so on. There are some really, really fascinating experiments in the laboratory around fibromyalgia demonstrating that if you take blood

samples from humans with fibromyalgia and humans without fibromyalgia and spin the samples down and inject them into, I think, either rats or mice, the mice injected with the serum from fibromyalgic patients developed symptoms akin to fibromyalgia. I mean it's astonishing, and it implies that fibromyalgia might be some sort of immune disease process. For people out there who have been told, "Well, you know, there's no cure. There's no this. There's no that," to just know that somebody out there is doing these experiments that in years to come that will lead somewhere. They should know that and so I tell people this in the clinic. But unless they were to come to this meeting and hear about that, you know, it's not widely reported. It's not the sort of stuff that gets into the newspapers.

Evans: You talk about fibromyalgia. It's very pertinent to me because I have fibromyalgia.

Ward: And did you know about this?

Evans: No, I didn't.

Ward: We all know about it, and it was awarded, I think, the best presentation or best poster presentation at the EFIC meeting a couple of years ago. It was big news. Well, you know now. And I hope you will learn more with the content of this meeting. In the past I think quite a bit of this was the output of laboratory research presented at a meeting, and it was called the annual scientific meeting. You could see over the years numbers drop a little bit. It's a multidisciplinary society so I don't think everybody wants to hear about laboratory experiments exclusively. What we try to do as a committee, and certainly personally, is open it up. At any time point in the day you could find something to interest you.

Evans: And there was plenty to interest me. That was Dr Stephen Ward. Well, after that revelation, what else as a person living with pain don't I know about what's around the corner? One of the speakers was Dr Simon Thompson. He's a consultant in pain medicine and neuromodulation with the Mid and South Essex University Hospitals NHS Trust.

Dr Simon Thompson: Neuromodulation is where the nervous system is impacted by electrical stimulation, sometimes light, sometimes targeted chemicals, or sometimes electrical energy in order to modulate or change the activity of neurones within any part of the nervous system for therapeutic good.

Evans: So, neurons, that's the nervous system, nerves and brain?

Thompson: Yep, so brain, spinal cord, peripheral nerves, autonomic nervous system.

Evans: And modulate, as you said, is to change something.

Thompson: Change the way they are functioning. So, the important thing is it doesn't destroy them, it's non-destructive, but it changes the way they function. Usually in the conditions we're treating they are functioning in an unhelpful way because of the kind of injury that they've had, so often it corrects them to normal.

Evans: Chronic pain is defined, if you like, as pain that is there for three months after an initial cause, or perhaps there wasn't an initial cause. So, something is happening to the nervous system.

Thompson: Really quite specifically, we are treating secondary pain syndromes where there is a cause. As we've got better diagnostically and through our understanding over the years, certain conditions which were known as primary, or could have been known as primary, have more of a secondary cause. You know, it wasn't so long ago that people didn't understand neuropathic pain, pain due to injury to any part of the nervous system, with pain felt in the body, even though there was nothing physically wrong with the body. But there was something wrong with that part of the nervous system. And so, you can damage the nervous system through infection, for example, like a viral infection, either of the cord like in transverse myelitis or peripherally like in post-herpetic neuralgia, or you can do trauma through surgical wounds, trauma wounds. The most common thing that we treat is people who have herniated discs that have caused nerve root injury. They may or may not have had previous surgery, but they have persistent pain. So, we can follow the route back and understand the cause of the pain.

Evans: So, take me on that journey from the root of the pain, the physical root of the pain, to why it should hurt in the first place.

Thompson: I think the easiest thing is to think of a herniated disc, and people often think of that as a like a washer. It's not really, it's like a doughnut where some of the jam has squirted out. That jam, the nucleus pulposus, in health it hardly sees anything of your blood system and importantly your immune system. And so, when it leaks out, it causes an intense local immune reaction. And it's the inflammation that activates the nerves that are very nearby and that causes a lot of the pain. The physical mass of the material that might squirt out can also cause compression of the nerve, which actually strangely is not necessarily painful on its own but causes a sort of numbness and some tingling. But it's the inflammatory response that initiates the acute pain. And then as healing occurs overtime, the changes in the nervous system, that whole nervous system from that nerve root through the spinal cord to the brain becomes sensitised. That's known as central sensitisation, so even if the inflammation dies away, the changes are still there in the nervous system and that is perceived as pain.

Evans: So, the injury, if you like, has gone, but the pain processor is still working. It's as if your nerves are amplifying something that actually shouldn't be there. Am I right?

Thompson: It is. I mean, they've been changed physically, so there may have been some loss of axons which are, you know, the fibres within nerves. And so, you change that balance. There can be a change in the receptors expressed in that nerve, how nerves communicate with each other. And some people can end up densely numb in their leg, but they've still got pain. I mean, the most extreme example is phantom limb pain, where a limb can be removed. You don't have a limb, but the patient's brain map tells them that they have got a limb. In fact, they can even wiggle their toes. And sometimes they get awful pain in the phantom limb.

Evans: So, I'm going back to neuromodulation now. How would that be used in, say, the herniated disc?

Thompson: It's important to realise that with the herniated disc, there isn't the idea that there would be a type of surgery that in one deft operation could make it much better. But when that possibility has been exhausted, and it may be because the disc has already resolved and there is no surgical target for them to remove anything, or it can be that they've had an operation on that disc. They've already removed it and they've still got pain and furthermore, scar tissue. So, we have a sort of algorithm of care so that these patients are really quite

common. It probably happens in about 20% of patients who have their first back surgery that they have continuing pain. Some patients put up with it. Some patients can resolve with medication, sometimes with a targeted injection, but really beyond that it's spinal cord stimulation. You know, there's reasons to believe that the kind of relief that you can achieve with spinal cord stimulation is so much better than repeat injections and being on drugs that actually it probably becomes an even better option. But we tend to try a few conservative type of management strategies first and then move on to spinal cord.

Evans: So, what's involved in spinal cord stimulation?

Thompson: A day case operation in my hands. Local anaesthetic. Some sedation. An epidural placement of the lead and threading the lead up in the epidural space. On table testing with the engineer through the computer to make sure that the stimulation is felt in the right place, or the leads are in the anatomically correct place. And then implanting a pulse generator, which is like a small microcomputer and all under the skin, usually under the skin of the back area.

Evans: Is this a one-off procedure?

Thompson: So, it's a rechargeable device that I use and that would last 12 years. You might need attention to it for some of the complications that may occur in that 12-year period. And then eventually, like any rechargeable battery, it doesn't hold its charge and needs replacing.

Evans: Is there a danger that the body becomes used to this?

Thompson: So, tolerance is, or can be, a feature. I always make the distinction between true tolerance because for some people there's been a progression of their illness. Now we have multiple wave-type devices so that can be quite good because it mixes up things so the nervous system doesn't get you so used to it. But there's much less tolerance with spinal cord stimulation than you see, for example, with TENS (transcutaneous electrical nerve stimulation). That's important to realise. But I don't take out that many because of loss of effect. And if I do, there's more likely a sort of technical issue or an upgrading of the system that can deal with it.

Evans: At what stage would somebody with a herniated disc get to you for this operation?

Thompson: If they've had a hernia, the tradition has been that patients are treated conservatively. If it's continuous, or if there are what we call red flags, and red flags are rapidly progressing neurological change, cauda equina syndrome which is loss of bladder and bowel function and saddle anaesthesia, then they go, well, for cauda equina, urgently to A&E for a decompression. If it's rapid progression of motor problems and unbearable pain, then usually they're best served by microdiscectomy. When the surgeons have done that and there has been some allowance for recovery, because typically people are improved for two or three months and the recurrence tends to start after about that time. Sometimes that's after they've been discharged from the surgeon. So, sometimes they get sent back to the same surgeon and there's a danger there because depending on your type of surgeon, they may feel that they can continue to treat this problem with more surgery and, you know, there are people who will treat chronic pain - well, they don't call it neuropathic pain but leg pain - with a fusion and a further decompression and there is a law of diminishing returns on successful outcome

with that. So, always take care before agreeing to revision surgery. I mean, spinal cord stimulation has been an explosion in innovation and we're learning about new conditions that we can take on with that. But there's also other types of neurostimulation. So, there's restorative stimulation of the nerves that supply the core muscles of the low back. Those muscles are the multifidus muscles, and this is a treatment for, if you like, back pain secondary to multifidus muscle dysfunction where it's not working properly, and that actually is probably the most common cause of back pain. Typically, those patients are treated, you know, with physiotherapy, core muscle exercising, and sometimes acupuncture. Sometimes they go to the pain clinic and they get interventional treatment with medial branch injections of the nerves and then radiofrequency. That can put quite a lot of patients into long-term remission. And if it's then coupled with functional improvements, they can then reverse some of the changes that have occurred to their multifidus muscle. But quite often that fails and multifidus nerve stimulation seems to be a rather good thing to do. Not only does it relieve pain, but it actually restores the muscle function. So, typically we find once we've put a device in, 40 to 50% of patients are improved significantly by one year, but as each year goes by, you get ever increasing numbers improve. And so, by the time you get out to four years, which is where we are now, 80 to 90% of patients are significantly improved. And that's in patients who've had low back pain on an average of 10 to 14 years.

Evans: Just explain to me what we're talking about now?

Thompson: So, we're talking about a device. It looks like a spinal cord stimulator. It's got leads. It looks like that, but the leads are not in the spine, they're around the bones of the spine. There is a nerve called the multifidus nerve, where we know anatomically where it is and it feeds into that muscle group. And so, when you stimulate it, you can feel the muscles clench. The therapy is, once it's implanted, to produce pleasant tetanic activation of the nerve. Patients do this twice a day for half an hour, morning and evening lying down, and it wakes up the whole muscle. The problem with back pain is that that muscle gradually disappears. It isn't activated in health, and the muscle turns to fat. It's called fatty infiltration, which is really a sign of the dysfunction. Those muscles have to be really good at maintaining strong loads and adjusting quickly to change in loading and positioning, and they lose all of that. And then what we're also finding is when they lose that, much like with nerve pain, they end up with changes in the brain. So the cortical representation of where the muscles are in the brain is altered. This is why chronic pain becomes chronic long term because it basically transfers, if you like, from the back to the brain.

Evans: So what you're saying, if I've got this right, is that those muscles that would turn to fat, they are being exercised, if you like, by stimulation, and exercised muscles makes them grow and work properly.

Thompson: We don't quite know about the growing yet, but it's all about restoring, perhaps, the types of muscle fibre so that they then do their original function better again. And there are other exciting things. If we do it early enough, will it prevent some of the lumbar spondylotic changes, which is the X-ray and MRI paresis around bones where muscles attach and you get ossification of these structures because they're being overstrained. And so, if you can then support them with your muscles, it may be that you can actually change the trajectory of the condition.

Evans: That's really exciting.

Thompson: It is a very exciting new thing which I think has got a long way to go and it's just really a matter of giving hope to people with secondary back pain. So, it's not a primary pain disorder. It really is one of those game changers.

Evans: That's Dr Simon Thompson. So, exciting stuff just around the corner. Dr Owen Williamson is a pain medicine specialist in Canada. He has an academic appointment with the School of Interactive Arts and Technology at Simon Fraser University in Vancouver, British Columbia, where he works with those designing virtual reality environments with the hope of bringing those techniques to the treatment of chronic pain.

Dr Owen Williamson: With acute pain, the virtual reality environment is mainly used to distract people whilst undergoing short-term painful procedures, and this was originally a technique used in paediatric burns units to reduce the amount of sedation children were given during dressing changes. But my particular area of interest is designing virtual environments to help manage people with chronic pain. What we know is there are certain pain conditions that are associated with distortions about the way we perceive our bodies, and those distortions are associated with pain. And if you can correct those distortions, the pain improves.

Evans: What sort of distortions?

Williamson: A common example just off the top of my head is when you go to the dentist and have freezing put in your gum and almost immediately your face feels swollen. Yet if you were to look in the mirror, it looks totally normal. So, what you have done is by having the local anaesthetic injected created a mismatch between the way your body perceives your face normally is and the way it feels once the sensation is taken away. And that manifests itself as this feeling of swelling, where in fact there's none that's observable. Another example that people might know about is phantom limb pain, where someone has had an amputation and yet still feels the body part that's been removed and can in fact feel pain in that body part. So, what we're interested in is these perceptual distortions. We do have some conditions like phantom limb pain, or the pain associated with the complex regional pain syndrome, that can be treated by treating the perceived body distortions.

Evans: Now I know with phantom limb pain, one of the treatments they use is a mirror which can - tell me if I'm wrong - rewire the brain to thinking that the limb that you see in the mirror is the limb that's gone. Am I right?

Williamson: Right, correct. And in a way, the virtual reality environments that we use under those circumstances mirror mirror therapy, but in fact we can extend it beyond it because we can actually, in the virtual environment, get the phantom limb or the mirrored limb, however you like to designate it - the non-functional limb – we can get it to perform a whole lot of different tasks, not just copying the movement that is reflected from a normal part.

Evans: How does that work? What is it doing to you?

Williamson: You are correct when you say at some level it's rewiring the brain. What we have come to appreciate is that the brain as it ages doesn't create new brain cells, but it can create new connections. New connections can bypass those areas of the brain that have either been

damaged in the past - that's what happens with stroke - or if there is an abnormal perception of pain, what we're hoping is by using these techniques we can rewire the brain so that signals no longer present themselves to that part of the brain that codes sensations as being painful or not.

Evans: You mentioned lower back pain. What is the body distortion there that maybe you can help get rid of?

Williamson: There are a number of different distortions. For instance, if you get somebody with back pain more on one side than the other, and you get them to draw a picture of their back, they will show that the side that is painful tends to look more swollen than the normal side. If you test sensation in the painful area, the ability of the body to accurately discriminate between points of contact, for instance with sharp objects, is diminished. There are other variations in the way that people perceive touch in chronic back pain in the affected areas compared with normal people. And then ultimately if you were to look at markers of brain metabolism associated with chronic back pain, there are changes in the circuitry that perceives stimuli coming from the back as painful in people with chronic back pain versus people without back pain. So, there are both local distortions and then there are changes within the brain in people that have chronic back pain, and the hope is that through facilitating this process by which nerves can establish new connections, that then we can bypass those processes that cause signals to be perceived.

Evans: So, some of the pain medications modify the brain signal chemically, if you like.

Williamson: Correct. For instance, people get confused when pain doctors prescribe medications that are labelled as antidepressants for pain. They assume that the pain they're feeling is not pain but it's being labelled as depression, but in fact some of the antidepressant medications modify the way that signals are processed within the brain. Some of the common antidepressants will actually facilitate the higher structures in the brain to suppress pain signals. Other ones will increase the ability of the brain to send pain dampening signals down the spinal cord, and you feel like you “head pain off at the pass”.

Evans: So, that is chemicals, or drug therapy. But that's not what you're talking about. You're talking about changing the way the brain works without those drugs.

Williamson: Correct. But there is some information that it's the same process that's occurring within the brain, it's just that it's being triggered by a different modality. And so there is evidence, for instance, that doing interventional pain procedures or using medications, or using virtual reality environments, or using other forms of behavioural therapies, change signals in a similar way.

Evans: We’re at the British Pain Society at the annual scientific meeting. I saw the title of your talk, ‘Modifying the Matrix: Virtual Reality’, and what I immediately thought is these are games. It's using gaming technology in a medical field.

Williamson: It could be thought simplistically as that.

Evans: I am simple.

Williamson: In acute pain, that's true. Often the techniques there in virtual reality are to provide distraction. You are providing the brain with an alternate sensory input that distracts from the brain interpreting other signals as being pain signals. In chronic pain we're actually trying to facilitate what's called neuroplasticity, or the rewiring of the brain, in order to bypass the areas, if you like, of the brain that are involved in interpreting signals as painful, or facilitating activity in those parts of the brain that suppress the signals that are interpreted as pain. And the reason I talk about modifying the matrix is that you think about the pain sensing system within the brain as being a pain matrix, and hopefully we're trying to modify that using virtual reality environments rather than operations, injections or drugs.

Evans: I just want to clear up something in my mind that... I mean, you talk about distraction. You distract the attention of a child when you're changing medications. It's not to put down distraction as a simple thing. The distraction actually changes what's going on in your brain.

Williamson: Yes, but there is a difference between which parts of the brain are activated by having fun playing a video game versus undertaking some sort of motor skill within a virtual environment.

Evans: Let me go back to simplicity. Again, if I were having treatment using virtual reality for my bad back or chronic pain, and anything else, would I be wearing the eye things that kids use now?

Williamson: Yeah, it's called the head mounted display. I mean, for virtual reality to work, the technology has to be occlusive, which means that you have to put something in your field of vision that causes you to focus on the image that you are receiving through the virtual reality application rather than being distracted by external cues. The whole reason for that is to ensure that the experience is immersive. But yeah, I mean the price of these things is coming down and you can have a head mounted display made out of cardboard costing $10 or less.

Evans: So, what would I be seeing through that head display? I mean, what images would be put into my brain?

Williamson: The one that we already using, we call it the virtual meditative walk. But basically it would appear as though you're walking along a country lane and the way that we've developed the programme is that we can use sensors, whether it be related to breathing or skin resistance or pulse, that you learn to modulate, and in doing so you modulate the environment. So, as you walk along and feel relaxed, the stormy clouds disappear, and the sun comes up and the flowers start to grow.

Evans: But if I'm not relaxed, the rain comes down.

Williamson: Exactly, yeah.

Evans: The flowers wilt.

Wiliamson: If you get upset, then the weather gets worse.

Evans: It's not unlike meditation.

Williamson: Meditation, in a way, is the opposite of distraction. Distraction is really outward looking. Meditation is inward looking, but both of those we would regard as changing attention.

But what we're also looking at now is changing embodiment, which is how we perceive ourselves in time and space. There is some evidence that when there's a discord between your view of your body and the sensations you're receiving, when there's a discord there, you get an unpleasant sensation. And that's why, for instance, people get motion sick because they're looking at a steady environment like a book whilst they're travelling in the car. But the ears are telling them they're not stable, they're moving around, and there's the discord between their visual input and their vestibular balance input. Then they get motion sick. And so there are some conditions in pain that we already know about where there is a disconnect between what someone sees and what they feel. Then they can get an abnormal sensation that they perceive as pain. For instance, people who have osteoarthritis in their fingers tend to perceive their hands as smaller than they actually are. If you put them in a virtual environment and stretch the hand so they perceive them as normal, the pain goes away and it actually stays away for several hours once they leave the virtual environment. So ,under those circumstances, instead of taking anti-inflammatory medications, you might say you just need ten minutes of finger stretching in the virtual environment three times a day for the same effect.

Evans: Are there any downsides to using this sort of popular culture therapy?

Williamson: Yes, I think there are. To create a safe and effective environment is very difficult because there are just so many variables that have to be taken into account. One of the things that we find is that in some environments, instead of people feeling more relaxed, they actually feel more agitated or fearful. The problem is, if someone were to develop a game and call it a virtual environment gain for the treatment of pain and they haven't gone through all the validation steps, under those circumstances that particular product may make someone feel worse rather than better. So, part of the development programme we do is including some form of patient monitoring so that if they are becoming distressed whilst in an environment, there is some way to mitigate that, either by taking them out of the environment or modifying the environment itself. The problem with the games, the simple games, is they can't modify the environment in response to the patient other than to start a different chapter of a story that's pre-written. So, we actually use artificial intelligence and body sensors so that the people in the environment are being monitored by the environment and the environment being modified in order to benefit the patient rather than cause distress.

Evans: That's Dr Owen Williamson. Now, at the start of each edition of Airing Pain I like to remind you that Pain Concern, the UK charity, provides information and support for those of us living with pain, our family and supporters, and the health professionals who care for us. So, it's important for us to reflect your opinions and guidance to help shape the future editions of Airing Pain, and you can help us by completing our online survey. It will only take a couple of minutes of your time and would mean a huge amount to us and the rest of the pain community. Just click on the link in the programme details or visit painconcern.org.uk/airing-pain-survey to tell us of your thoughts and we look forward to hearing your feedback. Now, if I may quote the great 16th and 17th century English poet John Donne, “No man is an island entire of itself. Every man is a piece of the continent, a part of the main.” And that, in a nutshell, was the message Dr Timothy Deer shared with delegates at the British Pain Society 2022 annual scientific meeting. He's an interventional pain doctor in West Virginia and president of the Spinal Nerve Centre of the Virginias in the United States.

Dr Timothy Deer: My closing remarks really were about the interaction between different parts of the world. So, research that was done maybe 100 years ago in Britain may impact research in America today. Also, how we are an international community trying to help pain patients. So, if we think we're doing something in a vacuum, we're wrong. There's always previous work done that influences future work if you're smart. The other thing I talked about was being humble and crediting others, and what I mean by that is that for every study, there are patients who trust and give their trust to physicians to be in the study. Without the patient no studies ever happen. There are scientists who think of the idea, there are clinicians who offer the treatment. There are statisticians and researchers who analyse the data. So, it's always a team effort and so if anyone gets to think it's all about them as a physician or a researcher, they're wrong. It's a team effort of multiple people.

Evans: I like to think of it as the treatment I am getting, or your patients are getting now, has been developed over the last decades, if not more. So. the headlines today will be reality in 10 or 20 years' time.

Deer: Just to play on your question a little bit here because I think it's a great question. If the evolution of what's going on, let's take, for example, complex regional pain syndrome - If you had that condition 15 years ago and we did a spinal cord stimulator for you, you had about a 50% chance of responding really well and a 50% chance you would fail. Now that wasn't terrible because most of those people had already failed everything else, so it still was better than zero. But now, based on the studies, and the studies have gotten much better, the devices are getting better selections, you have about an 80% chance of a long-term response. So, you've gone from 5 out of 10 to 8 out of 10. That's pretty good, right? That means if you're a patient you have a chance. 20% will still fail though, and won't respond. You know, it's hard to say if you going to be a responder or not. When you respond, it's wonderful. But I do think based on the new things we're doing, things like closed loop feedback, for example, where we measure your individual spinal cord, not to someone else's, but yours... And then biomarkers, I think there'll be a time in the next 10 years or so when the reality will be I'll be able to check some specific biomarkers on you and say, "Based on the biomarker, we know this is the best neuromodulation therapy for you personally." I think that's going to be where we go to, and I I hope I have another 10 years left in my career to be part of that. I may not be, but we're training a lot of great young people, so if I'm not, that's OK.

Evans: So the future is personalised management.

Deer: Absolutely. I think doctors who use the same exact device on every patient will be out of the mainstream. It'll be that you'll come in and you'll meet a doctor who is open-minded. She will look at you and they'll look at some markers, be it be your imaging, your blood test, your urine biomarkers, some factors. We'll look at those and then we'll get on the table and put the small wire in and the wire will measure your spinal cord and tell us how your spinal cord responds to different types of electrical current, for example. Then, based on that we will choose to put in a certain device or a certain waveform that day. We'll have probably a 95% or more predictability, and we're seeing this already with some of the new systems we're doing in America which are shortly available here in the UK, some of them already available in the EU. We can actually, on the table, tell if you're responding or not based on a measurement system and a feedback loop at 100 times a second. If you quit responding, guess what? Once the device is in your body it'll tell us when we do analysis that you're not responding. We're

also doing things now like remote programming. So, let's say you live on the coast of Great Britain and you've had an implant by someone who's two hours from you by car. The price of gas is pretty terrible right now, and you don't want to drive there. Now, I can go online, see you measure your device, see what's going on with your device, and change your programming without you ever leaving your home. We just published an article about that. During COVID that was made allowable by the United States government, but now it's available here in Great Britain. So, there are certain devices now where you can have remote home programming and never leave your house. I think when you're in chronic pain that's very valuable. You know, sometimes it's hard for you to drive two hours to sit in a waiting room for an hour, get seen, and drive back home, right? That to me is one of the biggest advances this year, but remote home programming is a great thing for people with severe pain, and I think artificial intelligence will take over our world. It'll be able to do things remotely. We remotely monitor you. We remotely programme you and collect your data. We're now using a lot of motion sensors and rings that tell us your activity levels. We can measure if you start to go down. We'll see it on our computers and we'll call you and say, "We noticed you aren't moving as much as you were last month, are you doing OK?" And we can make some programming changes based on that, so it's going to become analytics and artificial intelligence, that's where we're going. And with that, our outcomes will improve dramatically. I think what we have to do though is we can't be set in our ways as physicians and scientists, we have to be open to all those new ideas and realise that sometimes it's going to be smarter than we are. But I think we also need to not abandon the humanistic traits. So, while we have all these things, it comes down still to discussions with doctor and patient. That we share our ideas, that we listen to our patients, and that we respond to our patients not based on what we think but what we think together because I think you have to really be empathetic to your patients' needs, particularly when they're in chronic pain. To me, that's still going to be critical despite artificial intelligence, despite closed feedback loops], despite new wave forms. If we lose our empathy for our patients we will still fail. So, it comes down to all those things, plus empathy.

Evans: Dr Timothy Deer. As in every edition of Airing Pain, I'd like to remind you of the small print that whilst we in Pain Concern believe the information and opinions on Airing Pain are accurate and sound based on the best judgements available, you should always consult your health professionals on any matter relating to your health and well-being. They're the only people who know you and your circumstances and, therefore, the appropriate action to take on your behalf. I'll end this edition of Airing Pain with a few cautionary but optimistic words from Dr Owen Williamson to maybe manage our expectations. It refers to virtual reality, but I think it probably applies to many emerging technologies.

Williamson: There is already sufficient scientific evidence to suggest that it may be of benefit in chronic pain. The technique will need to be validated scientifically, just like we would validate the use of an injection, an operation, or a drug, or any other form of pain therapy. The exciting thing about using virtual reality environments is that they're becoming much easier to afford and distribute on a global level. I mean, low back pain is a global problem. We want a global solution. A great percentage of the world has access to cheap cell phones and cheap displays where we can place some, and cheap Internet connections where people, even in developing countries in both urban and remote areas or rural areas, can have access to a treatment if we could make it safe and effective and affordable, and we hope that we can do that with virtual reality.

Evans: Wow, that's really exciting.

Williamson: It's just really cool.

End

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