The Invisible Disease
Pain – Part I

(Circle Ariel)

KYANNA: (00:09)
Yeah, so my pain started in about 11 years ago and it seems so, so long ago, but it seems like just yesterday at the same time. I mean, I'm only 25 years old so 11 years is quite a big chunk of my life that I've been dealing with this.

So, after the onset of a back injury that I had doing gymnastics, I kind of never got fully better and I always had this lingering pain that you know became, became a chronic issue in my everyday life.

And I tried, you know, seeing many different doctors, many different therapists, you know, trying all these different modalities and different interventions and like different scopes of medicine practice and nothing, nothing could ever help me enough. And it would help me some, but it would always be very temporary…and it's kind of just this chronic issue that I deal with, you know, every day, all the way till now, it doesn't go away.

I have days that are better days. And I have days that I would consider to be flare days, where the pain is, you know, exacerbated and debilitating, you know, to the point where it does impact things that you want to do every day, even sometimes like getting up out of bed, taking a shower, going upstairs, getting out of a car. I mean, these are like simple things a lot of people, you know, they don't think about what the body has to do to be able to function in these ways, but you know when you have pain like that sometimes the simplest things can be a challenge.

(Watercool Quiet)

MARILYN: (01:59)
Hi, I'm Marilyn and I'm a graduate student here at UCSF.

RYAN: (02:03)
And I'm Ryan, a postdoc at UCSF.

MARILYN: (02:05)
You may have guessed it by now, but in this episode of Carry the One Radio, we'll be talking about pain. The audio you just heard is from the friend of one of our producers, Nancy. Nancy's friend would like to remain anonymous, so we'll call her Kyanna. Throughout this episode, you'll hear more about her struggle with chronic pain, while we learn about the underlying causes.

RYAN: (02:28)
This is actually part one of a two-part exploration of pain. Today, we'll tackle how pain is defined and the different types of pain, and next time, we'll talk about current and future treatments for pain.

(CTOR Tag)

MARILYN: (02:54)
This sensation that we all get, whether it's from an external stimulus like a hot stove [sizzle] or an internal stimulus like a stomach-ache [gargle]…we all call it pain. But what exactly IS pain? To help us understand this, we enlisted the help of two experts who study pain and how to treat it:

DR. BASBAUM: (03:16)
So I'm Allan Basbum, I'm professor and chair of the Department of Anatomy at UCSF.

MARILYN: (03:23)
And our other expert had something to say about Dr. Basbaum:

DR. ISHMAIL ABDUS-SABOOR: (03:28)
He's a true leader, yeah. We just had a pain meeting a few weeks ago. I got to hang out with him.

My name is Ishmail Abdus-Saboor. I'm an Assistant Professor in the Biology Department at the University of Pennsylvania.

(Cottonwoods)

MARILYN: (03:45)
We all know what "pain" *feels* like, when you get a cut or a bruise [ow!], but how would you describe the experience? It's…kind of difficult, right? Dr. Basbaum explains why:

DR. BASBAUM: (03:58)
"Bane of pain is plainly in the brain." It's a percept. That's the most important thing. It's not a stimulus, it's a complex perception that is painful. Everyone knows what painful means. It's unpleasant. It's an unpleasant experience.

Uh, it's influenced not only by the injury, but also the situation in which the injury occurs, and also the history of the individual, the context. So, it, the most important thing is that it is a perception, complex perception, in the same way that say, beauty is a complex perception. It's not necessarily inherent in the stimulus and it's a product of the brain.

RYAN: (04:38)
I'm not sure if that helps me understand pain, or just confused me even more. How can something so profound as pain, like Kyanna's for example, simply be called a *percept*? And touching a hot stove - that's a real stimulus. It's a physical thing that happens.

MARILYN: (04:55)
Well, for one thing, chronic pain is a whole other story that we'll get onto later. But rest assured, you're not the only one who thinks it's a little weird that something we experience physically – and can even react to before the sensation even gets to our brain – can be also a product of the brain.

DR. BASBAUM: (05:15)

The other analogy, which I use when I teach medical students, if you can picture this. Because they say, I don't really understand this, this bit about pain percept, emotions, and stuff. I say, well, all right, consider this. Look at a Mondrian painting, right? Familiar with a Mondrian painting? It's just a bunch of bars and stripes, yellows. You know, the kind of, you can make it on your PowerPoint presentation, Photoshop, easy, you know, piece of cake. Right?

Okay. So Mondrian has these paintings. You go to the museum and you see a Mondrian. Um, and somebody walks by and you know, [*blows raspberry*] nothing. And they, they don't get it. They just walk right by. Didn't do anything. Somebody else walks by and they know Mondrian, they know his history. They know where, why, what drove him to paint these particularly interesting bars and stripes. And heart palpitates, tears come, and at an auction they bid $30 million for the damn thing.

What's the difference? The retina responded the same way. My vision friends tell me, Oh, we know everything about vision processing, their bars and stripes in the visual cortex and colors and stuff. And I said, yeah, that's true. But what's the difference in the percept between these two individuals? There's an emotional component to one of them that didn't occur – was not induced in the other. Aha, just like pain, right? I don't know where pain is. I ask him, where's beauty in the brain? He says, "I don't know where beauty is." I said, that's right. It's the same problem.

RYAN: (06:40)
Okay, yeah, that makes a lot more sense. I would never have thought to compare a painting to an injury though.

MARILYN: (06:48)
Yeah, but both are subjective experiences. Dr. Abdus-Saboor explains from a societal perspective…

DR. ABDUS-SABOOR: (06:55)
If you take multiple individuals in the population, they'll have different experiences to pain, all right? And that's controlled by a number of factors that can affect pain sensitivity, like gender or race or ethnicity, um, even socioeconomic backgrounds, cultural norms and proclivities. All these, like, impinge upon how you sense pain and also genetics.

RYAN: (07:20)
Wow, I had no idea that things in society and the genes you're born with both affect how you feel pain. I guess I never really considered what shapes the way a person senses pain.

MARILYN: (07:32)
But it makes sense now that we've established that "pain is a percept". And to put it in the age-old context of "nature versus nurture," …it's a little bit of both.

RYAN: (07:49)
So, how does one's environment effect how much pain they're in?

DR. BASBAUM: (07:54)
The classic example: take two women in labor, in adjacent beds. One of them is looking forward to it, that the room's already been painted blue because they heard it's a boy. They're excited.

They've been through Lamaze where the woman learned how to practice breathing and anxiety and distraction.

Next bed—woman can't afford the child, not looking forward to it, she doesn't know how she's going to take care of the baby. Pretty much the same stimulus, but the pain experience is likely going to be very, very different. Okay? That's the cognitive component that is added on to the emotional and the sensory discriminative.

RYAN: (08:35)
Man, it sounds like there are a lot of aspects to it: how you're framing the experience in your mind, how you're feeling emotionally, and how your brain is processing the pain-- they're all changing the level of pain you feel.

MARILYN: (08:48)
Yep, that's exactly right. So, the nurture aspect, how we perceive pain, depends on our background and emotional state. But there are also important differences in our biology that affect how we feel pain, too. Let's dig a little deeper into the "nature" of pain, which researchers (like our guests) often study in lab animals, like mice.

DR. ABDUS-SABOOR: (09:10)
We know there's a genetic component to pain, all the genes or alleles that control this, um, are having been identified. So these studies in mice also inform how we think about pain susceptibility in human populations. And perhaps some of the genes we find that control pain, they'll have homologs in people.

MARILYN: (09:34)
To clarify that a little, alleles are just varieties of genes: bits of DNA you get from your parents. And, it's not just one gene that controls how sensitive you are to pain. There are tons and tons of genes that each contribute just a little bit to how we experience pain.

RYAN: (09:52)
I see, so some of our experience of pain is "baked in" to our genetic background. No matter the circumstances, we might be extra sensitive or less sensitive to pain.

MARILYN: (10:03)
Yup, exactly. And we'll talk more about the genetics of pain in episode 2.

RYAN: (10:09)
Okay, so to recap, so far we've learned that pain is a *perception* and that there are tons of factors that go into our sensation of pain…

MARILYN: (10:18)
[Chuckles] And if that's not enough for you, we will talk about four different *types* of pain based on the root cause, and location in the body. There is neuropathic pain, migraine, inflammatory pain, and cancer pain. Let's start with neuropathic pain:

DR. BASBAUM: (10:35)

It's a horrible condition produced by nerve damage, mostly in the periphery, but also in the, can be in the brain.

DR. ABDUS-SABOOR: (10:42)
So that's direct injury to any neurons within the pain wiring system from the periphery to the spinal cord or to the brain. A person may be in some type of accident or injury and they sever some of those pain sensory neurons. And this will be considered neuropathic pain, pain that is driven by direct injury to the pain nervous system. This pain is very hard to treat. It's actually amongst the hardest to treat of all chronic pain disorders. And some of it can subside within months, but oftentimes it can last forever.

RYAN: (11:26)
Got it. You know, I was diagnosed with sciatica a few years ago after an injury. The doctor explained that the shooting pain I was suffering from, down the back of my leg, actually came from the vertebrae pinching the sciatic nerve. But I didn't realize that this was called neuropathic pain - they didn't even really talk about that as part of the diagnosis…

MARILYN: (11:47)
Man, I'm really sorry to hear that. Sciatica is a pretty common condition in older folks because nerves and muscles deteriorate over time.

It's not the only type of neuropathic pain, though. For example, there is a condition called trigeminal neuralgia, which is caused by hyperactivity of the nerves in your face. So, things like brushing your teeth or putting on makeup can be extremely painful. In fact, it can be so unbearable that about 2% of patients die by suicide.

DR. BASBAUM: (12:22)
Trigeminal neuralgia, the most intense pain imaginable. Um, it's a disease of the nervous system that could end up killing somebody, so I look at the problem of pain as very different from just thinking as a symptom of some other condition.

MARILYN: (12:40)
So, in this case, pain is kind of a condition in and of itself, and neuropathic pain results from direct injury to the nervous system.

RYAN: (12:50)
But what about migraines? When I get one it feels like my brain and nerves are exploding, so wouldn't that also be neuropathic?

DR. BASBAUM: (12:58)
No, migraine is a unique pain.

MARILYN: (13:01)
…and it's our second type of pain. Kyanna will tell us a bit more about her firsthand experience with migraines.

(Taoudella)

KYANNA: (13:21)
I used to get these very weird migraines about every week. That's probably the most troublesome symptom to deal [*Nancy: Why?*] – just knocks you out, you can't do anything. It's so bad, it's pounding pain behind your eye and you kind of have to try to sleep it off. But, I don't know, it's so debilitating when I get the migraines 'cause nausea comes along with it, sensitivity to light, you know, you just can't do much.

Sometimes it's even more, and you feel it slowly coming on, And at first I would ignore it I'd be like, "oh, this is just a regular headache" and it would get worse and worse and sometimes I'd like get it at night, and I'd sleep on and think, "okay, you know, this is mild right now I can just go to sleep, hopefully wake up and it'll be gone."

Wake up and it's full fledge like can't move like feel like you're gonna throw up if you move, like so sensitive to light, can't open your eyes and I'm walking around the house with sunglasses on, ice pack on my head. And, you know, not fun [laugh].

DR. BASBAUM: (14:28)
Migraine is a disease caused by excessive vasodilatation of vessels over the cerebral cortex. Um, and it's caused primarily by massive release of a peptide, CGRP.

MARILYN: (14:43)
Vasodilation is the widening of your blood vessels. The blood vessels that lie right between your brain and the skull are surrounded by sensory nerve fibers. When the vessels dilate too much — like, when there's too much of a molecule called CGRP around — the surrounding nerves become activated. This hyperactivation leads to the painful sensation of migraine. (Source)

RYAN: (15:08)
Ugh, so that's why… At least we know what causes migraines, right? Maybe researchers can use that to come up with a cure, so that Kyanna and others don't have to suffer from migraines anymore.

MARILYN: (15:19)
Actually, medications targeting CGRP *have* been developed for migraines! …But we won't get to hear about that until the next episode, where we'll learn more about the treatments and research.

RYAN: (15:30)
Let's move on; talking about migraines is giving me a headache [ba-da-bing]. Let's talk about other types of pain. Like, what about if you have a typical injury – say you hit the ground after falling out of a tree and get all scratched and bruised up…then what?

MARILYN: (15:45)
That's from inflammatory pain, our third type of pain, which Dr. Abdus-Saboor can explain:

DR. ABDUS-SABOOR: (15:51)
Inflammatory pain, which you can get from an infection, okay, where you sensitize the immune system. So, one of the side effects of having a strong immune response is pain, because you have an injury, for example, and you may have swelling or lots of tissue damage and you have all

these immune mediators – cytokines, chemokines – that are coming in there to try to relieve the injury.

However, a lot of those immune system molecules have receptors on the surface of the pain sensory neurons. So, a consequence of trying to fight that injury or infection is hypersensitizing the pain system.

RYAN: (16:34)
Ah, the immune system. That's why you swell up after an injury, liked a sprained ankle from a soccer match…

MARILYN: (16:41)
Exactly! And I'm sure when it happened, you were told to "rest, ice, and elevate" the leg, which served to calm the immune system, thus decreasing the swelling. When immune system molecules get released, your sensory neurons that signal pain can get activated.

RYAN: (16:59)
Okay, so we have neuropathic pain from nerve damage, migraine pain from the widening of your blood vessels under your skull, and now we have inflammatory pain from tissue damage or an overactive immune system. But what about the last type of pain – cancer pain?

DR. ABDUS-SABOOR: (17:15)
Another major one is cancer pain, alright. So, most patients who die of cancer, their final months of life are just excruciating, not because of the cancer, but because of the pain associated with the cancer. Why pain comes along with cancer is still unclear. But pain associated with cancer is an important form of chronic pain that many basic scientists are starting to investigate.

MARILYN: (17:47)
Cancer pain is so challenging to pin down because it can be caused by either the cancer itself, or by the treatments that cancer patients receive. On one hand, a tumor can grow near a nerve fiber and press on it, generating neuropathic-like pain. Some cancers also affect the immune system, which in turn affects the nerves that transduce pain signals through inflammatory-like pain.

On the other hand, life-saving treatments such as radiation therapy or chemotherapy can cause harm to not just the cancer cells, but also, all the other cells in the body. When this happens, the immune system kicks in, or the nerves themselves are damaged – by the treatment. This triggers inflammatory pain, neuropathic pain, or a combination of both. So…you can see it's pretty complicated. Like Dr. Abdus-Saboor said, there are a lot of questions that remain about cancer pain and how to treat it.

RYAN: (18:49)
I'm glad they're doing research to sort this out. One of my relatives recently passed away from cancer, and I know in their last few months, they were taking tons of morphine to help relieve their pain, so it's definitely of personal interest to me.

(Taoudella)

RYAN: (19:18)

So, are there other ways to categorize pain? I mean, I get that a sprained ankle and cancer are different types of pain, but it feels like there should be some other distinction. What about a pain that changes over time? Like when Kyanna mentioned that her original back injury, from gymnastics, seemed to evolve into something else.

MARILYN: (19:36)
Yeah, time is absolutely a factor when classifying pain! We've already mentioned some types of chronic pain, but a sprained ankle is an example of acute pain. So, acute pain is usually more immediate and resolves soon after injury - it's something we've all experienced. And, whether you like it or not, acute pain can actually be helpful:

DR. ABDUS-SABOOR: (19:59)
So, acute pain serves an evolutionary benefit, right? If you injure yourself, you want to rest, then you don't want to move the – you want to localize the pain so you can remove your appendage that's hurting, you want to rest it and put ice and do all these things.

But chronic pain is pain that outlasts the healing period - it's months, you know, years after. So there's no more injury or damage, but you're still in pain.

MARILYN: (20:27)
Right, so acute pain is like a built-in warning sign. Chronic pain, on the other hand, can be a really serious health problem.

RYAN: (20:36)
That reminds me of what Kyanna was talking about at the top of the episode.

KYANNA: (20:40)
Well, I remember the onset of the injury. It was very acute type pain, I would describe it as, I remember. Very sharp, um…tingling kind of, because it was disc pain in my back. I did have some numbness and it just hurt to move in any way…any way. And it's, it kind of progressed, so it, it became less acute and more chronic, dull-like pain.

So nowadays it's more achy…more, like, disperse type of pain. And it doesn't present itself as this acute sharpness that it did 11 years ago, you know, it's this dull, never-going-away pain that just lingers, it lingers all the time.

MARILYN: (21:33)
...and that lingering chronic pain becomes its own disease. It really takes a lot out of you.

KYANNA: (21:40)
In the beginning, I had no idea how to deal with it, being a chronic condition. You know, I had dealt with acute injuries before, but in terms of chronic, chronic pain? I had *no* idea how to function in the world, living in pain every single day. And I've gotten to the point now where, you know, sometimes you have to prioritize certain things. You know, because you can't do everything that you want to do all the time.

RYAN: (22:07)

That must be so hard. Such a big weight to carry. So…I still have one question: When does acute pain switch over to being chronic pain?

MARILYN: (22:17)
That's a great question. In fact, it's still up for debate. Dr. Basbaum explains…

DR. BASBAUM: (22:23)
There's sort of an accepted definition that says that pain in the clinical world that lasts more than three months. And so, three months is somewhat of an arbitrary cutoff. It is an important question. One of the, um, most interesting questions is what determines the conditions under which there's a *transition* from acute to chronic pain. Many people, you get acute pain, it goes away. Other people, it lasts a little bit longer.

What is the explanation? Or, is it even possible that there's no transition, that it's chronic from the get-go? There's some people who are proposing the interesting idea that, in fact, there are resolving conditions where it's not that features contribute to the prolongation of pain, but it's the loss of features that normally would regulate the pain.

RYAN: (23:14)
So chronic pain is like your body thinking there's something painful when it shouldn't be?

MARILYN: (23:19)
Yeah, that's exactly it. In fact, one of the most dramatic examples of this is phantom limb pain, where some people who have lost limbs actually report that they feel pain in the missing, or "phantom", limb.

DR. BASBAUM: (23:33)
There's a phantom - everyone has a phantom. The limb's still there, 'cause there's a brain representation of the limb. Here, you have somebody who lost the limb and in 20%, or maybe more of those people, the phantom is in pain, right?

There's nothing there, but there's hyperactivities, the central nervous system has changed, the injured nerve fibers in the stump are hyperactive.

RYAN: (23:56)
That's really terrible for those patients, and kinda spooky. Do we know why the brain perceives pain if there's no limb?

MARILYN: (24:04)
Researchers are still working on this, but a major hypothesis for how chronic pain develops is what Dr. Basbaum meant by "loss of features that would normally regulate pain". In the nervous system, there are some off switches, or inhibitory neurons, that keep pain from being felt – unless, of course, there's actually a painful stimulus. For many chronic pain conditions, it's thought that these "off-switch" neurons are lost, resulting in the person constantly feeling pain.

RYAN: (24:35)
Okay, let me see if I got this right. We don't normally have constant pain because there's some active process in our bodies preventing the perception of pain. Then, when there's a traumatic

event, the brakes come off. And if later the brakes never get turned back on, you end up feeling pain all the time?

MARILYN: (24:53)
That's our best guess.

RYAN: (24:55)
Pain sure is complicated…

MARILYN: (24:43)
Yeah, phantom limb pain is pretty unique, and most conventional therapies don't alleviate it. But we do have drugs for other types of pain, and people like Dr. Basbaum and Dr Abdus-Saboor are working on finding new parts of the pain system that we can target with drugs. We'll discuss this more in part 2 of our series.

(Come As You Were)

RYAN: (25:37)
To be honest, I'm a little surprised that I'm only learning about some of this now. It's crazy to me that pain is so diverse and such a complicated problem, but there is so little attention on it compared to some diseases. When I took neurobiology in college, we were basically only taught that pain signals are transmitted to the spinal cord, which triggers a reflex that makes you pull your hand away from a hot stove or something. It was like one, *maybe* two lectures, and no one ever talked about chronic pain as a disease.

MARILYN: (26:08)
Yeah, I totally understand that. I've worked in a pain research lab before, so I'm pretty familiar with how complex pain biology is, both when looking at spinal circuits, like you learned about in neurobiology class, and these really sad – and kind of frightening – examples of very real pain that's generated within the mind, like phantom limb pain. It's certainly a challenge for scientists to study and something we don't fully understand.

RYAN (26:41)
I feel like if scientists have trouble understanding that, then it's no wonder that I would never have learned this in a college class. It's such an enigma.

DR. BASBAUM: (26:51)
The problem with pain, as opposed to most diseases, you can't see it, right? If someone's paralyzed, someone has MS [*muscular dystrophy*], or someone has muscular dystrophy or whatever, you can see it, right? You can tell and you empathize with pain. The fact is that you might have a neighbor who has excruciating pain. They go to work, maybe? You don't know it...

KYANNA: (27:16)
So I've had a lot of…not-so-great experiences with doctors and just different providers in general when I was seeking care and help for my chronic pain. So, throughout the years, you know, I have been not taken seriously as someone who appears young and non-disabled and rather healthy…like, I don't present like I'm having such chronic pain. I don't, I don't really know what

that looks like. But, you know, to me, it is more of an invisible disability or impairment and a lot of times that is very much discounted in the traditional medical community.

And I've had, you know, doctors totally disregard and invalidate my experiences and that's almost been, you know, traumatizing to some extent and to…you're already in this kind of inferior position coming in to seek help and then you're reaching out to them, hoping to get some type of answer. And I've had people laugh at me when I tell them that I have had this pain. I've had people say things like, you know, "You're so young. This can't be happening to you, you're too young for this."

And then there's also just people in the community that don't understand like, an invisible disability or what that looks like and… I use, occasionally, an accessible parking pass you know the handicap. And those blue handicap passes that allows you to park closer to store or, you know, building, you need to enter… And I've gotten backlash from random people on the street. People slow down, pull their car up beside and they'll say something like, "why you parking there", "you don't look like you have a disability", "sure, you're 'disabled'" and it's, it's hard to hear. And it, it hurts. I try not to let it get to me.

RYAN: (29:17)
That's so awful! How on earth can even *doctors* be so ignorant?! Of course that's hurtful, that's like the understatement of the century. Please tell me I'm missing something - why is there such a barrier to even acknowledging chronic pain?

MARILYN: (29:32)
It is really discouraging to hear stories like that. While it's true that so many people suffer from chronic pain, well, sometimes it all comes down to money.

DR. BASBAUM: (29:44)
You don't die *of* pain. You die *in* pain, right? But nobody sees it. You might report it, which is one reason why there's basically no pain research foundations that fund pain research at anywhere near as, say, American Heart, American Cancer, Diabetes, Arthritis, you name it because the person died of cancer…And the family says, please give money to the American Cancer Society.

RYAN: (30:12)
Okay, so we have this invisible disease that even doctors sometimes refuse to acknowledge. And, because it's not a prominent cause of death, it's not a popular funding target. That must make researching causes, and treatments of pain conditions, really difficult.

MARILYN: (30:26)
Yeah, that's certainly one reason. But remember how subjective pain is?

RYAN: (30:32)
Right! So, on top of all that, it's like, how can researchers be confident about what they are studying and doctors about what they're even treating?

MARILYN: (30:39)

It's a big problem. People, thankfully, can communicate their pain to their healthcare providers – both their symptoms – you know, where it hurts and when – and how they feel on a scale from 0-10, where 0 is no pain and 10 is the worst pain imaginable.

RYAN: (30:59)
Yeah! That happy face scale, with, like, the sad face on one side and then the happy face on the other side, with some in between faces, right? That sounds pretty easy, but I feel like there's a catch here…

MARILYN: (31:13)
…That only gets you so far when it comes to studying pain biology.

DR. BASBAUM: (31:18)
When I talk about the disease of pain, well, how did I come up with the idea that there's a disease of pain? Because we learn that the nervous system changes when there's nerve damage, that new genes are expressed, new circuits are formed. You'd never be able to figure that out, uh, in a human. It would be impossible.

Once you are able to figure that out, then you can direct new potential therapies. So it really is a matter of stages of investigation to understand the biological basis of the problem, to direct development of new therapeutic approaches. That's why I think the animal is absolutely essential.

MARILYN: (31:57)
So researchers like our guests use laboratory animals to really understand how genes and proteins and cells all interact to create the percept of pain. …but, to do all of that, first they need to ask: is the animal experiencing pain?

RYAN: (32:14)
Wait, but how can we *tell?*

MARILYN: (32:17)
[Chuckle] Well, animals obviously can't just *talk to* us about how they're feeling, so researchers have come up with different ways to infer if the animal is in pain or not. Then, they use those methods to test new drugs and treatments to look for a reduction in pain behaviors.

RYAN: (32:36)
Ooh, I want to hear more! Like how they discovered that migraine treatment we talked about earlier!

MARILYN: (32:40)
Ah yes, but…I'm afraid you'll have to wait till the next episode to learn more!

(Slow Toe)

RYAN: (33:04)

So today, we talked about four types of pain: migraine, inflammatory, and cancer. What was really interesting was to hear how these can all morph from acute pain, which is helpful, to chronic, debilitating situations.

MARILYN: (33:19)
And I learned a lot about Kyanna and, also, your personal experiences dealing with pain. It really is quite the invisible disease.

RYAN: (33:29)
Unfortunately so. But luckily there is a lot of research going on, right?

MARILYN: (33:34)
Yeah! In the next episode, we'll discuss how to treat pain and what are we doing to improve these treatments.

RYAN: (33:41)
I can't wait!

(Di Breun)

MARILYN: (33:50)
This episode was written and produced by Cindy Liu, Nancy Cai, Ryan Morrie, and me, Marilyn Steyert. We also had help from the rest of the team at Carry the One Radio.

Thank you so much to our guests, Dr. Allan Basbaum and Dr. Ishmail Abdus-Saboor for their time and expertise. Also, many thanks to our friend Kyanna, who shared her powerful personal story.

RYAN: (34.19)
We would also like to give a shoutout to our Patreon supporters: Samantha Ancona Esselmann, David Cabral, Carly Van Orsdel, Sama Ahmed, and Jeannine Cuevas for supporting us as science producers. You can be a science producer, too, by heading over to patreon.com/carrytheone and donating what you can. Otherwise, share this episode and tell your friends about us! Leave us a review! Find us on Twitter, Facebook, the Insta and start a conversation! Thanks for listening and...

BOTH: (34:50)
Stay curious!

*All music in this episode is by Blue Dot Sessions.