

Erin Welsh

"On the 7th of September, my boy took her from the pasture a little before sunset and harnessed her. While standing at the door I observed she slavered freely and was stupid and downcast in her appearance. I observed that she was loathe to go faster than the walk and although repeatedly urged forward by the whip, would shortly resume the walk. Once or twice on ascending a hill she stopped for a second as if fatigued or in pain and several times in descending small pitches she appeared in great danger of falling from the very bungling manner of using her forefeet. I continued my ride without discovering anything farther til the latter part of the evening except that whenever the whip was applied a distinct interval was obvious between the time I struck her and the time she perceived the blow. When she did perceive it the effect was greater than expected for she started off as if surprise had been added to the usual effects of the lash.

On my return home in the latter part of the evening I experienced great difficulty in keeping her in the road on account of an obstinate and constant tendency to the left that required strong effort to counteract. She could scarcely be urged out of the walk and it was perfectly evident that she was laboring under some alarming disease. I now made a careful examination and found the whole surface of the body cold and tremulous, countenance dull and listless, a leaning and stepping to the left with so much appearance of general weakness as to induce the fear that she would fall in the harness. With much ado I got her home which was then but a short distance. She, however, grew worse very fast and when she arrived home did not recognize her own stable. She was now well rubbed and a gallon of blood taken from the neck. While this was doing and afterwards she often kicked violently with her left foot.

About 11pm I was called from home and did not return until the next day about 2pm when she was down and incapable of rising. She was left in care of a farrier who had her blood again and given her several cathartic medicines without effect. She lay stretched out upon the floor with her head drawn back and the muscles of the neck, abdomen, and limbs frequently convulsed. At short intervals she would revive or attempt to get up but could only get upon her hind feet for her four legs appeared to be completely paralyzed. She would however make a powerful exertion to rise forwards and throw herself several feet ahead without regard to anything that might be in her way. No material alteration took place til next morning except gradual diminution of strength and exertion. In the morning she commenced moving her legs backwards and forwards, was generally convulsed, and apparently in greatest distress. This state of things continued til 9am when she expired."

TPWKY

(This Podcast Will Kill You intro theme)

Erin Allmann Updyke

Aw.

Erin Welsh

I know. It's really sad. Also that was about a horse.

Erin Allmann Updyke

Yeah.

Erin Welsh

It wasn't obviously clear in the firsthand but that was about a horse.

Erin Allmann Updyke

Right. Taking her from the pasture. We should guess, we should hope.

Erin Welsh

I don't know, four feet.

Erin Allmann Updyke

Four feet. (laughs)

Erin Welsh: So that was an account of the 1831 eastern equine encephalitis outbreak in Massachusetts written by Gardner and Peck and it was from a 1957 article titled 'An Epizootic of Equine Encephalomyelitis' by R. P. Hanson. Hi, I'm Erin Welsh.

Erin Allmann Updyke: And I'm Erin Allmann Updyke.

Erin Welsh: And this is This Podcast Will Kill You.

Erin Allmann Updyke: And today we're talking about Triple E!

Erin Welsh: Triple E! Eastern equine encephalitis.

Erin Allmann Updyke: Yes. That's very exciting.

Erin Welsh: It is. So we actually, similar to our dengue episode we have done this already in person at the University of Michigan.

Erin Allmann Updyke: Woot woot!

Erin Welsh: Yeah. But just like dengue I've forgotten everything.

Erin Allmann Updyke: I don't remember. I didn't even remember, Erin, like my own part of this so when I went back to my notes I was like oh, this is depressing.

Erin Welsh: Oh yeah. It's is. Yeah, I didn't remember any part of mine which definitely means I remember zero part of yours.

Erin Allmann Updyke: Oh no, I don't know the history of this in the slightest.

Erin Welsh: I feel like it's kind of alarming how-

Erin Allmann Updyke: How quickly we forget?

Erin Welsh: Yes. But it was super fun to be in Michigan.

Erin Allmann Updyke: It was a great trip.

Erin Welsh: And we really loved hanging out with Laura. So we wanted to give Laura and that group a huge shout out too for having us and inviting us.

Erin Allmann Updyke: Yeah. That was so fun, that was when we did actual chemistry, remember that?

Erin Welsh: Oh my gosh, it was such an action-packed fun day.

Erin Allmann Updyke: It really was. It was excellent.

Erin Welsh: We enjoyed meeting everyone and talking to everyone and yes.

Erin Allmann Updyke: It was super fun.

Erin Welsh: It was great. Ann Arbor is so cute.

Erin Allmann Updyke: Yeah, thanks for having us. Yeah I know, I wish we got more time there.

Erin Welsh: Yeah.

Erin Allmann Updyke: Maybe someday in the future we can go back.

Erin Welsh: Yeah.

Erin Allmann Updyke: Someday.

Erin Welsh: Someday.

Erin Allmann Updyke: All right. So we have any business to attend to, Erin?

Erin Welsh: I mean we could just do the usual suspects one more time. So we've got alcohol-free episodes, you can find them on thispodcastwillkillyou.com under the EPISODES tab. And we also have two things related to books, one is a Goodreads list, so we have a link to that on our website under the BOOKS tab and we also have an affiliate page on bookshop.org, that is an online bookseller that works with independent bookstores.

Erin Allmann Updyke: All right. Now for the most important business of all. It's quarantini time!

Erin Welsh: It's quarantini time.

Erin Allmann Updyke: What are we drinking today, Erin?

Erin Welsh: We are drinking the Triple E Shot.

Erin Allmann Updyke: That's a straightforward name.

Erin Welsh: Yeah, I know. I think at the time we were like oh, we'll come up with a better one when the episode comes out.

Erin Allmann Updyke: And then here we are today.

Erin Welsh: Our creative juices have just been dried up I think, or used up, I don't know.

Erin Allmann Updyke: Both maybe. Well what's in the Triple E Shot?

Erin Welsh: The Triple E Shot has three things.

Erin Allmann Updyke: Of course.

Erin Welsh: A half an ounce of coffee tequila.

Erin Allmann Updyke: Okay.

Erin Welsh: Delicious even on its own. A half an ounce of hazelnut liqueur and a half an ounce of half and half.

Erin Allmann Updyke: Fab.

Erin Welsh: It's delicious, it's simple, it's easy. There you go.

Erin Allmann Updyke: All right. Fabulous. Anything else that we should cover or should we just jump straight into this depressing episode?

Erin Welsh: I mean I think let's just do it Erin, let's just dive right in.

Erin Allmann Updyke: It's gonna be very interesting, okay. I promise.

Erin Welsh: Well I'm excited to relearn everything that I've forgotten.

Erin Allmann Updyke: Yeah, me too.

Erin Welsh: All right well we will start doing that right after this break.

TPWKY: (transition theme)

Erin Allmann Updyke: Eastern equine encephalitis, aka Triple E, aka also sometimes called sleeping sickness but not to be confused with African sleeping sickness or trypanosomiasis, okay.

Erin Welsh: Or encephalitis lethargica.

Erin Allmann Updyke: That too.

Erin Welsh: Cause I think at the time it was also confused with that disease for at least the early years.

Erin Allmann Updyke: Fascinating.

Erin Welsh: Yeah.

Erin Allmann Updyke: All right, well this is not that. Eastern equine encephalitis is a viral infection, it is an alphavirus which I don't believe that we've covered any alphaviruses thus far in this series. Triple E virus, it's an RNA virus, it is round in shape so it's kind of adorable when you look at it under scanning electron microscopes. There are four major lineages of this virus, so four major strains but group 1 which is the one that's most common in North America is also the most virulent and the most common cause of disease in humans. So that's the one that we'll focus on just cause that's the one that makes people sick. Okay? All right. So I'm not gonna talk a lot about the evolutionary history or the ecological cycle of this virus cause you're gonna do that, right Erin?

Erin Welsh: I hope so.

Erin Allmann Updyke: Excellent. But I will say because we have to understand how this virus is transmitted, trips E, that's what I wrote down as the name for it-

Erin Welsh: That's not gonna be confusing at all.

Erin Allmann Updyke: Triple E virus, it's mostly a bird virus, okay. So it circulates enzootically among a number of different bird species but it can cause both epizootics, so that is an epidemic in animals, when it jumps from bird populations into for example horse populations, equine populations, hence the name. And it can also cause zoonotic outbreaks in humans if it jumps from birds into humans. Okay? All right. So among birds it's primarily transmitted by mosquitoes in the genus *Culiseta* but it can be transmitted by a number of different genera of mosquitoes including *Aedes* mosquitoes and others, okay.

Erin Welsh: There's an asterisk to that statement that I'll go into.

Erin Allmann Updyke: Ooh, I can't wait to hear about it. I wanna know.

Erin Welsh: Okay. You wanna know right now?

Erin Allmann Updyke: Yeah, kinda.

Erin Welsh: So basically they call these other mosquito species the bridge vectors. Okay so jumping a little bit into the ecology side of things, *Culiseta* which is the genus, well *Culiseta melanura* which is the main species that seems to perpetuate this infection cycle in birds-

Erin Allmann Updyke: Right.

Erin Welsh: They are not mammal-biters or human-biters, like very, very little.

Erin Allmann Updyke: Right, yeah.

Erin Welsh: And so researchers are like well it might be that either they occasionally bite humans and that's how these things happen or it's bridge vectors. But in one study that looked at the viral load of other species of mosquito, some of the proposed bridge vector species, none of them had viral loads that were high enough to actually cause infection.

Erin Allmann Updyke: Fascinating.

Erin Welsh: So it might be that you can detect the virus because that mosquito fed on an infected bird but the virus might not be able to replicate within that mosquito.

Erin Allmann Updyke: Oh.

Erin Welsh: But there's still a lot of question marks in this sort of thing.

Erin Allmann Updyke: Right.

Erin Welsh: So it's like that aspect of the ecology is pretty not very well clarified yet in terms of the contributions of this mosquito species vs this mosquito specie and also geographically because that can play a huge role.

Erin Allmann Updyke: So then it's like unclear exactly which mosquitoes might be infecting humans.

Erin Welsh

Right. So basically I think the takeaway that I got from that article was that even if you detect this virus in a mosquito, it doesn't necessarily mean that it's going to be infected and able to transmit.

Erin Allmann Updyke

Right because these viruses have to be able to replicate within the mosquito and then leave the mosquito's gut and travel to their salivary glands and then be there in high enough concentration that when the mosquito bites its next host, it's injecting enough virus to actually get that host sick. So these are very complicated cycles within the mosquito so it makes sense that not every mosquito is gonna be able to transmit every virus.

Erin Welsh

Right, right.

Erin Allmann Updyke

Even if you can detect it just when you smush that mosquito, yeah you found some virus but where was that virus within the mosquito and how much of it was there?

Erin Welsh

Exactly.

Erin Allmann Updyke

Cool! How interesting. All right so we've covered now that this is a disease transmitted by mosquitoes, we'll ignore the details of which mosquito it is for now. So let's talk about how this virus makes you sick once it gets inside you, okay. So like many arboviral diseases, so viruses transmitted by arthropods like mosquitoes, when a mosquito bites you the first place that it spits that virus is kind of towards your lymphatic system, right. So it's kind of right under your skin. They don't spit it necessarily directly into your bloodstream but they spit it under your skin and that virus goes into your lymphatic system. From there it travels to your lymph nodes and in the case of eastern equine encephalitis virus, it infects our white blood cells.

Erin Welsh

Okay.

Erin Allmann Updyke

So those are the cells that it goes into and that's where it replicates. Remember that viruses have to replicate inside of our cells, they don't replicate on their own. So it turns out that Triple E replicates inside of our white blood cells. White blood cells can travel pretty much anywhere in our body including crossing the blood-brain barrier and making it into our nervous system. All right so let's go through kind of how this makes you sick. This is a bit of a spoiler but this is a horrible, horrible disease, okay.

Erin Welsh

So that much I do remember from Michigan.

Erin Allmann Updyke

Yes. If you had a magic 8 ball and you shook it, it would say 'outlook not so good'.

Erin Welsh

Yeah.

Erin Allmann Updyke

Okay. One of the questions that I like to try and answer when we look at a disease that causes such terrible outcomes is how does it do that? We are usually very good at fighting off infections, so how can this virus kind of beat our own immune system, right? Like how can it make us so very sick? Okay. So the other reason that it's important to understand how this virus makes us so sick is because in theory if we can understand how it makes us so sick, we could maybe try and do something about it, right, we can try and counteract that.

Erin Welsh

Right.

Erin Allmann Updyke

Okay. So I found a few different studies that tried to shed some light on exactly how this virus makes us so sick. One of the important things is that this virus is very good at evading our immune system. Specifically it seems to do a very good job of inhibiting one of our major responses to viral infections and that is something called interferon.

Erin Welsh

Okay.

Erin Allmann Updyke

Which I think we've talked about in the hepatitis episode probably. I don't remember. But anyways, interferon is a protein that we make that helps to stimulate our immune response specifically to target and kill viruses and virally infected cells.

Erin Welsh

Gotcha.

Erin Allmann Updyke

So Triple E, like many other viruses and a lot of arboviruses specifically, targets and shuts down then production of interferon it seems like in us. And what's really interesting is that there have been some other studies I found that compared the effectiveness of interferon on actually killing virus-infected cells. So even if you gave someone a bunch of interferon, like if that's the problem, the virus is blocking this production, give them interferon, this virus actually inhibits the action of interferon.

Erin Welsh

That's wild.

Erin Allmann Updyke

I know! And here's where it gets even cooler, this is why I get excited about this. Remember I said there are many different strains of this virus, like at least four, and it's only the North American strain that tends to be the most virulent and cause infection in humans. So this one study compared North American strains to South American strains and what they found was that across the board all cells infected with Triple E viruses, North American or South American, had very low levels of interferon. So they blocked the production of interferon. But on top of that the North American strains were the ones that we also resistant to the effects of interferon. So no matter how much interferon you had in your body, it was gonna be lower with a Triple E infection than with other viral infections.

Erin Welsh

Right.

Erin Allmann Updyke

But the interferon that you do have works to kill that South American virus but not the North American strains.

Erin Welsh

Wow, that's very interesting.

Erin Allmann Updyke

I know! Okay so that's how it causes disease and at least part of the reason why it probably causes such severe disease, okay. Now let's start to talk about the really depressing part which is the actual symptoms, okay? The one good news I have, this is it. It's estimated that only about 4-5% of human infections actually result in symptomatic disease.

Erin Welsh

I was just about to ask that.

Erin Allmann Updyke

Oh good. I preempted you. 96% of people who get infected with Triple E virus will never have symptomatic disease, they're gonna be just fine. Okay? That's the estimates.

Erin Welsh

Yeah but I feel like that's a trend that we see a lot in arboviral diseases, that there's a huge rate of asymptomatic individuals.

Erin Allmann Updyke

Yep.

Erin Welsh

Do these people have immunity? Do they develop immunity to Triple E virus?

Erin Allmann Updyke

Great question. I did see in several review papers just sort of talking about the symptoms in general that it is thought that yes, when you are exposed to this virus you develop long lasting immunity. Remember that point because it will become very interesting when we talk about the vaccine.

Erin Welsh

Yes.

Erin Allmann Updyke

Okay. But yes, it is though that if you get infected with this virus, whether you're symptomatic or not, you do generate long lasting immunity, yes.

Erin Welsh

Okay.

Erin Allmann Updyke

That's the thought.

Erin Welsh

That's good news.

Erin Allmann Updyke

It is good news, that's the end of the good news. Okay. So let's talk about the symptoms of the virus. It's called eastern equine encephalitis. Encephalitis, we've talked about this before, right. This is inflammation in your actual brain, it's not good news. So this causes a viral encephalitis. In theory almost any virus could potentially cause an encephalitis if it gets into your brain and causes infection there. For most viruses that's a very uncommon manifestation. But for some reason a lot of arboviruses, so mosquito-borne viruses, do cause viral encephalitis. And we've also talked on this podcast about one of the most famous causes of viral encephalitis, that is... rabies!

Erin Welsh

Oh.

Erin Allmann Updyke

I saw your face just be completely blank and I was like don't worry. So rabies is like the most probably famous viral encephalitis I think. So let's talk about the characteristic symptoms of viral encephalitis. There's three. Number one, fever. This fever tends to be quite high and it tends to come on very rapidly. Number two, headache because your brain is inflamed. Number three, altered level of consciousness. Now that doesn't necessarily mean that you will go unconscious although as you'll see it often leads to that but it does mean that overall you can have fluctuating levels of consciousness and kind of awareness.

Erin Welsh

Okay.

Erin Allmann Updyke

And then because viral encephalitis is a viral infection of your brain, you will often have specific neurological symptoms that can be very varied and they tend to depend, the specifics symptoms you see, tend to depend on what part of your brain is the most infected.

Erin Welsh

Okay.

Erin Allmann Updyke: So let's talk about Triple E specifically. If you have symptomatic infection with Triple E which again it's only 4-5% of people, so that's the good news, the symptoms begin with a prodrome which essentially means nonspecific symptoms before the real bad symptoms. This is like that fever, maybe headache, maybe even some abdominal pain, just very nonspecific symptoms. And then about 5 days later is when the neurologic symptoms begin. And in the case of Triple E this can be anything from a mild confusion to maybe some focal weakness like your arm feels weak or your leg feels weak.

Erin Welsh: Okay.

Erin Allmann Updyke: You might have seizures, seizures are actually very common in Triple E.

Erin Welsh: Okay.

Erin Allmann Updyke: You might have paresthesia, so like weird tingling feelings or just sort of sensory things that aren't normal.

Erin Welsh: Is this just because your brain is inflamed?

Erin Allmann Updyke: Yes, absolutely.

Erin Welsh: Okay.

Erin Allmann Updyke: Yep. But in the case of Triple E, once any of these neurologic symptoms tend to start, even just sort of confusion and maybe coming in and out of being very aware, you know, like not being able to focus, that kind of thing. Very rapidly in the case of Triple E people progress to coma.

Erin Welsh: Okay what's the timeline of this?

Erin Allmann Updyke: Hours to a couple of days.

Erin Welsh: Oh wow.

Erin Allmann Updyke: Yeah. So once people develop these neurologic symptoms, after this 5 day prodrome of kind of feeling cruddy, having a fever, having a headache, people deteriorate very, very rapidly. And then once they're in a coma the mortality rate is between 30-40%.

Erin Welsh: Okay so what proportion of people go into a coma, like develop these severe neurological symptoms?

Erin Allmann Updyke: Almost everyone.

Erin Welsh: Okay.

Erin Allmann Updyke: So if you become symptomatic, almost certainly you're going to go into a coma. Of those that survive, about 1/3 of them will have significant neurologic impairment permanently as a result of this infection.

Erin Welsh: Yeah.

Erin Allmann Updyke

Yep.

Erin Welsh

I have a question. These unlucky 4%, why?

Erin Allmann Updyke

Such a good question, Erin. I have no idea. And I think part of the reason... Okay, some of the literature says children under age 15 and adults over age 50, they are more likely to actually get the encephalitis form of Triple E. That's the most that I've seen in terms of who is it that ends up getting Triple E vs getting infected and not showing symptoms. I think we have to remember that this is a very, very rare infection.

Erin Welsh

Right.

Erin Allmann Updyke

So it's really hard to understand exactly who is the most at risk and why, like what is it about the characteristics of these people that make them more likely to have this neurologic manifestation vs never having symptoms.

Erin Welsh

Right, exactly.

Erin Allmann Updyke

Yeah. So of all the arboviral encephalitis viruses in the United States, this is by far the worst one.

Erin Welsh

Yeah.

Erin Allmann Updyke

Mortality rate is so much higher. It's possibly even worse than Japanese encephalitis although that's more common, that's not in the United States it's in China and Japan. But there's a vaccine for Japanese encephalitis.

Erin Welsh

So why isn't there a vaccine then for Triple E virus?

Erin Allmann Updyke

Oh Erin, I was gonna talk about all of this in more detail in the future, in the current events section.

Erin Welsh

Well let's just wait for the future then.

Erin Allmann Updyke

Yeah. Do you want me to talk about it now or do you want me to talk about it in the future?

Erin Welsh

Up to you, girl.

Erin Allmann Updyke

Let's talk about it later cause we'll talk in more detail about the research that is being done.

Erin Welsh

Okay.

Erin Allmann Updyke

But one thing that I think is really interesting is although there are small case numbers, there have been a few good studies grouping all of these cases and trying to understand what is affected in the brain when you get infected with eastern equine encephalitis. And it tends to actually be the basal ganglia which is part of the brain we talked about that's affected in Parkinson's, it's also infected in encephalitis lethargica, if you remember.

Erin Welsh

Yeah.

Erin Allmann Updyke

Okay. And it also infects your midbrain and that's part of your brain stem. And so it's really interesting because when I am looking at this, I want to think why do we see the symptoms that we see. So if you have a virus like rabies that infects your brain, it affects a part of your brain that changes the way that you behave, right, and your mood. And then we see that in the symptoms, right, where you get angry, etc. If you get a herpes encephalitis which is actually the most common cause of encephalitis, viral encephalitis in the US, it infects the temporal lobe which is where your language centers are so your symptoms are having trouble finding words which is called aphasia, okay. So for me I'm like okay, so we know that it infects this part of the brain but how come we don't see these symptoms like maybe shakiness like in Parkinson's or these certain types of symptoms?

Erin Welsh

Yeah.

Erin Allmann Updyke

My guess is because it causes lesions in these areas like your brainstem that are so important for generally being alive, then you progress so rapidly and deteriorate so quickly that there's no time to have those specific isolated neurologic findings.

Erin Welsh

Right, right. That makes sense.

Erin Allmann Updyke

Depressing. Yeah, yeah, it makes sense. We can talk quickly about treatment if you'd like.

Erin Welsh

Okay, sure.

Erin Allmann Updyke

There isn't any.

Erin Welsh

I was gonna say is it just supportive care?

Erin Allmann Updyke

Yeah, it is. There are no antivirals even in screening studies that have been shown to be effective against Triple E virus.

Erin Welsh

Okay.

Erin Allmann Updyke

So that's a bummer. I did find a few case reports where they've been using IVIG which is intravenous pooled concentrated human immunoglobulin which is used a lot in autoimmune disorders, it's used in the treatment of neurologic disorders. Whether or not it works, who knows? Cause I found two case reports that were like, 'We used this and they survived and did great!' And then I found one that said, 'We used this and they died.' But that person also had lymphoma so who knows? We have such little data on any of this and it's so difficult to study because we have so few cases that we really have no idea if IVIG would be actually an effective treatment or not at this point.

Erin Welsh

Gotcha. What about with other of the encephalitis viruses?

Erin Allmann Updyke

Whether we have antivirals?

Erin Welsh

Yeah.

Erin Allmann Updyke

Good question, I don't know.

Erin Welsh

Yeah.

Erin Allmann Updyke Yeah. I don't believe we have any for dengue which can cause encephalitis, the more common ones like St. Louis encephalitis, West Nile virus, I honestly don't know, I haven't done the research on those yet.

Erin Welsh Okay.

Erin Allmann Updyke Yeah.

Erin Welsh Interesting.

Erin Allmann Updyke But we will talk in more detail about the vaccine in a bit. But first Erin-

Erin Welsh First.

Erin Allmann Updyke What the heck? Where did this thing come from and why does it invade our brains and kill us so rapidly?

Erin Welsh I don't know if I can answer the 'why' to that, I think we're just sort of a bystander.

Erin Allmann Updyke Okay.

Erin Welsh I mean once again, we did not plan this but coincidentally we're talking about two things for which humans seem to be a bystander and for which birds are heavily involved.

Erin Allmann Updyke Birds! Killing us.

Erin Welsh Birds. (laughs) I will answer those, no, I will attempt to answer those right after this break.

TPWKY (transition theme)

Erin Welsh Okay, ready?

Erin Allmann Updyke Yes.

Erin Welsh The year was 1933.

Erin Allmann Updyke I love it when your sections start like this, Erin.

Erin Welsh (laughs) I'll do it each time.

Erin Allmann Updyke Perfect.

Erin Welsh

I also love the little cherry-picked things that I have here. I'm like why...whatever. Anyway, lots of bad things were happening in 1933. In the US the depression was in its worst year, Hitler began German Chancellor, the Dust Bowl was still raging in the Midwest in the US, an earthquake in California caused massive damage in Long Beach, there were forest fires in Oregon, and horses were dying by the dozens. In pockets of the Northeast, particularly along coastal and swampy areas of New Jersey, Delaware, and Maryland, horses started acting strange. They started to walk clumsily, their heads were only able to look in one direction, and that led to them walking in circles and gradually losing mobility before dying. About 90% of the 1000 horses roughly that were affected by this illness died during this epizootic.

Erin Allmann Updyke

Wow!

Erin Welsh

Yeah.

Erin Allmann Updyke

That's a lot. That's bad.

Erin Welsh

It's really bad. And because this was 1933, germ theory and microbiology had advanced enough to the point where researchers were kind of quickly mobilized, on the case, taking brain samples from these horses that had died, and seeing if they could isolate whatever pathogen was causing this damage. And they figured out pretty quickly that it was a transmissible, filterable agent which is essentially code for a virus most of the time. Or prion, not in this case.

Erin Allmann Updyke

Or prion.

Erin Welsh

Not a prion. And they discovered that it was this transmissible, filterable agent because they were able to successfully inject it, whatever it was, into guinea pigs who also died as a result of the same sort of symptoms.

Erin Allmann Updyke

Poor guinea pigs, acting like guinea pigs.

Erin Welsh

And the researchers gave this virus a name: eastern equine encephalitis virus. Eastern of course - like the etymology is not very exciting for this one.

Erin Allmann Updyke

Yeah, it's not.

Erin Welsh

Eastern' because it was in the eastern US.

Erin Allmann Updyke

East coast.

Erin Welsh

Equine' to indicate that it was found in horses as you've mentioned. 'Encephalitis' for all the reasons that you've mentioned. Boom. That's like the least exciting of all of it so far I think.

Erin Allmann Updyke

It is the most boring, yeah.

Erin Welsh

Yep. So at the time when this virus was isolated and named, many researchers were treating it as a new infection that had never been seen before but it didn't take long for people to realize that Triple E virus had shown up in the northeastern US previously and it only took a few more years to realize that this epizootic wasn't an isolated one-off, that there would actually be another outbreak even within the same decade. In 1938 which is 5 years after this massive outbreak in horses took place, another outbreak of Triple E began but this time it wasn't just in horses, although horses were affected. Humans, especially children, were showing signs of infection and also dying at extremely high rates. So in late summer and early fall in Massachusetts, particularly the southeastern part of the state, there were 34 cases in humans and 25 deaths.

Erin Allmann Updyke

Ugh. Oh man.

Erin Welsh

So pretty high case fatality rate.

Erin Allmann Updyke

And that's a lot of cases for just a couple of months in one state. Like that's a lot.

Erin Welsh

Yeah. And like you said, the handful of people that did survive had these long term effects. And so because of the severity of the disease and the really horrible side effects in the people who did survive, this kind of gained really widespread national attention.

Erin Allmann Updyke

I imagine too because it was primarily affecting children that that would attract...

Erin Welsh

Yeah, it was when it kind of really became apparent that children were a very high risk group for this.

Erin Allmann Updyke

Yeah.

Erin Welsh

And so because of the severity of this illness, people started to put in the hours to do research. They started to look in the past for old epidemics and they also started looking around them to see whether they could determine what the source of this current disease outbreak was and people started noticing some unusual deaths among pigeons and ring-necked pheasants in the same places that people were getting sick. And then researchers were able to isolate the virus from some of these birds. And researchers were suspicious that mosquitoes were responsible for transmitting the virus or the transmissible, filterable agent but it would take a little bit of time before they could pin down the exact species that seemed to be the culprit. And part of the reason is because a hurricane washed away all of these mosquito collection sites in 1938 when they were at the height of their research.

Erin Allmann Updyke

Oh dear. Just things on top of things, huh?

Erin Welsh

Things on top of things. Okay so as I mentioned researchers also realized hey, this is not a brand new disease to humans or to horses. So let's go back to 1831.

Erin Allmann Updyke

Yes!

Erin Welsh

The year was 1831.

Erin Allmann Updyke

(laughs)

Erin Welsh

Just kidding. But just like in 1933, in 1831 lots of horses were dying in the northeast, particularly Massachusetts. Not as many as in the 1933 epizootic but about 75 horses died in total which thinking about in 1831 and how people used to use horses so much more than they did in 1933, it would have been devastating to the horses' owners and also devastating emotionally. But yeah, in terms of economics losing a horse would have been hugely, hugely devastating.

Erin Allmann Updyke

Right.

Erin Welsh

And like in the 933 epizootic, the one in 1831 in horses also occurred in late summer and had a very high mortality rate as well, again close to 90%. Why is it higher in horses than in humans, Erin?

Erin Allmann Updyke

It's a good question. I've been thinking a lot about that ever since you mentioned that and also you were mentioning the symptoms that you see in horses where they have a lot more motor symptoms and trouble walking and leaning. Yeah, it's a really good question. I don't know enough about veterinarian medicine to know what the differences are in their immune response maybe or what but I wonder if they have a longer period before they deteriorate and that's why you see those motor symptoms as it affects their basal ganglia and things like that. But yeah, I don't know. Maybe they have less interferon or something to begin with, maybe they just have a different... I don't know anything about horse immunology. So I have no idea but it's a really interesting question.

Erin Welsh

Interesting, interesting.

Erin Allmann Updyke

Yeah.

Erin Welsh

So it's also interesting to contrast the 1831 epizootic and the 1933 epizootic in terms of the response, like the scientific response because if you think about 1831, germ theory wasn't really a thing yet and so people were like, we have no idea what's causing this. And so some of the guesses were like, well the horses that fed on grass were the ones who got sick, so there was maybe something in the grass.

Erin Allmann Updyke

I have another thought.

Erin Welsh

Okay.

Erin Allmann Updyke

Because it sounded like from what you were saying like 25 out of 30 kids died in Massachusetts, that's a lot higher than today so I wonder if it could too have to do with supportive care. Like today the mortality rate is 30% maybe in humans because we have some supportive care in the hospital whereas you're not gonna probably intubate a horse and try and keep them alive if they've got Triple E. I don't know, just a thought.

Erin Welsh

Yeah I mean that seems definitely possible.

Erin Allmann Updyke

Possible.

Erin Welsh

I don't know.

Erin Allmann Updyke

Yeah, I don't know.

Erin Welsh

Yeah so the 1938 outbreak was around 74% of people.

Erin Allmann Updyke Okay, yeah. Yeah so maybe it's just the difference in supportive care or something. I don't know.

Erin Welsh Yeah, yeah.

Erin Allmann Updyke We're guessing here.

Erin Welsh We should stay on not so shaky ground.

Erin Allmann Updyke Yeah.

Erin Welsh And so part of the reason that one of the guesses was oh well this horses that fed on grass were the ones who got sick as opposed to hay in the stables is because what they were seeing is that horses that were kept on the pasture seem to be more likely to be sick than the ones who stayed in the stable. And some of the miasma explanation almost kind of worked in this case but you know, let's go to the treatments. So treatments were not helpful for horses. Mostly, as you heard in the firsthand account, it was to drain the horse of a couple of gallons of blood.

Erin Allmann Updyke The one and only thing I remember from our Michigan day, Erin, was that we had someone in the middle of our presentation google how many gallons of blood does a horse have.

Erin Welsh Yeah. I loved that. I think that they also googled several other things for us in the midst.

Erin Allmann Updyke They did, yeah.

Erin Welsh (laughs) An auto-fact checker.

Erin Allmann Updyke Yeah.

Erin Welsh But do you remember how many gallons of blood a horse has?

Erin Allmann Updyke No, now I'm gonna have to google it for myself.

Erin Welsh Okay.

Erin Allmann Updyke 12.3!

Erin Welsh Did you get that from thehorse.com?

Erin Allmann Updyke Yeah, thehorse.com! (laughs) It's gotta be a legit website, right?

Erin Welsh Oh see now I'm seeing different responses here. Okay so it seems like, I mean horses come in all different shapes and sizes so if you have a massive horse it could be 15 gallons.

Erin Allmann Updyke Right, 15 gallons.

Erin Welsh Let's say 10-15 gallons.

Erin Allmann Updyke Sure, that sounds reasonable.

Erin Welsh So 1/5 of your blood you're draining.

Erin Allmann Updyke That's a lot of blood.

Erin Welsh It's a lot of blood. And it's not gonna do you any good. Okay. But after this relatively short-lived epizootic ran its course, it kind of just faded from memory because it showed up again in 1846 in horses again and people were like, 'Oh my gosh, there's this new disease, it's horrible, it's killing our horses, we don't know where it came from.'

Erin Allmann Updyke So interesting that it fades from memory so quickly.

Erin Welsh I think it was so localized in 1831...

Erin Allmann Updyke So it didn't happen to the same individual people that second time maybe.

Erin Welsh Right. Maybe it did happen in the same region but I also don't think, you know you can't google if you're in 1847, you can't google 'horse disease'.

Erin Allmann Updyke Yes. It's so true.

Erin Welsh So there were probably many other things on their minds as well. Okay so all of this had happened before, meaning Triple E outbreaks in humans and in horses. But what had taken so long for it to return? And since the 1933 outbreak in horses and the 1938 outbreak in humans, Triple E virus has continued and upward climb in human cases or at least in the frequency of outbreaks which is a pretty big concern for the people who live in these high risk areas.

Erin Allmann Updyke Right.

Erin Welsh Okay but in order to answer why it seemingly disappeared for about 100 years because from 1847 to 1933 there doesn't seem to be any outbreaks or at least notable outbreaks that I could find. And so to answer why it disappeared and then also why it's on the rise now, we have to look back at history but we have to do that through the lens of ecology which is-

Erin Allmann Updyke Our favorite!

Erin Welsh Our favorite. All right so we already talked a little bit about the ecology of Triple E virus but let's kind of go into it again in a little more detail.

Erin Allmann Updyke Yeah.

Erin Welsh All right so first of all we know about the Triple E virus itself, we don't need to cover that again. The mosquito species that's most closely associated with Triple E virus again is *Culiseta melanura*. And we have not talked about this mosquito on any other episodes of the podcast before even though we've done a fair number of mosquito-borne diseases at this point. And the reason for that is kind of what I've already said, this is not a human-biter and so it's not really associated with many human diseases like dengue, yellow fever, Zika, etc, some of the ones that we've covered. And so we haven't really had much of a reason to talk about it before.

Erin Allmann Updyke Yeah.

Erin Welsh

But this mosquito isn't really a mammal-biter at all, like I said. It feeds on birds. And so this mosquito species can be found over a pretty wide range geographically, so from the southeastern provinces of Canada, throughout the eastern US, and some southern states along the Gulf. They require freshwater wooded swamps or sphagnum bogs with little water-filled hollows in fallen trees in order to lay eggs for the larvae to develop.

Erin Allmann Updyke

Interesting.

Erin Welsh

So they need trees and water, right, typically standing water or at least water at the soil level. And after the larvae develop in these little nooks and crannies, adult mosquitoes then happily emerge to feed on whatever birds are around. And those birds tend to be water-dwelling birds although not 100% of the time. There was a study in Massachusetts that examined the blood meals of these mosquitoes both inside and outside of the swamp and in both times nearly 99% of the blood meals were from a bird host.

Erin Allmann Updyke

Okay.

Erin Welsh

So that's like a very specific feeding pattern.

Erin Allmann Updyke

That is, yeah.

Erin Welsh

Very, very specific.

Erin Allmann Updyke

Yeah.

Erin Welsh

So then the virus basically continues in this natural cycle, so in birds, in mosquitoes, in birds and mosquitoes. So from year to year it's not really entirely clear how it overwinters. It either overwinters in birds although it seems less likely because birds do recover from infection or they die.

Erin Allmann Updyke

Okay, I was gonna ask what happens to birds.

Erin Welsh

Some birds don't seem to be affected at all and some birds die within a few days of being infected at least experimentally.

Erin Allmann Updyke

So this is a lot like West Nile I feel like.

Erin Welsh

Right, there's varying susceptibility among avian hosts.

Erin Allmann Updyke

Birds, okay.

Erin Welsh

Yeah. And some birds contribute more than to the viral prevalence.

Erin Allmann Updyke

Yeah.

Erin Welsh

But yeah, humans, horses, pigs, so I don't think you mentioned pigs but pigs have also been shown to be infected with Triple E virus. These are all dead-end hosts as we've talked about, they don't contribute to the circulation of the virus in the environment. So basically what that means is that if a mosquito, let's say that a horse got infected with the virus and then a mosquito that was uninfected bit that horse, it probably wouldn't get enough virus to be able to replicate in that mosquito. And then it would also take the appropriate mosquito species to bite that horse which tends to be unlikely given the low biting frequency outside of birds.

Erin Allmann Updyke

Right.

Erin Welsh

Okay. So how on earth do humans or horses or pigs ever get infected? And it turns out the answer is not that straightforward as I mentioned earlier because of the disagreement on whether these bridge vector species actually contribute to infection. Okay but first let's talk about sort of this year to year variation in outbreaks because some years we see a big increase in cases, some years we see none at all. And because this is so rare, we don't have good enough data to make clear cut answers on this but what it seems to be is that it comes down to mosquito ecology. So mosquitoes, because they live outside, are super dependent on environmental conditions and the weather.

So let's say that there was a super rainy season last year and a hot and humid and early summer this year and that could mean higher, warm water for these mosquitoes to lay their eggs in the little nooks and crannies of the trees and then develop more quickly. And then the viral replication itself also depends on external temperature. And so that could mean, let's say last year, 2019, was rainy and hot in some of these more swampy or boggy areas, then maybe this year we would have higher cases of Triple E virus. And then geographically the variation has a lot to do with these larger weather or climate patterns and also just how much mosquito habitat there is for this particular mosquito. All right but let's look at some of these larger overall trends in the frequency of outbreaks, so more on this larger timescale.

Erin Allmann Updyke

Okay.

Erin Welsh

Okay, so remember people get infected by the bite of a mosquito whether it's *Culiseta melanura* or this bridge vector species but in either case those mosquitoes have to be infected by a bird and these birds tend to live in these boggy, swampy areas.

Erin Allmann Updyke

Right.

Erin Welsh

And so you'd think as a human you'd have to be pretty close to those in order to get infected.

Erin Allmann Updyke

Yeah, right.

Erin Welsh

All right. So let's talk about the history of swamps and bogs in the Northeast, particularly Massachusetts. And I'm using Massachusetts as a case study because that's where Triple E cases have been the highest and the outbreaks that seem to impact the most. All right so during the 200 years period from around 1650 to 1850, European settlers essentially stripped the land of forest and wetlands. They used pines for masts on ships, cedar swamps were destroyed to make shingles, posts, barrels, other forests were used for lumber, firewood, and charcoal or they were cleared entirely to make room for agricultural fields. And by the mid 1800s deforestation was at its peak in Massachusetts and the countryside was like naked, there was nothing left. Henry David Thoreau who wrote 'Walden' said about conquered Massachusetts around this time: "Of the primitive wood, woodland which was woodland when the town was settled, I know none."

Erin Allmann Updyke

Whoa.

Erin Welsh

And so as you can guess, this massive deforestation caused enormous cascading ecological effects and especially relevant to Triple E, bird numbers and species richness declined and *Culiseta melanura* also lost the swampy habitat that it needed to survive. Starting in the second half of the 1800s, reforestation picked back up because people were like we can't continue to overexploit the land because there's nothing left, like we have really put ourselves in a very bad situation by doing this already. And also people started to abandon these unproductive farms to move to cities. So it was sort of both a conscious decision of we need to reforest and also just sort of it happened naturally as people stopped using the wood for farms and whatnot.

Erin Allmann Updyke

Yeah.

Erin Welsh

And so this meant that forest cover increased greatly throughout the early 20th century with wetland restoration lagging a bit behind deciduous forests. But ultimately what this meant was more habitat for birds and mosquitoes and thus Triple E virus. And several researchers point towards this large scale landscape change as being a cause of the reappearance of the virus in the 1930s and why it has stuck around ever since then. But before you take up your chainsaws to re-clear cut the forests of New England and drain the swamps and bogs, consider please that it's not the mere existence of these habitats that leads to these Triple E outbreaks but really it's sort of the way that we develop suburban communities, especially the residential ones.

Erin Allmann Updyke

Right, it's the way we interact with those areas, yup.

Erin Welsh

And so a lot of these suburban neighborhoods tend to creep into and on the borders of these wetlands. And so that's where you have this, once you do that, once you get closer to that, that means that you're just more likely to come into contact with these infected mosquito species.

Erin Allmann Updyke

Right.

Erin Welsh

And also wetland conservation is hugely important for flood protection and healthy water supply and they provide these amazing habitats for diverse and unique communities of plants and animals. And so by the time this episode comes out it will have been roughly a week after Earth Day.

Erin Allmann Updyke

Oh cool.

Erin Welsh

Earth Day is April 22.

Erin Allmann Updyke

Earth Day is tomorrow; a couple days from now?

Erin Welsh

A couple days from now. And it'll be the 50th anniversary of Earth Day.

Erin Allmann Updyke

How exciting, wow.

Erin Welsh

Happy late Earth Day everyone! So let's just keep that spirit going.

Erin Allmann Updyke

Yes. We are certainly not anti-wetland.

Erin Welsh

No, no, no.

Erin Allmann Updyke

We are pro-forest, pro-wetland over here.

Erin Welsh

I think it's just a really interesting example of how large scale landscape change can influence disease transmission, particularly zoonotic diseases.

Erin Allmann Updyke

Yeah, definitely.

Erin Welsh

So from these outbreaks in the 1930s to the last decade or so we've seen sporadic human cases here and there, largely restricted to the northeastern US. But we have seen more horse outbreaks. But since that time we've seen both an increase in the frequency of cases and in their geographic distribution. And because this is a vector-borne disease, teasing apart the cause of this reemergence is tricky because it depends on so many factors, so like I talked about, increased rainfall one year, reestablishment of wetlands or development of human dwellings in close proximity to these wetland areas or any sort of habitat where *Culiseta melanura* likes to lay its eggs. So many things can play a role in this. And although this is a rare disease, it can be extremely deadly and that can lead to a fear response sometimes out of proportion to the actual risk. A lot of controversy surrounds the control measures that are often used to try to prevent infections. And there are these questions like should there be widespread aerial spraying with insecticides or is that just asking for another ecological disaster?

Erin Allmann Updyke

Yeah.

Erin Welsh

Is public education effective or is it even enough? Are we in for a bad year of Triple E virus? Erin, what do you think? Where do we stand with Triple E today?

Erin Allmann Updyke

Ooh, let's talk about it right after this break.

TPWKY

(transition theme)

Erin Allmann Updyke

So Triple E is unsurprisingly a nationally notifiable disease, right, because it's pretty devastating. So let's talk about how many cases we tend to see in the US per year. From 2009 to 2018, so about the last 10 years, on average there were 7 cases per year and that ranged from 3 in 2009 to 15 in 2012. Okay?

Erin Welsh

Okay.

Erin Allmann Updyke

So pretty rare and not a huge amount of variation year to year from 2009 to 2018. Now in total I will say that entire period there was only 72 cases in total.

Erin Welsh

Could you extrapolate upwards and say if that's 4% then there were x number of people who were likely exposed to the virus?

Erin Allmann Updyke

Sure, let's do that.

Erin Welsh

Is that a reasonable extrapolation?

Erin Allmann Updyke

That's a good question. Theoretically why not if we think that 96% of people are asymptomatic, then yeah, if there were 72 known cases that were reported then how many case is that total over that time period? Actually I have no idea how you do that math.

Erin Welsh: 76 over x equals 4 over 100 and then find the x?

Erin Allmann Updyke: 72 times 100 divided by 4? 1800 cases over about 10 years.

Erin Welsh: Still pretty low prevalence.

Erin Allmann Updyke: Pretty low, yeah, absolutely. Now that was 2009 to 2018. What about 2019? There's a reason that we did this as a live episode in Michigan and that is that 2019 was far and away the worst year of Triple E in a very long time. As of December 17, 2019 there were a total of 38 confirmed cases of Triple E in the United States including 15 deaths.

Erin Welsh: Wow.

Erin Allmann Updyke: Yep. That is more than twice the maximum of the last 10 years.

Erin Welsh: That's very... Okay, why?

Erin Allmann Updyke: Great question. I don't know. It likely was a lot of what you said, right, like a bad year for rainfall the year before or something like that. But what's interesting is that these cases happened in a number of different areas, it wasn't just all in one spot. The two states most hardest hit last year were Massachusetts and Michigan. So in Massachusetts there were 12 confirmed human cases and 10 confirmed deaths. Now there was also a large increase in the number of animal cases last year as well. There were in Michigan 48 cases of Triple E in animals last year. So yeah, it's a good question. I don't think that we have a full handle on exactly how to predict which years are going to be the worst like Fauci said in that article, right. He wasn't the first author but...

Erin Welsh: Yeah, it was Morens et al, come on.

Erin Allmann Updyke: Morens et al said in that article we need to do better research to be able to answer those types of questions, right. We need to have a better handle on what are the factors that contribute to whether or not we're gonna have a bad year.

Erin Welsh: Right.

Erin Allmann Updyke: Now the only good news about this is that... So you kind of mentioned where this tends to be a disease that's common, right, it's on the east coast, a lot of it in the northeast but also along the east coast and the Gulf coast as well as the Great Lakes region.

Erin Welsh: Right.

Erin Allmann Updyke: So the other states that had reported cases last year include Alabama, Connecticut, Georgia, Indiana, New Jersey, North Carolina, Rhode Island, and Tennessee.

Erin Welsh: What's the good news in this?

Erin Allmann Updyke: Most of those areas have a mosquito season.

Erin Welsh: Gotcha, okay.

Erin Allmann Updyke: So at least it's over for now effectively, right.

Erin Welsh: Yeah.

Erin Allmann Updyke: Although now it's springtime so welcome back I guess.

Erin Welsh: Yep, yep, yep.

Erin Allmann Updyke: Yeah so that's the only good news is at least it's over for now, we can hope that this year's gonna be better.

Erin Welsh: And that's the other thing too is that it seems to be based on when these cases happen, it does seem to be in a very narrow time window throughout the year, particularly in the more northern places where the mosquito season is so concentrated.

Erin Allmann Updyke: Right, yep. Which makes sense.

Erin Welsh: So you can sort of heighten your vigilance during that time, I guess.

Erin Allmann Updyke: So that's where we stand in terms of the number of cases of Triple E. You asked about a vaccine.

Erin Welsh: Cause there's one for horses.

Erin Allmann Updyke: There is one for horses, it is a whole killed virus vaccine, it's not great even for horses. So from what I have gathered, for some reason and this is very interesting considering that we believe that if you are infected with Triple E virus you do mount a good immune response and are then prevented from getting infected again. But for some reason the vaccine that we've tried to develop for humans and that we even have for horses and other animals, it doesn't generate a very good immune response and the immunity that it provides is not very long lasting even in horses.

Erin Welsh: Yeah.

Erin Allmann Updyke: So I'm not sure the schedule for if you have a horse how often you have to give that horse boosters, it might be something like I have to give my dog the rabies shot like every year or something like that so it might be the same for horses.

Erin Welsh: Yeah, they do boosters.

Erin Allmann Updyke: Yeah. So it's really interesting right, like why is it that we can't develop a vaccine that is more immunogenic, that provides us with a longer lasting immune response.

Erin Welsh: Is part of it in the funding in that this is a rare disease? You put the nail on the head there, Erin.

Erin Allmann Updyke: Is that how that goes?

Erin Welsh: That's how that goes.

Erin Allmann Updyke: Yeah. There is no market for a Triple E vaccine.

Erin Welsh

Right, right.

Erin Allmann Updyke

Right. We still don't even have a West Nile vaccine and that causes a lot more infection in humans every year than this does. So if you want proof that there's really not a market for it, I have found papers of people doing research on this. So in 2007 there was a really interesting paper that made a hybrid attenuated vaccine. So instead of doing a killed virus, they made a hybrid virus out of Triple E virus and some other virus, don't remember which one. And they tested it in mice and they found that it was highly immunogenic. That was in 2007. Nothing else.

Erin Welsh

Okay so in theory it could.

Erin Allmann Updyke

In theory it's possible. I did check clinicaltrials.gov which again is where you can find all the clinical trials that are happening and there are studies listed for Triple E. Two of them were USAMRIID, I don't know how you say it, the US Army Medical Research Institute of Infectious Diseases. They had two vaccine trials that are now concluded, one of them had results posted which are actually very difficult to sort through on clinical trials, by the way. Overall it's hard to give an estimate on exactly how longlasting the immunity was from this virus that they tested but it was somewhere between like 28% to 70% of people depending on the timeframe that you looked at it. So 70% of people that they tested had an immune response right after their second booster but then of the people they were able to test at a one year follow up, only 28% of them still had high titers of antibodies. So they mounted an immune response but it wasn't very long lasting.

Erin Welsh

Right, just like the horse vaccine.

Erin Allmann Updyke

Right, yeah. And so that makes it even harder to try and get funding for a vaccine like this if you think like this is a very, very, very rare infection and you would have to get a vaccine for it what, like every year? That's very difficult to try and sort of convince funders or people to get a vaccine like that. Right?

Erin Welsh

Right. So it comes down a lot more to the prevention and surveillance aspect.

Erin Allmann Updyke

Absolutely. Yeah, yeah. Definitely. So yeah, that's where we stand with Triple E virus.

Erin Welsh

Well do you know what the predictions are for this year?

Erin Allmann Updyke

I don't.

Erin Welsh

Was it rainy in places? Was it hot?

Erin Allmann Updyke

I don't know, let's see.

Erin Welsh

Is there an early summer? It snowed in Chicago like two days ago, so.

Erin Allmann Updyke

You know I've been thinking about that and it snows every April in Illinois. Every April I go, 'I can't believe that it's snowing!' But it does it every April.

Erin Welsh

I remember my prom in Kentucky it snowed once.

Erin Allmann Updyke

That's miserable.

Erin Welsh

Yeah, I got out out prom and there was snow on my car. And I was like, I'm in a hot pink sleeveless dress.

Erin Allmann Updyke

(laughs) I can't believe I've never seen pictures of your prom dress cause now I'm really...

Erin Welsh

(laughs) It was about what you'd expect.

Erin Allmann Updyke

Ugh, I really wanna see it now. Hot pink, sleeveless. I love it. Let's see. According to this news article I just found, health experts believe Triple E will rise again next year. I guess normally these cycles tend to last for 2-3 years where you have 2-3 years in a row of bad year. And it was very wet and rainy in 2019.

Erin Welsh

Great.

Erin Allmann Updyke

Great! You know how with Lyme disease and ticks there's that distinct, like the mast and the mice and then the deer and then the ticks-

Erin Welsh

Right. The sequence of events that lead to these high outbreaks out these outbreak years, they're just not well known and I think it's because the outbreaks themselves are so small.

Erin Allmann Updyke

So small and relatively rare.

Erin Welsh

And so it's sort of now we're playing retrospective detective trying to pick apart the pieces and that's challenging because ecology is ecology.

Erin Allmann Updyke

Right.

Erin Welsh

Things don't happen according to some plan or...

Erin Allmann Updyke

It's so hard, yeah.

Erin Welsh

Yeah. There's so much random noise in the system and so trying to say, 'Is this noise or is this a component?' is really challenging particularly when you have such a low incidence of disease.

Erin Allmann Updyke

Yeah.

Erin Welsh

And you have so many different hosts, you have so many different bird species that can be affected and they're affected so differentially that also plays a big part of it too, that's really difficult to get a handle on.

Erin Allmann Updyke

Disease ecology, Erin.

Erin Welsh

Yeah. I mean it's why I love it and also why it can be so frustrating.

Erin Allmann Updyke

Yup.

Erin Welsh

Okay.

Erin Allmann Updyke Well that was fun, hopefully it wasn't too depressing.

Erin Welsh That was fun. I don't know.

Erin Allmann Updyke We'll see.

Erin Welsh I don't think I can judge it anymore. Okay, sources?

Erin Allmann Updyke Sources.

Erin Welsh All right. So I wanna shout out a few, I have a bunch of papers that I liked but a few that I leaned more heavily on. One is by Armstrong et al from 2013 called 'Eastern Equine Encephalitis Virus: Old Enemy, New Threat'. And then there was that Arrigo et al paper titled 'Evolutionary patterns of eastern equine encephalitis virus in North versus South America', there's more to that title but it's very long so I'm not gonna keep going. Oh and then another one where I got a lot of the ecological sort of timeline of reemergence in Massachusetts is from a paper by Komar and Spielman from 1994 titled 'Emergence of eastern encephalitis in Massachusetts'.

Erin Allmann Updyke Excellent. There are a bunch of different papers that I used for different parts, we'll post all of these online. If you'd like kind of the most cited source of the clinical aspects of eastern equine encephalitis, there's a paper from 1997 called 'Clinical and neuroradiographic manifestations of eastern equine encephalitis'. But again we'll post all of our sources from this episode and all of our episodes online under the EPISODES tab, you can find all of our sources listed there as well as links to bookshop.org if you'd like to purchase the books.

Erin Welsh Yeah. And also we neglected to say it earlier but you can find the recipe for our quarantini and our nonalcoholic placeborita on our website thispodcastwillkillyou.com under the QUARANTINIS tab and we also post those on social media. So if you would like to see them, follow us.

Erin Allmann Updyke Yep.

Erin Welsh Thank you to Bloodmobile for providing the music for this episode and all of our episodes.

Erin Allmann Updyke And thank you to you for listening. Hope you enjoyed this episode.

Erin Welsh Yeah. Thank you always.

Erin Allmann Updyke And I hope anyone who was at the show in Michigan, first of all thanks so much for coming, we had so much fun there. And second of all, hope you still learned something new from this episode.

Erin Welsh Yeah, thanks again to everyone at Michigan who helped us make that trip one of just the most amazing days ever. Awesome. All right well until next time, wash your hands.

Erin Allmann Updyke You filthy animals.