TPWKY	This is Exactly Right.
Erin Welsh	The disease began in various ways but commonly with chills and heats, pressure and pain in the head, soreness of throat and hoarseness, some cough, sickness of the stomach, frequent vomiting and purging. These symptoms occurred more frequently in children and were then very severe. In adults they were less emphatically expressed. Commonly on the uvula, tonsils, velum palatinum, and back part of the pharynx, several whitish or ash-colored spots appeared scattered up and down which oftentimes increased very fast, soon covering one or both of the tonsils. These eventually proved to be the sloughs of superficial ulcers. The tongue at this time, though only white and moist at the top, was very foul at the root and covered with a thick yellowish or brown coat. The breath also now began to be very nauseous, the offensive smell increased hourly and in some instances became quite intolerable even to the patients themselves. By the second or third day, the sloughs were much enlarged and of a darker color and the surrounding parts tended much more to a livid hue. The breathing became more difficult with a kind of rattling stertor as if the patient was actually strangling, the voice being exceedingly hoarse and hollow.
TPWKY	(This Podcast Will Kill You intro theme)
Erin Allmann Updyke	Whoa.
Erin Welsh	Yeah that's pretty intense. So what does that sound like to you?
Erin Allmann Updyke	Sounds like diphtheria?
Erin Welsh	That's right. The topic of today's episode.
Erin Allmann Updyke	All right.
Erin Welsh	Hi, I'm Erin Welsh.
Erin Allmann Updyke	And I'm Erin Allmann Updyke.
Erin Welsh	And you are listening to This Podcast Will Kill You diphtheria edition.
Erin Allmann Updyke	Yep.
Erin Welsh	So.
Erin Allmann Updyke	I'm really excited.
Erin Welsh	I am really thrilled.
Erin Allmann Updyke	You've been talking about this one for a while now.
Erin Welsh	I know and there's also been something in my part that I have been dying to tell you about and I've been keeping it secret and-
Erin Allmann Updyke	Keeping it safe?

Erin Welsh	(whispers) Keeping it secret, keeping it safe. (laughs)
Erin Allmann Updyke	I can't wait to hear it.
Erin Welsh	Good. I guess though that we should start first with our quarantini.
Erin Allmann Updyke	Quarantinis!
Erin Welsh	So what do we have to drink tonight?
Erin Allmann Updyke	Tonight were drinking The Strangling Angel.
Erin Welsh	Sounds menacing.
Erin Allmann Updyke	It's a little bit. (laughs)
Erin Welsh	(laughs) But it's also quite delicious.
Erin Allmann Updyke	It's actually quite good. It's kind of a variation on a Penicillin, which who knew that was a real cocktail?
Erin Welsh	Maybe we should have. We do now.
Erin Allmann Updyke	We do. It's got what? Whiskey, lemon juice-
Erin Welsh	Either bourbon or rye.
Erin Allmann Updyke	Lemon juice-
Erin Welsh	Ginger liqueur.
Erin Allmann Updyke	And a little maple syrup. And in addition to our quarantinis this episode, we'll also be making - what are we calling them? Placeboritas?
Erin Welsh	Yeah. (laughs)
Erin Allmann Updyke	Placeboritas. Guys, come up with a better name for that. And we'll be posting the full recipe for the quarantinis and the placeboritas, we'll be posting those nonalcoholic versions online as well on all of our social media channels so you guys can find those and drink along with us.
Erin Welsh	Yeah. So.
Erin Allmann Updyke	So.
Erin Welsh	Now that that's out of the way-
Erin Allmann Updyke	Let's get started.
TPWKY	(transition theme)

Erin Allmann Updyke	So diphtheria is caused by a bacterium known as Corynebacterium diphtheriae and I did in fact look up how to pronounce that.
Erin Welsh	Oh good.
Erin Allmann Updyke	That's like the first time for me ever.
Erin Welsh	It's a strange spelling.
Erin Allmann Updyke	Yeah I looked at it and I was like, I'm gonna look this one up. Corynebacterium diphtheriae, it's a gram-positive rod, so it's shaped like a little tube not a ball or anything.
Erin Welsh	Like a little Good & Plenty?
Erin Allmann Updyke	Yeah, Good & Plenty, that's a great one actually. And one thing that's interesting about this disease is the disease that we associate with diphtheria is not caused by the bacterium itself, it's caused by a toxin. And this toxin is produced by a virus, a bacteriophage that actually infects the bacterium.
Erin Welsh	What?
Erin Allmann Updyke	Yeah so a lot of the toxins, we talked about toxins in the MRSA episode, a lot of the toxins that quote unquote "bacteria" produce are actually produced by viruses.
Erin Welsh	So it's this little mutualism?
Erin Allmann Updyke	I mean I guess.
Erin Welsh	Or commensalism, maybe?
Erin Allmann Updyke	Yeah commensalism. I haven't really seen... I mean presumably, at least in the case of humans which are the pretty much only reservoir for diphtheria, you might be getting more sick, so I guess if that's beneficial then you could call it a mutualism but I don't know if that actually... Like I don't know if the bacteria survives any better with this bacteriophage or not.
Erin Welsh	Okay.
Erin Allmann Updyke	So maybe someone else who knows can tell us.
Erin Welsh	That's really interesting though.
Erin Allmann Updyke	Yeah so it's not the bacteria itself. So there are strains out there that are what are called nontoxigenic strains, those can still infect you, they can still cause some disease but they generally don't cause as severe disease and not the type of disease that we might associate with diphtheria.
Erin Welsh	Okay.
Erin Allmann Updyke	So, ready?

Erin Welsh	Uh huh.
Erin Allmann Updyke	So diphtheria, and from now on whenever I talk about it we'll just assume it's a toxigenic strain of the bacterium, so it's making toxin, it's trying to kill you.
Erin Welsh	Gotcha.
Erin Allmann Updyke	It's transmitted via aerosols, so coughing, spitting, sneezing, etc.
Erin Welsh	Lovely.
Erin Allmann Updyke	The incubation period is 2-5 days. So if I cough on you, 2-5 days later, you're gonna be getting sick most likely. And historically, not to step on your toes or anything-
Erin Welsh	(laughs) No worries, my toes are safe.
Erin Allmann Updyke	But historically diphtheria has been a disease of childhood, very specifically of childhood, meaning babies didn't usually get it and adults didn't usually get it. Do you have a guess as to why?
Erin Welsh	I'm guessing that in babies it would have to do with maternal antibodies from breast milk.
Erin Allmann Updyke	Boom! Nailed it.
Erin Welsh	And adults I would assume that most of the adults would have been asymptomatic and been exposed to it and then developed immunity?
Erin Allmann Updyke	Or just had it and survived it. Yeah, exactly.
Erin Welsh	Yeah, yeah.
Erin Allmann Updyke	So they definitely were exposed and either got the infection and survived it or they were asymptomatic carriers which is very common in diphtheria, meaning just cause someone looks healthy doesn't mean they are.
Erin Welsh	Dun-dun-dun!
Erin Allmann Updyke	(laughs) All right, so let's get into what actually happens when you get infected.
Erin Welsh	Okay.
Erin Allmann Updyke	So the first place that diphtheria tends to colonize is your nasopharynx, so that means your nose and your throat.
Erin Welsh	Okay.
Erin Allmann Updyke	It is possible to only infect your nasal passages, in which case the disease that it causes is more like the common cold, it's not as severe, you get a lot of bloody mucus and pus coming out of your nose.

Erin Welsh	Ugh, oh my god.
Erin Allmann Updyke	Yeah, it's pretty gross. But it's less common, so more commonly it's actually gonna kind of go straight to the back of your throat and that's its sort of favorite spot to infect. So the progression of the disease I saw described as insidious, which is not a good...
Erin Welsh	No.
Erin Allmann Updyke	You don't want something in your body to be-
Erin Welsh	There's a negative connotation to that word I think.
Erin Allmann Updyke	Pretty negative. (laughs) So here's how it begins. You start with a fever but not like a crazy high fever, so maybe not one that makes you go, 'I need to get to the doctor'.
Erin Welsh	Okay.
Erin Allmann Updyke	You're running like 100, maybe 101 max. So you're feeling crappy. You're feeling tired, maybe weak, you've got just generally like malaise, you're like, 'God, I'm coming down with something. Maybe it's the flu, I don't know.' And then your throat, like it really hurts, it's hurts pretty bad. So then because you're feeling crappy and your throat hurts, you've got anorexia right. You don't wanna eat anything, you don't wanna swallow, and you just feel bad.
Erin Welsh	So anorexia just means not wanting to eat anything?
Erin Allmann Updyke	Yeah, exactly, it means not eating.
Erin Welsh	Okay.
Erin Allmann Updyke	And so you're like, 'Wow, maybe it's strep throat? Maybe is that what I've got? I don't know.' But then within 2-3 days you're not getting better and at the back of your throat you'll see this thing. And it starts out white, just sort of attached to the roof of your mouth and back near your tonsils and then it gets bigger.
Erin Welsh	I don't like this.
Erin Allmann Updyke	It just keep getting bigger. And it starts out white but as it grows to cover your entire soft palate, it can turn green or gray or black.
Erin Welsh	Oh my god! Black!?
Erin Allmann Updyke	Yeah. And it's not really pus because pus, you can kind of spit that out right? Like mucus you could sort of put your finger back there and scrape it off.
Erin Welsh	Ugh.

Erin Allmann Updyke	You can do that with this cause it's stuck on and if you try, like if you really, really try in there, you're just gonna cause yourself to bleed a lot cause it's stuck on there. And at this point it might be getting kinda hard for you breathe. So if you finally were to go to the doctor and they put the stethoscope up to you, they'd hear a sound, something like this: (high pitched wheezing). Was that good? (laughs)
Erin Welsh	Oh my god. I am feeling like the need to breathe very deeply. I'm feeling very stressed right now.
Erin Allmann Updyke	Yeah, Erin's really... I've made her very anxious.
Erin Welsh	I am highly anxious.
Erin Allmann Updyke	So that sound that I mimicked, I'm pretty proud of myself for that, I practiced.
Erin Welsh	It was excellent.
Erin Allmann Updyke	Thank you. It's called stridor, it's not a good sign, it's a very, very bad sign. So at this point, if you've progressed this far, you have two fates. Either you recover somehow or you die. It's pretty much a 50/50 chance. The end. Just kidding. (laughs)
Erin Welsh	I am just letting this sink in because I have read, obviously like it's come across my research about sort of the membrane and the dying but it's... Ugh.
Erin Allmann Updyke	When you hear the whole-
Erin Welsh	When you hear the whole thing and you just imagine this... Well first of all, I'm going to be terrified for every time I get a cold from here on out, I'm gonna be constantly checking the back of my throat for little diphtheria patches.
Erin Allmann Updyke	You don't need to do that, you've been vaccinated, Erin.
Erin Welsh	Some of us are just nervous by nature.
Erin Allmann Updyke	I know. Yeah.
Erin Welsh	Naughty by nature. (laughs)
Erin Allmann Updyke	(laughs) So yeah. So this thing that's on the back of your throat is called a pseudomembrane. I don't know why they call it that but that's what they call it. It seems like a pretty real membrane and not a pseudo one but that's what they're calling it. And basically what happens and one of the very common ways that you end up dying from diphtheria is that this thing grows so large and then your surrounding lymph nodes will also swell up that basically your airway is blocked off and you suffocate.
Erin Welsh	Oh my gosh.
Erin Allmann Updyke	Now that's not the only way that you can die from diphtheria.
Erin Welsh	Oh cool. Perfect, love it.

Erin Allmann Updyke	But before we talk about the other ways that you can die, we'll take a step back and let's talk about what's actually going on inside your body.
Erin Welsh	Okay, good.
Erin Allmann Updyke	Why are these specific symptoms happening? So like I said, the primary thing that's actually causing this disease is a toxin, diphtheria toxin, not the bacterium itself. So what happens is this toxin is released form the bacterium, made by the bacteriophage inside, released from the bacterium into your body. It enters your cells, so it can actually attach to certain receptors on your cell and get inside of your cell and once it's in your cells of the epithelium of your throat, right, it basically inhibits protein synthesis. One of the main things that cells do is make protein, if your cells cannot make protein, they will die.
Erin Welsh	Yeah. So inhibiting that seems pretty bad.
Erin Allmann Updyke	It's not good. So it basically causes cell death. So this toxin gets into your cells, stops them from doing their job, and then results in their death. The pseudomembrane that you're actually seeing on the back of somebody's throat is a direct result of this toxin, it's made up of a whole bunch of dead cells that have been infected by this toxin and then killed. And then what happens is because the bacteria are also there, right, so there are colonies of bacteria, you've got macrophages and neutrophils which are white blood cells that are coming in to try and eat the bacteria and also clean up after all these dead cells that are now in the back of your throat. And when there's dead cells, what they do is they lay down this stuff called fibrin which is like scar tissue.
Erin Welsh	Oh.
Erin Allmann Updyke	And so that's why it's adherent to the back of your throat. It's not like when you get sick with another, like strep throat for example and you might have a bunch of mucus. That mucus is also just white blood cells and bacteria. The difference here is that because you have a bunch of cell death, you have fibrin being laid down and everything is attached still to your healthy, living tissue.
Erin Welsh	That makes sense and is also that much more horrifying in a way.
Erin Allmann Updyke	Yeah, definitely, yeah. Because there's no just like, oh, let me just hack cough really hard and hack this thing up.
Erin Welsh	Right.
Erin Allmann Updyke	You can't hack it up.
Erin Welsh	And it suffocates you.
Erin Allmann Updyke	Suffocates you.
Erin Welsh	I feel claustrophobic.
Erin Allmann Updyke	I can tell. It's a small room. (laughs) But like I said, asphyxiation is not the only way that you can die.

Erin Welsh	Cool.
Erin Allmann Updyke	So the toxin is released into your bloodstream and your nasopharynx, especially the back of your throat, is just rife with blood supply which means that this toxin can make it into your blood supply and then it can go to the rest of your body.
Erin Welsh	Cool. Cool, cool, cool, cool, cool.
Erin Allmann Updyke	It can travel to your heart where it will do the same thing that it does in the back of your throat. So it's going to infect your heart cells, cause cell death, and then fibrosis or scarring. And what happens when you have scarring on the muscles of your heart is the conductance, the electrical activity that controls your heart is impaired. So you've got a bunch of scars from everywhere where you've got dead cells cause this toxin killed your cells and now your heart can't send impulses so it can't pump correctly. So you end up with arrhythmias, your heart's not beating in sync with itself. So you can die because your heart stops beating correctly. You can also die - (laughs) there's more.
Erin Welsh	Your heart will just stop beating.
Erin Allmann Updyke	Yeah, you go into like a tachycardia or arrhythmia where your heart is not beating correctly, like maybe your gonna have atrial fibrillation which means that the top part of your heart is like - say what my hands are doing cause I can't. What do you call this? Fibrillation, I don't know.
Erin Welsh	I mean that looked like jellyfish tendrils.
Erin Allmann Updyke	Okay so it's kind of like that. (laughs) Like instead of being like thunk-thunk, thunk-thunk, your heart's like brrril-brrril.
Erin Welsh	It's fluttering.
Erin Allmann Updyke	Yeah, exactly. So that can happen and that will kill you, right. Cause if your heart's not thunk-thunking, it's not pushing blood out. That's what thunk-thunk is, right? You also could just become paralyzed.
Erin Welsh	Cool, great.
Erin Allmann Updyke	Because it can affect your nervous tissue and if it infects your nerve cells and then your nerve cells die, then you can't transmit electricity. So yeah, it's pretty gnarly. You also can get cutaneous diphtheria which is basically a giant ulcer on your skin, it's pretty gnarly-looking. We should post a picture but I don't know if we should post a picture cause-
Erin Welsh	Maybe we can do like a 'click to see graphic content'.
Erin Allmann Updyke	Yeah, cause it's pretty gross.
Erin Welsh	Now is that again with the fibrin?
Erin Allmann Updyke	No, it's actually usually a nontoxigenic strain that infects your arms.
Erin Welsh	Interesting.

Erin Allmann Updyke	Well not just arms but your skin. I'm not exactly sure why. But I have some good news cause it looks like you could use it.
Erin Welsh	Yeah I'm very tense right now, my arms are folded.
Erin Allmann Updyke	She's very walled off.
Erin Welsh	I feel like my heart is arrhythmic right now.
Erin Allmann Updyke	(laughs) Untreated... I guess I have a little more bad and then we'll get to the good. Untreated, the mortality rate is up to 50%. So about half of people who get infected and do not have any treatment will die from diphtheria.
Erin Welsh	So high.
Erin Allmann Updyke	It's pretty high. Treated - so we do have a treatment - treated the mortality is between 5-10% which is still kind of high.
Erin Welsh	It's very high.
Erin Allmann Updyke	And in young children it's actually as high as 20%. And the thing that's really sad is this case fatality rate has not improved over the last 50 years. So we're not any better at treating it now than we were in the 1940s and 50s.
Erin Welsh	That's scary.
Erin Allmann Updyke	Yeah. But do you wanna know how we treat it? It's kinda cool.
Erin Welsh	Yeah, yeah.
Erin Allmann Updyke	So there's two things that you have to do. The first is give an antitoxin. You do that to actually treat the symptoms. The thing about this treatment, the antitoxin, is that it only works on toxin that is not already bound to your cells.
Erin Welsh	Oh.
Erin Allmann Updyke	So you have to be treated very, very early in the course of disease cause any cells that are already infected with the toxin are screwed.
Erin Welsh	Okay.
Erin Allmann Updyke	And then on top of that you also treat with an antibiotic and that's both to kill the bacterium itself, so it stops making more, and to protect those around you, so to make sure that you don't spread this disease to anybody else.
Erin Welsh	Gotcha.
Erin Allmann Updyke	And the best news is that there is a vaccine but we'll talk more about that later. So tell me how did we get here?

Erin Welsh	Excellent question.
TPWKY	(transition theme)
Erin Welsh	Diphtheria. Where to begin?
Erin Allmann Updyke	(laughs)
Erin Welsh	Before I started researching this, the word diphtheria didn't really mean much to me on it's own, right. It was more just like part of a vaccine lumped in with other diseases that you don't really hear much about anymore except more recently with the whole anti-vaccine movement which I'm sure we'll get into a bit later. Yeah. Anyway but as I read more about the history of this disease, I found that the mention of diphtheria in a village or a city could cause a huge panic.
Erin Allmann Updyke	Whoa.
Erin Welsh	Yeah, and it was one of the most feared diseases in pre-vaccine times for a few reasons. One, it attacked children primarily so it causes horrible, slow suffocating death that you just talked about.
Erin Allmann Updyke	Yeah.
Erin Welsh	Which just sounds so awful.
Erin Allmann Updyke	Yeah you just like watch your kid suffocate.
Erin Welsh	Yeah. I cannot imagine. Yeah.
Erin Allmann Updyke	It's pretty bad.
Erin Welsh	And also two, it would show up suddenly and tear through an entire town or village and nothing seemed to stop it. So let's just check off the etymology of this disease before going into any more of it's gory, historical details. Diphtheria didn't get its name until 1826.
Erin Allmann Updyke	Whoa, that seems super late.
Erin Welsh	Yeah. And so in this year, a French pathologist named Pierre Bretonneau came up with diphtherite or something like that which is from the Greek root 'diphthera' meaning leather, which is of course what that tough membrane in the throat resembled. Leather! Leather. God.
Erin Allmann Updyke	Grody. It's like a football.
Erin Welsh	Yeah and apparently it smelled really bad according to the firsthand account.
Erin Allmann Updyke	Okay I really think that was just poor hygiene.
Erin Welsh	There were so many firsthand accounts that I read that were like it smelled disgusting.

Erin Allmann Updyke	I mean it does make sense cause it's just like a bunch of dead stuff in the back of your throat but some of that description in the firsthand account was like, 'It's tongue was brown'. I'm like bro, that's you man. (laughs)
Erin Welsh	Okay, well, fair enough. But in reading some of this it seemed like there was a characteristic diphtheria smell. Yeah. But the naming itself was really important in the history of diphtheria because before this, outbreaks of sore throat were called by a bunch of different names which made tracking and monitoring outbreaks difficult, not to mention developing any kind of treatment that was reliable or consistent.
Erin Allmann Updyke	Right.
Erin Welsh	Okay. So the name didn't come about until the 19th century but this wasn't a new name given to a new disease. This disease has really characteristic signs like extreme sore throat, leathery membrane. So you would think that tracing the history of diphtheria would be somewhat easy, at least compared to diseases like Staph which was much more non-consistent.
Erin Allmann Updyke	Right. It's like everywhere and everything and causes so many different types of disease.
Erin Welsh	Exactly.
Erin Allmann Updyke	Yeah.
Erin Welsh	But it actually doesn't have that much of a history before the 1700s.
Erin Allmann Updyke	What?
Erin Welsh	Yeah at least that I found. And I could be wrong and I could be looking in the wrong places but there were some mentions. In the 5th century BCE, Hippocrates writes about a disease that sounds an awful lot like diphtheria and there's another mention a few hundred years later by Aretaeus The Cappadocian in which he describes ulcers in the throat and warns that, quote: "If it spreads to the thorax by the windpipe, it occasions death by suffocation within the space of a day."
Erin Allmann Updyke	Yep.
Erin Welsh	And that, quote: "Children until puberty especially suffer."
Erin Allmann Updyke	Yep. That does sound a lot like diphtheria.
Erin Welsh	Diphtheria, probably. And that's really more or less the last mention of the disease until the late 1500s and early 1600s.
Erin Allmann Updyke	Weird!
Erin Welsh	And so that's when there was this series of epidemics of sore throats resulting in suffocation that swept through Spain and parts of the New World. This epidemic was referred to as El Año de los Garotillos, essentially meaning the year of strangulations. That was one translation I found for it.
Erin Allmann Updyke	I got chills when you said that.

Erin Welsh	(laughs) Yeah it sounds terrifying.
Erin Allmann Updyke	A year of strangulation.
Erin Welsh	Yeah. But it remains a bit of a mystery as to why there's no mention of this disease for over a thousand years and so I was starting to wonder, well are we just missing historical accounts or did it not really act as an epidemic disease for all that time? Or were the ancient descriptions of the disease actually something else that just happened to resemble diphtheria?
Erin Allmann Updyke	Yeah.
Erin Welsh	I could really find a whole lot of information on that, on this missing puzzle piece but I did see somewhere that the bacterium is thought to have come from domestic herbivores which means it probably has ancient origins.
Erin Allmann Updyke	Right.
Erin Welsh	Maybe the incorporation of the bacteriophage was more recent and then the toxin was more recent.
Erin Allmann Updyke	Maybe.
Erin Welsh	But I don't know.
Erin Allmann Updyke	I don't know.
Erin Welsh	Yeah.
Erin Allmann Updyke	And the thing is, it's like humans from what I've read are the only reservoir, so it's not currently a zoonotic disease so-
Erin Welsh	Right, so that would further point to an ancient origin.
Erin Allmann Updyke	Yeah, exactly.
Erin Welsh	I don't know.
Erin Allmann Updyke	Weird.
Erin Welsh	In any case, diphtheria emerged with a vengeance in 1735 when outbreaks of the illness occurred in New England, Great Britain, France, and the West Indies. People called it 'throat distemper' and sufferers either died from suffocation by the thick grayish membrane covering their throat-
Erin Allmann Updyke	She's gonna say that like a hundred more times.
Erin Welsh	It just is the most horrible thing to me, I don't know why. Or if they survive that, they could just drop dead a week or two later, as we've heard.
Erin Allmann Updyke	Yep. Arrhythmia. (laughs)

Erin Welsh	So cool, cool, cool, cool. Love it. This outbreak disproportionately affected children and some families lost all of their kids. Like entire families, just kids all gone.
Erin Allmann Updyke	I know it is quite infectious and so it does make sense that if you've got a bunch of kids it's gonna go like chickenpox from one to the next to the next and then boom, boom, boom.
Erin Welsh	Yeah. Awful. In Kingston, New Hampshire, a third of all children in this town died from the disease.
Erin Allmann Updyke	Whoa.
Erin Welsh	A third of all the children. And the state itself lost 5% of its entire population.
Erin Allmann Updyke	So that's really crazy because that means it's not just like always there, it's like coming into these communities, wiping them out, and then moving on.
Erin Welsh	Exactly.
Erin Allmann Updyke	Cause otherwise you would just have like low levels of death all the time.
Erin Welsh	Right.
Erin Allmann Updyke	Weird, I never knew that.
Erin Welsh	It's an epidemic disease, it's not an endemic...
Erin Allmann Updyke	So then it's even weirder that there's not more accounts of it!
Erin Welsh	Yes.
Erin Allmann Updyke	What?
Erin Welsh	I know. Yeah, yeah. It's bizarre.
Erin Allmann Updyke	That is super bizarre.
Erin Welsh	Obviously with such a huge loss of life comes people seeking answers or at least where they can point fingers and many puritan ministers said that the people had brought it on themselves by straying too far from the religious path, which I'm sure is exactly what they needed to hear as they lost their entire children.
Erin Allmann Updyke	(laughs) Oh god, it's your own fault, mothers.
Erin Welsh	Right. God.
Erin Allmann Updyke	The wanton mother.
Erin Welsh	The wanton mother. Ridiculous. Anyway, so after this first big diphtheria epidemic in 1735, outbreaks showed up every 25 years or so.

Erin Allmann Updyke	Whoa.
Erin Welsh	Yeah. And it slowly shifted from this epidemic rural disease to a more endemic cosmopolitan disease by the mid 1800s. And it seemed to increase in virulence the entire time.
Erin Allmann Updyke	Interesting. Yeah.
Erin Welsh	It was during these outbreaks in the 1800s that diphtheria got is name, the strangling angel, which is the name of our quarantini if you remember. In an outbreak in New York City in 1857, the case fatality rate was 42% which is, I mean as we know that's just what you said but that's still so high. That's almost bubonic plague level.
Erin Allmann Updyke	And it's children, right.
Erin Welsh	Children!
Erin Allmann Updyke	So you've got a schoolhouse with 100 kids in it, they're all gonna get infected, right, like realistically. 42 of them are gonna die.
Erin Welsh	Yeah. 42.
Erin Allmann Updyke	You now have 58 kids in your class. Is that right?
Erin Welsh	That's right.
Erin Allmann Updyke	Thank you. That's... What? Oh man.
Erin Welsh	Yeah. And no amount of therapy or supportive treatment could save the lives of those suffering and so they died this slow, terrible death.
Erin Allmann Updyke	God.
Erin Welsh	So physicians deeply feared diphtheria because they felt pretty much helpless against it.
Erin Allmann Updyke	Yeah.
Erin Welsh	And even more helpless than the parents because the parents would take their children to them expecting this person to try to make things better, and no.
Erin Allmann Updyke	Help.
Erin Welsh	So it was the parents' absolute nightmare to watch their child suffering so horribly. And for this reason, diphtheria played a prominent role in the development of germ theory in the 1800s.
Erin Allmann Updyke	Our fave!
Erin Welsh	Oh yes. All right, so it's the mid 1800s.

Erin Allmann Updyke	Okay.
Erin Welsh	Let's take a minute to consider some of the prevailing thoughts on what caused disease.
Erin Allmann Updyke	Your bad sexual habits. Okay wait, that's actually true. (laughs)
Erin Welsh	(laughs)
Erin Allmann Updyke	My bad, I'm sorry, let me try that again. Not praying enough.
Erin Welsh	Actually I don't really have that in here. I think by that time it wasn't so much about the morality.
Erin Allmann Updyke	Oh, okay. Bad air.
Erin Welsh	Bad air.
Erin Allmann Updyke	There we go.
Erin Welsh	Yes, absolutely. So miasma, that kind of thinking which if you remember from John Snow and the Broad Street cholera outbreak-
Erin Allmann Updyke	Episode 4 if you haven't listened to it.
Erin Welsh	Yes. That was all thought to be miasma. And then there's also humorism or humoralism which we've talked about during tuberculosis.
Erin Allmann Updyke	Right, right. Episode 9.
Erin Welsh	And then there's germ theory.
Erin Allmann Updyke	Yes!
Erin Welsh	So the idea that many diseases are caused by microorganisms. So this idea was around but not necessarily widely accepted quite yet because humorism was still kind of the prevailing thought. But it pretty quickly fell out of favor as formal medical research focused on specific tissues or cells as indicators of disease. Importantly, they started asking whether if a specific tissue or organ was inflamed, there could be multiple causes for the same symptom. For instance, diphtheria, scarlet fever, and strep throat all result in inflammation of your throat. Does that mean that they are one disease or many? So this was a big shift in the way that people thought about disease.
Erin Allmann Updyke	Yeah.
Erin Welsh	So the answer might be obvious to us now, of course these are different diseases, they have different symptomology, blah blah blah.
Erin Allmann Updyke	Yeah.

Erin Welsh	But back then before germ theory had taken hold, this wasn't straightforward and the concept of multiple causes for the same disease symptoms was really huge and it partially paved the way for germ theory, especially the one germ, one disease concept. With diphtheria, one thing seems certain: it was contagious. If it showed up at a school in one kid it was only a matter of time before the entire class, as we illustrated, was sick at home or in the hospital or dead.
Erin Allmann Updyke	Yeah.
Erin Welsh	Now that we knew it was contagious, it was like okay well we need to know which microbe caused the disease. Which was difficult to do because the mouth and throat normally contains this really diverse array of microbes. So being able to say that one specific microbe was the cause of a disease wasn't simple. But there was at least a jumping off point: the membrane. By the late 1800s, this dude named Klebs found two types of microbes in the membrane.
Erin Allmann Updyke	Klebs like Klebsiella?
Erin Welsh	It might be.
Erin Allmann Updyke	Oh! How exciting.
Erin Welsh	(laughs) But he didn't know which bacterium was responsible. So that question was solved a few years later in 1884 by a dude named Friedrich Loeffler.
Erin Allmann Updyke	Oh.
Erin Welsh	He also discovered that the bacillus was only found in the membrane and didn't invade deeper into the body. But diphtheria also causes effects in the more distant parts of your body so he figured that the distant effects of disease could be caused by a toxin.
Erin Allmann Updyke	Wow! What a smart guy!
Erin Welsh	Right? We had the causative agent but there was still the mystery of why an outbreak of diphtheria would suddenly show up without any warning and sweep through a village or a school. Where did it come from?
Erin Allmann Updyke	Yeah.
Erin Welsh	Well a couple of years after the causative agent of diphtheria was identified, there was an epidemiological survey of children in Berlin that showed that 5% of healthy children carry the bacterium in their throats. So this was the first evidence that carriers of the disease existed. And this was a big deal because it helped to explain the mystery of these sudden outbreaks and it also led to forced quarantine for people who were suspected to be carriers.
Erin Allmann Updyke	Uh oh.
Erin Welsh	Yeah people were held for months in isolated hospital units, there were quarantined stickers or plaques to put on people's houses if there was an outbreak of diphtheria in a certain house.
Erin Allmann Updyke	Dang.

Erin Welsh	Yeah. Soon after the discovery of diphtheria carriers, Pierre Paul Émile Roux, who was Loeffler's assistant, found the diphtheria toxin by showing that if you passed bits of diphtheria secretions like from the membrane through a superfine filter that would keep the bacteria out and other cells and then injected the filtrate into an animal, you could cause diphtheria-like symptoms in the animal.
Erin Allmann Updyke	Wow, that's cool.
Erin Welsh	Yeah.
Erin Allmann Updyke	I mean not cool for the animal but...
Erin Welsh	But it's kind of like boom, toxin. Got it. Proof in hand.
Erin Allmann Updyke	Yeah.
Erin Welsh	When a couple of other microbiologists named Emil von Behring and Kitasato Shibasaburō heard about the discovery of the diphtheria toxin, they were like, 'We know what to do with this information. If we can fight the toxin, we can fight the disease.' So they began working towards developing the diphtheria antitoxin which was first used in the 1890s.
Erin Allmann Updyke	Wow.
Erin Welsh	Yeah. And for this research, von Behring was awarded the first Nobel Prize for medicine in 1901.
Erin Allmann Updyke	What? For diphtheria antitoxin?
Erin Welsh	Yeah.
Erin Allmann Updyke	Oh cool!
Erin Welsh	Diphtheria was a big deal. Still is.
Erin Allmann Updyke	Yeah I definitely had no idea that it was such a big deal.
Erin Welsh	Yeah.
Erin Allmann Updyke	Like it's just the 'd' in Tdap. That's all it was to me.
Erin Welsh	Yeah it was a lot more and it really left a mark. And it's kind of funny cause it seems like so much of diphtheria's history is squeezed into just a few decades. It was only in the 1850s that the disease became endemic in cities and within 50 years the bacteria had been identified, its toxin isolated, and a moderately effective treatment produced.
Erin Allmann Updyke	Wow.

Erin Welsh	Boom, boom, boom. But diphtheria was in no way defeated or forgotten. It was still one of the illnesses that most terrified parents and racked up a hefty death toll. Even with the advent of antitoxin, it remained the number one killer of children in some countries, killing thousands of children every year. For instance, in the U.S. 13,000-15,000 children died every year form diphtheria in the early 1900s.
Erin Allmann Updyke	Oh my god.
Erin Welsh	And in January 1925 it would take the front page of so many newspapers in a dramatic race against time.
Erin Allmann Updyke	Race against time?
Erin Welsh	(laughs) Okay, let's take a quick trip to Nome, Alaska.
Erin Allmann Updyke	Yes!
Erin Welsh	Do you know where this is going?
Erin Allmann Updyke	No.
Erin Welsh	Okay, great. In 1924, Nome is still a baby city. It had been founded only 27 years earlier by a few gold prospectors which then led the way for hundreds more to rush to this extremely remote part of Alaska which was still just a U.S. territory and not a state. Nome is just a couple of degrees south of the Arctic Circle and extremely far west on the Seward peninsula. We'll post a map.
Erin Allmann Updyke	(laughs)
Erin Welsh	In 1924 it was one of the most remote cities on earth. Nome was closer to Siberia than it was to any other major town in Alaska.
Erin Allmann Updyke	Whoa.
Erin Welsh	Its population had shrunk from around 20,000 during the peak of the gold rush to around 1500 brave or crazy people that made it their home in 1924.
Erin Allmann Updyke	Wow.
Erin Welsh	For most of every year, from around October or November to July, Nome was more or less shut off from the rest of the world. The port was inaccessible due to freezing water, no train reached that far west, and planes hadn't yet been designed to withstand the extremely harsh winters.
Erin Allmann Updyke	Oh my god.
Erin Welsh	Yeah.
Erin Allmann Updyke	Until July? No thank you.
Erin Welsh	I think that's like when the ice melt was.

Erin Allmann Updyke	Uh uh. I'm complaining about 50s over here.
Erin Welsh	(laughs) So that left sled dogs as the only reliable way to get around. So before those ships left for the winter, you really had to make sure that you had everything you needed or wanted for that long winter and spring and half of summer ahead of you. In the summer of 1924, Nome's only doctor, Curtis Welch, sent a request for more diphtheria antitoxin after he noticed that the units that he had were expired. But when the last ship of the year came and went without any new antitoxin, he crossed his fingers and hoped for the best.
Erin Allmann Updyke	Oh no. Uh oh.
Erin Welsh	Being so isolated might protect them from any outbreaks coming their way and they had been lucky avoiding diphtheria in previous years. But the 1918 flu still linger on everyone's minds. I don't know if I mentioned this in our flu episode since it was like 100 years ago.
Erin Allmann Updyke	It was about a year ago.
Erin Welsh	But this part of the world suffered some of the highest death rates during the flu. In Nome, 50% of the population of Alaska natives died.
Erin Allmann Updyke	You know, you did mention that.
Erin Welsh	Okay I thought so cause it was such a high mortality rate.
Erin Allmann Updyke	Yeah.
Erin Welsh	And so on Christmas Eve 1924 when Dr. Welch heard of a 7 year old girl who had a very sore throat, he worried. If this was diphtheria, Nome was on its own with enough expired antitoxin to help just a handful of people. And in particular he worried about the thousands of Alaska natives living in the area who had lower resistance to diphtheria.
Erin Allmann Updyke	Oh no.
Erin Welsh	A few days later on December 28th, the girl died and several more cases of sore throat began popping up. Welch didn't officially diagnose anyone with diphtheria until mid January and by this time at least 5 children were dead of the illness. This is in a really small, super isolated town.
Erin Allmann Updyke	Yeah.
Erin Welsh	So now was the time to panic. He sent out a telegram to the U.S. public health service pleading for antitoxin. Some way, get it Nome, please. Getting together that much antitoxin wasn't a problem but the issue was getting it to Nome. By sea was impossible because of ice, by plane was considered too dangerous, but by sled dog was another story.
Erin Allmann Updyke	(gasps) Oh my god.
Erin Welsh	This still doesn't sound familiar to you?
Erin Allmann Updyke	No.

Erin Welsh	Okay.
Erin Allmann Updyke	Wait, wait, wait. Is this a book or something?
Erin Welsh	Well it is a book but it's also a movie.
Erin Allmann Updyke	Is it Balto?!
Erin Welsh	Yeah. (laughs)
Erin Allmann Updyke	Stop it!
Erin Welsh	Yes.
Erin Allmann Updyke	This is Balto?
Erin Welsh	Yes.
Erin Allmann Updyke	Balto's about diphtheria? (laughs) I had no idea.
Erin Welsh	Yep. It's why I was so thrilled. (laughs)
Erin Allmann Updyke	Your face is so happy right now, it's like so satisfying.
Erin Welsh	Oh I love it. Well, Balto was... So Bloodmobile, who provides all of the music for this episode and all of our episodes is my brother Dan and-
Erin Allmann Updyke	We've blown his cover.
Erin Welsh	I think we already said that.
Erin Allmann Updyke	Yeah, I know.
Erin Welsh	He was obsessed with Balto, like we had to watch it over and over and over again.
Erin Allmann Updyke	Oh my god. That's adorable.
Erin Welsh	Yes. I've always loved it. Okay so... (laughs)
Erin Allmann Updyke	She's still so happy.
Erin Welsh	Anyway, so officials decided that they would use a relay of dogsleds to transport the serum 674 miles or 1085 kilometers from Nenana to Nome.
Erin Allmann Updyke	Wow.
Erin Welsh	Nenana's close to Fairbanks.

Erin Allmann Updyke	Okay.
Erin Welsh	The heroic efforts of the sled dogs and their handlers were on the front page of every U.S. newspaper.
Erin Allmann Updyke	Oh my god.
Erin Welsh	And much of the population awaited anxiously to see whether the antitoxin would successfully make it to Nome. These handlers, most of whom were Alaska natives, and their dogs had to endure extreme winter conditions. Dogs lost their lives, people lost their fingers or suffered permanent damage from frostbite. But in just 5.5 days, an area of 674 miles-
Erin Allmann Updyke	Of frozen, frozen...
Erin Welsh	Frozen. This is in January. Over 1000 kilometers in January. Mid January.
Erin Allmann Updyke	In Alaska. Oh my god.
Erin Welsh	Yeah. The antitoxin arrived in Nome carried by Gunnar Kaasen and his lead dog, Balto.
Erin Allmann Updyke	Balto!
Erin Welsh	About whom the movie was made. But I want to do my part to clear up a historical misrepresentation about Balto and the serum race. Even though Balto and Kaasen were the ones to deliver the serum to Nome, they were only the last ones in a long relay which involved many more dogs and handlers. Among these is the dog considered the true hero of this story: Togo.
Erin Allmann Updyke	Togo.
Erin Welsh	And his handler Leonhard Seppala. Togo ran more than 261 miles.
Erin Allmann Updyke	Oh my goodness.
Erin Welsh	420 kilometers during this relay and his leg of the relay was 91 miles, 146 kilometers which was more than twice any other team. He safely led his team through some of the worst conditions and across the treacherous Norton Sound which is this frozen inlet of the Bering Sea. So over frozen seawater.
Erin Allmann Updyke	Oh my god.
Erin Welsh	Yeah. But Togo didn't get any of the recognition or at least not nearly as much, especially right after the serum got there that Balto received, which like there's a statue of Balto in New York City's Central Park. And Seppala, who was the handler, was super salty about this.
Erin Allmann Updyke	Well yeah, I would be too cause he was with him.
Erin Welsh	Yeah, I know. The outbreak in Nome was small. Only 6 or 7 children died and maybe 50-100 people were infected with diphtheria but the numbers could've climbed a lot higher had the serum race not been successful. And maybe Togo will finally get the recognition he deserves because apparently there's a live action Disney movie in the works called 'Togo'.

Erin Allmann Updyke	Stop it.
Erin Welsh	In which Willem Dafoe, everyone's favorite hero-
Erin Allmann Updyke	What?
Erin Welsh	-will play Leonhard Seppala.
Erin Allmann Updyke	No. No, veto. Sorry Will.
Erin Welsh	Well, we'll see. Definitely gonna keep an eye out for that though. So I tell this story about Nome and Togo and Balto to underline just how scary this disease was.
Erin Allmann Updyke	Right. People were willing to go to pretty extreme lengths to protect this tiny little town.
Erin Welsh	Yeah! And they were captivated, like this was on the cover of every newspaper. A few years after the Nome serum race, a diphtheria vaccine was created using the toxoid, which was the inactivated form of the toxin, and it went into wide use in the 1930s and the disease really dropped off to where most doctors today have no idea what a diphtheria membrane looks like.
Erin Allmann Updyke	Only in pictures.
Erin Welsh	Or smells like.
Erin Allmann Updyke	(laughs) I think that's why we don't, like it's not in a picture.
Erin Welsh	Yeah, exactly. Scratch and sniff.
Erin Allmann Updyke	Yeah, we talk a lot about smells of some bacteria specifically that the bacteria make the smell, but with this my guess is that it's just a bunch of deadness that is making the smell.
Erin Welsh	I just wanna repeat again what I said about a scratch and sniff book.
Erin Allmann Updyke	Scratch and sniff pseudomembrane.
Erin Welsh	Scratch and sniff medical textbook.
Erin Allmann Updyke	Oh (laughs). Grody, dude. Nah, I would not. I would not buy.
Erin Welsh	That's genius! No but somebody would buy it for you.
Erin Allmann Updyke	Yeah that's true.
Erin Welsh	That's basically all I've got.
Erin Allmann Updyke	That's it? You're done?
Erin Welsh	I'm done.

Erin Allmann Updyke	You're like, 'And then they made a vaccine, story over'?
Erin Welsh	Well that's because I think that's where you pick it up and you tell me about how the anti-vaccine movement might be changing things.
Erin Allmann Updyke	Okay, let's do it.
TPWKY	(transition theme)
Erin Allmann Updyke	So just because we invented a vaccine doesn't mean we've pulled a smallpox. (laughs) This has not been eliminated from the world, it has not been eliminated from the United States, still exists. But in the United States it is actually a pretty huge success story. So for example, in 1921 in the United States before there was any kind of vaccine, there were 206,000 cases of diphtheria reported.
Erin Welsh	That's a lot. Reported!
Erin Allmann Updyke	Yeah, there were also over 15,000 deaths. I know, poor babes.
Erin Welsh	Oh my... Most children.
Erin Allmann Updyke	Yeah. But since 1980 there have not been any double digit year cases. So no double digit cases. That was a weird way to say it, Erin.
Erin Welsh	Fewer than 10.
Erin Allmann Updyke	Fewer than 10. There you go. And in many years 0 cases in the United States have been reported.
Erin Welsh	That's great.
Erin Allmann Updyke	It's very great. It's not so across the globe. So the World Health Organization, and I'll actually post this cause I don't think I'm the only one who'll find it interesting, has little fact sheets about the number of cases of all of the vaccine-preventable diseases of which diphtheria is one and how many or what percentage of people are actually vaccinated across the world. So this is aggregated, all of the countries of the world, how many actual case reports there have been of all of these diseases.
Erin Welsh	Okay.
Erin Allmann Updyke	So keep in mind as always that, you know, it's just the reported cases, there's a lot of underreporting and many places who might not report it at all, etc etc. But the numbers have been generally getting better for the most part. In 1980 worldwide there were over 97,000 cases of diphtheria reported.
Erin Welsh	Wait hold on, 1980.
Erin Allmann Updyke	1980

Erin Welsh	97,000!
Erin Allmann Updyke	97,000!
Erin Welsh	Okay.
Erin Allmann Updyke	1990 that number had dropped to 23,000.
Erin Welsh	Oh wow.
Erin Allmann Updyke	Holy crap, way to go, world. Right?
Erin Welsh	That's because of the vaccine?
Erin Allmann Updyke	I mean the vaccine has been in use since the 20s but vaccination rates-
Erin Welsh	Well sure but I mean better coverage?
Erin Allmann Updyke	Yeah they went up from 31% in 1980 worldwide to 88% in 1990.
Erin Welsh	Whoa.
Erin Allmann Updyke	Yeah, that's for one dose of the vaccine.
Erin Welsh	Okay.
Erin Allmann Updyke	So one thing I will say is that the vaccine for diphtheria is usually given in combination with tetanus and pertussis, so you might hear people say DTP or Tdap or Dtap, there's a lot of different versions of it. Yeah so these are all different combinations of diphtheria toxoid, which is just an inactivated toxin, tetanus toxoid, inactivated tetanus toxin, and pertussis, either the whole bacterium or parts of the bacterium. And because in all of those cases you're giving a killed toxin and not a live bacterium, your immune system only mounts a partial response to it. So one dose is not enough to actually give you full immunity. So in the U.S. children actually get five doses of Dtap.
Erin Welsh	Okay.
Erin Allmann Updyke	Up until they're about 6 years old. And then after that it's recommended that you get a booster every 10 years. Worldwide, one of the biggest challenges is making sure that people get all of the recommended doses of vaccines like the DTP vaccine because giving just one is good but giving three or four or five is a lot better.
Erin Welsh	Right.
Erin Allmann Updyke	So globally the rates of children who have received at least one DTP vaccine is pretty high but the rates that have received at least three, which is what's recommended by WHO, is a bit lower. Okay so where were we? We were in 1990, right, with 23,000 cases worldwide.
Erin Welsh	Yeah.

Erin Allmann Updyke	Cut to 2000. Still doing great, only 11,000 cases.
Erin Welsh	All right.
Erin Allmann Updyke	All right. 2013, 4000.
Erin Welsh	What? That's great!
Erin Allmann Updyke	2014, 7000? Must've been a fluke. 2015, back down to 4000.
Erin Welsh	Awesome, what's up?
Erin Allmann Updyke	2016, 7000?
Erin Welsh	Okay.
Erin Allmann Updyke	2017, 8800.
Erin Welsh	Okay, not a fluke.
Erin Allmann Updyke	Not a fluke, it's not great. It's hard to say for sure what the cause of this is because globally vaccination rates, at least reported vaccination rates, have not changed. Globally. That is not true in the United States. But what it basically mean sis that at least over the last five years, we haven't really gotten better, right?
Erin Welsh	Right.
Erin Allmann Updyke	We haven't made huge strides in the last few years in terms of actually reducing the burden of diphtheria. And it definitely still exists. and something that I thought was really interesting that i definitely didn't realize is that if you were to randomly screen a whole bunch of people's noses or nasal pharynxes in the United States, even in areas where you have relatively high or I suppose what someone would think would sound relatively high vaccination rates like say 80%, which sounds high but for vaccination rates is actually not good-
Erin Welsh	Yeah.
Erin Allmann Updyke	You can find a lot of people colonized with diphtheria in the United States. So this bacteria still exists here. So even though we haven't had a case of diphtheria in the United States since in 2012 we had 1, and before that it was 2003 we had 1.
Erin Welsh	Okay.
Erin Allmann Updyke	So even though the case rates of diphtheria in the United States are very low, that doesn't mean that it's not here, right.
Erin Welsh	Right.
Erin Allmann Updyke	The R0 of diphtheria is 6-7 which is really high.
Erin Welsh	It's really high.

Erin Allmann Updyke	It's second to measles, which we haven't-
Erin Welsh	It's like 14, I think.
Erin Allmann Updyke	How have we not talked about measles yet?
Erin Welsh	Because there are tons of diseases!
Erin Allmann Updyke	Okay, but we need to put that on the list.
Erin Welsh	It's on our list, yeah.
Erin Allmann Updyke	But yeah so it's really high. So what that basically means is that yeah, for every one infected kid you could potentially infect 6 or 7 more kids.
Erin Welsh	That's crazy.
Erin Allmann Updyke	It's crazy!
Erin Welsh	And scary.
Erin Allmann Updyke	It's really scary, especially also because the Tdap, Dtap, whatever you call it vaccine, they're different vaccines but whichever vaccine it is, is recommended for pregnant women and that's because since you have this waning immunity you wanna make sure that a pregnant woman is immune so that she passes on those immunoglobulins to her baby. Because babies don't actually get vaccinated until two months old. So for those first two months, they're super, super susceptible.
Erin Welsh	Gotcha.
Erin Allmann Updyke	If a woman maybe doesn't have access to prenatal care or doesn't have health insurance or things like that and doesn't get that, then you can potentially have babies that are completely susceptible. And so that's why this whole vaccination thing becomes really important is that it's not just about your individual risk, it's about the fact that there are a lot of people in the community that either are too young to be vaccinated, are very old so they just don't have a good immune system left, are already immunocompromised whether it's from something like HIV or leukemia or other immune disorders so they can't be vaccinated.
Erin Welsh	Right.
Erin Allmann Updyke	And so those are the people who are most at risk when you have low levels of vaccination in a population.
Erin Welsh	It just blows my mind after reading about this disease and hearing about this disease from you and the progression of disease that there are people who choose to go, 'No, I'm just gonna take my chances.'
Erin Allmann Updyke	I think that the thing is though that we don't hear about this.

Erin Welsh	Yeah, that's true.
Erin Allmann Updyke	It's not on the front page of our newspapers because one kid has gotten it since 2012.
Erin Welsh	In the U.S.
Erin Allmann Updyke	But it's also not in everyone's face and it's not everyday and it's not everywhere, so it's very easy individually to say that problem is elsewhere and it's not going to affect me. I mean I think that's why it's just about making sure that people are aware that these diseases still do exist and that's why these vaccines are important.
Erin Welsh	The disease itself is scary and what's the scariest thing is that there are people who can be protected against it and can by doing that protect other people against it and they are choosing to not do that.
Erin Allmann Updyke	Yeah.
Erin Welsh	That's the scariest part to me.
Erin Allmann Updyke	Yeah. Yeah it is, it's scary. It is scary.
Erin Welsh	Well.
Erin Allmann Updyke	I wish I had some happy note. I mean worldwide vaccine coverage is about 85-90% which is great.
Erin Welsh	Yeah.
Erin Allmann Updyke	Yeah that's good old diphtheria. Who knew? Quite honestly I didn't know most of this stuff.
Erin Welsh	Yeah. Yeah I feel like there's a lot more to diphtheria than I knew was going to be out there and I'm really glad that we covered this.
Erin Allmann Updyke	Yeah. Thanks Balto. I mean Togo.
Erin Welsh	Thanks, Togo.
Erin Allmann Updyke	Sources?
Erin Welsh	Yeah, I have a few.
Erin Allmann Updyke	Okay.
Erin Welsh	So the story of Balto and the whole sled dog race and the race for the antitoxin, it's called 'The Cruelest Miles' and it's by Gay and Laney Salisbury. And I also used The Cambridge World History of Human Disease, 'The Epidemic Streets' by Anne Hardy, and a couple of papers. But I also wanted to plug, I read this book in middle school and when it came up in the searches I was like I definitely recognize that cover. And it's called 'Running out of Time' by Margaret Peterson Haddix. It is quite dark, so no wonder I loved it.

Erin Allmann Updyke	(laughs)
Erin Welsh	Anyway, you should definitely read it, 'Running out of Time'.
Erin Allmann Updyke	I wanna read it.
Erin Welsh	Yeah, you should.
Erin Allmann Updyke	Also we'll definitely add that book to our Goodreads list which as a reminder you can find all of our sources including all of the articles and books that we read for each episode as well as links to our Goodreads list on our website thispodcastwillkillyou.com.
Erin Welsh	Thank you as always to Bloodmobile, also Balto's number one fan.
Erin Allmann Updyke	Yep.
Erin Welsh	And to all of you for listening.
Erin Allmann Updyke	Also don't forget if you aren't already to subscribe to all of our social media situations. Rate, review, subscribe on iTunes.
Erin Welsh	Well until next time, wash your hands.
Erin Allmann Updyke	You filthy animals!