TPWKY	This is Exactly Right.
Lauren Cowley	When the Ebola treatment center in Sierra Leone, the diagnostic lab that I was working in was adjacent to, when it first opened, the first Ebola patient was an 8 year old girl who was very, very ill. She actually only survived for a week after that but she made a special request that she would like some coconut water, it was very easy to get a hold of this and it was all arranged. But one lasting image that's like forever burned in my mind of my time in Sierra Leone is a doctor all kitted out in full Ebola PPE carrying two coconuts into the high containment Ebola treatment tent.
Nell Bond	One of the stories that really, really struck me was one of our survivor health advocates, Kulako Koroma. She had several children, she was married, and they ended up contracting Ebola from a couple traveling into their village from a different village that was affected already. And so they got sick and died and the couple had a baby and Kulako had a baby also, and so she took the baby and his mother had succumbed to the disease and breastfed that baby to keep the baby alive. And so the baby unfortunately had gotten Ebola from its mother and passed it on the Kulako and then she passed it on to her baby. And so she ended up losing four of her children including her infants as well as her husband.
	And it's incredible to hear someone tell that story and all of the emotion but then also see how strong she is afterwards and how she's showing up everyday, she wants to be a part of her community, she wants to rebuild her family, and just have so much hope for the future. And so that was pretty incredible. There's a lot of heartbreak but there's also a lot of hope that came out of it. People caring for people that they loved were the ones who were getting this disease and it's like a crazy thing.
Sarah Paige	Yeah it's vicious. It's vicious. Like passing along this deadly disease through acts of love is really, really hard to imagine. I mean, can you imagine being told that you can't comfort your infant or your toddler or your spouse while they're in exquisite pain? Just incredible.
TPWKY	(This Podcast Will Kill You intro theme)
Erin Allmann Updyke	Hi!
Erin Welsh	Hi.
Erin Allmann Updyke	And welcome to Episode 11-
Erin Welsh	Of This Podcast Will Kill You.
Erin Allmann Updyke	Wow, that's exciting.
Erin Welsh	I know!
Erin Allmann Updyke	(laughs) I'm Erin Allmann Updyke.
Erin Welsh	And I'm Erin Welsh. In case you haven't figured it out, this episode is all about Ebola. What you just heard were firsthand accounts of the 2014 Ebola epidemic told by three badass women: Lauren Cowley, Nell Bond, and Sarah Paige. We're gonna let them introduce themselves.
Lauren Cowley	So my name is Lauren Cowley and I'm a postdoctoral research fellow at Harvard T.H. Chan School of Public Health.

Sarah Paige	So I'm Sarah Paige, I had a circuitous pathway to my current field. So I work as a Global Health fellow, I am based at USAID. So I'm a Senior Infectious Disease Advisor sitting in on the Health Scheme and African Bureau so I work really closely with the Global Health team that's dealing with the emerging vets division in Global Health Security.
Nell Bond	Yeah so I'm Nell Bond. And so I first went to Sierra Leone part of a Lassa fever lab which is really interesting and exciting. And then now I'm working on AIDS pathogenesis in an immunology lab.
Erin Allmann Updyke	So we'll get back to them and some of their stories a little bit later in the episode. So what are we drinking today?
Erin Welsh	We are drinking The Spillover.
Erin Allmann Updyke	The Spillover! (laughs)
Erin Welsh	What is in The Spillover, Erin?
Erin Allmann Updyke	Today it's tequila, kombucha, some lemon juice, and some honey.
Erin Welsh	And don't forget the rim, which is a salt and sugar rim.
Erin Allmann Updyke	But the most important part of The Spillover, you could really make any drink that you want-
Erin Welsh	Anything. Beer, wine, water, juice.
Erin Allmann Updyke	Yeah. La Croix, for example.
Erin Welsh	Absolutely.
Erin Allmann Updyke	Just make sure you fill it all the way to the brim of the glass so that it's about to spillover. (laughs)
Erin Welsh	Yeah.
Erin Allmann Updyke	We're hilarious. Our most clever quarantini yet!
TPWKY	(transition theme)
Erin Welsh	So let's dive right into the biology of Ebola.
Erin Allmann Updyke	Absolutely.
Erin Welsh	One of the scariest.
Erin Allmann Updyke	So Ebolavirus is of course a virus.
Erin Welsh	What?

Erin Allmann Updyke	Shocking, I know. Specifically it's in the family known as Filoviruses, think that's how you say it. They're called this because they're filamentous viruses, under a very, very high-powered microscope, they look like worms.
Erin Welsh	Right.
Erin Allmann Updyke	All the viruses in the Filovirus family cause hemorrhagic fevers, all of them. Did you know that?
Erin Welsh	I don't know all the viruses in the-
Erin Allmann Updyke	Do you wanna know them? There's only two. Ayo!
Erin Welsh	Really?
Erin Allmann Updyke	I made it seem really dramatic but there's only two viruses in this family. (laughs) It's Ebolavirus and Marburg virus.
Erin Welsh	Oh okay, okay.
Erin Allmann Updyke	Yeah.
Erin Welsh	I didn't know it was just so limited.
Erin Allmann Updyke	I didn't either. So Ebolavirus is an RNA virus which we've seen before, yadda yadda, it has a fast replication rate, it makes lots of mistakes, etc etc.
Erin Welsh	Which means faster evolution.
Erin Allmann Updyke	Exactly, right. There are at least five known species of Ebolavirus: Sudan ebolavirus, Zaire, Reston - which is a very interesting, are you gonna talk about it?
Erin Welsh	I am.
Erin Allmann Updyke	Yes! I'm excited. And then Taï Forest which was formerly known as Ivory Coast or Côte d'Ivoire ebolavirus, and finally Bundibugyo, I think is how you say that, which actually wasn't discovered until 2008. Which that's crazy, an entire new species of virus!
Erin Welsh	Well.
Erin Allmann Updyke	Except that it's not that crazy since like we basically know nothing about microbes and even less about viruses, not just the ones that infect humans but overall.
Erin Welsh	Right.
Erin Allmann Updyke	Okay, so. There are five strains of Ebola and they differ in their pathogenicity. So the Zaire strain is the most virulent with fatality rates of up to 90%.
Erin Welsh	Yup.

Erin Allmann Updyke	It's really, that's terrifying. And then the Sudan strain which is probably the one that we know, Zaire and Sudan we've known about for the longest so we know the most about them.
Erin Welsh	They've caused the most outbreaks.
Erin Allmann Updyke	Exactly. That one has a case fatality rate of usually about 50%. And then the other ones tend to be lower. We don't entirely understand the pathophysiology of Ebolavirus.
Erin Welsh	Meaning the way it causes disease in your body.
Erin Allmann Updyke	Exactly, so we're not 100% clear on exactly what's happening inside your body. We know a few things. We know that it attacks your immune system, a few different types of your immune cells, and then it causes spontaneous cell death in other cells in your immune system. So basically it's causing a lot of damage to your ability for your body to fight it off.
Erin Welsh	Okay.
Erin Allmann Updyke	We also know that it additionally infects your endothelial cells which are the cells that line your blood vessels, which is why you can get hemorrhaging which we'll talk more about later. Because it basically makes your blood vessels leaky because it's damaging those cells, so then you have blood leaking out.
Erin Welsh	Yeah. Little pinpricks caused by the virus.
Erin Allmann Updyke	Exactly. And one thing that is clear is that those people who survive an Ebolavirus infection do so because they have a really good antibody response.
Erin Welsh	Interesting.
Erin Allmann Updyke	So somehow their bodies are making a lot of antibody and that's what makes a difference in the outcome of infection.
Erin Welsh	That's really interesting that it has to do with an individual immune response and I wonder whether that's entirely genetic or it has anything to do with the number of diseases you've been exposed to in your lifetime.
Erin Allmann Updyke	Or just the initial infection dose that you get infected with, like how many viruses you're infected with to begin with. And honestly from my reading of it, and so someone can correct me if we actually know this, I don't think we really know. It's not really clear what the distinctions are between individuals that end up surviving and not surviving aside form this antibody response and what causes them to have that response is unclear.
Erin Welsh	And also like high risk groups...
Erin Allmann Updyke	Exactly, right.
Erin Welsh	Yeah.

Erin Allmann Updyke	Yeah. Ebolavirus has an incubation period, which we've talked about before but I'll remind you, is the period of time from when you get infected until when symptoms first appear, that's between 2-21 days. On average I've seen about 10 or 11 days, that's what it was for example in the last outbreak in 2014/2015 was around 11 days on average.
Erin Welsh	Okay. So you touch somebody or you get infected-
Erin Allmann Updyke	You get infected.
Erin Welsh	And then-
Erin Allmann Updyke	11 days later you start to show symptoms.
Erin Welsh	You start to get the symptoms.
Erin Allmann Updyke	And one thing that's important about Ebolavirus is that you are not infectious until you start showing symptoms.
Erin Welsh	That is very important.
Erin Allmann Updyke	It's very important and you are not very infectious for the first few days of your infection after you start showing symptoms. So what that means is that how infectious you are to other people, meaning how easily it is for you as an infected individual to infect somebody else, depends on how many viruses are in your body. And that number of viruses is gonna increase over time. So at the beginning of your infection, you're not very infectious.
Erin Welsh	And so this is different than some of the other diseases that we've covered.
Erin Allmann Updyke	Exactly.
Erin Welsh	Where you are highly infectious even before you show symptoms.
Erin Allmann Updyke	Right, something like influenza for example, you're infectious several days before symptoms start and you tend to be most infectious at the beginning of the course of infection. Whereas with this you're most infectious at the end of the course of infection, which we'll talk about a lot later but is really important, was really important in this most recent outbreak.
Erin Welsh	Right and is really important in general in terms of predicting what diseases might be related to outbreaks or epidemics and so on.
Erin Allmann Updyke	Exactly.
Erin Welsh	Interesting.

Erin Allmann Updyke	Yeah. So the first symptoms of Ebolavirus, Ebolavirus disease... So Ebolavirus disease used to be called Ebola hemorrhagic fever, it's no longer called that. But the symptoms include a pretty sudden onset of fever and a relatively high fever, fatigue, muscle pain, headache, and often a sore throat. Then this is pretty quickly followed by vomiting, diarrhea, rash, liver and kidney failure and sometimes, although importantly not all of the time, internal and external bleeding. So that's where it got its previous name hemorrhagic fever because 'to hemorrhage' is basically just to bleed uncontrollably. So internal bleeding, which is something that we talked about I believe in yellow fever as well, that can result in things like black or bloody stool or vomit if you're bleeding into your GI tract. And then external bleeding, it's not... I think a lot of people have a misconception that Ebola results in you like exploding blood out of your orifices.
Erin Welsh	Right.
Erin Allmann Updyke	That doesn't happen in Ebola. You can get oozing of blood from your gums or your nasal passages, maybe the corners of your eye, things like that. Because Ebola can infect a huge variety of tissues. Ebolavirus does exist in basically all of your mucus membranes and things so anywhere that it exists you can get bleeding, but you don't have like explosive bleeding.
Erin Welsh	Right, there's no bleeding out.
Erin Allmann Updyke	Right. So you tend to die from things like very similar to what you die from in septic shock which is just your body being overloaded by both immune defenses and the virus itself and then just organ failure and that's what ends up actually causing death. The virus is transmitted via direct contact with certain bodily fluids, actually most bodily fluids. Feces, saliva, blood, vomit, semen, no one said it but I would assume vaginal fluids as well. And then the virus has to enter the next person that it's going to infect via contact with their mucus membranes, so eyes, nose, mouth, or a break in the skin. So it's not like you can get Ebola just from being in the same room as somebody with Ebola, it tends not to be transmitted via respiratory droplets but I'm hoping your gonna talk more about that.
Erin Welsh	Just a little bit, yeah.
Erin Allmann Updyke	Ooh! It's really interesting. It's actually really terrifying. That's I think the thing that makes people the most scared about Ebola is the potential for transmission via respiratory droplets which we've talked about before but again is coughing, sneezing, things like that. Yeah that's scary.
Erin Welsh	Close talkers.
Erin Allmann Updyke	Close talkers. So yeah, so that's how you get infected with Ebolavirus.
Erin Welsh	Bodily fluids.
Erin Allmann Updyke	Bodily fluids and direct contact. So healthcare workers are especially at risk of exposure because they're dealing with bodily fluids of people who are infected. Now it's still not what I would call 1000% certain what the animal reservoir for Ebola is but realistically it's bats. (laughs)
Erin Welsh	Mm-hmm. Yeah, probably.

Erin Allmann Updyke	Yeah so more than a few studies have found Ebolavirus, at least RNA, naturally in bat populations and without any evidence of infection. So the thing is that we know that ebolaviruses can infect other primates and other animals, they've been found in antelopes and things like that, but they tend to cause similar symptoms and massive mortality in a lot of those animals whereas in bats we don't see that. So that is the evidence that bats might be their quote unquote "natural" hosts because if viruses circulate for a long time in a host, they tend to evolve to be less virulent in that host whereas when they jump to new hosts it's unpredictable what the virulence is going to be. The one thing that we do know for sure, and I think that this is gonna be the transition to you talking about this, is that outbreaks tend to occur almost exclusively due to spillover events. So the question is how did we get here? What's up with Ebola and how did it start to be this virus that spills over and kills a bunch of people?
Erin Welsh	That is a question I am going to try to answer.
Erin Allmann Updyke	(laughs)
TPWKY	(transition theme)
Erin Welsh	Our story begins not in Africa, as you might expect, but rather in Germany.
Erin Allmann Updyke	Oh, okay, yeah.
Erin Welsh	Yeah. In a sleepy, picturesque little town. In 1967 several people arrived at the hospital with symptoms of extreme headache, internal clotting, fevers, and most severely, terminal shock.
Erin Allmann Updyke	Oof.
Erin Welsh	What did these people have in common? Well, they were all workers at a lab which produced polio vaccine from the kidney cells of African green monkeys. In total, 31 people were infected with this infectious agent and 7 of those died.
Erin Allmann Updyke	Wow.
Erin Welsh	During the outbreak, no one knew exactly what was causing the disease but the appearance of similar symptoms and death rates in the green monkey populations at the lab pointed towards an infectious agent.
Erin Allmann Updyke	Right.
Erin Welsh	Eventually researchers isolated the teeny tiny little nugget of RNA that was causing this terrifying disease and named it after the outbreak's location, Marburg.
Erin Allmann Updyke	So now we don't have to do an episode on Marburg, how disappointing. (laughs)
Erin Welsh	Well, I mean it could still be a future episode.
Erin Allmann Updyke	Yeah.
Erin Welsh	But this episode is not about Marburg.
Erin Allmann Updyke	No, it's not.

Erin Welsh	It's about Ebola.
Erin Allmann Updyke	Yep.
Erin Welsh	So why do I talk about Marburg?
Erin Allmann Updyke	Great question.
Erin Welsh	Well to answer that, let's jump ahead to 1976.
Erin Allmann Updyke	9 years.
Erin Welsh	9 years after the Marburg outbreak in Germany. In mid September, a report came in to Kinshasa, the capital of Zaire which is now known as the Democratic Republic of the Congo, DRC, of a strange new illness causing bloody vomit, bloody diarrhea, bloodshot eyes, and ultimately death in dozens of people. The epicenter of this outbreak was a mission hospital in Yambuku. A few weeks before this report was issued, the first case appeared, a local school headmaster named Mabalo Lokela. At first the doctors though malaria and sent him home with some pills to deal with it, but he didn't get any better.
Erin Allmann Updyke	Not malaria.
Erin Welsh	No. And saying he didn't get any better is a bit of an understatement.
Erin Allmann Updyke	Oh, he died.
Erin Welsh	Yeah.
Erin Allmann Updyke	Yeah.
Erin Welsh	But a week after he left the hospital, he died in pain, confused and bleeding from multiple orifices. His body was tended to and buried according to local customs-
Erin Allmann Updyke	Oh no.
Erin Welsh	Which include washing the body, clothing it, clipping fingernails, touching it and kissing it during funeral proceedings.
Erin Allmann Updyke	Yeah.
Erin Welsh	Yeah.
Erin Allmann Updyke	Yeah.
Erin Welsh	And since as we know Ebola is spread through close personal contact, it should come as no surprise to you that 21 of his close friends and family members became infected during this funeral.
Erin Allmann Updyke	And that's when you're sort of most infectious is at the end of the course.

Erin Welsh	Right.
Erin Allmann Updyke	But they had no idea.
Erin Welsh	They had no idea!
Erin Allmann Updyke	No idea.
Erin Welsh	And so from there it erupted, prompting the panicked reports for help. International help did come in the form of epidemiologists, virologists, and physicians. They went to work mapping out victims and tracing contacts. One unusual pattern emerged first.
Erin Allmann Updyke	Ooh.
Erin Welsh	The hardest hit group was women between the ages of 20 and 30. Why do you think that these were the people most likely to suffer from Ebola and have the highest death rates?
Erin Allmann Updyke	Were they the healthcare workers? Were they nurses?
Erin Welsh	No.
Erin Allmann Updyke	Were they the ones preparing the bodies?
Erin Welsh	Uh uh.
Erin Allmann Updyke	Who were they?
Erin Welsh	Females, 20-30, tended to be the ones who were either pregnant or recently pregnant.
Erin Allmann Updyke	Oh.
Erin Welsh	Right. One of the groups at highest risk or highest impact are those who are pregnant or recently given birth.
Erin Allmann Updyke	Is that because their immune systems are depressed?
Erin Welsh	I think that's one of the reasons. The other reason is that it turns out that this clinic, this hospital was used a lot for prenatal care.
Erin Allmann Updyke	Oh no!
Erin Welsh	And the nurses and nuns who were working at the hospital tended to reuse needles.
Erin Allmann Updyke	Cross contamination! Oh that's so sad.
Erin Welsh	Right? So yeah, the epidemiologists there were pretty confident that they were tracking an outbreak of an infectious disease but many questions remained. First, what was the pathogen? Second, how was it being transmitted? And third, where had it come from?

Erin Allmann Updyke	Yeah, all good questions. (laughs)
Erin Welsh	Right. Essential in an outbreak.
Erin Allmann Updyke	Tell me the answers.
Erin Welsh	So to answer the first question which is what was this, they sent blood samples from infected people to the CDC to try to isolate whatever pathogen might be in there.
Erin Allmann Updyke	Okay.
Erin Welsh	The earliest theory, which is that the cases were yellow fever, was quickly rejected because of the extremely high mortality rate and the different yet equally or even more terrifying symptoms of the illness.
Erin Allmann Updyke	Yeah.
Erin Welsh	Next Marburg. Even though only a handful of people became sick during the Marburg outbreak, it made huge news and kind of woke up a generation of virologists, epidemiologists, physicians, and so on. So when these healthcare professionals saw what was happening in Zaire mirrored what had happened in Marburg, they figured it could be a similar if not the same disease. But let's look past the conjecture to some cold, hard facts.
Erin Allmann Updyke	Yes!
Erin Welsh	I'm talking microscope.
Erin Allmann Updyke	Oh yes.
Erin Welsh	Under the scope, the virus in the sample received by the CDC looked very similar to Marburg. It was thin and filamentous.
Erin Allmann Updyke	Yeah. Wiggly. (laughs)
Erin Welsh	(laughs) So similar in fact that later analysis would put them in the same family of viruses, as we've heard, the Filoviridae. But this new virus wasn't quite the same as Marburg. It needed its own name and for this part the healthcare workers in Zaire basically walked outside the clinic, closed their eyes, twirled around a few times, and pointed.
Erin Allmann Updyke	(laughs)
Erin Welsh	And their fingers ended up pointing towards the Ebola river.
Erin Allmann Updyke	Isn't it the case that they're not supposed to do that anymore? Name diseases after the place that they were discovered because it puts a lot of stigma on them?
Erin Welsh	Very true.
Erin Allmann Updyke	Yeah.

Erin Welsh	It hasn't really stopped the trend in Ebola.
Erin Allmann Updyke	No, not at all, like every different species is named after where it was found. Like come on guys, get it together.
Erin Welsh	Okay. So at this point, the scientists can put a name to the face of this virus. But there are still unanswered questions. How was it being transmitted? Could it be vector-borne? Researchers checked bed bugs, mosquitoes, biting flies, but found no trace of infection. The numbers of infected, though terrifying, seemed too low for it to be airborne. That left close physical contact and exposure through infected bodily fluids. Still the last question remained.
Erin Allmann Updyke	Yeah.
Erin Welsh	Where did this disease come from?
Erin Allmann Updyke	Seriously.
Erin Welsh	And that is actually a question that researchers are still struggling to answer. It's probably bats as we've heard but to date no live virus has been isolated from a bat. But why do we think bats?
Erin Allmann Updyke	Good question.
Erin Welsh	Why are bats the top contender? Well first of all, bats are incredibly species-diverse.
Erin Allmann Updyke	Yeah they are.
Erin Welsh	Did you know that 1 in every 4 mammalian species is a bat?
Erin Allmann Updyke	No! 1 in every... I knew there was a lot of them but oh my god!
Erin Welsh	Yeah. There are over 1100 species of bats.
Erin Allmann Updyke	So you go like cat, dog, monkey, bat.
Erin Welsh	Yes.
Erin Allmann Updyke	And then like armadillo... What are some other mammals? Dolphin, whale, bat. That's how you do it!
Erin Welsh	(laughs) That's exactly how you do it.
Erin Allmann Updyke	Wow, that was embarrassing for me.
Erin Welsh	(laughs) What are some other mammals besides...
Erin Allmann Updyke	Oh, here we go, here we go. Rat, shrew, vole, bat!

Erin Welsh	There you go!
Erin Allmann Updyke	There's a lot of rodents, too.
Erin Welsh	There are a lot of rodents.
Erin Allmann Updyke	(laughs)
Erin Welsh	Yeah and so if each species of bat carries an equal viral diversity or viral load, that's a lot of bat viruses.
Erin Allmann Updyke	Ooh yeah.
Erin Welsh	And to add to that is the fact that most bat species are highly social and live in large groups.
Erin Allmann Updyke	Yep.
Erin Welsh	And does that remind you of anything?
Erin Allmann Updyke	Yep.
Erin Welsh	Like what happened when a human started living in large groups?
Erin Allmann Updyke	I was gonna say ants, but... (laughs) Sorry!
Erin Welsh	Put on your disease ecology hat. Yeah.
Erin Allmann Updyke	Disease ecology hat. Humans when they gathered in large groups like during the agricultural revolution, that's when we saw a huge amount of infection and disease. Totes.
Erin Welsh	Disease emergence, disease spread, etc. yeah. Also many species of bat tend to have lifestyles or natural histories, sure, that bring them into close contact with humans like roosting in buildings or in fragmented forests.
Erin Allmann Updyke	Yeah. And that's because we tend to destroy their natural habitats.
Erin Welsh	I'll get at that later.
Erin Allmann Updyke	Okay great. (laughs)
Erin Welsh	Finally, bats can fly.
Erin Allmann Updyke	Yep.
Erin Welsh	They can travel great distances, particularly during migrations, up to 800 miles. And so that allows for the exchange not only of pathogens within and among bat species but also with humans and wildlife.
Erin Allmann Updyke	Yeah, big time.

Erin Welsh	Many Ebola outbreaks actually have been preceded by large scale die-offs of primates such as chimpanzees and gorillas. In fact, one thing I read suggested that 1/3 of the global gorilla population has been destroyed by Ebola outbreak.
Erin Allmann Updyke	Because of Ebola specifically!
Erin Welsh	1/3.
Erin Allmann Updyke	Oh my god that's so sad!
Erin Welsh	It's insane.
Erin Allmann Updyke	Wow!
Erin Welsh	Yeah and so overall the lack of information that we have about the natural history or the ecology of this virus is really pretty worrisome because it then becomes harder to predict or prevent outbreaks from happening.
Erin Allmann Updyke	Yeah. Definitely.
Erin Welsh	And it also means that we don't know how risk will change in the future as many countries in Africa continue to become more urbanized and the climate continues to change. So all of this, all of this thought about bats and the natural reservoir and primates and how they play a role, all of that was in the background of these researchers' minds who were present at the Zaire outbreak in 1976.
Erin Allmann Updyke	Wow.
Erin Welsh	What was actually occupying them was the extremely high death rate. 318 cases with 280 deaths.
Erin Allmann Updyke	Oh my god.
Erin Welsh	A mortality rate of almost 90%.
Erin Allmann Updyke	That's...
Erin Welsh	It's really hard to imagine. All within the span of a couple of months. And eerily, reports of another outbreak were coming in from Southern Sudan around the same time.
Erin Allmann Updyke	Oh no.
Erin Welsh	Since there were already researchers on the ground in Zaire, a few of them figured they'd head to Sudan to assess the situation. And once there, they found a village already well within the throes of a similar outbreak. What were the chances?
Erin Allmann Updyke	What were they?
Erin Welsh	I have no idea. (laughs) Infinitesimal.

Erin Allmann Updyke	Yeah.
Erin Welsh	These outbreaks had to be related though, right?
Erin Allmann Updyke	Yeah, I would assume so.
Erin Welsh	But there was no way that an infected individual could travel the long distance between the two impacted areas without A) dying, or B) spreading infection to villages along the way.
Erin Allmann Updyke	Inbetween, yeah.
Erin Welsh	Samples were collected and shipped off to the CDC form the Sudan outbreak who confirmed that yes, this is Ebolavirus, but a completely different strain.
Erin Allmann Updyke	Wow.
Erin Welsh	An apparently less lethal strain with only, and 'only' here is relative, 150 dying out of 284 cases, which is about 53%.
Erin Allmann Updyke	Yeah.
Erin Welsh	So in 1976, two outbreaks of Ebola occur almost simultaneously.
Erin Allmann Updyke	That's crazy!
Erin Welsh	Miles apart, alerting the world to this disease for the first time.
Erin Allmann Updyke	And two completely different strains, like what are the chances that that would happen at the same time? Wow.
Erin Welsh	Yeah, it's very interesting.
Erin Allmann Updyke	Yeah.
Erin Welsh	After making its big debut in the 70s, Ebola goes underground for a while with a few individual cases popping up here and there throughout the 80s and 90s, and one resurgence of the Sudan strain in the same location as the '76 outbreak. It's not really until the mid 90s that we see outbreaks of similar size occurring, and I'll return to those later. But first I want to talk about one of the most infamous Ebola outbreaks, one with a human death toll of 0.
Erin Allmann Updyke	What? Oh yeah!
Erin Welsh	Hazleton Laboratories, Reston, Virginia.
Erin Allmann Updyke	Virginia, United States, by the way.
Erin Welsh	1989

Erin Allmann Updyke	Yeah.
Erin Welsh	If you've read The Hot Zone, as I suspect many of you have-
Erin Allmann Updyke	To be honest I haven't but don't hate me for it.
Erin Welsh	I don't hate you for it. This story may sound familiar, though with a little less of the blood and gore that Richard Preston, let's face it, likes to overdo.
Erin Allmann Updyke	(laughs)
Erin Welsh	In these labs, crab-eating macaques, a type of monkey imported for research purposes, started to show signs of extreme illness: bloodshot eyes, bloody vomit, you know the drill. And then they started to die. Red flags, right?
Erin Allmann Updyke	Yeah, poor babies.
Erin Welsh	Yeah, for sure. Samples of tissue from infected monkeys are sent to the U.S. Medical Research Institute of Infectious Diseases, USAMRIID, which you may have heard of.
Erin Allmann Updyke	Wow.
Erin Welsh	Yeah, it's a long title. Where initial tests indicate the presence of Ebolavirus, Zaire strain. But so far no human had gotten sick, very unlike Ebola Zaire.
Erin Allmann Updyke	Yeah.
Erin Welsh	Nevertheless, blood samples were taken from a bunch of workers who handled the monkeys and six of them actually ended up seroconverting. Basically, antibodies for Ebola were detectable in their blood.
Erin Allmann Updyke	But they weren't sick at all.
Erin Welsh	No one was ill! No one was sick!
Erin Allmann Updyke	That doesn't sound like Ebola to me.
Erin Welsh	Uh uh. So closer examination revealed that this virus, though very similar to Ebola Zaire, was actually yet another strain of the Ebolavirus. Apparently not harmful to humans.
Erin Allmann Updyke	Wow.
Erin Welsh	And also transmitted by air. The scariest part of it.
Erin Allmann Updyke	This is the thing that when I read it, I was like oh now I understand why they were like, 'Oh, we need to do a crap ton of research on Ebola because there is a strain that is transmitted by respiratory droplets because these monkeys in cages that were separated from each other all got sick.'
Erin Welsh	It's very scary.

Erin Allmann Updyke	And what would happen if one of these very severe strains like Zaire, because it's an RNA virus that mutates so rapidly, just happens to mutate something that makes it possible to be transmitted this way?
Erin Welsh	I mean all these hypotheticals are what drives our anxiety and fear.
Erin Allmann Updyke	I know, I know. This is why I bought two night guards today for my teeth grinding.
Erin Welsh	(laughs) Oh my god!
Erin Allmann Updyke	(laughs) That's too much personal information. I live with anxiety.
Erin Welsh	(laughs) Sorry for laughing.
Erin Allmann Updyke	It's pretty funny, I bought a two-pack because-
Erin Welsh	This is how I measure my anxiety.
Erin Allmann Updyke	Yeah, my dog ate the last one, so. I'm sorry. Getting off topic here.
Erin Welsh	Okay, so.
Erin Allmann Updyke	Back on track.
Erin Welsh	Back on track. So in keeping with the geographical tradition of strain-naming, this virus is called Ebola Reston. Over three months, about 1/3 of the monkeys who were at the facility died and at the peak of the outbreak, two or three were dying each day. If you really know your primate natural history, you know that crab-eating macaques aren't from Africa, which is the continent we most associate with Ebola, but rather Southeast Asia.
Erin Allmann Updyke	Yeah, dude.
Erin Welsh	These monkeys had been imported from the Philippines. While the Reston outbreak was happening in a contained facility in Virginia, more monkeys were dying by the dozens in the wild in the Philippines and also in China, along with some pigs.
Erin Allmann Updyke	Oh.
Erin Welsh	Yeah. This outbreak revealed a few frightening things about Ebola. One is that different strains of the Ebola virus might be a lot more widespread than we previously thought.
Erin Allmann Updyke	Yeah.
Erin Welsh	Another is that outbreaks could easily occur in places where the Ebola virus reservoir doesn't exist. If the Reston strain of Ebola had been harmful and transmittable by humans, basically if it had behaved the way we expected it to, it could have been an enormous epidemic if not pandemic and in the U.S. which obviously got a lot more people interested in it.
Erin Allmann Updyke	Yeah.

Erin Welsh	Now that it wasn't just some quote "over there" disease but one that could happen over here, you know, typical. Typical response.
Erin Allmann Updyke	That's still true today.
Erin Welsh	I mean basically the only time that any westernized country cares about any of these diseases is if it could actually happen to mostly wealthy, white people.
Erin Allmann Updyke	Is if they're personally affected. Right.
Erin Welsh	Anyway.
Erin Allmann Updyke	Anyway.
Erin Welsh	After the Reston outbreak in 1989, Ebola went relatively quiet for another couple of years until 1994-1996 when Ebola Zaire caused outbreaks in Gabon and the DRC with mortality rates ranging from 60-81%.
Erin Allmann Updyke	God.
Erin Welsh	Again, scientists deployed to the impacted areas attempted to trace the outbreak to its natural origin but were unable to. In one outbreak, several of the index cases were workers in mines inhabited also by bats. In another it was traced to the consumption of a chimpanzee that had been found dead in the forest.
Erin Allmann Updyke	That's not a good idea.
Erin Welsh	Nope. Samples were taken from many species of animals but still active infection was not found. 2000-2013 saw outbreaks in Uganda, Gabon, Republic of the Congo, Sudan, DRC, with the number of cases ranging from a few dozen to over 400, finally reaching 1976 numbers and mortality rates around 50-60%.
Erin Allmann Updyke	Wow.
Erin Welsh	These numbers of course would pale in comparison to what the world saw in 2014, but we'll get to that in a bit.
Erin Allmann Updyke	Yeah.
Erin Welsh	First though, let's chat about the evolutionary history of Ebola.
Erin Allmann Updyke	Okay!
Erin Welsh	Why has it taken so long to show itself? Or has it popped up many more times but we failed to recognize it?
Erin Allmann Updyke	That's a really good question. Do you know the answer?
Erin Welsh	Uh uh.

Erin Allmann Updyke	(laughs)
Erin Welsh	No one does.
Erin Allmann Updyke	Ugh! If only we could answer these unanswerable questions on this podcast. We'd make millions! Just kidding. We'd solve world problems. That's more important.
Erin Welsh	(laughs) I know where your mind first went though and I'm judging you.
Erin Allmann Updyke	Okay.
Erin Welsh	So anyway, to try to answer this question though, viral paleontologists - which how cool would it be to have that on your business card?
Erin Allmann Updyke	Oh my god.
Erin Welsh	Traced the origin of the family of viruses that Ebola belongs to, the Filoviridae. I keep wanting to say 'feeloviridae'.
Erin Allmann Updyke	I don't know which one it is.
Erin Welsh	Whatever. They traced it back millions of years.
Erin Allmann Updyke	Really?!
Erin Welsh	Apparently this family may have emerged as far back as 15-23 million years ago.
Erin Allmann Updyke	What?
Erin Welsh	And then they continued to evolve and diverge.
Erin Allmann Updyke	Interesting.
Erin Welsh	So these viruses aren't brand new but maybe some of the strains are brand new to humans. Anecdotal reports suggest that at least one of the doctors who tended to people with Ebola in the 1976 outbreak was immune to the disease, having recovered from a very similar severe illness six years prior.
Erin Allmann Updyke	Interesting.
Erin Welsh	But still, reports of earlier Ebola outbreaks are pretty sparse.
Erin Allmann Updyke	Yeah.
Erin Welsh	So why 1976? In a word: urbanization. Urbanization means increased contact between humans and wildlife and a subsequent exchange of pathogens between the two. But before you break out your pitchforks and kill all the bats - seriously, don't do that, bats are incredible and they also perform a lot of ecosystem functions.

Erin Allmann Updyke	Yes.
Erin Welsh	Know that humans really only have ourselves to blame.
Erin Allmann Updyke	Yeah, as usual.
Erin Welsh	Urbanization is responsible for, I think it's safe to say, really the majority if not all of the zoonotic spillover events in the past 100 years.
Erin Allmann Updyke	Yeah. Well plus on top of that, like just on top of the fact that you're gonna have more spillovers the more that you're encroaching on forest systems, you also then have humans, like we've talked about, in close contact which allows for human to human transmission.
Erin Welsh	I mean it has to do with the difference between an outbreak and an epidemic or an outbreak and a pandemic.
Erin Allmann Updyke	Or a single case that you might never hear about. So.
Erin Welsh	Sure. Exactly.
Erin Allmann Updyke	Yeah.
Erin Welsh	Yeah and urbanization plays a huge role in the 2014 epidemic that left over 28,000 people infected.
Erin Allmann Updyke	Yeah.
Erin Welsh	Until 2014, all of the Ebola outbreaks tended to be limited to central Africa in rural villages close to forested areas. And the 2014 epidemic started off that same way with one important difference. It began in the West African country of Guinea, something that would delay its recognition as an outbreak of Ebola. The first person infected with Ebola during this epidemic was a 2 year old named Emile who lived in a rural Guinean village. He picked up the virus in December 2013, probably when he and a group of children were playing near a hollow tree occupied by a colony of bats. Sadly, Emile died of his infection and during the burial ceremony, several other family members and village members became infected. From there, the disease spread, eventually jumping beyond this index village, crossing borders, and invading large urban areas where it spread like wildfire, infecting and killing thousands. But that is a story that I want you to tell.
Erin Allmann Updyke	(laughs)
Erin Welsh	So please, Erin, tell me about the biggest epidemic of Ebola so far.
TPWKY	(transition theme)
Erin Allmann Updyke	I'll try. So like you said, we call it the 2014 outbreak but it started in 2013 and it continued until well into 2015.
Erin Welsh	Yes.

Erin Allmann Updyke	In total there were 28,616 cases according to WHO and 11,310 deaths.
Erin Welsh	Wow.
Erin Allmann Updyke	Yeah.
Erin Welsh	That's so crazy.
Erin Allmann Updyke	Yeah. So one thing that was really important in this outbreak was being able to diagnose cases rapidly on the ground and trace those cases based on their contacts. So to tell you more about that, let's go back to Lauren Cowley who was there helping to do exactly that.
Lauren Cowley	It was back in November 2014, Public Health England which was where I worked at the time decided they were gonna set up three diagnostic labs in Sierra Leone and I volunteered to be a member of Team 1. So we set up and ran the Ebola diagnostic labs in Port Loko in Sierra Leone and we provided Ebola and malaria diagnostics for the area, so we served the Ebola treatment center and the surrounding towns and villages. And so I was there for five weeks and we ran the diagnostic lab there and I cam home on Christmas Day. And then I actually went out again, I was deployed six months later in June, 2015 to Guinea to provide sequencing of new Ebola cases using Nanopore sequencing technology and this was in cooperation with the European mobile lab.
	Our sequencing lab was adjacent to the Ebola treatment center in the outskirts of a town called Koya in Guinea. And there we were using RNA extractions from new cases of Ebola that were sent from all over Guinea to be sequenced. And then we use these sequences to look at transmission tracing and epidemiological investigation. So yeah, we were trying to look at genetic similarities to try and cross the cases that might be causing transmission chain based on their geo sequences. For a disease like Ebola, in order to effectively tackle an outbreak, you quickly need to be able to establish very fast diagnostics and transmission tracing and then hopefully chain interception by the epidemiologists. And just as we looked at with Ebola, you were actually able maybe to be able to use genetic information to help with it.
Erin Allmann Updyke	So that's pretty incredible that they were able to do this rapid diagnostic testing both in PCR but also with sequencing. So one thing that's important is that this left over 10,000 survivors of the disease and we've never seen numbers of survivors of Ebola that are that high, so that's something that countries and the world are sort of grappling with at this point is how to best serve these survivors of the disease.
Erin Welsh	And here to tell us about that are a couple of experts, Sarah and Nell, whom you've heard from earlier and they're going to talk about their awesome project Ebola Survivor Corps. This project was originally submitted as part of a Gates Grand Challenge, it wasn't funded but it did receive a lot of encouragement. So they took it upon themselves to raise funding for this organization. Let's let them share their experience.
Sarah Paige	There was an opportunity to volunteer with Partizan Health or Médecins Sans Frontières but once you go into the volunteer application, first they would say, 'Yeah, we want anthropologists' but then there's no place to actually check off the box. I was like this is what I've been waiting for, this is what my training is about. But there wasn't a chance to get involved so instead I helped convene the lab at University of Wisconsin and this disease ecology group, the lab together to come up with a proposal to respond to a USAID Gates Grand Challenge to sort of encourage treatment-seeking.

	And thought it would be really useful and empowering and obvious to support Ebola survivors or reentry into society and into communities and take advantage of this existing immunity from renewed infection and put them to work as first responders and train them to do infection prevention control and sort of loop them into the surveillance teams. It became really consuming but also really, really rewarding because we were able to do something to respond within our skill sets and what space there was for us. So we raised $15,000 and during that campaign we found Nell and Nell was able to transform the Ebola Survivor Corps concept into a project on the ground. I'll let Nell take over from there.
Nell Bond	So I went in 2015 and saw the project. So the Ebola outbreak at that time was sort of winding down, still happening but it was winding down, and when I got there our first goal was to identify any like top local stakeholders and identify Ebola survivors to work with. And so we went out into the field and we're working in this really remote area of northern Sierra Leone in Koinadugu District and it had sort of got the outbreak later and didn't have quite as intense of an outbreak but that actually worked well for us due to the scale of our project so we could actually like manage the relatively smaller number of survivors.
	So we went there and met with the survivors and with the chief and everything and started doing infection prevention control training with them and like a social mobilization training and got them basically set up to work initially as sharing infection prevention control information but also as sort of like a health educational resource for the community. So they're going out and they're talking to different people in their community in the local language and explaining different health issues, mostly infectious disease stuff, on a level that people can really understand and trying to make that information more accessible.
Erin Allmann Updyke	Yeah. There has been a lot of critique of the response to this outbreak.
Erin Welsh	Mm-hmm.
Erin Allmann Updyke	There's actually a really great article that I'm not gonna wait to cite cause I know a lot of people don't listen to our citations.
Erin Welsh	That's okay.
Erin Allmann Updyke	It's fine but I wanna tell you about this article because it's great.
Erin Welsh	Okay.
Erin Allmann Updyke	It's called 'Critiquing the response to the Ebola outbreak' and you can find it... It was by Vera Scott et al in 2016, google it. So the World Health Organization response to this outbreak was very similar to the response that they've had to all the other outbreaks. It's what we would probably call a classic outbreak control response which basically means a whole bunch of technical and medical professionals swoop in and they isolate people and they try to break the chain of infection. And the thing is in past outbreaks this has been fairly effective in blocking further transmission. We never saw outbreaks that reached even the thousands before this. What was the biggest one in 2001 or 2002?
Erin Welsh	450
Erin Allmann Updyke	450? Not that that's not a ton of people but it's nothing like what we saw in 2014.
Erin Welsh	Yeah.

Erin Allmann Updyke	So this outbreak clearly spiraled out of control. There are a lot of reasons for this, it's not like there's one single answer as to why this happened. For one thing, when people swoop in and start telling everyone on the ground what to do, there's often resistance and in many cases in these areas... So the three countries that were most affected by this outbreak were Guinea, which was where it started, Sierra Leone, which is where it spread next, and Liberia, which is where it went after that.
Erin Welsh	Right.
Erin Allmann Updyke	So in many cases in these countries there's not a lot of trust of the government or authorities and especially not foreign authorities that are just coming in and telling people what to do.
Erin Welsh	Which is-
Erin Allmann Updyke	Exactly what happened.
Erin Welsh	Historical, right. But that's because of historical reasons, colonization...
Erin Allmann Updyke	Exactly. Right. Yeah. On top of that, there's not any good treatment options for Ebola.
Erin Welsh	Right, it's just maintain.
Erin Allmann Updyke	Yeah so if you bring your family member to the hospital and they end up dying and then you bring your next family member to the hospital and they end up dying, why would you wanna keep bringing your family members to the hospital? They're just going to die. So during this outbreak and especially towards the beginning, hospitals honestly weren't even trying to treat and there's not any evidence that hospitalization made a difference in terms of mortality rates. So they set up a bunch of these Ebolavirus disease treatment centers but they were basically holding cells.
Erin Welsh	Like quarantine or...?
Erin Allmann Updyke	Yes, they were isolation facilities that were just trying to break the cycle of transmission, which from a public health perspective I understand. You have to try and break the cycle of transmission but imagine that you're a mother or a father or a child of a person who's infected, why would you bring your family member to a place where they're not going to be able to touch anyone or see anyone, just to die? Like there's not a lot of incentive to cooperate with these people who are just taking your family members away, not doing anything to help them, and just letting them die.
Erin Welsh	Right.
Erin Allmann Updyke	Plus healthcare systems in these three countries were woefully understaffed and underfunded and just overwhelmed by the sheer numbers that were coming in. In these healthcare facilities they also didn't always have protocols in place or they didn't have enough equipment to even follow protocols, so you had a lot of what you call nosocomial infection which just means hospital-acquired infection. So both healthcare workers and maybe people who were in the hospital for other illnesses ended up getting infected with Ebola because of practices that were happening in these hospitals.
Erin Welsh	Right.

Erin Allmann Updyke	So there were a lot of sort of issues that led to this epidemic being as big as it was. Distrust in authorities, people swooping in and just sort of not being cognizant of local customs in the areas that they were dealing with. One of the biggest things that directly led to a large number of cases were local burial practices. So you mentioned this before but local burial practices in these areas, because of religious reasons, involved directly touching or washing the body. And it's estimated that at least 20% of new Ebola infections occurred during the burials of people who died from Ebolavirus.
Erin Welsh	Yeah.
Erin Allmann Updyke	Because like we mentioned before at the time of death from Ebola, your viremia, the number of viruses in your body, is really, really high. So you're really infectious. And at first, I didn't see this explicitly written anywhere, but from what I gathered reading various sources, the WHO was requiring that all bodies of people who died from Ebola be cremated which is very much against the normal practices in these areas.
Erin Welsh	Right, so you imagine all of these people coming in and being like, 'Uh uh, don't do it the way that you've been doing it for generations. Don't do it according to your religion, according to your traditions, do it my way.' How is that gonna be well received?
Erin Allmann Updyke	Right. Yeah. Like we're going to take your family member away from you, not let you give them a burial that is important for their afterlife... It's extremely problematic. And so it took them a long time, they eventually got together a safe burial protocol and they sort of got their ish together in figuring out a way to sort of work within what is normal for that region and still prevent further infection. But yeah, it's just another example of western countries coming in, or people from western countries coming in and not-
Erin Welsh	Being sensitive to cultural practices.
Erin Allmann Updyke	Right. And because of that, making things a lot worse, you know?
Erin Welsh	Right. And being like, 'How don't you know that this is what you're supposed to do?'
Erin Allmann Updyke	Right. So a lot of people were not bringing their family members in to the hospitals or once they died, not bringing them in because they didn't want them to be cremated. Yeah. On top of that, the infrastructure there, like we said, wasn't very good, so a lot of people couldn't survive the trip from maybe their village to the hospitals because road infrastructure, roads, vehicles weren't available to them to even transport their family member to begin with.
Erin Welsh	Right.
Erin Allmann Updyke	So there was a lot of things working against the WHO before they even got there but they didn't do a great job. I think the problem was that they sort of expected this to be like every other outbreak they had dealt with before and it wasn't. The outbreak definitely started in December of 2013, the WHO was notified about outbreak status I believe in March of 2014, and it wasn't until August of that year that they said, 'Hey, this is a really huge public health problem.'
Erin Welsh	Are you freaking kidding me?
Erin Allmann Updyke	August. I think it was August 8th of 2014 that they were like, 'This is a big problem.'

Erin Welsh	By that time how many thousands of people had died? Are you kidding?
Erin Allmann Updyke	Yeah. I mean it definitely got worse from there is the thing, so... Yeah. So. One thing that I'll say that's important to keep in mind is that there's a lot of reasons that these countries weren't able to deal with these epidemics on their own that have to do with former colonization and with the World Health Organization and other international organizations sort of constantly being in these countries taking over, if that makes sense. So-
Erin Welsh	Like not actually building up infrastructure or public health but just coming in when needed.
Erin Allmann Updyke	Exactly. So the international public health community has a focus on disease preparedness, like we have to prepare for the next outbreak, which a lot of people have implicated this in weakening the health systems for day to day life in these areas. Where if you're only focused on what's coming next, then you're not necessarily building general health systems, you're siphoning off these resources that could be used so that when an outbreak actually does happen, you don't have the resources in place to be able to deal with it.
Erin Welsh	Right.
Erin Allmann Updyke	So yeah, it's a pretty depressing thing and I don't know, I hope that there's a lot that will be done now that we've sort of recognized this to be able to make it better in the future. Just not only for Ebola but overall.
Erin Welsh	Yeah for overall health.
Erin Allmann Updyke	But jumping back to Ebola, one thing that I think is really interesting is that initially both after this 1976 outbreak that was the first outbreak but especially after the - was it '89 outbreak in Virginia in monkeys?
Erin Welsh	Yes.
Erin Allmann Updyke	So because of that outbreak specifically, there was a lot of interest in Ebola because of its potential as a bioterrorism agent.
Erin Welsh	Uh huh.
Erin Allmann Updyke	Yeah so for a while there was a ton of research that was being done about Ebola, not because it was actually causing small outbreaks every year and killing people but because western countries were afraid of bioterrorism.
Erin Welsh	Of course.
Erin Allmann Updyke	Because they knew that they and other countries were working on Ebola, like engineering it to be an agent of bioterror. So there was a ton of research being done into vaccine development well before this 2014 outbreak and at some point, I don't know exactly when, but it seems like the money kind of dried up for vaccine development. So at the point of this most recent outbreak, there were a lot of vaccines that had been tested and been shown to be effective in monkeys and nonhuman primates. That's why in 2015 there was actually a vaccine tested and deployed for the first time in humans. And the good news is it was shown to be extremely effective. 100% of people that were given this vaccine did not develop Ebola.

Erin Welsh	That's awesome.
Erin Allmann Updyke	Yeah, it's really exciting. There's definitely still a lot of work to be done, there's a lot of questions as to how long lasting this immunity is. So there's question as to whether this vaccine could be effective in preventing illness overall, like whether this should be a vaccine that sort of... Like the chickenpox vaccine now where everybody gets it so that we just sort of try and not have chickenpox be a thing, or if this is just a vaccine that could be used in the case of future outbreaks where you do something like they did in 2015 called ring vaccination where you vaccinate all the contacts of cases and all the contacts of those contacts. But in that case, this has shown to be very effective which is cool and exciting.
Erin Welsh	Yeah, that's very cool. So instead of asking how scared we should be about Ebola, what have we learned from the 2014 epidemic?
Erin Allmann Updyke	Well let's actually let Sarah answer that because I think she had some really nice things to say.
Sarah Paige	I think we've learned a lot but I think it's the same lesson we've always been learning when there's an infectious disease outbreak of any kind of scale, and that's whenever there's an event or an outbreak, one of the first things that a country will do is set up their national task force and then deploy people to do active surveillance and risk communication. And there's this assumption that risk communication is obvious, that messages are already developed and all you do is blast them over radio or drive around in the white pickup with a speaker on the back and blast them through the local language and people will just automatically accept the information and change behavior. But it's becoming clearer and clearer that that approach, the very top-down vertical approach, isn't effective.
	And what ended up being the most effective for stopping the outbreak was communities actually taking it upon themselves to change their behavior in the midst of not necessarily going with the flow of what the outside people who are coming in and telling people what to do wanted them to do. So it took a long time for sort of the messaging and the behavior change to harmonize and it required a lot more than just blasting messages, it required a lot of community meetings and one on one personal stuff and getting the survivor stories out and the affected family stories out and people realizing that Ebola was real. And even if it wasn't crushing the neighbor it still could kill you regardless of where it's coming from.
	And there's a humongous focus back on Africa now and sort of reinforcing some of the negative stereotypes about the dark continent as being like the heart of disease emergence. So we're neglecting Asia, I think in this process, so I think we need to not lose sight of the fact that emerging diseases can come from any part of the world and infections like antimicrobial resistance can be found in which countries too. So I think that we need to figure out how to be laser focused and broad at the same time and then we also need to figure out how to do better engagement with communities and people on the ground and sort of take advantage of all the local experts that exist in all these countries at their universities or maybe even in the diaspora who can be tapped to join that rapid response team. So there's lessons learned and I think we are seeing some changes actually, for once.
Erin Welsh	So while the 2014 epidemic was very scary, it seems like we learned a lot of lessons from it.
Erin Allmann Updyke	Yeah and hopefully things are going to change for the better moving forward.
Erin Welsh	Sources time?
Erin Allmann Updyke	Yeah. (laughs)

Erin Welsh	So because we had such an action-packed episode this week, we are going to, instead of going into detail on our sources, just direct you toward our Facebook and Podbean website where we will list our sources for this episode.
Erin Allmann Updyke	You can find them all there. Check, check, check it out.
TPWKY	(transition theme)
Erin Allmann Updyke	Thank you again to Nell and Sarah and Lauren for sharing your stories with us.
Erin Welsh	Oh my gosh, they're amazing.
Erin Allmann Updyke	Yeah.
Erin Welsh	You guys, thank you.
Erin Allmann Updyke	And thank you for what you do, like you guys are incredible.
Erin Welsh	Yeah. And thanks to Bloodmobile for providing the music.
Erin Allmann Updyke	As always. And get real pumped because next week is gonna be awesome.
Erin Welsh	It really is.
Erin Allmann Updyke	Get your crying hat on. Is there a hat you wear when you cry?
Erin Welsh	No I just wear my crying blanket and sweatpants.
Erin Allmann Updyke	Okay so get your crying sweatpants on, you're gonna need it for next week. (laughs)
Erin Welsh	(laughs) That's true. It's very true.
Erin Allmann Updyke	Yeah.
Erin Welsh	And you know what? Wash your hands.
Erin Allmann Updyke	You filthy animals. (laughs) Just in case.