

## Episode 43 M-m-m-my Coronaviruses

Erin Welsh

Fang Lin began to feel feverish just as the weather was starting to turn dry. Fang made it through that day and night having to pause during his work in a chop room to catch his breath and he took frequent cigarette breaks on the back stairs. The next evening when he went out for a cigarette break and sat down on the back steps, he couldn't get up. His fever had climbed probably to over 103 degrees, and he found that no matter how deeply he breathed, he felt perpetually winded. His body aches had reached a point where whatever position he stood or sat in, he felt as if his muscles were being pulled from his bones. The antifebrile medication did nothing to assuage his fever, which may have spiked north of 104.5. Twice he was unable to rouse himself from his sleeping pallet in time to reach the toilet in the hall, each time soiling his trousers. He found that if he moved even slightly to roll over or sit up he would be completely out of breath. The muscle aches were so severe, he recalls, that he found staying still unbearable, yet any movement would leave him gasping for breath. What was happening to him? Fang knew he was ill. But he still assumed he was suffering from another of those respiratory infections that regularly burned through the Click. Everyone seemed to have a hacking cough of some sort; whether it was due to cigarettes, persistent asthma, or air pollution was impossible to say. But he had been on his back for several days now and wasn't feeling any better. Most terrifying for him, when he was conscious, was the sense that no matter how deeply he breathed, he felt that what he was inhaling was not oxygen but some other odorless, tasteless gas with similar properties but without the life-sustaining force of simple oxygen. He was running out of air, yet he felt he was breathing freely. He now had to stay perfectly still. To move was to suffocate. Stay still. And breathe. Breathe as deeply as possible. On about the sixth day of his illness, he lost all track of his environment. From then on, there were only dark dreams and the sensation that his life was literally being squeezed from him. His muscle aches would come in steady, rolling waves and would peak as gripping cramps around his spine and in his neck and upper legs, a dreadful tightening that would coincide with a gasping inability to draw in enough oxygen. He lay still and struggled to stay awake so that he could focus on maintaining his steady, ineffectual breathing. He feared that if he fell asleep, he might forget to breathe, and that would be it. Perhaps that is what dying is, he wondered - your body forgetting how to breathe. But he did begin to drift off, always remembering even in his unconscious state, that he must stay still. Any movement at all, even or wiggling of toes, even blinking, used precious oxygen. That was air he didn't have. So he lay perfectly still, and in those moments between severe cramps and muscle aches, when his bowels were settled, he would drift into dark snatches of unconsciousness. But it was a cruel sleep, one that never let him forget, for even a moment, his suffering. During those naps, he would always feel very far from home and very alone. A terrifying idea began to glow in the darkness: he would die far from home, away from his family. He understood finally the importance of that Chinese tradition of rushing home when you were ill, even if only to pass away. And then he thought of another matter: who would pay for the cost of his funeral arrangements?

[musical interlude]

Erin Updyke Oof, Erin

Erin Welsh Oof indeed, Erin. That was adapted from chapter 7 of China Syndrome by Karl Taro Greenfeld, and that description was of SARS.

Erin Updyke SARS

Erin Welsh Yes. And on this episode of This Podcast Will Kill You, we are talking all things coronavirus.

Erin Updyke Because you guys asked for it and we obliged.

[laughter]

Erin Welsh I'm Erin Welsh.

Erin Updyke And I'm Erin Allmann Updyke.

Erin Welsh Welcome.

Erin Updyke Welcome.

Erin Welsh So this episode we're talking all things coronavirus, which means the endemic ones that cause basically like a mild cold in humans, SARS, MERS, and then the 2019 novel coronavirus which doesn't yet have a catchy acronym.

Erin Updyke Right.

Erin Welsh And the reason that we're talking about all of these is because, for one thing they are all related to one another, and what we can tell about this 2019 novel coronavirus, a lot of that comes from the information that we have from these other coronaviruses. So we wanted to give you the full picture of all of these things.

Erin Updyke We were not planning on covering coronavirus this season. [laughter]

Erin Welsh No. [laughter]

Erin Updyke But yeah it's, it's making big headlines and for good reason, so we want to help everyone to understand what coronaviruses are and, as much as we can, let you know about what's going on with the current coronavirus outbreak. A few things to keep in mind: we are not experts.

Erin Welsh Once more for the people in the back? We are not experts.

Erin Updyke So we are not the ones on the ground doing this research, working on this outbreak. We are going to tell you what we know, and, because we're not experts, we're going to bring in some people who have much more expertise than we do to talk about what's going on with the current novel coronavirus outbreak. But we will do what we

do best, which is tell you about the biology and the history of coronaviruses in general.

Erin Welsh Yeah. Should we also note that we are recording this at 9:30 am on February 2nd?

Erin Updyke Yes. This is something that's happening so rapidly that by the time you listen to it, things will be drastically different.

Erin Welsh The earliest you'd be hearing this is on February 4th, so it's likely that some of the numbers that we are reporting about the 2019 novel coronavirus will have changed, but hopefully the broad strokes will still be enough to get you the information that you want.

Erin Updyke And we'll also point you in the direction of where you can find reputable sources to stay abreast on what's going on with the current outbreak.

Erin Welsh Yes. I guess, though, we should start with quarantinis?

Erin Updyke We should because we must. [laughter]

Erin Welsh [laughter] This week's quarantini is called the Breath Taker, and it's called that because that was the colloquial name for SARS in China when it first started making the rounds.

Erin Updyke I love it. [laughter]

Erin Welsh And Erin, what's in the Breath Taker?

Erin Updyke Well, it has to start, of course, with a Corona.

Erin Welsh And I should, we should also point out that Corona beer has nothing to do with coronavirus at all.

Erin Updyke And this is not sponsored. [laughter]

Erin Welsh Not sponsored. It also has Ancho Reyes Chile liqueur and some lime juice and some tomatillo salsa.

Erin Updyke A little spicy something or other to get you through this episode.

Erin Welsh Yeah, it's basically, basically like a michelada.

Erin Updyke And we will post the full recipe for this quarantini as well as our non-alcoholic placeborita on our website [thispodcastwillkillyou.com](http://thispodcastwillkillyou.com) and all of our social media channels.

Erin Welsh Okay. I mean, I think we should probably just jump right in. People are already chomping at the bit.

Erin Updyke Yeah they wanna, we should just, we should stop messing around here. Let's take a quick break and then we'll talk biology.

Erin Welsh Sounds great.

[musical interlude]

Erin Updyke Straight off the bat I want to let y'all know that coronaviruses are nothing new.

Erin Welsh Nope.

Erin Updyke Nothing new. This novel coronavirus that's making headlines is a new individual specific virus, yes. However, coronaviruses like say, influenza viruses, are a large group of RNA viruses that we not only have known about for a long time but have been circulating among humans and many, many other species of animals for a very very long time.

Erin Welsh Mhmm.

Erin Updyke Okay. Fun fact - this is my only fun fact this episode. [laughter]

Erin Welsh Oh great [laughter].

Erin Updyke Corona means crown, and the reason that coronaviruses are called crown viruses is because when you look at them on a scanning electron microscope they have a little halo crown of proteins around the outside. Isn't that cute?

Erin Welsh Aww, a little viral royalty.

Erin Updyke Yes, royal virus. That's the end of my fun fact. Here's how kind of this episode biology is going to be structured, alright? First, we're going to talk about the most common human coronaviruses in general. These are the ones that circulate all the time. Almost definitely if you are listening to this podcast, you've been infected with a coronavirus at some point in your life.

Erin Welsh Mhmm.

Erin Updyke And then I'll talk about the three big headline-grabbing coronaviruses. That is, SARS, MERS, and the newest 2019 nCoV. Cool?

Erin Welsh Gotcha. Sounds great.

Erin Updyke All right. So, coronaviruses in general. There are several different large groups of coronaviruses, and a lot of them actually infect animals, all different kinds of animals. Pigs, chickens, cats. And in animals, they often cause GI illness, so like diarrhea and stuff like that. But they can also cause respiratory illness. There are four human coronaviruses that are really common, and they cause the common cold.

Erin Welsh Yeah.

Erin Updyke So these are upper respiratory tract infections, in general. So the question first that we like to answer is what exactly do they do in your body and how do they make you sick? What is their pathophysiology? Turns out, that for the four human coronaviruses, we don't entirely know their pathophysiology. Because, like for many viruses, we don't have really great animal models to study them. But from some really interesting and probably ethically questionable studies that they've done in humans where they intentionally infect "volunteers"-

Erin Welsh When were these studies from?

Erin Updyke Uh the 80s and early 2000s.

Erin Welsh Uhhh okay. That's, that's, yeah.

Erin Updyke Anyways, what we do know from these studies is that these four human coronaviruses colonize the upper respiratory tract, so your nose and throat in general.

Erin Welsh Okay.

Erin Updyke And we know that they invade and replicate in your respiratory epithelium, so the sort of first cells lining your respiratory tract. So in the case of these four common coronaviruses that's pretty much where they seem to stop. They're not super infectious. In these human studies, up to like a third of people that they inoculated didn't actually even get infected with a virus, and most of those that did had very mild or maybe moderate colds. So we all know what the common cold looks like, right? Erin, what kinds of symptoms do you have?

Erin Welsh Runny nose, sneezing, coughing.

Erin Updyke There you go, exactly.

[laughter]

Erin Updyke Yeah, so these are very mild upper respiratory symptoms: cough, runny nose, stuffy nose, maybe you get a headache, maybe rarely you spike a fever, but in general you're not all that sick. The way that common cold viruses like coronavirus are generally transmitted is by respiratory droplets. So since they make you cough and sneeze, when you cough and sneeze, you cough and sneeze out liquid droplets full of virus, and that's how the next person gets infected. So it's not like something like measles that we talked about that can hang out airborne in the room for many, many hours in the air.

Erin Welsh Right.

Erin Updyke These are viruses that are contained in water droplets that you cough and sneeze out. It is also possible that these droplets can land on surfaces, and the virus can then live on these surfaces and be transmitted from say a doorknob to your mouth, if you touch a doorknob and then touch your mouth.

Erin Welsh Mmhmm.

Erin Updyke Does that make sense?

Erin Welsh Yes.

Erin Updyke Okay, so that's the four common viruses. They don't cause a lot of morbidity or illness. They don't cause a lot of mortality, except in very, very, very rare cases. And it's estimated that anywhere from 10 to 30% of all common colds around the world are caused by one of these four coronaviruses.

Erin Welsh Huh. I didn't realize that.

Erin Updyke Yeah. They're really common. And I think that's important to keep in mind because even when SARS first came on the scene, while we'll see that it was very novel in the type of disease and the severity of disease it caused, it wasn't a completely unknown alien invasion virus.

Erin Welsh Right.

Erin Updyke And neither is this new novel coronavirus that's circulating today. Okay, so let's get into the more serious things. And that starts with SARS. SARS stands for severe acute respiratory syndrome. What was novel about SARS when it first came on the scene in 2002 is that it caused a very serious illness in people. It caused an illness that was so severe especially compared to what coronaviruses normally cause, which is like a cough and runny nose, that we didn't recognize it as a coronavirus for a long time, and there's a number of reasons for that many of which I'm sure, Erin, you'll get into, right?

Erin Welsh Mmhmm.

Erin Updyke Okay. But at least in part it's because we didn't expect before SARS that coronaviruses could cause the kind of disease we saw with SARS, right? So why did we see more severe infection? And the answer is that while SARS still mostly affects the respiratory tract, unlike the other coronaviruses SARS is able to extend its infection to the lower respiratory tract, so not just your nose and throat but actually colonize your lungs and cause disease in your lungs itself.

Erin Welsh What allows the SARS-CoV to do that? Like what is stopping the other four endemic, milder coronaviruses from invading your lungs?

Erin Updyke Good question, and this was one of my, I put a little asterisk next to this cuz I thought you might ask it.

[laughter]

Erin Updyke So let's talk about it. So remember that viruses can't replicate on their own, right? They have to enter our cells in order to replicate and then use our cellular machinery in order to replicate and make new viruses. So in order to do that, they have to get into our cells and the first step in doing that is to bind to some receptors on our cells and use those receptors to get into our cells.

Erin Welsh Mhmm.

Erin Updyke Different viruses use different proteins, and bind to different proteins in our cells. And what proteins they bind to and where in our body those proteins are found, like what cell types have those proteins, determines what's called the tropism of the virus. What organs in our body the virus tends to invade.

Erin Welsh Oooh, like where it goes. Okay, yeah.

Erin Updyke Exactly. And so, in the case of SARS, we found out later (we know now) that SARS binds to a protein called ACE2. Angiotensin-converting-enzyme. This protein is expressed in very high concentrations in our lungs and also in our small intestine and some other organs too, kidneys, etc. Because this is the protein that SARS uses to bind, it was able to then invade our lungs because our lung tissue has a lot of ACE on its surface.

Erin Welsh Mhmm.

Erin Updyke I didn't look up exactly what proteins the other four coronaviruses use to invade because there's four of them and that would be too long of an episode, but it's not generally ACE, right. So they, the other coronaviruses use different receptors that they recognize that are located more in the upper respiratory tract.

Erin Welsh It seems like knowing the proteins that these viruses bind to would be great targets for treatment.

Erin Updyke Absolutely, yes. So there's been some ideas because we have...ooh, this is probably getting too much, Erin but there, we, we have drugs that actually target ACE because it's an important component of how your body manages blood pressure.

Erin Welsh Whoa. Oh! Omigosh! Okay.

Erin Updyke Yeah so we have things called ACE inhibitors, so there's this stop that like oh could maybe you use these to treat SARS? We don't as far as I know there isn't actually good evidence that that works, but it's like yeah, cool idea, let's do some research on it. But yeah knowing how viruses get into our body is often a good place to at least try to target for treatments. I'll just say we don't have any, though, at this point for SARS, or MERS, or the novel coronavirus. Just throwing that out there, okay?

Erin Welsh Yeah, there we go.

Erin Updyke So yeah. So SARS gets into your lungs and is able to cause a lung infection. Lung infection means pneumonia. So this is a virus causing viral pneumonia. So the symptoms of SARS, because it's a more extensive disease, tend to start more systemically. So fever is the number one symptom of SARS, actually.

Erin Welsh Okay.

Erin Updyke Fever, chills, myalgias like you described in the first hand account, these muscle aches can get really, really severe, and then you do still get some upper respiratory symptoms. But a lot of the symptoms are more lower respiratory, so you'll get a cough, um, but less of the like runny nose type symptoms that we see with other coronaviruses. And then as this disease progresses and more damage is caused to the lungs themselves you'll get other more serious symptoms like shortness of breath, tachypnea, which means a really fast breathing rate, pleurisy, which is like pain in your chest and lungs when you breathe, and then, depending on how late in the course of disease people present to the hospital, because this is a very serious illness most people will present to the hospital, almost everyone when you take an x-ray of their chest, it will look like what we call ground glass opacifications.

Erin Welsh Oh my gosh, that sounds terrible.

Erin Updyke It is terrible. So if you've ever seen an x-ray of a normal chest, like a not ill chest x-ray, you know that the lungs are filled with air so they're mostly black because air is black on x-ray.

Erin Welsh Uh huh.

Erin Updyke So you can see the outlines of ribs, and then you can see, sort of, black in between the ribs with maybe little bits where you can see like blood vessels and things like that. That's a normal, not sick, chest x-ray. With SARS it looks like you're looking through like a bathroom, you know the glass they put on bathroom windows?

Erin Welsh Yeah, I have some of that on my bathroom window.

Erin Updyke Exactly. So it looks like that. So it's not so opaque that you can't still see like the shadow of your heart and your ribs. You can still see that, it's not completely whited it out, like it might be with a bacterial pneumonia.

Erin Welsh Ooh, because the bacteria has colonized, whereas this is just inflammation?

Erin Updyke Well, bacteria still produce a lot of inflammation, but it'll be localized to one spot and it'll be so much in like one corner of the lung that it's totally whited it out.

Erin Welsh Okay.

Erin Updyke Whereas this is bilateral, often, throughout your whole lung fields, top and bottom, often, it's all just kind of murky looking.

Erin Welsh That sounds terrible.

Erin Updyke Yeah, it's bad. It's not good. And then this can sort of just progress. So about one-third of people with SARS will get better on their own, but 20 to 30% end up needing mechanical ventilation because their lungs are just so inflamed that they're not able to get enough oxygen in on their own.

Erin Welsh Mmhmm.

Erin Updyke And I want to point out that this kind of supportive treatment is the only treatment that we have, since we don't have any antivirals for SARS. And overall, what we saw from the SARS outbreak was a case fatality rate of just under 10%. So about 10% of people who were infected with SARS ended up dying from SARS or SARS complications.

Erin Welsh That's a very high mortality rate.

Erin Updyke It is, and it varied a lot based on demographic factors. So in people older than 65, the mortality rate was over 50%.

Erin Welsh Wow! I didn't realize it was that high.

Erin Updyke Yeah, it was really high. So that's kind of what the disease looked like for SARS. We learned a lot about it after the outbreak because, as you can probably see with what's going on with the new outbreak right now, it's really hard to get good information while the outbreak is going on, right?

Erin Welsh Right.

Erin Updyke Because you're just kind of dealing with, like, trying to keep people alive.

Erin Welsh Well, and also there's steps to publishing reliable information that has to go through the peer review process-

Erin Updyke Absolutely.

Erin Welsh -and you know, some of those things are are lifted right now, and people are getting early drafts out. But it's then, you know, what information is reliable? Sample sizes tend to be small etc. etc.

Erin Updyke Yeah, but still things that we know now, looking back at SARS, since the outbreak has passed, we know that, with SARS, subclinical infection, so, like, asymptomatic infection, was really rare. So in looking at seroprevalence studies of people in areas where there were high rates of SARS, there's very little evidence of infection in people who didn't have symptoms of SARS.

Erin Welsh Interesting. Okay.

Erin Updyke Yeah. So we know that in the case of SARS, infection almost always led to symptoms, and, in general, those symptoms were very severe. And the other thing that we learned about SARS was that the viral load, so how much virus you had in your body, was a really driving factor of infectivity.

Erin Welsh Okay.

Erin Updyke And so, in the case of SARS, the incubation period, so the time from when you first got infected to showed symptoms, was usually about four to seven days, and viral load actually increased slowly over that time. So people were most infectious about 10 days after first getting infected. And so that means that people for SARS were really only infectious if and when they showed symptoms, which made SARS relatively easy to screen for and to help contain. So that's pretty much SARS.

Erin Welsh Okay.

Erin Updyke So let's, let's move on. [laughter] The next most famous coronavirus was MERS - Middle East Respiratory Syndrome. So was MERS just the same thing as SARS but in a different part of the world? No, not really.

[laughter]

Erin Updyke It was another novel coronavirus that was discovered in 2012 after an outbreak in, I believe, Saudi Arabia was the first identified cases. Is that right, Erin?

Erin Welsh So it was first isolated from an outbreak in Saudi Arabia but retrospective testing showed that actually the first cases seem to be in Jordan earlier that year.

Erin Updyke That's right, that's right. Okay. So, symptomatically MERS presented very similarly to SARS in a lot of ways. It started off with fever, myalgias, muscle pain was really common. Oh, I forgot to mention this, but a really common symptom for SARS was actually diarrhea and in some cases nausea and vomiting. So you often, in addition to this viral pneumonia, had pretty extensive GI symptoms.

Erin Welsh Mmhmm.

Erin Updyke You also saw this in MERS. And then, like with SARS, you would get a really rapidly progressive viral pneumonia. You'd have similar findings on chest x-ray - those ground glass opacities - and it could lead to respiratory failure and potentially death. We know that MERS also had a similar incubation period, a similar time to symptoms as SARS.

Erin Welsh Does it also bind to the ACE2 protein?

Erin Updyke Oh I'm so glad that you asked, Erin!

[laughter]

Erin Updyke No!

Erin Welsh Really?

Erin Updyke As it turns out, MERS binds to a different protein called DPP-4, dipeptidyl peptidase. This is another protein. It's similar to ACE, okay, but it's expressed in high levels in the lungs and the kidney. So can you guess another very common symptom of MERS that's different from SARS?

Erin Welsh Renal failure.

Erin Updyke Renal failure, absolutely. So ACE is also expressed in the kidney, so you can still get renal failure with SARS, but it's more common in MERS because I think DPP-4 is expressed at very high levels in the kidney.

Erin Welsh Right.

Erin Updyke Oh how fun. Okay. Unless you have MERS. So let's talk about some of the differences between MERS and SARS. First off, MERS? Way more deadly.

Erin Welsh Yes.

Erin Updyke Okay. So, in looking at the outbreaks of MERS, the case fatality rate is close to 40%. About 36%.

Erin Welsh That's very, very, very high.

Erin Updyke It's very high. For SARS, it was just under 10%, right? So a case fatality rate of 40% sounds very terrifying. So let's calm ourselves down for a minute and not freak out too much about MERS. Here's a few reasons why. Number one: it turns out that MERS is not nearly as infectious as SARS. So person-to-person transmission is not very efficient for MERS.

Erin Welsh Why is that?

Erin Updyke You know, that's a really good question that we don't fully understand the answer to. What we do know is that when we compare the R0s, so the average number of cases from a primary case to secondary case, for SARS it was probably around 2 to 3, I think? Is that right?

Erin Welsh Mhmm, yeah.

Erin Updyke For MERS, it's like 0.7.

Erin Welsh Okay. Do you think it has something to do with the tropism of the virus? Is it in the lungs as much? Is the infectious dose different between SARS and MERS?

Erin Updyke It could be the infectious dose, absolutely. I think that probably has a lot to do with it. Uh, it could be the tropism, although, you know, DPP-4, like, it causes just as bad of a viral pneumonia, if not worse. But here's another important part about MERS, and this I think helps, at least I think this makes more sense as to why it maybe doesn't transmit as well. The vast majority of cases of MERS, not even just the deaths but the people who were infected with MERS, 75% of them had some kind of underlying disease.

Erin Welsh Okay.

Erin Updyke Some kind of comorbidity. So it seems like maybe MERS requires that a person is already a little sick, so they have diabetes or some kind of underlying lung disease or heart disease, something that makes their immune system not work as effectively that allows for MERS to colonize, infect them, and then make them very, very sick.

Erin Welsh Gotcha.

Erin Updyke Whereas with SARS, you know, healthy people got infected, sick people got infected, SARS just infected pretty much anyone. Does that make sense?

Erin Welsh Yes.

Erin Updyke So overall, that's the good news about MERS. It's a lot less transmissible, almost every outbreak or group of cases had at least some documented spillover events, and it's thought that there were many, many individual spillovers that happened with MERS. Whereas SARS, you'll probably talk more about, was one big outbreak, right?

Erin Welsh Right.

Erin Updyke And MERS, the vast majority of people who have been shown to be infected had at least some underlying comorbidities.

Erin Welsh Mmhmm.

Erin Updyke Okay. So that's MERS and SARS.

Erin Welsh You saved a special one for last.

[laughter]

Erin Updyke The special one for last. So, those two novel coronaviruses, as a recap, are different than the other four coronaviruses that circulate because they cause more serious illness by infecting the lower respiratory tract. So that brings us to today: 2019-nCoV, the newest coronavirus on the block. I don't have all the answers for you about what

is this virus and what's the fatality rate and et cetera, et cetera. Not only because we are not the experts on this topic but because this is such a new virus and an ongoing outbreak, that we can't answer all of these questions. We can make estimates based on the fact that we've seen SARS and MERS in the past. We can guess that in a lot of ways this novel coronavirus likely operates very similarly to SARS and MERS, and honestly, the other coronaviruses. So how do we think is transmitted? Most likely respiratory droplets, right? That's how all coronaviruses tend to be transmitted. It's certainly possible that fomites or surfaces can be an important part of transmission. So we don't know how long this particular coronavirus can survive on, say, a doorknob or your cell phone, but we know it can probably live for at least a period of time, since other coronaviruses can survive for many hours. And what it appears, based on the number of people who have had severe symptoms, is that this novel coronavirus is also able to infect our lungs and cause serious viral pneumonia. So this is a more severe coronavirus than the four typical coronaviruses.

Erin Welsh We don't know anything about the protein that it binds to?

Erin Updyke So there has been at least one study that has shown that it likely actually uses ACE2 as well.

Erin Welsh Okay.

Erin Updyke Or at least potentially. But that study was, it's very preliminary, and it wasn't using a live virus. They, like, conjugated it to a herpes virus, and it was just in cell culture. So no, we don't know for sure what protein this novel coronavirus is using. Um, it might be the same one as SARS, it might not be.

Erin Welsh Okay.

Erin Updyke We also don't quite know what the  $R_0$  is, so the basic reproductive value. There've been a lot of people trying to make estimates. It seems at this point on February 2nd, like, it's likely between two and two and a half, maybe.

Erin Welsh Okay.

Erin Updyke That's the estimates that I've seen. So probably similar to SARS, maybe not quite as infectious, although we've seen numbers go up a lot more rapidly than with SARS. And one thing that I think is really, really important is that we cannot estimate a case fatality rate until this outbreak is over.

Erin Welsh Yeah.

Erin Updyke Period. And I think that there's a lot of people on the internet right now saying well, the mortality rate is this and the case fatality rate is that. We can't estimate either of those numbers right now at all. We can calculate a proportion of, you know, total deaths from this disease so far, but because, so, okay February 2nd at 10 a.m., there are currently 14,600 total cases that we know about.

Erin Welsh Uh huh.

Erin Updyke 348 of those have recovered and 305 of them have died thus far.

Erin Welsh Okay.

Erin Updyke So if you use those numbers then it would look like a proportionate mortality of around 2%. But this is not a fixed number. 14200 of those 14600 are still sick, and we don't know how severe their illness is going to be and whether they're going to end up in the recovered group or the death group, and there are thousands more tests that haven't been run. So we really don't know at all what the case fatality rate is going to be at this point.

Erin Welsh Mmhmm, makes sense.

Erin Updyke Yeah. But otherwise this likely operates, it seems, similarly to SARS. So it's estimated that the incubation period is likely no more than 14 days. That's, like, the max that we've seen in both SARS and MERS. So if you're two weeks out from being, say, next to someone with this novel coronavirus and you haven't gotten sick, you're probably not going to get sick. [chuckles]

Erin Welsh Mmhmm.

Erin Updyke And then there's a lot of other questions about, like, when exactly are you infectious, how many asymptomatic or subclinical infections might there be, and at this point it's looking like it's more likely than with SARS that there might be kind of low-level illness rather than only serious severe cases.

Erin Welsh Right. Which might be part of the reason why that number of infected has surpassed SARS already.

Erin Updyke Exactly. Right. Yeah. But we don't have a ton of answers and so, later in this episode we'll talk more about what we know about this outbreak overall and what's being done about this outbreak with some experts on the topic, people who know a lot more than we do.

[laughter]

Erin Welsh Yes.

Erin Updyke But first, Erin, can you help us to understand where these coronaviruses came from and how we got through the SARS and MERS outbreaks and, and kind of the lay of the land?

Erin Welsh I think I can help out with that a little bit.

Erin Updyke Awesome.

Erin Welsh Let's take a quick break first.

[musical interlude]

Erin Welsh Alright, are you ready for this?

Erin Updyke Oh I'm so ready.

Erin Welsh It's a big one.

Erin Updyke Okay.

Erin Welsh And there's a ton of info here, so I tried to organize it into discrete units just like you did.

Erin Updyke Okay.

Erin Welsh So I'm gonna start with talking about the ecology and origins of coronaviruses in general,

Erin Updyke Okay.

Erin Welsh And then I'm going to focus on the 2002 to 2003 SARS epidemic. Then I'll talk a little bit about MERS, and finally I'll go into what's been on everyone's mind, which is the 2019 novel coronavirus.

Erin Updyke Awesome.

Erin Welsh Alright, let's go. As you mentioned, Erin, SARS and MERS and this 2019 novel coronavirus are all types of coronaviruses, and as a subfamily, they're pretty diverse. So like you said, they can be found all over the world, in different animal species, in wildlife, in domestic animals, in humans, and they can cause different degrees of illness in all these animals. It's difficult to know exactly how long coronaviruses have been infecting humans, but it's likely that it goes way back, particularly for those mild endemic strains. And it's also possible, of course, that there have been historical epidemics of more deadly coronaviruses like SARS and MERS and so on, but the first one that we are, that we were aware of is the one from the SARS outbreak 2002 to 2003.

Erin Updyke Mmhmm.

Erin Welsh And then MERS popped up in 2012 and then finally this one in 2019. The common thread among these more virulent or deadly coronaviruses is that they all seem to have their origins in bats.

Erin Updyke Mmmm.

Erin Welsh So with SARS-CoV, it was likely a spillover event from bats to civets to humans, and with MERS-CoV the in-between animals were camels. We're not exactly sure yet how the 2019 novel coronavirus spilled over into humans, but according to two papers, one of which I want to point out is not peer-reviewed - it's just a draft of an early paper - bats have been implicated as the source as well.

Erin Updyke Mhmm. Makes sense.

Erin Welsh SARS, MERS, 2019 novel coronavirus - these viruses are novel to humans, but the way that the outbreaks occurred is not. And before I get into the nitty-gritty on each of these coronavirus outbreaks, I wanted to talk more generally about emerging infectious diseases.

Erin Updyke Yes!

Erin Welsh [chuckles] Yeah. Because these coronavirus outbreaks won't be the last, and if we want to be able to control or predict these spillover events, we have to understand the factors driving them.

Erin Updyke Mhmm.

Erin Welsh The incidence of emerging infectious disease events has risen significantly over time, and the majority of these have their origins in wildlife. And the term emerging infectious disease can also be used to describe something that has evolved, like an antibiotic-resistant strain of bacteria, or something that's been with humans for a long time but has recently increased in incidence, like Lyme disease, but it also can mean pathogens that are brand-new to humans. And with this last category, the so-called emerging disease hotspots - so the places around the globe where spillover events are most likely to occur based on what we've already seen - these tend to be concentrated in the tropics, so like in low-latitude areas, and subtropics. That also happens to be where animal and pathogen diversity is high.

Erin Updyke Mhmm.

Erin Welsh And also in resource-limited countries, particularly those with high population densities.

Erin Updyke Mhmm.

Erin Welsh As our human population grows, as we continue to build and spread into natural areas, as urbanization increases, as the climate changes, humans and domestic animals become more likely to interact with wildlife and with pathogens from wildlife. And we've seen this time after time. With Ebola, with Marburg, with Hendra, with Nipah, with bird flu, and with many more. Detection or surveillance of novel pathogens in these areas is challenging mostly because the funds just aren't there-

Erin Updyke Mhmm.

Erin Welsh -both nationally and internationally. And if we want to reduce the likelihood of another outbreak like this or be better at controlling it from the start, we need to channel more resources into early detection and surveillance both in humans and wildlife, conservation of natural areas, and especially interdisciplinary collaboration like we see in a One Health approach, with ecologists, epidemiologists, physicians, etc. all working together.

Erin Updyke Get it, Erin, get it!

[laughter]

Erin Welsh And there should also be a push towards the free and open exchange of information, which is actually something great that I've noticed with this 2019 novel coronavirus. So there are several scientific journals that are saying, "we're putting all of these articles, we're taking them from behind a paywall, making them free to the public, open access, publish early with, like, you know, a note that it was a draft or whatever." But there are still so many journals and journal articles that are behind a paywall. And this current outbreak of 2019 novel coronavirus, it's probably not going to be the thing to wipe out the human race.

Erin Updyke No.

Erin Welsh But the next one could be unless we make certain changes and we work really hard on the prevention and surveillance aspect of this. Okay. Now are you all scared?

[laughter]

Erin Welsh Just kidding. SARS. The earliest signs of the SARS epidemic began in November 2002 in Guangdong Province in China. In Guangdong Province, as well as many other places throughout the country, open air markets and restaurants featured animals of all different species, often held in tiny enclosures with their poop and breath and blood all mingling constantly.

Erin Updyke Poop and breath, yeah man.

[laughter]

Erin Welsh There were many restaurants that offered any part of any species you could possibly want, and to ensure that the meat was fresh, the animals on the menu were often held in cages and alleys behind the restaurant. It was at these restaurants and markets that the first cases of SARS would emerge. On November 16th, 2002, an official on the village committee was admitted to a hospital in Foshan, Guangdong Province, complaining of respiratory symptoms. His family also came down with the illness. Over the course of the next month, case numbers of this mysterious atypical pneumonia steadily rose. By December 25th, 2002, 35 people were infected and 8 had died. And this, it's important to note, it was a retrospective count for the most part-

Erin Updyke Okay.

Erin Welsh -but deaths were apparent. And so with these number of deaths from a mysterious respiratory ailment, some public health officials were growing suspicious and a little bit concerned. Rumors started to circulate of an influenza epidemic, possibly avian influenza. And since the outbreak of avian influenza in Hong Kong in 1997, there was constant vigilance for the virus because it is extremely deadly, and if person-to-person transmission was established that could be a real problem. But other people doubted that it was avian influenza. This was, after all, the winter season, when it seemed like everyone had a respiratory complaint of one kind or another, and rumors circulated every year about a mysterious hemorrhagic fever or wild skin disease. These rumors were different, though. For one, these rumors all focused on the respiratory ailment and were pretty consistent, at least as far as rumors go. Cloudy chest x-rays, burning fevers, and high prevalence among medical personnel. The first official public statement about the SARS epidemic was released on January 3rd, 2003, a little over a month since the beginning of the outbreak. At this point there were 48 people infected and 9 dead, another retrospective count. This statement was published on the front page of the Heyuan Daily. It read, "There is no epidemic in Heyuan. There is no need for people to panic. Regarding the rumor of ongoing epidemic in the city, health department officials announced at 1:30 a.m. this morning, "there is no epidemic in Heyuan." The official pointed out that people don't need to panic and there is no need to buy preventive drugs." Despite this incredibly reassuring statement, people panicked.

Erin Updyke [chuckles]

Erin Welsh They rushed to the pharmacy, buying all the acetaminophen and antibiotics that they could get their hands on, because antibiotics are available over-the-counter without a prescription there.

Erin Updyke And they're very useful against viruses. Not.

Erin Welsh Not. They're not useful at all.

Erin Updyke They're not. They are not.

Erin Welsh Public health officials were dispatched to the Heyuan Number One Hospital to conduct an investigation into the mysterious pneumonia. Some suspected a species of Chlamydia, which can cause pneumonia, but the infection didn't respond to broad-spectrum antibiotics. Others thought maybe it was caused by a virus, possibly influenza or possibly a virus not yet described. They also interviewed patients and medical staff about their experiences. Disturbingly, they found that several patients had been to multiple hospitals, moving either by their own choice or being transferred.

Erin Updyke Uh oh.

Erin Welsh      Yeah. By the end of January, rumors were soon swirling yet again, this time in Zhongshan about an atypical pneumonia, which was now circulating in multiple hospitals in the city, as well as popping up outside of hospitals. By this time it had earned the nickname “breath taker” or “breath stalker” which is where we got our quarantini name. And whereas in Heyuan the disease was largely confined to one hospital, what was going on in Zhongshan appeared to be the first community outbreak of the mysterious disease.

Erin Updyke      Mmmm.

Erin Welsh      And it would later be determined that the first known superspreader of SARS nicknamed the Poison King-

Erin Updyke      [chuckles]

Erin Welsh      -was transferred from Zhongshan, where he had infected 6 medical personnel, to Guangzhou where he would continue to infect people.

Erin Updyke      Mmmm.

Erin Welsh      And these superspreaders, it's no fault of their own. People didn't know how to control the infection at this point or how infectious it was, but these superspreaders would be a hallmark of the SARS outbreak, where a lot of the infections originated from one source like that.

Erin Updyke      Mmhmm.

Erin Welsh      Okay. So by late January, medical officials were pretty certain that it was caused by an extremely infectious virus transmitted through respiratory droplets, but getting that information out there was a different story because it was standard practice among the Chinese government to keep this information top secret and classified, to not share it among anyone less than the top-most ranking public health officials. Not the public and certainly not to the outside world.

Erin Updyke      Mmhmm.

Erin Welsh      So the rest of the world finally caught wind of a mysterious and deadly outbreak in China on February 10th, 2003, at which point an estimated 393 people were infected and 40 had died, retrospective count.

Erin Updyke      Okay.

Erin Welsh      Somebody posted a report on ProMed.

Erin Updyke      ProMed!

Erin Welsh      Alright, you ready? There's like, also there's, this is like a quote within a quote so just keep that in mind as I'm trying to say it.

[laughter]

Erin Welsh      Okay. "This morning I received this email and then searched your archives and found nothing that pertained to it. Does anyone know about this problem?" And then here's the email: "Have you heard of an epidemic in Guangzhou? An acquaintance of mine from a teacher's chat room lives there and reports that the hospitals have been closed and people are dying."

Erin Updyke      Hmm.

Erin Welsh      So around this time, the WHO got an email describing panic in Guangdong as the death toll from a mysterious pneumonia was climbing. But official word from the Chinese government was still lacking. But once other countries started reporting on this disease, speculating with what little information they had, panic and anxiety set in anyway, and the Chinese government was forced to hold a press conference on the disease in Guangdong. And this press conference held on February 11th, which was one day after the ProMed announcement, was full of assurances that this disease wasn't anything to be concerned about. They said there are only 305 people infected and it was already under control. Meanwhile in Hong Kong, a doctor from Guangzhou arrived at a hotel where he was staying for a wedding. This would be the next superspreader.

Erin Updyke      Mmm.

Erin Welsh      He started to feel worse and worse and eventually sought medical care, but it was too late to stop the spread of the virus. Also at this hotel was a woman from Toronto, a Chinese American businessman, and a Hong Kong local who went to the hotel to visit a friend. All of these left the hotel to continue on their travels or to return home, unknowingly bringing with them this hitchhiking virus.

Erin Updyke      Mmm.

Erin Welsh      And this marked the start, the real start of the global spread of the virus. Hong Kong, Toronto, Hanoi, Singapore, Beijing - these would be the next hot spots of infection. On February 28th 2003, parasitologist Carlo Urbani, based in Vietnam, alerted the WHO about a highly contagious atypical pneumonia after treating the Chinese American businessman who had stayed in that hot zone hotel in Hong Kong and several health care workers who had also come down with this pneumonia after treating this person. Back in Toronto, a similar scene was unfolding. So the woman who was infected in Hong Kong died in a hospital back in Toronto, and five of her family members were found to be infected as well.

Erin Updyke      Hmm.

Erin Welsh      On March 15th, the WHO was notified of a possible SARS-infected doctor traveling from New York back home to Singapore with a stopover in Frankfurt. Mid-flight, the

doctor, his wife, and his mother-in-law were all cordoned off, and then as soon as the plane landed in Frankfurt, they were placed in isolation.

Erin Updyke That's one of the few moments that I really do remember from the SARS outbreak.

Erin Welsh When it was like "there's a person traveling on the plane."

Erin Updyke Yeah and, like, on the plane. And then they, like, quarantined them when they landed in Germany. Like, I don't know why that's one of the moments. I wasn't that into disease at the time. I was in high school.

Erin Welsh Yeah.

Erin Updyke But I remember that.

Erin Welsh You should read his um, his account. It's really interesting because he talks about the depression of isolation-

Erin Updyke Yeah.

Erin Welsh -and how much insight it gave him as a physician to know what his patients had been going through.

Erin Updyke Mmhmm.

Erin Welsh Ah, so this doctor, his wife, and his mother-in-law, all three of them developed SARS. I don't know if they infected anyone else, actually, I don't remember. But regardless, these signs of a global spread or potential global spread prompted the WHO to declare a travel advisory and to come up with a name. And as we said, locations were out, but acronyms can be catchy, so someone suggested SARS and it stuck. But what no one realized at the time was that SARS was very similar to what China called Hong Kong: Special Administrative Region, SAR.

Erin Updyke Oh! [chuckles]

Erin Welsh So in a way, it was, it placed a lot of stigma on Hong Kong,, who already experienced stigma about the avian influenza outbreak in 1997-

Erin Updyke Oh man.

Erin Welsh -and subsequent outbreaks, and then it sort of further stigmatized Hong Kong. Okay. At the hospitals where the people with atypical pneumonia were being treated, the pattern that emerged was that healthcare workers were becoming infected by the dozens. There weren't enough beds to put all the sick people, and there were too few people left to help care for them, so hospitals were beginning to crash. Some were, some emergency hospitals were being built, and one practice that developed was to form "dirty teams," which were composed of medical staff that had

volunteered to treat the infected people, and they would live at the hospital in isolation.

Erin Updyke Whoa.

Erin Welsh And those who were not on the dirty team would not be permitted to go near the patients. And so this would reduce the number of medical staff that was potentially exposed.

Erin Updyke Whoa.

Erin Welsh And filling out the dirty team was never a problem. More people volunteered than there were places, always.

Erin Updyke Wow!

Erin Welsh Yeah. And the SARS epidemic, like this coronavirus epidemic, and other epidemics is filled with these stories of selfless people, especially healthcare workers, many of whom lost their lives to the illness. And one of these was the parasitologist that I mentioned earlier, Carlo Urbani, who, just before he died, asked to have his lung tissue sent to the CDC so they could use it for research.

Erin Updyke That's who the, in the movie Contagion, that's who Kate Winslet's character is based off of.

Erin Welsh [gasp] I didn't realize that, that's cool!

Erin Updyke Yep.

Erin Welsh Wow. On March 21st, researchers at Hong Kong University announced they had found that the pathogen causing this atypical pneumonia was a coronavirus, beating the CDC by a couple of days. And up to this point, a coronavirus, as we have said, had never been known to cause such severe disease.

Erin Updyke Right.

Erin Welsh And it was kind of low on the list of potential agents because of that.

Erin Updyke Right.

Erin Welsh And also there was a couple of cases of H5N1 avian influenza that had shown up in Hong Kong, and so it was kind of thought maybe this is just a mutated strain and for some reason we're not detecting in these samples and so on. Anyway, on March 21st there it was - coronavirus. And that allowed people to test whether people had, were infected or not which was, uh, a great help in terms of understanding the extent of the epidemic. At this time, though, the Chinese government was still refusing to give up any information on the disease, holding firm with its February 11th totals of 305 people sick.

Erin Updyke Ooh.

Erin Welsh The real numbers as of March 18th, 2003, another retrospective count, were around 1400 infected and 137 dead.

Erin Updyke Wow.

Erin Welsh And those are global totals.

Erin Updyke Okay.

Erin Welsh And those numbers would continue to climb as the nature of transmission changed a bit. Earlier in the epidemic, transmission mostly seemed to be happening within hospitals, which is why there was such a high proportion of those infected being healthcare workers, but then there was a bit of a shift to community outbreaks, notably in Hong Kong at the end of March. Several people showed up to the Prince of Wales Hospital in Hong Kong with symptoms of SARS but they had no obvious connection to or contact with other infected people, so what was making them sick? Turns out they all happened to be residents of a housing complex called Amoy Gardens. Pretty soon after the discovery, the housing complex was put under strict isolation - no one in, no one out. And this went on for weeks.

Erin Updyke Whoa.

Erin Welsh But what if that wasn't enough? They had to find out how this had spread in a housing complex before it started doing the same in other parts of the city. Elevators? Eh, maybe. But air and water were both tested and found to be clean. Rats may have contributed, but they alone couldn't account for the infection pattern that had been observed. And around this time researchers realized that the virus could be spread in fecal matter-

Erin Updyke [gasp] Yeah, yeah.

Erin Welsh -from infected people, and so their new hypothesis became that fecal matter containing viruses was being aerosolized every time a toilet was flushed. The contaminated droplets were spread to other apartments via a dried-up U-trap, which is that thing under the sink, and so when there's standing water, that water acts as a barrier. But a lot of the U-traps had dried up, and so it was effectively spraying poop virus particles.

Erin Updyke Dude.

Erin Welsh Yeah. And it is, like, it's important to note that that is still a little bit debated, whether it was that or the rats or some combination of multiple things, but regardless, it was like a sequence of really unfortunate events. The isolation seemed to work, though, of Amoy Gardens. Those cases there seemed to mark the peak of the epidemic in Hong Kong, and by April it was largely over, there. Part of this was

because increased precautions at hospitals in terms of personal protective equipment, the formation of these dirty teams. Part of it was because contact tracing and an eSARS database were proving effective at identifying potentially exposed people and isolating them. And part was that community outbreaks died out as people changed their daily routine. Hong Kong became a virtual ghost town during the epidemic, as people who could leave did so and others stockpiled food and dared not go outside. Okay, April. Moving on to April.

Erin Updyke Okay.

[laughter]

Erin Welsh April 1st, 2003, an estimated 2300 people infected, 255 dead.

Erin Updyke Globally?

Erin Welsh Globally.

Erin Updyke Okay.

Erin Welsh Even though the epidemic in Hong Kong seemed to be waning, its spread in other places was a concern to the WHO, who was still getting the same numbers from government officials in China, unchanged for about two months.

Erin Updyke Hmm.

Erin Welsh So the WHO resorted to making surprise visit to hospitals in Beijing, where the official numbers were 12 infected and 3 dead. At at least one of these hospitals, minutes before the WHO was due to arrive, a fleet of ambulances pulled up, and the hospital director ordered all 31 SARS-infected healthcare workers to get into the ambulances, where they were driven around until the WHO left. The WHO showed up to the hospital to the promising sight of an outbreak nearly over. Regardless, they still amended their estimates of those infected in Beijing to, like, one to two hundred people. In reality, it was much higher than that. And I want to note that among healthcare workers and among people in the community, there was ample communication. People were trying to get the word from one hospital to another, from one city to another, to get some sort of idea of the scope of the outbreak, how to protect yourself, what was being done, etc. But communicating that info to press outside of China could have serious repercussions because it was sharing, it would be the sharing of state secrets. What was needed was a whistleblower, and what we got was a whistleblower.

[laughter]

Erin Welsh And this whistleblower was named Dr. Jian Yanyoung. And Jian, who had treated many of the students injured in the Tiananmen Square massacre-

Erin Updyke Mmm.

Erin Welsh -became aware of the extent of the SARS crisis in Beijing when he called the hospital to check on a friend of his who had lung cancer. And the doctors that he had talked to, who were respiratory specialists, sounded panicked as they described how at least 60 people were infected with SARS, many of them healthcare workers, and that this was happening in hospitals all over the city. Remember, the official numbers were still 12 total infected in Beijing at this point.

Erin Updyke Oh!

Erin Welsh Yeah. Jian did a bit more calling around and made tallies of the number of estimated SARS cases in different hospitals across Beijing, and he sent those numbers in a note to a couple of Chinese TV stations. But unfortunately, his note was ignored. But it was eventually picked up by Time Magazine, which made it into international news. That there was an epidemic could no longer be denied, and on April 16th, an official announcement was made by the Chinese government, saying that the SARS situation is "extremely grave".

Erin Updyke Huh.

Erin Welsh The numbers were revised from 12 to 339 infected in Beijing-

Erin Updyke Wow.

Erin Welsh -with hundreds more suspected. And it wasn't just 305 people infected in all of China, which is the number that the government had been sticking to since early February, it was over 2200.

Erin Updyke Wow.

Erin Welsh With, again, many more suspected. And then the government did a remarkable thing - they canceled the week-long spring holiday and admitted that they were wrong. After the announcement, the number of cases went up tremendously and continued to grow, but was that because people now felt they could report accurate numbers? Was the epidemic actually growing? But with this sudden shift to finally acknowledging that SARS was a big freaking deal, the propaganda around it changed. There was now 24-hour coverage of the epidemic, whereas previously there had been almost none in, in China specifically. And then, whereas before sharing information about SARS meant betraying state secrets, the government now threatened the death penalty to anyone spreading misinformation or hiding aspects of infection.

Erin Updyke Whoa.

Erin Welsh Yes.

Erin Updyke Whoo, swing one pendulum to the other. [chuckles]

Erin Welsh Yes. The Chinese Ministry of Health finally put into place some preventive measures, foremost among them being thermal scanning for fevers.

Erin Updyke Mmhhh.

Erin Welsh So these scanners were put into place at train stations, banks, office buildings, everywhere, and if you were found to have a fever, you would be rushed off in an ambulance and placed under quarantine for up to 21 days.

Erin Updyke Wow.

Erin Welsh And even though this method was perhaps crude, it was probably pretty effective because a person was found to be most infectious, as you mentioned, between 10 and 21 days after infection. And during that period, they would almost certainly have a fever.

Erin Updyke Mmhhh.

Erin Welsh This quality of SARS made it easier to control, as we've talked about, and the authoritarian aspect of China was a double-edged sword, because on one hand, it restricted the flow of information that would end up fueling the outbreak, but on the other hand, once the epidemic had been acknowledged, it could mobilize people and put into effect practices, some that are questionable in terms of civil liberties, that might have been more delayed in a more democratic society.

Erin Updyke This is where public health becomes difficult, man.

Erin Welsh This is where public health becomes difficult, because these are civil liberties-

Erin Updyke They are, yep.

Erin Welsh -that are trampled on and, but that's why I say, you know, it's been called this double-edged sword. Alright, we're almost done with the SARS outbreak.

Erin Updyke Okay.

[laughter]

Erin Welsh Throughout May and into June, the epidemic began to wind down as Vietnam, Singapore, Hong Kong, and Beijing are all declared free of SARS.

Erin Updyke Okay.

Erin Welsh First case was in November, now it's May.

Erin Updyke Okay so like half a year, okay.

Erin Welsh      Yeah. In July, Toronto and Taiwan see no new cases, and it's been announced by the WHO that SARS has been contained worldwide.

Erin Updyke      Awesome.

Erin Welsh      The final tally of infected and dead is 8098 people infected, 774 people dead.

Erin Updyke      Mmhmm.

Erin Welsh      The economic costs of an outbreak like SARS are extreme. People lost jobs, personal bankruptcies went through the roof, tourism and travel revenue fell tremendously, the economies crashed in many of the affected areas. But I think what is often not as highly considered is the personal impact. Many people lost their lives, and those lucky enough to survive the infection often experienced long-term health consequences, and many also experienced PTSD or depression and were highly stigmatized for a period after.

Erin Updyke      Yeah.

Erin Welsh      The costs of an epidemic like this are far-ranging, and some costs are more easily quantified than others, and I think that's important to keep in mind as we talk about the 2019 novel coronavirus outbreak. And, as we'll get into also, a little bit of the issue of stigma and xenophobia-

Erin Updyke      Yeah.

Erin Welsh      -that are surrounding things like this.

Erin Updyke      Yeah.

Erin Welsh      And, and how travel bans restricting people from entering certain countries does not seem to be effective-

Erin Updyke      Right.

Erin Welsh      -and is actually a way of disguising xenophobia and racism.

Erin Updyke      Yeah, we can look back at times when we've instituted travel bans in past outbreaks and see that they, in general, cause a lot more harm than good. So I think that's really important to keep in mind, considering that they've already been put in place, supposedly, during this outbreak.

Erin Welsh      Yep.

Erin Updyke      So.

Erin Welsh      Okay. Let's move on to MERS.

Erin Updyke Let's.

Erin Welsh Alright. This is going to be really fast, I promise.

Erin Updyke Cool. Cool cool cool cool cool.

Erin Welsh Alright, so MERS. Most cases have an association with dromedary camels, and analysis of past samples show that the virus may have been circulating in camels at least since the early 1980s, which is 30 years before the first known human case. And this also suggests a long history of association between camels and the virus.

Erin Updyke Mmm.

Erin Welsh And I also want to note, though, that MERS-related viruses have been found in bat species on five continents, so it's suggested-

Erin Updyke Wow!

Erin Welsh Yeah. There are like, you know, clusters of MERS-related coronaviruses, SARS-related coronavirus-

Erin Updyke Right.

Erin Welsh -that are found in bat populations or animal populations, uh that don't have the ability to infect humans or don't appear to.

Erin Updyke Yet, yeah.

Erin Welsh But it does show that this is a very diverse and wide-ranging group of viruses.

Erin Updyke Yeah. Yeah yeah.

Erin Welsh Okay. So MERS-CoV was first isolated in June 2012 from a 60 year-old from Saudi Arabia who died of pneumonia and renal failure, and, as I mentioned earlier, this wasn't the first case of MERS. Retrospective testing showed that there was a cluster of cases in a family in Jordan a few months earlier to this-

Erin Updyke Mmhmm.

Erin Welsh -with likely human-to-human transmission occurring.

Erin Updyke Yes.

Erin Welsh Since then, there have been a handful of MERS outbreaks, though none as large as SARS or as the 2019 coronavirus is turning out to be.

Erin Updyke Mmhmm.

Erin Welsh Most of these outbreaks or clusters seem to be regional with limited spread outside of the hospital setting-

Erin Updyke Mmhhh.

Erin Welsh -and with most infected people being close contacts of the index case.

Erin Updyke Yeah.

Erin Welsh Since its first appearance in 2012, it has caused outbreaks in Saudi Arabia, the United Arab Emirates, South Korea, and many, many other countries have had isolated cases or very small outbreaks, clusters.

Erin Updyke Mmhhh.

Erin Welsh Uh, some larger than others, and as of December 29th, 2019, there have been 2499 lab-diagnosed cases and 861 deaths-

Erin Updyke Ooh!

Erin Welsh -and 84% of these cases were reported from Saudi Arabia.

Erin Updyke Yep.

Erin Welsh Okay. Novel coronavirus.

Erin Updyke Yes!

Erin Welsh 2019 novel coronavirus.

Erin Updyke This is what, everyone had to wait an hour and a half to get to this point.

Erin Welsh We're sorry, not sorry.

Erin Updyke Not sorry. These are important things to understand the context of this outbreak. Absolutely.

Erin Welsh I agree. I mean, I think that these are really important lessons to be learned, from SARS in particular, but just from the way that these outbreaks occur and how they progress and, you know, we learn something new every single time.

Erin Updyke Yeah.

Erin Welsh So as I, as I, you know, hammered on over and over again in the SARS, uh, history the Chinese government seemed very reticent in keeping the rest of the world updated on how the outbreak was progressing, and that does not seem to be the case so far-

Erin Updyke Right.

Erin Welsh -with the 2019 novel coronavirus-

Erin Updyke Yeah.

Erin Welsh -and I think that's a really important thing to consider. There's been a huge push towards the free and open exchange of information, as we mentioned, with these early articles being published in certain journals. The sequence of the virus has already been published, like, this is pretty incredible and very encouraging, I think.

Erin Updyke We are getting information so incredibly rapidly in this outbreak, more than we ever could have seen in the past, which is incredible. But I think also, in some ways, people are now freaking out about it, because there's a lot of triple exclamation point, all caps going on that maybe isn't always valid. And so I think trying to understand this outbreak, what's really going on in context is really important.

Erin Welsh Yes, absolutely. So what is going on?

Erin Updyke Yeah.

[laughter]

Erin Welsh Well, in December 2019, a bunch of people became sick with atypical pneumonia after visiting the Wuhan Huanan Seafood Wholesale Market, which also sells non aquatic animals such as birds and rabbits. This cluster of 27 pneumonia cases, 7 of them severe, was reported by the Wuhan Municipal Health Commission on December 31st, 2019. On January 9th, it was announced that a novel beta coronavirus, which is just a subtype of coronavirus.

Erin Updyke That's the same subtype as SARS and MERS.

Erin Welsh Yes. The next day, January 10th, the genome sequence of the virus was announced, it was published.

Erin Updyke This is incredible, we're talking like two weeks-

Erin Welsh Yes!

Erin Updyke -from first cases.

Erin Welsh It's incredible.

Erin Updyke Yeah.

Erin Welsh Um, so genomic analysis suggests that the virus likely originated from a bat, as I mentioned before and then maybe jumped into an animal that was at the market. This is yet to be determined. I'm sure that in the upcoming months, more will be discovered about the origins and the exact nature of that initial spillover event. The

numbers of infected and dead have continued to grow since that first cluster was announced. So Erin, how about we check in on how the current epidemic is progressing.

Erin Updyke Let's. Would you want to take a break first?

Erin Welsh Let's take a break.

[musical interlude]

Erin Updyke Erin, it is 10:51 a.m. now on February 2nd, 2020.

[laughter]

Erin Welsh This is a long episode, we're sorry.

Erin Updyke It's fine. Listen, I am on the Johns Hopkins map that they've created. We'll put a link to this on our website and in the show notes that is updating very rapidly with confirmed cases. So as of right now - this will change by the time you listen - there have been 14,628 confirmed cases of the novel coronavirus. The vast majority of these, 14,451, have been in mainland China. The rest have been in a number of countries across the globe. There have been 305 total deaths confirmed from this novel coronavirus, only one of which has taken place outside of China and that was in the Philippines. There have been 348 people that are confirmed to have recovered from this infection thus far. Cool?

Erin Welsh Cool.

Erin Updyke Cool. So that's the details that we have. [chuckles] That's about it, Erin. There's a lot of questions that remain.

Erin Welsh Right.

Erin Updyke And like we've hopefully informed you all, we are not experts on this topic. So to give you guys a better sense of what is being done, what can be done, and kind of what the differences are that we've seen so far between SARS and MERS in this novel coronavirus, we had the fortune of interviewing four people who are much better experienced in outbreaks and infectious disease and coronaviruses than we are. So let's talk to them about what's going on, shall we?

Erin Welsh Let's do that.

Aneesh Mehta Hello, my name is Aneesh Mehta. I am an infectious disease physician at Emory University. I specialize in infectious disease care of oncology, so cancer patients and solid organ transplant patients, and I am also a member of the Emory Serious Communicable Diseases Unit, which is our biocontainment unit at Emory University Hospital.

**Colleen Kraft** My name is Colleen Kraft. I'm an infectious disease physician at Emory University Hospital. I'm also trained in medical microbiology, and so I sort of enjoy my role of bridging those two worlds between diagnostics and also seeing patients. I love being on both sides of that, of the computer screen, if you will. I've been at Emory Hospital since 2010.

**Carlos Del Rio** So my name is Carlos Del Rio. I am a professor of medicine and global health at Emory University. I have been involved in infectious disease for many, many years. I finished my fellowship in 1988, 89. So I've been doing this for 30+ years. Most of my work is around, uh, HIV but I've been involved also in infectious disease generally and particularly in global aspects of infectious disease. I was very involved with Mexico during the 2009, uh, swine flu pandemic and I worked closely with CDC and with Mexico in working on that outbreak and in controlling that outbreak. I also am a co-PI of the recently funded Emory vaccine treatment and evaluation units. I work a lot also in vaccinology and the use of vaccines to prevent infectious diseases.

**Marshall Lyon** My name is Marshall Lyon. I am an MD, and I am an infectious disease physician at Emory University Hospital in Atlanta, Georgia. My day job, if there is such a thing, is the director of transplant infectious diseases, and that is the bulk of my clinical care, is taking care of patients who have had a transplant or are being considered for transplants and get an infection. So we deal a lot with viruses, both latent viruses and community-acquired viruses. One of my other roles is as a physician in Emory's Serious Communicable Diseases Unit. As one of the high-level biocontainment units in the United States, when novel coronavirus broke in Wuhan and started to become more of an issue, we started to pay attention and started thinking that potentially a case might come our way. And so we've certainly been paying attention to the outbreak as it's unfolded in China and the measures that the public health US is putting in place to try to keep the public safe.

**Erin Updyke** So, we'd love for you to talk about this new coronavirus that's been making headlines. This isn't the first time that we've seen a coronavirus causing a disease outbreak, but this virus is new. So can you tell us a little bit about this 2019-nCoV?

**Aneesh Mehta** So the first, sort of, novel coronavirus we saw was SARS, and then more recently we saw the Middle Eastern Respiratory Syndrome coronavirus or otherwise called MERS-CoV. And we've learned a lot from those novel viruses that have developed, which I think have us a little bit better prepared now for what we're seeing. And that's this novel 2019 coronavirus.

**Marshall Lyon** So, this is actually an interesting outbreak because when it first started, the majority of patients seemed to have contact with this wet market or this seafood market in Wuhan. And so it looked like it was more of a point source outbreak or a zoonotic outbreak. And so when we think of those, we think that people who got sick all had a common exposure and that if you weren't exposed to whatever that agent is or that location, in this case the market, then you probably didn't have risk of getting infected or getting disease. It was only later when it appeared, so when the second wave of patients began to come in, it became evident that there was now person-to-person transmission of what we now know is novel coronavirus 2019. And so, it now

it starts to take, the epidemic or the outbreak takes on a different characteristic where you have to think about how do we limit contact with sick individuals.

Erin Welsh Right. Quick question about viral or about pneumonia caused by viruses. What is the mechanism by which that occurs? Like, why, why does that look different than one caused by bacteria?

Colleen Kraft One of the things we should think about is when viruses cause pneumonia, that is when we become fearful, sort of, as clinicians. And so that's a lot of what happened, we think, in 1918 is that we believe that some of those deaths that were so dramatic probably came from influenza virus pneumonia, which I think is a lot different than how we think about pneumonias today, which are typically bacterial. And so I think, for me, when this started, when it was kind of announced on December 31st, you know, our first question is how frequently does this cause a viral pneumonia vs you know, kind of a bronchitis or even the upper respiratory tract, which is what we usually think about coronaviruses.

Aneesh Mehta The things that really worried me about a viral pneumonia as opposed to a typical bacterial pneumonia is that when we have a bacterial pneumonia we generally, though not universally, see that pneumonia in one region of the lung. One of the things that often concerns me about patients with a viral pneumonia, it's usually affecting multiple regions of the lung, potentially all of the regions of the lung. And in that situation, there's so much inflammation produced that the ability for the lungs to extract oxygen out of the air gets minimized very rapidly, and you see patients develop something we call acute respiratory distress syndrome, where they cannot exchange oxygen and require a lot of ventilatory and oxygen support to keep all the systems of the body running. And also, in that inflammatory condition that you can develop a bacterial pneumonia on top of the viral pneumonia's inflammation. And that can compound the issue and further cause not only damage to the lung, but further develop problems in oxygenating the body. And finally, the other concerning issue that goes on with viral pneumonias is the fact that we have very limited therapies, unlike bacterial pneumonias and antibiotics to address these. There are some antivirals that are out there, but most of them do not have any ability to treat the viral pneumonias that we are seeing nowadays.

Erin Welsh I know that it's sort of early stages in this outbreak and there's still a lot that we don't know about this virus and how it behaves, particularly, I was, you know, trying to get a handle on the infectious period and how that overlaps with the period during which symptoms are apparent. And so I know that that's sort of now more in the gray zone, but correct me if I'm wrong about that. But based on how we've seen this virus spread so far and what also we have seen in past coronavirus outbreaks, what do you think we might be able to expect in the next few weeks or months as this outbreak progresses?

Marshall Lyon Yeah, so you're right, we are in a gray zone about our understanding of this, but I think there are a few things that we do know. So the incubation period seems to be somewhere around five days, that's sort of the median or the mode of the incubation period. And, um, there is variation probably anywhere from two to the

longest being 14 days. We're pretty comfortable that 14 days is kind of the outside limit. And what we are starting to learn from what's happening in China is there may be an infectious prodrome before someone gets sick. And so, a prodrome is a period of time where someone can actually transmit the virus to somebody else but they don't have any symptoms of illness. And they don't know that they're about to get sick. They feel normal. And so, unfortunately, what that means is identifying people once they're sick won't absolutely terminate this epidemic and this is slightly different than SARS because SARS was really transmitted by sick individuals. And that most of the outbreaks could all be traced back to someone who had developed illness but was not in medical isolation.

**Erin Updyke** So, in terms of looking at this outbreak, so far how does it seem that this virus might differ from, say, the SARS coronavirus or the MERS coronavirus, both in terms of the disease that it seems to cause and also how the outbreak is actually progressing.

**Colleen Kraft** So I'm currently at a ASM biothreats meeting where I got to hear Tony Fauci this morning from NIAID talk about this virus. And I think one of the things that he really talked about that we're noticing is the total number of cases from SARS, you know, we've almost exceeded, and we're only like, you know, a couple weeks. And I think the main question that remains to be answered is really how severe is this.

**Aneesh Mehta** Yeah, I believe what we're seeing with this current novel corona outbreak is quite concerning, as far as the tenor of infection and spread goes. Initially I thought it was similar to SARS, which is quite concerning in itself, but the number of cases that we've just had in the past week alone and now exceeding the total number of cases of SARS that we had previously is concerning not only for China and the population there, but, given the amount of travel that occurs from China, to China, the ability for this virus to spread. The other concerning thing that I think is out there is lessons that we learned from SARS was that hospitals and healthcare systems, clinics can sort of be incubators for the spread of these type of coronaviruses. And that's something that really was harkened by SARS, and we've learned a lot of lessons from that, but I think still there's a lot of vulnerability in our healthcare systems for the virus to spread within healthcare systems and therefore create broader outbreaks that can spread throughout the community.

**Erin Welsh** So, as with SARS, it seems that there's a decent proportion of cases with this novel coronavirus that are healthcare workers who were likely exposed while treating someone who was infected. Does there seem to be any other pattern in the people who develop maybe severe disease or more negative outcomes?

**Marshall Lyon** So, certainly. Like with many respiratory viruses, it seems that people who are older or have other chronic illnesses are more likely to have severe disease and have worse outcomes. So the first seventy-some odd cases that were reported out of China, of the patients that died, I think the average age was 75 years old. And so that is, it's a similar pattern to what we see with the viruses that were familiar with.

Erin Welsh Could you elaborate a bit on the first steps that are normally taken when an outbreak like this occurs and you think, okay we might need to be prepared if somebody happens to be infected and comes to the US?

Marshall Lyon What US public health has done is first, for over a week now they've been screening passengers who are coming in from China, looking for anyone who might be ill or might have fever, so that if they are sick they can be identified quickly. And then contact tracing could be done of everyone who was on the airplane with them. So early identification is one of the keys in terms of limiting, then, subsequent contact to that sick individual. So the other sort of measure that is then put in place is social distancing. So if you have something that is passed from person to person, especially the coronavirus which uses the droplet method of transmission, if you can distance the infected individual more than two meters from anyone else, then in theory they would not be passing that virus on to someone else. And so if you, you know, cover your mouth, wear a mask etc. all those things can sort of decrease the amount of droplet production that a sick individual will make and therefore reduce the amount of droplets that are in the environment, which someone else could be exposed to. So those are sort of the early measures that public health is using right now to try to prevent an outbreak in the United States.

Erin Welsh The interconnectedness of everything and sort of this decreasing barrier between humans and wildlife has really seemed to be the pattern that's emerged behind all of these recent outbreaks of novel diseases. So what do you think in terms of prevention that can be done to prevent the spillover from these animal hosts to humans?

Carlos del Rio The first thing is we need to invest more in global health security, and we haven't done enough in investing in global health security at the level we should. And I quote Dolly Parton when she said, you know, "you have no idea how expensive it is to look this cheap". You know, if you think the cost of investing in global health security is high, wait until you get the bill for what this outbreak is gonna cost us. So not investing in global health security is going to make you spend more money at the end of the day. With climate change, with connectivity, the flights that we talked about, with growing population, all those things together are essentially a recipe for more and more outbreaks. They're not gonna end, they're just gonna be, the question I always have is "what's next?" not "will we have something?"

Erin Welsh In speaking more broadly, not just about the 2019 coronavirus but in any sort of novel outbreak or emerging infectious disease, what are some of the logistical issues in infection control, both maybe at a hospital level and then also with multiple countries working together?

Carlos del Rio Well, you know, that's where WHO fits in, right? That's when you need to have international collaboration, you need to have international cooperation. An outbreak in China should be a concern to the US, to England, to, you know, every other country in the world. So we all need to work together. We also need to get away from saying, "Oh, this is a problem of China, let China deal with it. This is not our problem." Because at the end of the day, that's not true, so nationalism has to

disappear. Microbes do not recognize borders, they travel without passports, and therefore we should get away from thinking about countries and think more about the globe.

Erin Welsh So one of the, I guess, challenging things about an outbreak like this today is the role of media and social media and the rapid spread of information, which is sort of this double-edged sword. What role do you see social media in particular playing in the spread of information during an outbreak such as this important?

Marshall Lyon Well, I think it's important that all media, whether it's traditional media or social media, presents the facts that surround any sort of an outbreak. And I think that, because social media and our global information age does allow us to get information so quickly, it almost feels as if China is next door when it's actually halfway around the world. By the same token, then it also enables people, like yourself, who are putting together a podcast to reach the masses to put the truth out there and to help people see things in perspective. As of today, which is January 30th, China is reporting that they have around seven to eight thousand confirmed cases. This is in a country of 1.5 billion people. That's a lot of people, and it still is a very tiny minority of their population which has so far been affected. In the United States, we've had five confirmed imported cases, and that's, you know, again in a country of 330 million. This is, it's a very small number compared to the larger population. And so I think that social media should be trying to put forth the truth and to try to keep the perspective of things that are going on but by the same token, I think that social media should continue to, to examine this and look at it, and I think, I'm not sure how big of a part social media played in this or the fact that social media exists now, where it didn't really exist to this extent in 2003, I think that the Chinese government has actually been fairly transparent with this outbreak and with what they're doing, as it compared to the SARS outbreak in 2003. I think social media has been good because it, to some extent, has kept governments honest.

Carlos del Rio Some of the media has been great, some of the media not so much. I mean, I think that newspapers sell headlines, right, so talking about the end of the world and this going to kill us all is, gets people's attention. But the reality is we tend to forget about the common things, like for example right now, CDC estimates that over 6,000 in the US have died of influenza, this epidemic. And yet we're more concerned about the coronavirus, and we should be telling people, you know, "get your flu shot" and "wash your hands and do respiratory etiquette". Because that's gonna be more important, that's gonna save you from influenza, but it's also probably going to be preventing some other respiratory viruses. So I think that the media needs to, needs to inform, needs to communicate, and more importantly, I think the media needs to rely on reliable sources. I cringe a little bit when, you know, the media starts quoting an expert in nutrition as an expert in this disease. We need to talk to people who know what they're talking about, and there are plenty of experts out there.

Erin Welsh While I was doing the research for this episode, I came across a bunch of articles that compared this current outbreak of the 2019 coronavirus to things like the 1918 influenza pandemic and of course SARS. And in many ways, SARS kind of feels like a bit of a bullet dodged because the control measures that we used, like contact

tracing and quarantine, these things worked really well. What do you think that says about the current outbreak?

Colleen Kraft I really liked what you said about the bullet being dodged because I think, if you think about us having the most population on Earth that has ever been of human population, some of that is really because we have learned how to do things to prevent ourselves from dying from infectious diseases. So in 1918, I can only imagine it was so scary. To think about, you didn't have really anything. Supportive care really was, like, nothing. And so when you think about having mechanical ventilation, then whole specialties, you know, sub-specialties, you know, pulmonary critical care that are dedicated to super sick people with bad lungs, I just think we have made a lot of advancements. And what Aneesh and I have seen since even Ebola virus five years ago and, and SARS and MERS is this rapid development of bringing in therapeutics into clinical use a lot sooner than we'd ever seen before. And that's because we're getting used to saying, you know, the longer we wait the less information we have, the less knowledge we have. Even the fact that we've had the sequence of this virus so quickly is pretty amazing, even from five years ago. And so I really like your dodging the bullet, but I think it's pretty cool to think about all the, kind of, advancements that we have, even in the last decade, not, not even since, you know, a hundred years ago.

Erin Welsh Less of a dodging the bullet and more building the shield, I guess?

Aneesh Mehta Yeah, I agree. I like, I like that analogy of building the shield. And, you know, one of the great lessons we learned from SARS and Colleen and I really witnessed this during the Ebola outbreak, was how important it was to communicate information about what's going on with patients, what's going on in the public health setting, what's going on immunologically and with the virus, very rapidly to healthcare environments and scientists and public health officials around the world. And with this outbreak, we're seeing exactly the same thing. As soon as there were reports coming up, sort of the infectious disease community, the public health community, the emergency medicine community throughout the United States was coming together. We're having conference calls, we're having rapid communication, and importantly, our colleagues in China were putting out all this information about what they were seeing. They put out immediately the sequence of the virus so that people could work on diagnostic testing and learn more very rapidly. And I think those are the lessons that we have learned as a global public health community on how to really address these new challenges.

Erin Updyke One of the questions that many of our listeners are very concerned with is basically how scared should we be of this, which is a pretty big and loaded question. So could you maybe talk about something about this virus or this outbreak in particular that is quite concerning to you and then maybe something that also is reassuring, that maybe, you know, this isn't the end of the world, we hope?

Colleen Kraft Yes, I'm pretty sure it's not the end of the world but one never knows.

[laughter]

Colleen Kraft I would say that, that there's always this initial panic about something new. And without being glib, I want to say that this isn't like an alien invasion of something we've never seen. We have dealt with things that are similar, and so it falls within our paradigm to be able to figure out, you know, yes it may be more severe, but we understand how these things are transmitted. We also understand how to protect ourselves. In terms of what makes me nervous, I think, is the surface aspect of virus transmission. And so what does that mean. It's kind of what I've already been saying, but if somebody coughs on like a seat that I now sit in or a surface that I now touch because I'm getting, you know, like a fast food takeout or something. How long does it stay on that surface, and how much of that has to be transmitted to me to make me really sick?

Aneesh Mehta And maybe, maybe I'll add something, but before I do, I just have to say that Dr. Kraft has really taught me to fear my cell phone and make sure I clean it all, all the time.

Colleen Kraft It really, like it literally has poop bugs on it. I don't let my children touch my phone, and I lens wipe clean it every day.

[laughter]

Erin Updyke I know, I looked down at my cell phone and I was like, "oh dear".

Erin Welsh I just like kicked it out of the way, I was just like, "no!"

[laughter]

Aneesh Mehta I think every reporter I've talked to you in the past 72 hours, the first question is "should we panic"? and my answer is there is no reason to panic. There are things that are worrisome. The thing that I think is worrisome to me is how quickly it's spread and how quickly we found cases in other countries, which means that we really need to institute good controls and screenings to make sure that we don't have continuous spread. I think just like any novel infection, early on one of the greatest fears is what we don't know about it. I think we will learn more about the virus in the coming weeks that will be reassuring to us, but there's still some that's unknown and how it's transmitted, how severe the disease can get, and who's most susceptible. But as my colleague Dr. Kraft mentioned, there are a lot of things that are reassuring about this. I think going back to our experience with SARS, what we learned from both experience in China and our experience with our colleagues in Canada and here in the United States, is that once we're able to identify the infection and, and the signs of infection, we're actually able to do really good epidemiologic contact tracing and appropriately isolate people, put people who were at risk inappropriate monitoring, and suddenly the cases start to get, to go down very rapidly. And the morbidity and the mortality from SARS start to go down rapidly. And so I think we have the tools in place to understand how to control infections like this. And it has worked with SARS, it has worked with MERS-CoV and

preventing the spread around the world of MERS-CoV, and I think it will continue to work, those lessons will work here with the novel coronavirus.

Carlos del Rio What scares me? I mean, I'm more scared about driving home this evening and getting killed in an accident than I am about this virus, quite honestly. So, you know, I think we all need to put it into perspective and realize what the risks are. I think what concerns me is that, is that this virus can continue to spread and, and can reach places like, for example, Africa and other places that are not going to be able to control it as quickly as China has been able to. And again, it makes me worry about, about the lack of support for international and global health security and the need that we need to have to talk to Congress, to talk to others and say, "hey, we have to invest in global health security." We have to support WHO and other agencies. And we really need to think about how to make global health security a priority for all of us because the reality is, right now, that we're all worried about this. It's the right time to do that.

Erin Welsh What do you think our listeners can do on an individual level to try to push that cause forward a bit more, having, having more investment in global or national health security?

Carlos del Rio I think you send an email or call your member of Congress and say, "hey, you know, with this outbreak, I worry that we're not investing in global health security." We need to do that, I think. We need to grab the attention of the people that have the, that are the funders, right?

[musical interlude]

Erin Welsh That was so fantastic. Thank you again so much to Dr. Aneesh Mehta, Dr. Colleen Kraft, Dr. Carlos del Rio, and Dr. Marshall Lyon. Those interviews were so wonderful, and we really appreciate you taking the time to come and talk to us.

Erin Updyke And a huge thank you to Sonia Bell from Emory University, who hooked us up for these interviews. We never would have gotten to talk to such experts without you. Thank you so much.

Erin Welsh Thank you, Sonia! Before we dive into sources and stuff like that, I feel like there's a couple things that we wanted to say.

Erin Updyke Yeah. Hugely important things.

Erin Welsh One is influenza.

Erin Updyke Yeah, okay. Listen, like Dr. Kraft especially mentioned in her interview, the ways that we can protect ourselves against this novel coronavirus will also protect us against things that really you should be more concerned about than this novel coronavirus at this point because you're far more likely to be infected with influenza than you are with this novel coronavirus even in China.

Erin Welsh Mmhmm.

Erin Updyke Across the entire world. Let's talk about what a toll influenza has taken thus far, shall we?

Erin Welsh Yeah, you're not just more likely to be infected you're also more likely to be hospitalized or die from influenza then you are from the 2019 novel coronavirus.

Erin Updyke Yes!

Erin Welsh Have you gotten your flu shot this year?

Erin Updyke Have you? Because thus far in the United States alone, it's estimated that there have been, in this flu season, between 180 and 300,000 hospitalizations from influenza and upwards of 10,000 deaths due to influenza in the US alone. Just in these few weeks where we have seen 14,000 confirmed cases of novel coronavirus, there have been over 40,000 confirmed cases worldwide of influenza and that's just the confirmed cases. The vast majority of influenza cases are not reported.

Erin Welsh Get your flu shot if you haven't, protect yourself, protect others.

Erin Updyke Mmhmm, mmhmm, mmhmm.

Erin Welsh Please. I think that one, one of the lessons that we can take away from this outbreak, as with past coronavirus outbreaks and other types of spillover events, is that these epidemics reveal these international wealth disparities.

Erin Updyke Oh my gosh, yeah.

Erin Welsh It can decide who will get the vaccines, who will get the treatments-

Erin Updyke Mmmhmm.

Erin Welsh -who has the financial support for control or, importantly, prevention and emergency preparedness.

Erin Updyke Yeah.

Erin Welsh As several of our interviewees said, microbes don't know country boundaries. They don't, they don't acknowledge them, recognize them. These are not national concerns. This is a call for international concern. An epidemic in one place is an epidemic globally with the interconnectedness that we have. And I think that, you know, some of the ugly sides of these epidemics are this, you know, pointing fingers and saying oh it's, it's this country's problem, not mine.

Erin Updyke Mmhmm. And that's not effective, right? When we have something that's of international concern, what we need is international collaboration and working together. And I think what's great is that we have seen a lot of that in this novel

coronavirus outbreak. We see people exchanging information and talking with each other in order to do our best to prevent this outbreak from getting worse.

Erin Welsh Exactly. Okay, sources?

Erin Updyke Sources.

Erin Welsh I have oodles of sources, but I wanted to shout out a few of them. A couple books that I read that focused on SARS one is called *21st Century Plague* by Thomas Abraham and the other is called *China Syndrome: The True story of the 21st Century's First Great Epidemic* by Karl Taro Greenfeld - that's what our firsthand account was drawn from. And then I have a few other articles, a couple I want to shout out are by Cui et al. in 2019, "Origin and evolution of pathogenic coronaviruses", and by Jones et al. in 2008, "Global trends of emerging infectious diseases." And then also by Lee et al. 2005, "Bats are natural reservoirs of SARS-like coronaviruses."

Erin Updyke Excellent. I read a great chapter in the book *Viral Infections of Humans*, all about coronaviruses in general, if you're interested in that. Two articles I loved, one was "The Severe acute respiratory syndrome" in the New England Journal of Medicine about SARS, and one called "Middle East Respiratory Syndrome" in the Lancet. And then if you'd like the most up-to-date information about the novel coronavirus, which I know that's what you all are here for, our experts recommended a few sources that we also have been relying upon, that is the World Health Organization Situation Report. They're updating this daily. Every single day there's a new situation report that's released. So you can get the most up-to-date information on the number of cases, oh look, they just updated it. Let's see what it says. Yep, it's a little less up-to-date than the other up-to-date source which is the Johns Hopkins website of, of a map that's continuously updating. And finally, the CDC has a great site on the novel coronavirus if you're interested in specific things that you can do to help prevent yourself from getting infected, uh wash your hands and cover your mouth. And we'll post the link to all of these in the show notes and on our website.

Erin Welsh Awesome. Thank you again so much to our wonderful, wonderful guests. We really appreciate it.

Erin Updyke And thank you to Bloodmobile for providing the music for this episode and all of our episodes.

Erin Welsh And thank you to you, listeners, for allowing us to keep making this podcast. It is our absolute favorite thing to do and with that, wash, wash, wash your hands!

Erin Updyke Our experts had something else to say about this.

Aneesh Mehta Don't panic, just wash your hands.

Colleen Kraft And wash your cell phone!

Erin Updyke You filthy animals!

[laughter]

[musical outro]