COVID-19 Chapter 4: Epidemiology

Katie Burson	So I'm Katie Burson, uh, I live in Japan with my husband and two daughters, um, Louisa and Zuzu. They're five and three. And we had heard about the coronavirus, which is what we were calling it at that point, maybe just a few weeks before we were scheduled to go on our cruise. Um, the cruise was leaving out of Yokohama and coming back to Yokohama, which was really ideal because we didn't have to fly anywhere, which we thought would be safer. But, uh, you know, my mom, who is actually a manager at a hospital laboratory, was all up in arms. She's like, "please, see if you can cancel. I'm really worried about it." And we were like, "oh, mom. It's fine." [laughter]. And so, um, we actually had to meet with the preventative medicine officer, because we're in the service, prior to leaving to make sure our vaccinations were up to date and we were aware, you know, of what the risks were. And it didn't really come into play. We met with her two weeks prior, then the week prior to our departure, and it wasn't a concern. It was just wash your hands, you know, don't be stupid. [laughter]So, um, my husband and my daughters decided not to get off the ship in Hong Kong, um, because we didn't want to risk it with the girls. We didn't really know what we were dealing with, but I went ahead. I wore, that was our second stop on the cruise, so we're like five days into the cruise. Um, I carried my hand sanitizer, we exercised what we thought was extreme caution. Which, at this point, we actually know what extreme caution is. But anyway, I came directly back onto the boat, got in the shower, washed the clothes. You know, we were trying to be as careful as we could. I didn't say hello to the girls; they were in their kid camp for the day. Until I had, like, thoroughly de-germed. But then, you know, we carried on. We didn't have any other real concerns or red flags with the virus until we got to Okinawa, which was our last stop of the cruise. And, um, they said that, you know, the Japanese Ministry of Health is exercising caution and needs to scan each and every individual passenger prior to them deboarding. So we, we were delayed somewhere between three and five hours getting off the boat because they were scanning everyone. And so we thought, man, you know things are really ramping up, they must be, you know, more of a concern. But we still didn't think, or we didn't know, I don't think anyone did, um, know what it really was, like the animal that we were dealing with. Until two days later, when we arrived in Yokohama and, Erins, this part was like so surreal. We're sitting in there at our last dinner, and the waitstaff must have known what was up. They must have been briefed because they didn't miss a beat. They continued serving, they didn't pause to listen, there wasn't a reaction. But the captain came on and he spoke in English first, and of course the dining room is primarily English passengers, Japanese passengers. So he spoke in English first, he explained that there was a passenger, um, who had boarded at Yokohama, stayed on only until Hong Kong, and then deboarded because he wasn't feeling well and Hong Kong was his home. And he had tested positive for the coronavirus. And so, you know, my husband and I just kinda looked at each other, you know, we don't

want to react because we don't want to alarm the kids. So, and also we didn't really know what that meant for us. So we, we sat and we listened. And then, because we knew what was being said once the announcement was being made in Japanese, it was really kind of eerie. Because I'm looking at the Japanese passengers as they're receiving this information, and I could see the colors draining from their face. Like, they were gray. You know, and it was very somber in the dining room.

We finished our meals and, um, and we went back to our room and we had to call a couple of people that my husband works with and say, "here's the situation", and we, we packed. We were ready to get off the boat the next morning at seven in the morning. And, of course, seven rolls around, there's no announcements. Eight o'clock rolls around, there's no announcements. Nine o'clock rolls around, the ship is being quarantined for a full fourteen days. And so we just, you know, we took it as that, you know. Looks like we're gonna be here for a while. We explained to our girls there are bad germs, we don't think we have any but we have to keep them away, we're going to be washing our hands, you may not leave the room.

And every day was different, as far as the information that we received. Obviously, the ship was in reaction mode. So we didn't receive our meals that first day until like three o'clock in the afternoon, which is really hard with kids. But we don't, we never blamed them, there was never any anger, um, it was just everyone's trying to do their best to keep this thing contained. Really, the staff and crew on the ship really rallied to keep the kids entertained. I mean, gosh, they ate so many kid's meals and they had so many toys delivered. [chuckles] You know, we just exercised extreme caution, and it really paid off. We all came off healthy and well, and then we went straight from the boat to another fourteen-day quarantine because we live on a military base.

People look at me and they're like, "god, you've been through something, and it must've been so hard." But really, like truly, I got to wake up with my babies snuggled next to me every day. I didn't have to cook, like cook, I didn't have to clean. All we had to do was play and be together. And hope for the best. You know? Like, you just control what you can. And as, as a military family, I have never, in my entire marriage or since my kids have been born, had six weeks of my husband all to myself. Really, the outcome of it, it was kind of just like this beautiful moment in humanity. Like, so many people cared. I mean, I was hearing from people I haven't spoken to in probably twenty years. And it wasn't just like a little message on Facebook. It was like this in-depth message like, "I'm praying for you," you know, "we can send you things, what do you need?" It was just really beautiful. People were delivering breakfast, lunch, and dinner as if I couldn't cook. Like, you know? [laughter] Like, they wanted to do nice things, they wanted to reach out and help. And it just made me feel, like, so loved and so supported. And, I think that would be like a really great takeaway from this tragedy is, you know, like, when we can work together and support each other, it's a beautiful thing. And we should also value our older generations.

[musical interlude]

Erin Welsh	So you just heard from Katie Burson, who we were so excited to connect with and talk about her experience on the Diamond Princess. She was on the Diamond Princess, y'all!
Erin Updyke	Yeah, that's like a big deal. Famous.
Erin Welsh	That's wild. So. Thank you so much, Katie.
Erin Updyke	I just, like, Katie, what an incredible human. She had the most positive outlook I have ever heard from someone who went through something like that and really helped me try and see silver linings in things as well. So I just really appreciated getting to speak with her too.
Erin Welsh	Absolutely. Hi, I'm Erin Welsh.
Erin Updyke	And I'm Erin Allmann Updyke.
Erin Welsh	And this is This Podcast Will Kill You.
Erin Updyke	Hello.
Erin Welsh	Welcome to Chapter Four of our Anatomy of a Pandemic Series on COVID-19. So far, we've discussed the biology of the virus, how the disease progresses, and the control strategies that we're using to slow its transmission. And in this episode, we dive into the epidemiological characteristics of this pandemic.
Erin Updyke	We brought back the amazing Dr. Carlos del Rio, who chatted with us in our first coronavirus episode back in February about the importance of investing in global health. You might remember his excellent Dolly Parton quote to go along with that.
Erin Welsh	I sure do! [laughter]
Erin Updyke	So in this minisode, we ask him all about the R0 of the virus, that reproductive rate of the virus, and how to bring it down, what flattening the curve means, and why we see different case fatality rates in different regions of the world, and the absolute necessity of acting now to help slow the spread of this disease. But before we get into that, we have some business to take care of. It's quarantini time!
Erin Welsh	What are we drinking for this one?
Erin Updyke	A pickle martini? Is that right?
Erin Welsh	Yeah, that's the one!

Erin Updyke	A pickle martini.
Erin Welsh	Quarantini 4!
	[laughter]
Erin Welsh	Our first ever martini?
Erin Updyke	No, bubo bebida.
Erin Welsh	Oh, yeah you're right. That was so long ago, does it even count?
Erin Updyke	Steel trap, Erin, steel trap.
Erin Welsh	Yeah, do you know how difficult it is to think of, I'll be like "oh this is a great recipe" and then I have to scroll through all of the old ones.
Erin Updyke	Oh, also if you didn't know we have a great resource of all of our quarantinis on our website, by the way.
Erin Welsh	Yes! You can click the quarantini tab.
Erin Updyke	Mmhmm. And all of our placeboritas, the non-alcoholic version, which we'll post the recipe for this pickle, for this pickled jalapeño martini.
Erin Welsh	Yeah, you could also just use a pickle if you don't have pickled jalapeños. I didn't have a pickle, so I had to use pickled jalapeños. [chuckles]
Erin Updyke	It's desperate times, ya know? [chuckles]
Erin Welsh	Desperate times. I wasn't gonna go to the store for a jar of pickles!
Erin Updyke	No, of course not. It's shelter in place, Erin.
Erin Welsh	Shelter in place.
Erin Updyke	Okay, before diving into the interview, we also wanted to talk a bit about the disease ecology, since that's kind of our forte, of spillover events in general and then go through a timeline of events to give us an idea of the spread of this virus. This timeline is, it's intense, everyone.
Erin Welsh	It's intense.
Erin Updyke	But it really gives us a good picture of what exponential growth looks like.
Erin Welsh	And how fast a disease like this can spread across the entire world.
Erin Updyke	Math, man. Who knew?

Erin Welsh	Who knew. [chuckles] Mathematicians, that's who. Modelers, statisticians, epidemiologists.
Erin Updyke	Good point.
	[laughter]
Erin Updyke	Anyways.
Erin Welsh	Anyways. The disease ecology of COVID-19 and its emergence, it deserves a more nuanced discussion than I'm gonna give it here because we want to get to the meat of this episode quickly, right? But I wanted to touch on a few things. As has been reported in peer-reviewed articles, as well as from experts on these episodes, this virus likely emerged from a bat, which is also where SARS originated. From bats, the COVID-19 virus was probably passed to another host before infecting humans. This sequence of events, from bats to other animal species to humans, it's not unprecedented. In fact, this has happened in many other disease outbreaks. And it does not mean, in bold, underlined, it does not mean that killing bats or destroying their habitat will prevent spillover events. So don't get your pitchforks out and start to try to kill all the bats.
Erin Updyke	No. We're not blaming bats, "blaming". That's not correct.
Erin Welsh	This is how ecology works. It's just, it does not mean that bats are malicious or that we should kill bats. In fact, doing those things, like culling bat populations or destroying their habitat, that has been shown to actually lead to an increase in disease outbreaks from bats and spillover events from bats. So bat conservation and the preservation of habitats is actually one of the most important ways that we can reduce spillover events, and funding bat conservation, especially in regions that may not have the resources to do so, that is crucial in this fight against emerging infectious diseases.
Erin Updyke	Bats also provide really enormously important ecosystem services; they're pollinators, they're seed dispersers, they eat insects, ones that annoy us for example.
	[laughter]
Erin Updyke	And they're one of the most amazing and fascinating groups of animals on the planet. This is our personal opinion.
Erin Welsh	Mmhmm.
Erin Updyke	And the role that some bat species play in some spillover events from wildlife to humans cannot and should not be ignored. This is a multi-faceted problem. Ignoring it prevents a complete understanding of the ecology of these events and how they happen, and it can ultimately be more damaging to bat conservation. If

	we want to prevent spillover, we need the complete picture. If you want to read more about the ecology of bat virus spillover events, there are a couple of great papers by Dr. Raina Plowright, boop boop!
Erin Welsh	She's awesome.
Erin Updyke	And we'll link to those on our website. We're also going to put up a paper that discusses a lot of the ecosystem services that bats provide and that's by Kunz et al. on our website as well. Cool?
Erin Welsh	Cool.
Erin Updyke	Don't hate the bats.
Erin Welsh	Don't hate the bats!
Erin Updyke	But also don't ignore the role that they play in these spillover events.
Erin Welsh	Okay. Now on to the timeline. It's a big one. Let's start at the beginning.
Erin Updyke	[laughter]. You guys, it's like eight pages of timeline.
Erin Welsh	I know, but you know, we're just gonna work through it. But I will say that this is not even a complete timeline, like we cut a lot of this out. And so I have, one of the great resources I have found is, and so this is where we got all of this timeline information basically, is from Al Jazeera. They are continually updating a timeline about COVID-19 across the entire globe. And so if you want really detailed information, that's the place to go.
Erin Updyke	Awesome.
Erin Welsh	Okay. So. Chinese officials are still looking for the "patient zero" of the disease, but it's possible that they will never be identified. But what is clear is that the disease had been spreading for a while before it was recognized as a novel infection and one of concern. And so what might be the earliest case was traced to November 17, 2019 in a 55 year old person, but that hasn't been confirmed. If it is, though, that predates the wet market where the first apparent cluster of COVID-19 emerged. So community transmission might have been going on for a while before it was recognized or it could have been amplified at that wet market, but the market may not have necessarily been the site of the spillover event.
Erin Updyke	Which I feel like kind of makes sense to me in some cases because I know early on they were trying to identify like what animal at the wet market, and we couldn't really find a good one. So if it was a person at the market who just happened to be there infected that ended up causing this spread, that kind of makes sense.
Erin Welsh	Mmhmm. Yeah.

Erin Updyke	And, honestly, a delay in recognizing a novel disease, especially a respiratory infection whose symptoms can pretty easily be mistaken for diseases caused by a number of other respiratory viruses, it's not that unusual. It might take a while before you realize a) that there's an unusual number of pneumonia cases outside of the norm and b) that the cases are caused by a new virus that you haven't seen before. So by late December, there were several cases of unusual pneumonia caused by an unknown virus in Wuhan, and Chinese health officials notified the WHO of this on December 31.
Erin Welsh	Yep. The next day, January 1, the wet market, where this first cluster I mentioned was apparent, the Huanan Seafood Wholesale Market, was shut down. At this point, there were more than 40 people infected.
Erin Updyke	On January 7, officials announced they had identified a new virus, according to the World Health Organization. The novel virus at that time was named 2019-nCoV and was identified as belonging to the coronavirus family.
Erin Welsh	January 9, the first death from the disease occurs in China.
Erin Updyke	January 13, the WHO reported a case in Thailand, the first outside of China, in a woman who had arrived there from Wuhan.
Erin Welsh	January 16, Japan reports a confirmed case, again from someone who had visited Wuhan.
Erin Updyke	Between January 17 and January 20, the US, Nepal, France, Australia, Malaysia, Singapore, South Korea, Vietnam, and Taiwan all confirmed cases of this novel coronavirus.
Erin Welsh	I mean, that's a matter of weeks.
Erin Updyke	Yep.
Erin Welsh	Okay. January 22, the death toll in China jumped to 17 with more than 550 infections. Airports in Europe and Asia increase screenings of passengers traveling from China.
Erin Updyke	Wow, 550 by January 22!
Erin Welsh	I know! I keep getting chills when I read this timeline.
Erin Updyke	Me too. January 23. Wuhan was placed under effective quarantine. At this point, the WHO said there was no evidence of the virus spreading between humans outside of China and the outbreak did not yet constitute a public emergency of international health concern.
Erin Welsh	January 26. New cases were confirmed in the US, Taiwan, Thailand, Japan and South Korea.

Erin Updyke	January 27, the death toll in China rose to 106, with 100 in Hubei province. Another 4,515 people in China were reported to be infected. There were 2,714 confirmed cases in Hubei province, up from 1,423 the day before.
Erin Welsh	That's like a doubling, essentially.
Erin Updyke	Mmhmm.
Erin Welsh	On January 30, the WHO declared COVID-19 a global emergency as the death toll in China jumped to 170, with 7,711 cases reported. On this same date India and the Philippines confirmed their first cases of the virus, with one infected patient in each country.
Erin Updyke	On January 31, the next day, the number of confirmed cases in China jumped to 9,809. Russia, Spain, Sweden and the United Kingdom all confirmed their first cases of the virus.
Erin Welsh	And on February 2, the first death outside China was reported in the Philippines.
Erin Updyke	On February 6, the death toll in mainland China rose to at least 563, with more than 28,000 cases confirmed. Meanwhile, authorities in Malaysia reported the country's first known human-to-human transmission and the number of people infected in Europe reached 30.
Erin Welsh	30!
Erin Updyke	30. February 6.
Erin Welsh	On February 7, Li Wenliang, a doctor who was among the first to sound the alarm over the coronavirus, died, and Hong Kong introduced prison sentences for anyone breaching quarantine rules.
Erin Updyke	On February 9, the death toll in China surpassed that of the 2002-03 SARS epidemic, with 811 deaths recorded and 37,198 infections. It's worth noting that the SARS epidemic infected 8,000 people.
Erin Welsh	Yes. On February 11, the WHO announced that the new coronavirus would be called "COVID-19".
Erin Updyke	As of February 12, there were 175 people infected on board the Diamond Princess cruise ship.
Erin Welsh	February 14, Egypt became the first country in Africa to report a case and France reported Europe's first death from the virus.

Erin Updyke	As of February 17, there were 1,770 deaths reported in mainland China and 70,548 cases. Japan also confirmed 99 new cases of the virus on board the quarantined Diamond Princess cruise ship.
Erin Welsh	February 18 saw China's daily infection figures drop below 2,000 for the first time since January, with the country's health commission reporting 72,436 infections on the mainland and 1,868 deaths.
Erin Updyke	On February 19, Iran reported two deaths from the coronavirus, hours after confirming its first cases.
Erin Welsh	On February 20, South Korea reported its first death from the coronavirus.
Erin Updyke	February 22, South Korea saw its largest spike in a single day with 229 new cases of the virus. On that same day, Italy reported its first two deaths, while Iran confirmed a fifth death among 10 new infections. A sixth death was later confirmed, though it wasn't clear whether this case was included in the country's 28 confirmed cases.
Erin Welsh	February 26, the global death toll neared 2,800 with a total of about 80,000 confirmed cases reported globally. On this same day, Norway, Romania, Greece, Georgia, Pakistan, North Macedonia, and Brazil all detected their first cases of the coronavirus.
Erin Updyke	On February 27, Estonia, Denmark, Northern Ireland and the Netherlands reported their first coronavirus cases. The number of infections globally passed 82,000, including more than 2,800 deaths.
Erin Welsh	On March 3, Italy announced the death toll in the country reached 77, equaling the total deaths in Iran, which stood at 77.
Erin Updyke	On March 7, the coronavirus had killed nearly 3,500 people and infected another 102,000 people across more than 90 countries.
Erin Welsh	On March 10, both Iran and Italy recorded their highest death tolls in a single day. A total of 54 people died in Iran over a 24-hour period, while in Italy, 168 new fatalities were recorded from the coronavirus. On this same day, Lebanon and Morocco reported their first deaths from the virus, while Democratic Republic of the Congo, Panama and Mongolia confirmed their first cases of infection.
Erin Updyke	On March 11, World Health Organization declared the coronavirus outbreak a pandemic, as Turkey, Ivory Coast, Honduras and Bolivia confirmed their first cases. In Qatar, infections jumped drastically from 24 to 262 in a single day.
Erin Welsh	On March 16, New York Mayor Bill de Blasio ordered the city's bars, theatres and cinemas to close down, as the number of cases continued to rise in the US.

Erin Updyke	On March 19, Italy overtook China as the country with the most coronavirus-related deaths, registering 3,405 dead compared to 3,245 in China. The death toll in Spain soared by 209 to 767 fatalities from the previous day. A roughly 25 percent increase in infections was recorded, taking the country's total to 17,147.
Erin Welsh	On March 20, which is just a couple of days ago, coronavirus-related deaths surged past 10,000 globally, which is more than the number of people infected with SARS during the entire course of the epidemic. The number of cases in Germany rose by 2,958 overnight to a total of 13,957. Spain, meanwhile, had a death toll of 1,002. On this same day, though, in China, no new domestic cases were reported for a second consecutive day.
Erin Updyke	That's a big deal. On March 21, Europe remains the epicentre of the coronavirus with Italy reporting 627 new fatalities, its biggest daily increase, bringing the total number of deaths to 4,032 amid 47,021 cases. Spain is the second worst-hit country in Europe with more than 21,000 infections and at least 1,000 deaths.
Erin Welsh	On March 22, which is the day that we're recording this episode, the global death toll rose above 13,000 while infection count surpassed 311,000. So right now, it is 1141 US central time, and there are 318,209 confirmed cases in the globe, and 13,664 deaths. 94,700 total recovered.
Erin Updyke	Wow.
Erin Welsh	It's a very chilling timeline.
Erin Updyke	That is a very chilling timeline. That, that was, uh, really helpful I think to go through though. Because even if you didn't catch every single number and every single date, I think it's very clear from going through that that this is a) rising and spreading very rapidly
Erin Welsh	Exponentially.
Erin Updyke	Exponentially. And b) that we're still in that exponential growth right now, today, March 22.
Erin Welsh	Right. So how do we slow that down. Well, to answer that question and to talk about the characteristics of this disease, we brought back Dr. Carlos del Rio. So let's let him take it away.
Erin Updyke	Right after this break.
	[musical interlude]
Carlos del Rio	So my name is Carlos Del Rio. I'm an infectious disease physician and a public health expert and I'm a professor of medicine and global health here at Emory University where I'm also the executive associate Dean of Emory at Grady.

Erin Welsh	So at this point in the epidemic, we've seen a lot more about how the virus has spread in different places and in different populations. Do we have a better sense of what the R0 is for the virus?
Carlos del Rio	Well, you know, I think we're beginning to know better what again and we should define what R0 is. Even though people are probably now hearing this term ,and a term that was sort of a epidemiology lingo is now becoming like household dinner conversation term. But you know, I've been talking to, I've been talking to CEOs, so companies and others who now call me and, I had a CEO of a company today, call me, "What do you think about the R0?, you know, today" [laughter] So it's interesting to me that R0, has become sort of a lingo that we all talk about. But, but basically what this means is the reproductive number, right? It's the number of infections that a virus causes. So one person, infected person leads to other people being infected. And there are diseases like measles for example, that may have an R0 of 15, so one infection leads to 15. And then if the R0 is below one, then the disease dies, it disappears. So, so MERS has typically had an R0 below one, so we, we rarely see epidemics. We have not seen an epidemic from MERS. But this disease has an R0 of about two and a half to three which means that somewhere between two and a half and three individuals get infected after a person has been infected. And that's what causes what we call an exponential growth in this epidemic. Because, and I try to explain this to people in simple terms, if you have one infected person that a person infects, let's say two and a half persons, so let's go with the lower limit. So that means that after five days you're going to have two and a half infected persons. So now you have that person plus two and a half, but then in 30 days you're going to have 406 infected people. That's what we call exponential growth.
Erin Welsh	Can you talk a little bit about the progression of the epidemic in China and in some other places where the disease seems to be slowing down? In those places is there a risk of a second wave of infections?
Carlos del Rio	You know, I think there's always a risk. So let's suppose we can decrease, I told you, you know, one to two and a half to 400 at the end of 30 days. If you can decrease exposure and can decrease transmission by 50% so you can bring the R0 from two and a half to let's say, 1.2, 1.25. Now at the end of five days, you have 1.5 infected people instead of 2.5 and at the end of 30 days you'll have 15 infected people instead of 400. Now if you can bring that R0 below one, now at the end of five days, you'll have, let's see, 0.7 of a person infected, so not even one. And then at the end of 30 days, you will have maybe two people infected. So you will probably still see some cases, but as long as you can really decrease exposure. And that happens by two mechanisms. Number one, initially China has done it by social distancing, right? By quarantining, by isolating people, by really going into a national shutdown. But something that's going to happen eventually as you get more people infected, essentially have a you know, a herd immunity and there's not enough people to infect others. So the number of transmissions also goes down. So I suspect there'll be little clusters here and there, but I don't think there's going to be a huge wave. Again, assuming that there's immunity to this virus.

Erin Updyke	And so kind of along those lines that you mentioned about trying to decrease that R0 overall, can you talk us through what the stages of an epidemic are and what it means to try and flatten that epidemic curve? How do we know when that actually happens?
Carlos del Rio	Well, we know when that actually happens. I mean this is a complicated phenomenon, but you know the epidemic starts, it starts growing. It's really when you get that inflection point where the number of, when cases are now growing by a factor of one, when you get two cases growing by a factor of only one, then you start seeing that flattening of the curve. Then you start seeing, but, but that by that point it’s a little too late. And I think about it like a plane taking off, right? Initially you were seeing, you know, 10, 20, 15, 40 a hundred cases, you know, the plane was just still running down the runway very quickly. Then the nose goes up and then, you know, we start seeing in the U S a hundred cases and now we're, you know, at whatever number of cases we're at today, we're like 16 or 18,000 right? So now the plane’s at 18,000 feet. At some point in time you're going to see it get to 30,000 it's going to start a leveling off. So just like a plane, you get to a point where you have enough people infected out there and you have enough transmission because the number of susceptibles is going down. So, I don't like to talk about phases of an epidemic because it's really no phases. The natural history of an epidemic is to continue until you infect, or you cause all susceptibles to be either infected or death, right? But, but what you want to be sure is that you prevent that. And, and what we need to do is, is do everything we can to, to shut down that R0, to decrease the, R0 to below one. If we can bring the R0 below one, we will control transmission,
Erin Welsh	Right. And so that needs people to say at home and practice social distancing and so on. And, but, I'd like to revisit something you mentioned in talking about how the epidemic has progressed in China. And so one of the things that you talked about was herd immunity which would require that this infection with this virus leads to immunity. Is that something that we have seen? Do, are people who are infected with this virus and then they recover, are they immune and resistant to future infections?
Carlos del Rio	Well, there's been a lot of talk or whether you can get reinfected or not. I think from what I can tell that people are, are gonna develop immunity and are going to not get infected. So I think immunity is going to help us going forward.
Erin Welsh	Gotcha. I guess like, what is the relative effect that social distancing has had versus herd immunity has had?
Carlos del Rio	You know, it's really hard to tease that apart. But I will tell you that if they hadn't done what they've done, that, the massive shutdown that they did, I think social distancing, probably may have played a huge role there. And the reason I say that is because if they had not done this, I think the numbers would have been staggeringly higher. And you know, just, I look at it today, you know, I mean, I was just in shock today when I saw that you know, China as of today has about 80,000 cases with 3,200 deaths. Italy has half the number of cases, 40,000 cases, but has

	more deaths than anywhere else. Italy has now surpassed China deaths. But I think China really emphasized the social distancing and that's why their number of deaths compared to the number of cases is so much lower, it's 4% versus Italy, which is 8% right?
Erin Welsh	Right, right. And I think that's one of the things that this outbreak has revealed, particularly here are looking at the US, is that, you know, we have to slow the spread of disease. People need to stay at home, they need to practice social distancing. But I feel like at least anecdotally, this message and also from what I've seen on Twitter and on some other news reports, I feel like this message doesn't seem to have properly sunk in, especially in areas that may not be currently experiencing the same number of confirmed positive cases as other regions or in populations that have been said to be at lower risk. So how can we convince people just how important it is to stay home when they can?
Carlos del Rio	Well, you know, again, it's in your hands to become infected or not, right? If you become infected, you will then lead to other infections. So the best thing, I mean the best vaccine we have for this is to not get infected, because if you don't get infected then other people won't get infected. And if other people don't get infected, then you'll stop the chain of transmission. And that, to me, is what we need to do right now. So I mean the term flattening the curve, well, the way I explain it is by saying, look, if I'm in the hospital and 300 people come in sick today, I can't take care of them. But if three hundred people come in sick over a month, I can take care of them. It's easy or it's easier, right? So, so we want to spread out the number of cases, but more importantly for the general individual, it's in your hands to prevent transmission. If you don't get infected, you're not going to pass it to others. And if you don't pass it to others, you're cutting down the transmission chain. So cutting down that transmission chain is something that we all have the ability to do.
Erin Welsh	Yeah, absolutely.
Erin Updyke	Yeah. And so I had another question for you, actually, about, in looking at the differences in fatality rates between like in China versus in Italy, how do you feel like that compares to something like South Korea where they tested very large numbers of people and the death rate there was as low as I think, like, less than 2%. Is that because of better identification of cases in your opinion, or because of better social distancing and treatment methods, or what do you think some of those differences are?
Carlos del Rio	I think that two things happen. I think that, you know, every country's a little different and there's some issues. Italy clearly if you look at who got infected in Italy, clearly, Italy had a much older population and I think that clearly was playing a role. If you look at the distribution of Italy versus South Korea in South Korea, almost 30% of their cases were between the ages of 20 and 29 and almost 20% between the ages of 50 and 59. In Italy, in the country, I would say almost 40% of cases were between the ages of 70 and above. So you have a very different distribution of cases in a population. You'll also have very different distribution of

	comorbidities in a population. So, it's not simple. And we're learning very clearly that mortalities are very different in different populations, right?
Erin Welsh	Right.
Carlos del Rio	And that to me, that to me is, is very important because our populations look very different.
Erin Updyke	Yeah.
Erin Welsh	You know, recently, earlier this week, there was that report that came out from the Imperial college of London that had these you know, variety of modeling predictions based on, you know, no control strategies, mitigation strategies, suppression strategies. But all of the numbers were fairly alarming. And so, can we make any guesses at this point to what we might see in terms of numbers infected or just how long the outbreak will last? Like what is the end game on this?
Carlos del Rio	Well, the end game is to stop it. And, I worry that, you know, here in the United States we don't have, we have several problems. Number one, we don't have Wuhan. We have multiple Wuhans. We have a Wuhan, in Washington state. We have a Wuhan in New York state. We have a Wuhan now happening in the South. So we have multiple Wuhans. And I think that to me is one issue that, you know, we don't have one Wuhan. And the other thing we have, our public health is, is, de-centralized, so it's not centralized, right? In China the central government can say do this and it will happen. Here in the US, the federal government doesn't have that authority. The federal government makes recommendations. And then after the federal government's recommendations then the states, really, public health is run at the state and local health department level. So, you have States saying, Oh, you know California saying "we're going to shut down the State," and state of Florida saying, "Oh, you know, we're okay." You know, "we don't want to…," yesterday I was hearing the governor, we interviewed him saying, you know, "we don't really don't want to impinge on individual liberties and the college students want to be partying out there, it's their right." So, so you have a very different approach and if you put in the middle of this, the economy, and there's no doubt that epidemics have huge economic consequences. I mean, epidemics hurt business and epidemics hurt consumption and epidemics hurt a lot of things. And we've seen already, what the stock market has done, and what, you know, is going to happen to small business and to other businesses. So, I can see a politician being reluctant to take the tough measures that are needed. And that's when you say, we need an independent body that can help and make those recommendations. But unfortunately we don't have such independent body in this country. It's all based on, you know, it's all based on political decisions and, unfortunately, it's not, it's not going well. I mean, I think you and I will agree that the response to the U S has been haphazard at best.
Erin Welsh	Yeah. In, in one of the things that, that I think a lot of people are wondering is that at the beginning, we were looking at this as a matter of weeks and as the

	epidemic, as the pandemic has progressed, it seems like now we're looking at this on the scale of months.
Carlos del Rio	I think the more you delay the response, the more the time is. Right? And I think that's something that, that people need to understand, that, as you take more time, more time takes you, you know, basically, it becomes harder to do the right things.
Erin Welsh	Yeah. I mean that's what it seems like is that even in places that have been relatively low impact by the virus, it seems like not even the tip of the iceberg, but the tip of the tip of the iceberg where we don't even know the extent of the community transmission that's going on. And so, you know, we see these actions like shelter in place that have been happening in California and in parts of New York, and maybe going into effect elsewhere. But is that like, should that be happening now in places that haven't seen the number of cases that those States have seen?
Carlos del Rio	So the answer is yes. When somebody says to me, Oh, we only have 20 cases, we've got this under control. I said, if you only knew, right? By the time you have 20 cases, you're already, you know, 20 cases too late. So I would, I would emphasize and say over and over, no, you cannot do that. I mean, that is the mistake that everybody has made. And I don't want to get political or anything, but you know, you know, I look at different Trump quotes through the epidemic, right? And the first press conference about this was "we got in in February 28th, we sparked 14 cases. We've got this under control. Next week there's going to be no cases," and now we have a national emergency, you know, so you get distracted and, and this comes back to haunt you, right?
Erin Welsh	Yeah, absolutely.
Erin Updyke	There's been a lot of talk about this virus potentially becoming another seasonal influenza type virus. What do you think about, is that something that we think is likely at this point that this is now so well established that this is going to be kind of a recurrent seasonal thing?
Carlos del Rio	No, I can't. I can't, I don't, I, it's possible. I'm gonna I think at this point in time, it's speculative to say that. I don't want to worry about the future. I want to worry about the present. And the present is, we have, the house is burning, right? We have a fire in the house. And I almost sound here like somebody asking me, well, you know, "once you rebuild a house, do you think there'll be another fire again?" I said, let's put the fire out again first. You know, let's worry about that later. [laughter] So, lets take care of the current problem. And the current problem is let's stop this, and then we'll figure out the rest. You know, there's a lot of really good work happening in vaccines and other things, so, so depends whether we have a vaccine. That's I think is the answer.
Erin Welsh	Yeah. Yeah, absolutely. You know, I think one of the things in particular that I'm still trying to get a grasp on, on the entire timeline or an understanding of it is the

	testing, and the controversy around the testing. Can you walk us through a little bit of that and why there were, why it was slow at the beginning? What's going on now? Just sort of a, a brief on the testing aspect.
Carlos del Rio	Well, I think in a testing aspect we have, we have three things. Number one, we have found a new virus and the virus sequences were put in the internet and the CDC developed a test. And, then of course this is not, you know, people came on talking about a kit. This is not a kit. You know, this is not a something that you go to a store and you buy, right? This is something that they developed. This was a home group. You know, this as best I can describe it. This was say a laboratory developed test. They did it in-house and of course because it's a laboratory developed tests it has some challenges. And during those challenges because of some regulations that exist existed, you know, unfortunately when the president activated or says this, a national emergency that activated a series of rules that blocked others from developing a test at this point in time, at that point in time. So, most people were not developing, so some people were developing tests but others were not. So, there was a lot of, I would say, things that I will describe between bureaucracy, unfortunate mistakes, and, and just dealing with something new that prevented us from developing what would have been a robust test. And then now a lot of tests are being developed and, and companies are getting involved. But also, you know, initially CDC started getting tests out to the health departments and we know, you and I know, that health departments are there to do public health, but not to do clinical care. But as clinical patients were coming, then all of a sudden the health department is, are supposed to be providing clinical testing. Right? Which is not what they're designed to do. So now I think it's, things are a little better, because now you have companies out there working and doing all this stuff and that makes a huge difference. And I think we're seeing, you know, the FDA is approving tests. That's been right. So I, there's going to be more testing and I think we need a lot more testing and as you see, the US is way behind. The problem is, is that we would like to offer the test to more people, but we still ae at a point where we need to ration our testing. And we're in a situation right now in this country that we've never been before. We are rationing, testing, we're rationing PPE. So I tell people now you know what it feels to be in a developing country, right? Because we're rationing things and that's something that we don't necessarily feel comfortable doing. But that's the reality, right? Is we are in a rationing environment, and rationing is very hard.
Erin Updyke	Yup. Absolutely. So at this point, I know, I know some of this, it kind of varies state to state or even, maybe County to County as well, but are there general recommendations at what point a person, if they suspect that they're infected, should go and try and get tested? Even in spite of these shortages?
Carlos del Rio	If you have symptoms, if you are, think you have the disease, you need to go to your doctor and, or you need to call your doctor, and then you'll be told whether you need to be tested or not. But what I want people to know is that if you are asymptomatic and just, I don't want the worried well to go get tested right now because the reality is it's just going to overwhelm the system and is going to take care of tests that we need for people who actually need it right now.

Erin Updyke	So you've touched a bit already on, on that we're kind of learning as we go with this whole pandemic, but what do you think that this outbreak so far has taught us how to prepare for what we're experiencing right now? How can we do better, kind of moving forward?
Carlos del Rio	I think right now it's really hard to know, but when we're done with this, I think we have to sit down and do the, they'll do the postmortem, right? We need to do, let's go over this and find out where, where were the mistakes, you know, and what got us in the trouble we're in, because we should've never been in this kind of trouble. And you know, I would start with one thing. I think we have under-invested in public health for years, right? And many administrations, not just the current, but I started with Obama, have really under invested in public health. And you know, CDC has I think over 700 vacancies. And now because we under invested in public health for years and now we're having to spend billions in taking care of the problem. If we had invested in public health to begin with and had the surveillance equipment and other things. And I'll tell you an example of under investment, the state health departments are having trouble scaling up testing the way they should. Why? Because they don't have enough machines. They don't have enough personnel because they, we've under invested. So I would, I would really want to see people to rethink public health and whether we, we have to put our priorities are, if we don't invest in public health, then we are going to be having another pandemic. And you know, I think about 2009, we had pandemic influenza and now we have this 10 years later. So let's rethink this so we don't have the pandemic 2029.
Erin Welsh	Yeah, absolutely. So I'll end with asking you a question that I asked in our first episode on coronaviruses. And I asked what about this disease concerns you and what about the response or how the epidemic has been handled so far, is there anything about that that is cause for optimism?
Carlos del Rio	Well, what concerns me the most about this disease right now is the transmission in healthcare settings. Because I tell people that are healthcare workers, doctors, nurses, you know, advanced practice providers, et cetera, you know, respiratory therapists, you name it, are, are in the front lines, are finding this virus in the battlefield. And we have been unable to give them all the necessary personal protective equipment. So there's not enough personal protective equipment, and therefore we are sending into battle without enough protection. And that to me, we're doing the best we can, but we're still not where we would like to be. And you know, we're having meetings to talk about, well, you know, "how do we, how do we use PPE more appropriately?" I mean, if we had enough to be, I would feel so much comfortable, so not having enough material to provide to our doctors, our nurses, our healthcare workers, the necessary protection, that worries me a lot because I think we're going to see a lot of infections among healthcare workers in this country. And that is bad, and that is something that it should be unacceptable and we need to make a big cry about that. But number two is, I also worry that people are not taking it seriously and the people are still, you know, partying and I saw the videos of the college kids in the beach in Florida saying, "Oh this is no big

	deal." And what gives me hope is science. And I think, you know, what I've seen come together, how science, how industry, how the communities coming together gives me hope. Because where I come from, where my research has been with my work has been, which is in HIV, that was the solution. We are where we are in HIV because the community, the scientists, industry, and governments came together and got us where we are. To me it's unimaginable to see where we are, I could have never predicted that we would be where we are in HIV. And it's because of that coalition, that made us better and made us stronger. So, I have hope between science, community, and everybody coming together, we'll be in a better place.
	[musical interlude]
Erin Updyke	Dr. del Rio – he said we could call him Carlos but it just feels wrong.
(simultaneously)	Carlos, thank you so much.
	[laughter]
Erin Welsh	We really, we really appreciate it. I mean all of the people that we've talked to, I know we keep saying this, but all of the people that we've talked to took time, precious time, out of their incredibly busy schedules to talk with us and to help spread some factual information about this disease, and for that we thank you so, so much.
Erin Updyke	Yeah, really. Thank you so much. So what have we learned?
Erin Welsh	What have we learned. I think one of the things, number one, that we've learned, is that there does appear to be immunity to this virus, and that this immunity could substantially contribute to what slows this pandemic. So even though we have talked about the horrible concept of using herd immunity as a strategy, it could be what happens naturally as people do get infected, especially since we're seeing this exponential growth now. That might be what helped to contribute to the decline of cases in China.
Erin Updyke	Mmhmm, mmhmm.
Erin Welsh	But more importantly is the social distancing measures, and we'll talk about that as well.
Erin Updyke	Absolutely. Number two. An important thing that we learned from this episode is that we have to consider characteristics of this disease and this epidemic in the context of the places that are being affected. So we're seeing different infection rates and different case fatality rates in different regions in part because the populations affected in those regions are different. And we don't, at this point, necessarily know what all those differences are that are driving the differences in case fatality and infection rates. That's something that we might only be able to recognize in retrospect, once we make it through the other side of this outbreak. And I think that's really important because there's been a lot of talk about the case

	fatality rate is this in Italy and this in South Korea, and we don't fully understand what those differences mean in this context yet.
Erin Welsh	Right. And how much they're going to change as we test more people, as the number of cases grow, as our knowledge about this disease grows.
Erin Updyke	Exactly.
Erin Welsh	Yeah. Number three. We have underinvested in global health security and in international public health and pandemic preparedness on national scales, international scales, regional scales, local scales, state scales, whatever.
Erin Updyke	On every single scale.
	[laughter]
Erin Welsh	Every single conceivable scale. For years. And years and years. This lack of investment in global health security and pandemic preparedness, it is coming back now to haunt us. And so the amount of money that, you know, speaking for the US, the amount of money that we have saved by cutting programs such as the CDC and pandemic preparedness initiatives, that number is infinitesimally small compared to the bill that this is going to lead to. And that's just the economic bill. The psychological impacts, the social impacts, I mean this is going to have repercussions for every aspect of our lives. And I think that it is going to fundamentally change the way that we live, the way that we work, the way that we communicate, and the way that we think about our own health and safety.
Erin Updyke	Mmhmm. Say it, Erin. Number four. We learned from this interview that there were a lot of different factors that contributed to the slow rollout of tests that we've seen in the US. We're doing better now, for sure. There's a lot of different private labs and private hospitals and public hospitals that are developing their own tests, and people are working really hard to try and roll out more and more tests. But that delay has really prevented us from getting the precious knowledge that could have helped to slow this disease. And I think you can't really underestimate just how important that was. Like this is a thing that we kind of botched. And like Dr. Kraft mentioned in one of our episodes, it's not like we could have made this overnight, right? But it was kind of months of not ramping up production on something like this to not be able to start rolling out these tests well. And now we're running into further issues of running out of protective equipment, of running out of swabs to actually run these tests. Like, we have a lot of issues in the actual supply chain of testing for this virus.
Erin Welsh	Absolutely. And I think, you know, if we want to silver lining this, then this is hopefully something that we can take and learn from.
Erin Updyke	Yeah.

Erin Welsh	We've talked about this before in terms of epidemiologists always being viewed as either overprepared or underprepared or overreactive or underreactive.
Erin Updyke	Yep.
Erin Welsh	So it's a huge challenge.
Erin Updyke	It is.
Erin Welsh	Point five. I think this is a really important one and this is something that we have hammered on in other episodes of this series so far. We can bring down the R0 of this virus through control measures and personal decisions. Our individual actions, each one of us, has the power to help slow the spread of this disease. We really need to take this seriously.
Erin Updyke	So there was a really great, um, modeling study that looked at the data from Wuhan like retrospectively after the fact, and they suggested from this that the restrictions that were implemented and by people actually changing their behaviors, they were able to decrease the R0 in that infection from around 2.4 to 1.4. So they cut it by 100%, which is massive, massively important.
Erin Welsh	Yeah. It can be done! It can be done. It has been shown to be done. So, let's do it! Let's do it.
Erin Updyke	Let's do it.
Erin Welsh	So.
Erin Updyke	Okay.
Erin Welsh	Sources?
Erin Updyke	Yeah, so that paper that I just mentioned, um, that was a paper by Li et al published in Science on March 16 titled, "Substantial undocumented infection facilitates the rapid dissemination of novel coronavirus."
Erin Welsh	And then there's those papers that we mentioned earlier by Plowright et al. and Kunz et al. We'll post those papers on our website.
Erin Updyke	And for more details on the timeline as well as for updates on it, we'll post the link to that Al Jazeera article as well.
Erin Welsh	Yeah, it's awesome. Thank you again so much to Carlos, we really appreciate it.
Erin Updyke	We do. 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 sticking through one more episode of this. There's more coming your way. Until next time, wash your hands…
Erin Updyke	You filthy animals!
	[musical outro]