

Patrick Fine: Welcome to *A Deeper Look* podcast. I'm Patrick Fine, CEO of FHI 360, and this is where we take a deeper look into the issues affecting human development. I like to remind everybody that you can subscribe to *A Deeper Look* and that way you can have our monthly podcast just come right to you and you can hear the views and perspectives of some of the most interesting and engaged practitioners and thinkers working on international and human development issues.

This year, as our returning listeners know, we're taking a deeper look into humanitarian crisis and emergency response. And in this episode, we're going to explore the epidemic and pandemic crises that we've seen emerging in recent years and look at the prospect for pandemics to shape humanitarian crisis in the future. I'm delighted to have with me today Dr. Jonathan Quick, a family physician, a health management specialist, one of the international leaders on epidemic prevention and control. Jono, welcome to the podcast.

Jonathan Quick: Thank you, Patrick. Good to be here.

Patrick Fine: Listeners, Dr. Quick is the author of a new book, *The End of Epidemics: The Looming Threat to Humanity and How to Stop It*, which was published earlier this year. The book is available in the U.S. and worldwide. Dr. Quick is also a senior fellow at Management Sciences for Health, where for many years he was the chief executive officer. MSH is a global nonprofit organization working in the world's poorest places to build strong, locally led, locally run health systems. So, it's a peer organization to FHI 360 and certainly has made a huge contribution to global public health under Dr. Quick's leadership.

Dr. Quick has personally carried out assignments in over 70 countries in Africa, Asia, Latin America, and the Middle East – so, he's worked around the globe. He currently serves as chair of the Global Health Council, and he's on the faculty of the Harvard Medical School and the Boston University School of Public Health. Previously, Dr. Quick was the Director of Essential Medicines at the World Health Organization and is a fellow of the Royal Society of Medicine. So, we're talking with one of the eminent practitioners and thinkers in global public health today.

Now, what, what I'd like to do is get your perspective on the issue

of pandemics. They've had a lot of attention over the last five years — especially since the Ebola outbreak in West Africa — and how you see pandemic disease or the threat of pandemic disease affecting the international community's approach towards humanitarian response.

Jonathan Quick: Okay. Well, thank you, Patrick. And thank you for that introduction, kindly. I think it's important to get a couple of concepts clear. So, an epidemic is an increase, a significant increase in — and usually we've been using "infectious disease outbreak" — and a pandemic is when it crosses borders and goes worldwide. So, what we saw in 1918 was a devastating pandemic that infected a third of the world's population and killed 50 to 100 million people.

Patrick Fine: And that was a flu.

Jonathan Quick: That was a flu pandemic. And we'll come back to the flu. Then, we need to distinguish what you might call regional epidemics of significance. And so, that's really what the Ebola outbreak was in 2014. It was a regional epidemic. Ebola, because it has a real high horror value and high mortality, but it's relatively hard to catch, it doesn't lend itself to being a pandemic. Ebola will do a lot of damage in the countries it's in, in the regions it's in, but it won't go global.

Paradoxically, flu, which most of us think of as a bad cold, that actually had and still has the potential to go global in a matter of months. And, if we had something like 1918, which we could still have something like that today — we're just as vulnerable but for different reasons — a pandemic like that would kill 30 million people in 6 months.

Patrick Fine: Around the entire world.

Jonathan Quick: Around the entire world. Yeah.

Patrick Fine: Now, I've read that the 1918 pandemic flu actually had a very low mortality rate: Something like 0.2 percent of the people who contracted the flu died of it.

Jonathan Quick: That's, that's actually about what seasonal flu is. It was higher than that.

Patrick Fine: Do you recall what it was?

Jonathan Quick: It was about – it depends, depends on which total death rate you take, but closer to five percent.

Patrick Fine: So, five percent.

Jonathan Quick: Yes.

Patrick Fine: But compare that to a disease like Ebola, where the mortality rate can be as high as 50 to 60 percent.

Jonathan Quick: Yeah. No, and you have, you have flu viruses today that have a mortality rate of 60 percent.

Patrick Fine: Oh, you do?

Jonathan Quick: Yeah, some of the bird flus. But what happens is, to get a pandemic of the magnitude we had, the virus needs to be both highly contagious and highly deadly. And that's really what we had in 1918.

Patrick Fine: In recent years the pandemics that we've seen concerns about have been SARS, MERS, bird flu and Ebola. And you've clarified that Ebola is more of a regional epidemic as opposed to a global pandemic because of the mode of transmission, correct?

Jonathan Quick: Exactly. Yeah. The airborne ones, the ones that you've described as pandemic, all of those are airborne. Those are the viruses that are most likely to go global.

Patrick Fine: Because they can travel on airplanes.

Jonathan Quick: Yeah. They can travel on airplanes. They can transmit on airplanes. They also can transmit on surfaces.

Patrick Fine: So, are there other lurking, infectious diseases out there that we should be on the watch for?

Jonathan Quick: So, on the side of pandemics we've talked about flu, which is the nightmare scenario, particularly given the fact that we also have a not-well-performing vaccine and all. But – so, flu is one. Known viruses that have pandemic potential like SARS, severe acute respiratory syndrome.

Patrick Fine: Severe.

Jonathan Quick: This was the first new pandemic pathogen of the 21st century. AIDS was the first new pandemic pathogen in modern times. That was, it came out in the 20th century. But SARS, this is a virus which was totally unknown, came from a bat in rural China to a delicacy animal called a civet to a doctor who had treated somebody who had been infected – a Chinese doctor who ended up on the ninth floor of the Metropole Hotel in Hong Kong, spread it to a dozen other people on that floor. Within weeks, that virus was in 27 countries.

But because of really decisive action and rapid action on the part of the World Health Organization at that time and others worldwide that came into this, that virus, after getting to 27 countries in a matter of weeks, was put back in the box in 6 months and hasn't returned.

Patrick Fine: How many people were infected?

Jonathan Quick: A total of 8,000 people. And about 800 died. It was "small" as an epidemic. But, the economic impact was on the order of \$30 billion dollars. There's the effect of the epidemic, the disease process, and then there's the aversion affect: all of the reactions, the fear. And so, those reactions basically, literally closed airports in China, some for a week, and reduced travel by half. There were countless people who lost jobs in businesses that were closed because of that. But, again, because of rapid action and good public health work that was put back in the box. It was probably one flight away from getting into countries who couldn't have controlled it – in Africa or elsewhere – and if that had happened, it could still be with us today.

Patrick Fine: So, is SARS similar to MERS.

Jonathan Quick: Yes. They're both in the similar family of viruses. The most common effect is respiratory. They basically get in, inflame your lungs, and you may get severe acute respiratory distress where your lungs fill with fluid. You need an intensive care unit, and those aren't around in many places, or they ravage the lungs enough so that you get a secondary infection.

Patrick Fine: Like pneumonia?

Jonathan Quick: Yeah. Like pneumonia. And the story about SARS that we don't hear a lot – we say, "Well, ten percent death rate. That's bad, but not awful." But, probably over a quarter of the SARS victims had respiratory problems, had permanent damage to their lungs, so there are those knock-on effects.

Patrick Fine: And what about MERS? Was it – it wasn't at the same level.

Jonathan Quick: MERS is a virus that comes out of the Middle East. It's associated with camels. And they're part of the ecology of the virus. What happened there was a single person, a guest worker from Korea, travelled back to Korea and was misdiagnosed at a couple of hospitals. And then there was a relatively small number of cases,* but it caused a panic, so much so that it affected the stock market and they actually had to adjust the prime interest rate to try to balance off on the economics of it.

You may remember after the Hajj a couple of weeks ago there were a couple of airplanes that were stopped on the tarmac at JFK that were returning from the Hajj.

Patrick Fine: So, returning from Saudi Arabia.

Jonathan Quick: From Saudi Arabia. The underlying fear was if there was MERS on that flight, that would have been bad. In the end, it was not.

Patrick Fine: I want to ask you about putting things back in the box because you've made reference to the kind of response that is necessary. And part of what we're exploring in this podcast is humanitarian response. So, when there is a catastrophe, when there is a complex emergency, what are the responses necessary from either a nation or the international community to control it? And, it seems to me that when we're talking about infectious diseases that we're talking about very specific types of response.

Jonathan Quick: So, the first priority is on prevention, preventing outbreaks in the first place with good public health education. Simple things like handwashing and ...

Patrick Fine: With soap.

Jonathan Quick: ... hygiene – handwashing with soap. Front and back of the hand. Twenty seconds – that's two, two verses of "Happy Birthday." That – and

that's what you really need. And don't use hot water that burns you so you don't finish. But those sort of basic measures are really important. And having vaccination programs in place when needed. So, that's a critical part of it. Early detection is vital, so whoever's on the ground needs to be alert to identify new outbreaks, things that haven't been there.

Patrick Fine: And that's having surveillance systems in place, is that right?

Jonathan Quick: Well, it's surveillance, sort of a specialized process of kind of actively looking. But it's also having frontline health workers trained in recognizing. So, it's not primary health care or outbreak identification; it's both.

And, I'll give you an example. Uganda is a country that has suffered some of the worst Ebola outbreaks. They've handled them but – it's known there. So, there's an accredited drug sellers program that with the Gates Foundation support that Management Sciences for Health worked with our Ugandan colleagues to put in place. And before the recent Ebola and anything else, part of that training for those frontline, trusted, local drug sellers was teaching them how to identify unusual events.

Patrick Fine: Right.

Jonathan Quick: And interestingly, there was a spinoff of this program in Liberia of accredited drug sellers – 700 who had been identified and were trained or in the process, 700 of these, these accredited drug sellers, all of them in Montserrado County, which was the ground zero for –

Patrick Fine: The epicenter.

Jonathan Quick: Yeah, epicenter. Yeah. And during the outbreak, while the formal facilities were closing because they had become transmission centers and all, the drug shops stayed open and doubled their business. And so, you know, we visited some of them after, not during Ebola but afterwards, and it was really fascinating to hear their stories. And, I asked them how they protected themselves. It was really interesting. So, they had all of the chlorine stuff at the door to wash and all, but their counters were about a yard deep.

Patrick Fine: Just, just to give people an idea, we're talking about small, little shops ...

Jonathan Quick: These are shops of maybe the size of a kind of a small study. I mean, they're maybe ten feet by ten feet.

Patrick Fine: Right.

Jonathan Quick: They stock a lot of medicines, and in many countries they will let you use antibiotics. So, it's the essential medicines for lifesaving problems. Diarrhea, that sort of thing. So, these shops continued to provide all these primary care services, lifesaving prevention and treatment, and had a way within these little shops, because they did have counters, these glass counters, you see, of protecting themselves from getting Ebola.

Patrick Fine: And how did they protect themselves? So, they had disinfectant at the doorway. Which was chlorine – or Clorox, right? Bleach, essentially.

Jonathan Quick: Yeah.

Patrick Fine: Then, what did they do at the counter?

Jonathan Quick: Well, they're display counters.

Patrick Fine: Right.

Jonathan Quick: So, they're about 30 inches deep. And so, they took a no-touch approach with their clients. And they would be really vigilant about that.

Patrick Fine: I have a question I want to go back to. You mentioned that HIV/AIDS was the first new pandemic infectious disease of ...

Jonathan Quick: Modern times.

Patrick Fine: ... modern times.

Jonathan Quick: Yeah.

Patrick Fine: And that that appeared in the 20th century, I think. It traces this back to 1948 or so.

Jonathan Quick: Actually, it traces back to 1920.

Patrick Fine: Oh, really? Okay. So, it goes back to the – close to the start of the 20th century.

Jonathan Quick: Yeah.

Patrick Fine: Now it travelled worldwide. It sexually spread. And, it created probably the biggest public health mobilization that the world has seen to date to deal with a pandemic disease. Would you agree with that?

Jonathan Quick: Absolutely. And certainly from a treatment point of view, it's the biggest public health treatment program in history. But yeah, I would say in terms of global mobilization, yes.

Patrick Fine: And now in a number of regions, the pandemic appears to have been brought under control because of both prevention, care and then new treatments, effective treatments, especially effective antiretroviral drugs so that it is more of a chronic disease. So, would that be an example of a disease that was a pandemic and then it has been brought under control in some regions because of effective response, but in other regions it remains at epidemic or regional pandemic levels?

Jonathan Quick: It's an interesting progression because you get an outbreak, which is a few cases, you get an epidemic, you get a pandemic, and if it stays and stays at about the same level, it's what's called endemic. So, AIDS is an endemic disease – which people say, "Oh, well, you know, that doesn't sound so bad." But actually, it's the worst outcome because it's still with us.

And the thing with AIDS is the endgame for AIDS is gonna be tough. And it's an example of two things. One is: What happens when a new disease gets ahead of you? And so, we were really lucky with SARS that we caught up with it. But, we really let AIDS spiral out of control. And in this country, we politicized it over the first decade, both from the right and the left. And, the result is that we have continued to have higher attack rates and higher death rates than other countries of comparable economic status.

Patrick Fine: From HIV/AIDS?

Jonathan Quick: From HIV/AIDS. Yeah. So it illustrates what happens if you let an epidemic really get ahead of you.

Patrick Fine: And if you politicize it.

Jonathan Quick: Yes. Which is probably the most common way that an epidemic gets ahead, is they get politicized, they don't get the response that's needed, and then you have a big problem. But the other thing with AIDS is because of the way it's transmitted, and you have a long period without symptoms but when you're contagious.

Patrick Fine: Right.

Jonathan Quick: So, it is indeed different in different places. In some countries, it's a concentrated epidemic around drug use, but in most places it is sexual. In this country AIDS moved from a sort of initially West Coast gay population to now a southern, poorer population which doesn't get the health care. There have been, basically, ideological fights over good public health measures like syringe exchange and things like that. So, those are just examples of how it's the human response that differentiates between huge impact and not just the virus itself.

Patrick Fine: Right. Which brings us back to how we respond to these humanitarian crises when they emerge. So, just listening to you, some of the lessons are, one, find ways to avoid politicizing the response.

Two is some of the basic public health measures that you spoke about, everything from washing your hands to having frontline health workers, whoever they may be, whether they're the certified drug sellers or – what about community health workers?

Jonathan Quick: Oh, absolutely critical. Absolutely critical. Because it's early detection that really lets you get the move on.

Patrick Fine: With the SARS example, where you had 8,000 people who were infected – and it had spread to 27 countries, did you say?

Jonathan Quick: Yeah.

Patrick Fine: Was that early detection? Or, what?

Jonathan Quick: Yes, it was. It was early detection and rapid response. So, there were some very astute clinicians, one by the name of Dr. Urbani, who worked for WHO, who actually went out there, at first said, "I

thought this was flu but it's something different." He ended up actually dying of SARS, but the key thing was he recognized it as being something different and mobilized a much more rapid response.

Patrick Fine: In your book, when you talk about the end of epidemics, you're really not talking about the end of epidemics, are you?

Jonathan Quick: Yeah, I'm not talking –

Patrick Fine: You're talking about the threat of epidemics.

Jonathan Quick: We're not talking about the end of infectious disease outbreaks. The bugs are always going to be with us, and will always have the last word, as Louis Pasteur said over a hundred years ago. But, the difference between a local disease outbreak and a catastrophic regional epidemic or global outbreak is more often than not human action or inaction. It's really stopping the preventable epidemics.

Patrick Fine: And, you're optimistic that we're at a place now where the international community has the tools, the knowledge, the institutions to do that?

Jonathan Quick: We know what's needed and we've made a lot of progress in the last five years. So, the tools have moved a lot in the last five years.

Patrick Fine: And, do you think Ebola was a main driver of that?

Jonathan Quick: Yes, that accelerated it, for sure. The threats are real and growing. The public health and scientific community know what's needed and are doing it. But, as always, we're moving too slowly with too few resources. We go back and forth from Jim Kim calls "the cycle of panic and neglect." And we're in that again.

Patrick Fine: We're in the neglect side?

Jonathan Quick: We're back on the neglect side. Yeah. We're back on the neglect side. And we're just not taking it seriously enough and keeping on point. This whole bundle of responses is under the banner of global health security. Infectious diseases have killed far more people than armed conflict, but it's easy to get all the money in the world for military. We haven't had a nuclear bomb dropped in 70 years, but everybody's really, really vigilant about that. But they're not concerned about the fact that in fact North Korea has got

smallpox in their lab and could weaponize it if they wanted to and we're just not prepared for these things. But, we could be if we moved quicker and stayed on focus with it.

Patrick Fine: So, we're not allocating the resources – you're talking about the U.S. in this case, but – I don't hear much talk about biological weapons. And perhaps that's just because it's too terrifying a thought for people to contemplate. But, when thinking about future pandemics, how do you look at the prospect for those to be started deliberately as part of an attack by one state or non-state actor?

Jonathan Quick: The risk and potential for that – the likelihood is low but the risk and the impact is high. High enough that when the Johns Hopkins Center for Health Security several months ago did a scenario, they chose a bioterror virus as the focus of it. And it was a roleplay and you had the two former heads of CDC on there as part of that roleplay. You had several people, two people from Congress playing themselves in the roleplay. They took it seriously.

Patrick Fine: You've pointed out that in the past few years there's been attention given to how to prevent and respond to pandemics, and much of that was driven by the Ebola outbreak in West Africa and the panic that that created. That gave rise to the Global Health Security Agenda here in the United States, but it also gave rise to reforms at the World Health Organization and to actions by other countries.

And you've noted that now in the last year or two – as that threat receded, so did the attention of the international community and the attention of the American government. And, we've seen the Global Health Security Agenda, the funding for that was one of the first items on the chopping block as the current U.S. administration has sought to reduce expenditures. What needs to be done for us as a nation and for the international community to be prepared for the next pandemic?

Jonathan Quick: So, what we need is leadership and engagement at all levels. We want to look at our elected leaders and say, "They're not doing what they need to be doing." But they are subject to the politics and economics of now. And so, they're going to face different pressures and all. And if the public is not concerned, then, you know, they're going to get blown in different directions.

Patrick Fine: Right. Right.

Jonathan Quick: We need to take interest in what's happening in Congress in this area. And, that's a critical part of it. The other part of it is the business community. And, the business community has the most to gain from being able to work in a country safe from pandemic threats and the most to lose if it's not safe. But, a lot of the business people that I've talked to say, "Well, that's government's responsibility." If I was a business leader and I was working, you know, in any country that's at risk, which is pretty much all countries, I actually wouldn't go to the Ministry of Health. I'd go to the Ministry of Finance and Trade and say, "If we're going to do business in this country, we want to know we're not going to get decimated like the mining industry did in West Africa or the tourist industry did in Southeast Asia. So, Minister of Finance, we want you to support the work that the Ministry of Health knows needs to be done to make this country safer from these outbreaks."

Patrick Fine: Right. Which, as you've explained, is pretty straightforward actions. It doesn't sound that complicated.

Jonathan Quick: Technically, it's not. And one of the big achievements in the Global Health Security Agenda, which is global – at least 60 countries involved worldwide, and good shared leadership – one of the key things is we now have a tool that will let them assess, and it's actually an external assessment. So, you bring outside folks in also and do an assessment of prevention, early detection, rapid response. So, there's no question of what needs to be there and countries are helping other countries to do that assessment.

Patrick Fine: Is there a system for doing those assessments?

Jonathan Quick: There's a system for doing the assessment, but each country has to step forward.

Patrick Fine: Has to volunteer to be assessed?

Jonathan Quick: And it's a joint thing. Yes.

Patrick Fine: Right.

Jonathan Quick: They do a self-assessment first, and then a joint outside. And the nice thing about this is this isn't the north telling the south what to do. This is collective. They're called JEE, Joint External Assessment. The U.S. has done its JEE. It's pretty much all green

with a few yellows. Australia has done theirs. Laos, when they did theirs, was lots of red and yellow. So, it's a really important tool.

Patrick Fine: Is that managed by the World Health Organization?

Jonathan Quick: It's a World Health Organization tool and they will provide technical assistance. But again, WHO has the authority of international law through the international health regulations, so they can declare emergencies. They can set the standards. What they don't have the authority to do is actually force countries to come up to standards.

Patrick Fine: But, your sense is that in terms of using this tool – because that does sound like a really important advance in terms of countries assessing their own status, doing it collaboratively with experts from different parts of the world — is that looking like it will become institutionalized or a regular part of the international agenda for countries to participate?

Jonathan Quick: Yes. And there is an accountability body that has been set up under the World Health Organization, that is chaired by the former head of the World Health Organization, Gro Harlem Brundtland. She was the one who was director-general at the time of SARS. She has proven that she knows what success looks like, and she does hold people accountable. So, I think those are all really promising developments.

Patrick Fine: I think we have time for one more topic, which is often referred to as "One Health."

Jonathan Quick: Yeah.

Patrick Fine: And that has to do with human health in a broader ecosystem that includes animals. Do you want to say something about that?

Jonathan Quick: Yeah. I mean, if we look at it, we've had a steady increase in the number of outbreaks – about 60 percent were from a species jump, animals to humans. And actually, the big ones have been animal to human. So, if you look at AIDS, AIDS was originally a monkey virus, the southeast of Cameroon, around 1920, made five different jumps into humans. And, only one of those succeeded big. When an animal virus gets into a human, it's a sort of trial and error whether it's going to make it because it's a different environment.

We've got viruses like the Zika virus, which hung out in East Africa pretty quietly for 70 years and is transmitted by mosquitoes. And that, through increased air travel, ended up getting into Brazil at a time when they'd lapsed on their mosquito control. And, it's sort of a little bit like a forest fire that gets into the roots and smolders for a while and then all of a sudden the whole forest is on fire. The Zika virus got into the whole mosquito population there, and then we have thousands of women in Latin America that are facing real preventable grief because of the birth defects that Zika causes-- the small brains and a cascade of other birth defects. And then a smaller number of paralysis that adults can get. So, those are two examples of how animal viruses get into humans.

Patrick Fine:

Well, and flu comes from birds. Right?

Jonathan Quick:

And flu – yes. The flu virus is constantly trading genes among waterfowl, pigs and chickens, humans, and it's the waterfowl that are the intercontinental transporters. Although most of the bad flu viruses come out of Asia and China, two of the biggest epidemics of flu have come out of the U.S.

The 1918 flu, the biggest source of that was military bases in Kansas. And then, that was probably the original major source of, of influenza. And then, 2009, there was the swine flu that kind of came out of kind of simultaneously, California and Mexico.

Patrick Fine:

So, in terms of being prepared to address pandemics, how does the One Health approach or thinking about the animal side of the equation fit in?

Jonathan Quick:

So, there are two key parts. There's the bush and the barn, the bush being things that come out from reservoirs and monkeys or bats or mosquitoes, whatever. And so, we need to be monitoring for that and being really vigilant to pick up new outbreaks when it happens. On the barn side, which is the chickens and the pigs ...

Patrick Fine:

Domesticated animals.

Jonathan Quick:

Domesticated animals. And it is primarily chickens and pigs. And poultry. Ducks are in there big time too. But we, we need to be vigilant about the, the food industry, because it's when humans and pigs are interacting, humans and chickens, and sharing the same air or the same foods. It's being vigilant about the, the food industry.

Patrick Fine: Right. To prevent the transmission from our food sources, domestic animals to humans.

Jonathan Quick: Right.

Patrick Fine: So, Jono, I want to thank you for joining me today. We've talked over the course of this year mostly about man-made disasters, complex emergencies that arise out of conflict. It's been fascinating to hear your perspective on the way that societies manage their animal populations or the way they prepare themselves will have a big impact on their ability to respond and weather an epidemic or a pandemic. But this is more of a natural-caused humanitarian crisis.

Jonathan Quick: Well, they used to say that about famines, that famines were an act of God. We now know that to a very large extent they're the result of human action or inaction.

Patrick Fine: That, in fact, today in the 21st century we know that famines, that hunger, is a man-made phenomenon.

Jonathan Quick: Right. I think that famine and the hunger is a good analogy because we can make the world safer. I think there's a lot of parallels between what's happening with pandemic threats and global warming. And our generation is – the people online can't see the gray hair ...

[Laughter]

... but our generation is leaving a world that's much less sustainable because we turned a blind eye since the first warning 30 years ago. I don't want to also leave the next generation – my daughters and their kids – a world that is more dangerous for infectious disease outbreaks.

Patrick Fine: And your book, *The End of Epidemics: The Looming Threat to Humanity and How to Stop It*, is a great place to see how we can address that particular issue and leave a legacy of a safer world to the future. Jono, thanks very much for being with me today.

Jonathan Quick: Thank you, Patrick. Good talking with you.

Patrick Fine: As always, listeners, I want to thank you for tuning in and listening to this fascinating conversation. I think that last point is particularly interesting, while pandemics may be viewed as a

natural phenomenon, the way that mankind or humankind has managed our environment makes them much less natural and falling into that man-made category.

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I've been thinking about the theme for the podcasts for next year, for what we're going to take a deeper look at next year, and we're thinking about a theme that looks at the darker side of development, that looks at some of the paradoxes and unintentional consequences from our efforts to build a better world. So, I want to encourage listeners, if you have ideas for particular topics or episodes that need a deeper look into the darker side of development, please send them in. I really appreciate the comments that I've received from you over the course of this year. They've helped to inform the conversation. Please keep those comments coming. And, if you've got a topic you want to suggest for next year on that idea of the darker side of development, please let me know. Thank you very much.

* Between its first appearance in 2012 and September 2018, MERS has infected nearly 2,300 people in sporadic outbreaks, with just over 800 deaths.