What's Next? Coronavirus, Disease X, Maternal and Adult Immunization

[Intro audio montage on Coronavirus news reports]

In December of 2015, The World Health Organization or WHO, put together a plan to help research and development efforts respond more quickly to an emerging outbreak.

Within this plan, called the R&D Blueprint, they drafted a list of infectious diseases that could cause a severe outbreak but did *not* have a drug to treat it *or* a vaccine to prevent it.

This list includes some names you might recognize like - Ebola, Marburg, Lassa fever, and Zika. The list also included a name that none of us have heard of before – Disease X – a place holder for something that didn't exist yet but could happen. Flashforward to 2020 – and we now have Covid-19, a new coronavirus which was first identified in Wuhan, China and become our Disease X.

In this final episode, we'll be talking about some of the biggest challenges like global health security and antibiotic resistance, but also some of the biggest opportunities like immunizing across the lifespan. This is The Antigen, and I'm your host, Yasmeen Agosti.

Anna Mouser, from the Wellcome Trust, explains how Covid-19 fits into a much larger and important topic: Global Health Security. Keep in mind that at the time she and I spoke, Covid-19 had not yet been given a name or labeled a pandemic.

From our perspective at Wellcome, we're very, very interested in ensuring that the world's prepared to meet whatever challenges come its way in terms of outbreaks of infections and infectious diseases. So that's really our take on what is known as global health security. It's about having the right systems in place, the right partnerships in place so that we can respond when diseases break out. And obviously we have a very, very live issue right now of the coronavirus and that's really putting some of the systems we have to the test. How well can we respond to outbreaks such as this? And that's a really important topic to us at Wellcome.

Covid-19 is a newly identified virus that is believed to have originated in animals and then spread to people. It can cause mild to severe respiratory illness and its main symptoms are fever, cough and difficulty breathing.

The impact of Covid-19 upon our daily lives, our families and communities has been profound. And while the daily news reports have understandably caused a tremendous amount of concern and uncertainty, it's important to remember the global health community has shown that it can rally and organize itself in response to an infectious threat.

Most recently, we've seen this type of cooperation at work in response to the Ebola virus outbreak, including the urgent development of an Ebola vaccine.

In fact, it was the Ebola outbreak which inspired the WHO to make their R&D Blueprint.

I think the one point I would make is that we can, whilst the recent Ebola outbreak has been extremely worrying and has had a huge human impact, we should take heart from the fact that that outbreak is now much, much better under control. We've deployed an Ebola vaccine and some of the most challenging circumstances that you could possibly imagine with health workers under considerable, um, pressure, but also, you know, facing real threats to their own security. And despite that, we've been able to now contain the outbreak and it, and the numbers in effect are falling.

And I think we have to each time learn the lessons and something that we've learned from the Ebola crisis is how important community engagement is and really understanding the cultural context of communities and building that into how vaccines are delivered, but also how new vaccines are researched. Um, there are some amazing developments in that space.

One example of a lesson learned from the Ebola crisis was how to best utilize a vaccine to control the outbreak. In this case, something called a ring vaccination strategy was used.

So effectively ring vaccination as a strategy, which is used to protect really around where there are cases of a disease or you find those cases of the disease where people have been infected and you vaccinate all of the people who've been in contact with them and then all of the people who've been in contact with that first line of people who've been in contact. So it moves like a concentric circle around the individual case and if you get far enough out you should really, it's like creating a perimeter really around that disease and making sure that the disease doesn't spread. It's been found to be pretty effective I think in tackling the Ebola crisis.

Interestingly, ring vaccination isn't necessarily about drawing a circle and vaccinating everyone inside of it.

Instead, it's mapping out and vaccinating a social network of people and places that have come into contact with the person who was sick with the Ebola symptoms. The WHO notes on their webpage dedicated to Ebola vaccination, that each ring can be made up of an average of 150 persons.

Anna points out that this isn't the only way to handle an outbreak and that there are many other things to consider in how best to approach bringing the outbreak under control.

I think there are questions as to when and where this method is best deployed. It really depends on the nature of the disease and how infectious it is and also the circumstances for identifying who someone's been in contact with. Other strategies of course are to, to isolate by area so you can choose rather than doing ring vaccination, which is contact based to actually look at a whole city or a whole town. And sometimes that will be the right approach to take. It really depends on the nature of

the disease and also how fast it's spreading, how mobile the population is as well. So, um, where you have a lot of population movement, different forms of strategy will be more relevant.

As we have seen with Covid-19, the current strategy, is to isolate or quarantine an individual, a specific group of people or a geographic area.

Part of what has enabled Covid-19 to spread to different countries is the fact that we live in a highly interconnected, global age. Professor David Salisbury, an Associate Fellow at the Center for Global Health Security in London's Chatham House Royal Institute for International Affairs explains how this is so.

Well, the world has changed so much in the last hundred years that if you think back to the terrible influenza pandemic of 1918, it was really difficult for people to travel from one country to another and from one region to the other. And now we do that, uh, in a matter of less than a day. I can get to the United States the same day I was in Europe yesterday. And so we are connected in ways that we never used to be before. And if someone gets infected in one place and the incubation period, the time it takes for that infection to emerge is five days. They can be anywhere by the time they become infectious. So we have to be much more aware of how much people move. We have public transport where many, many people are crammed into a small space that we didn't have years and years ago and one person that's coughing or sneezing can infect so many others so easily.

Global outbreaks aren't just enabled by how we move but also by how we live.

One of the other factors that we all now appreciate is the way in which people live is quite different to the way that they used to live. The structure of villages and towns and cities is progressively changing with depopulation from the countryside and people moving into towns but particularly moving into cities and often in circumstances that are less than advantageous with overcrowding and sometimes with poor sanitation because by and large people who move into cities do this for work purposes and they may not be able to afford a housing and accommodation of a decent standard. And this then adds to overcrowding and poor sanitation adds to the risk of infection and the transmission of infection.

Right now, as we watch Covid-19 spread from country to country, global interconnectivity may seem like a bad thing in that it can enable infections to spread quickly and easily. While this is true, it's important to remember that the same interconnectivity enables us to work more closely and effectively together as a global health community.

Well Ebola, I think, is a good example of global health security working in the best possible way. Ebola is a terrible infection that is easily spread and uh, has a very, very high fatality rate. That means that if you catch Ebola, you have a very high chance of dying because there is very little that

is available that can treat and cure you. Unfortunately, the people and the places where Ebola has been its most dangerous are those whose health services are sometimes the least well developed. And we could all sit back and just watch what happens. And we could say, well, that's a terrible thing for people living in those circumstances, but we don't need to worry about that.

But that's wrong. It's wrong for those people to be left unprepared and undefended. And it's also wrong because the risk actually could spread to many other people in many other places and therefore we do have a responsibility as a global community to look to the security of everyone. And the Ebola example is good because those who could afford it certainly contributed to help those who could not afford it. And so mobile hospitals were brought into the affected countries. Huge research was done at breakneck speed to try to find treatment, but really impressively at huge speed, safe and effective vaccines were developed and indeed made available to the communities who were at highest risk.

Those of us working on *The Antigen* realize there's no way we can tackle all the pertinent information on Covid-19 here & now, but we are planning to do a special episode on this topic in the very near future.

Over the years, we've developed a number of vaccines to help prevent many of the worst infections known to humankind. But we don't have vaccines to prevent every kind of infection out there. In certain situations, we need to treat the infections which have already taken hold. For bacterial infections, there are different kinds or classes of antibiotics. Unfortunately, we are now seeing a rise in antibiotic resistance. Something the Centers for Disease Control or CDC has stated as "one of the greatest public health challenges of our time."

We've been using antibiotics since the 1940s, you know, since the end of the second world war. And Alexander Fleming actually won a Nobel prize for the way that penicillin was discovered. And, uh, in his Nobel prize winning speech, he warned everyone that if we overuse these drugs, that the bacteria will, will change and become resistant. So we've known about this problem from the very beginning. Um, we didn't do well, uh, to heed, uh, Alexander Fleming's warnings in the first, you know, 30 or 40 or 50 years of having antibiotics. The last couple of decades, we've taken the threat more seriously.

That's Professor Kevin Outterson, the Executive Director of Boston University's CARB-X foundation - the world's largest supporter of preclinical research and development for antibacterial products. I reached out to him to learn more about this issue of antibiotic resistance and how it started.

Every time we use an antibiotic or anything which tries to kill bacteria, uh, they can adapt and share adaptation and, uh, evolve in a way that makes them less effected by whatever the antibiotic was.

And so over time that bacteria, uh, change so that the drugs that used to work five or 10 years ago, uh, don't work today.

Bacteria have different ways of resisting antibiotic treatment – which is really just a defense strategy. For example, they can do this by changing or destroying the antibiotic with enzymes or preventing the antibiotic from getting inside or pumping it back outside of its walls. Whichever way it resists the antibiotic – the result is the same.

According to the CDC, every year here in the US, at least 2.8 million people get an antibiotic-resistant infection, and more than 35,000 people die because of it.

You know, that's really more people that are dying from resistant microbes, uh, then die in the United States every year from traffic injuries, you know, from cars and pedestrians dying on the roads. So it's a very serious problem that really is under the radar for considering the number of people that are affected.

I think the people that noticed first were physicians, uh, patients that used to respond remarkably well, uh, to penicillin or to methicillin one of the earlier drugs. They stopped working, things that worked clearly in the previous year. Doctors were noticing that, uh, the patients weren't getting better. Eventually we tracked down what was happening, you know, to the bacteria. How they were changing so that the drugs didn't work against them anymore. But, uh, the first sign of a problem here are sick patients that aren't getting better the way that you would expect.

This can mean that an infection is harder to treat or not treatable at all. There may be a longer hospital stay or more follow up care required with a doctor, or the need for other treatments, which are more costly or potentially toxic.

Very recently, the CDC provided a list of 18 antibiotic-resistant bacteria and fungi categorized by level of concern – urgent, serious and concerning. People often refer to these as Superbugs. They also added 3 additional infections to a Watch List – serious infections, which could become resistant in the future.

One could easily conclude that the answer to rising anti-microbial resistance is simply to make new anti-microbials. But research and development require a lot of time and funding. On average, it takes ten years and hundreds of millions of dollars to create a new antibiotic. The science behind this is complicated and failure not uncommon.

According to Carb-X, there have been no new classes of antibiotics discovered after 1984 and nearly every antibiotic used today is based on a discovery made more than 36 years ago. This is the

main reason behind the Carb-X mission, which is to “fund antibiotics, vaccines, rapid diagnostics and other life-saving products that target the most serious forms of Gram-negative bacteria.”

I asked Professor Outterson how vaccines fit into the picture of combating anti-microbial resistance.

For vaccines, we have great evidence that, you know, vaccines both against viruses and vaccines against bacteria dramatically affect the issue of superbug infections or antimicrobial resistance. Um, you wouldn't think that a vaccine against a virus would. Uh, but it does because if people get fewer viral infections, they go to the doctor less frequently and, and it's less likely they get an unnecessary antibiotic.

Part of the problem isn’t just that certain germs are figuring out how to resist antimicrobial treatments - it’s also that we over-prescribe the antimicrobial treatments that we have. According to the CDC, at least 30% of antibiotics prescribed to outpatients in 2017 were unnecessary.

And you can think of this as a layer defense. You know, one layer of defense is clean food and clean water and healthy, clean healthcare facilities. The second layer of defense are vaccines and other prevention, uh, technologies. The third layer defense, if, if everything else fails, is an actual therapeutic like an antibiotic. We just don't want to go to that, you know, final ditch immediately. We want to use what we can to prevent infections before we actually try to treat them.

Reducing inappropriate antibiotic prescribing is just one of many layers needed to address the issue of anti-microbial resistance.

At the time of my interview with Professor Outterson, Carb-X was in its fourth year of operation and funding 55 projects worldwide in hopes of discovering new therapeutics, diagnostics and vaccines.

Up until this point, The Antigen has largely focused on immunization for children. But vaccines are also needed throughout the lifespan. This is because we’re at risk for different diseases at different points in our lives. As we age, our immunity to some of those diseases, which were provided by childhood vaccines, can wane with time.

According to the CDC, all adults need a yearly flu vaccine and a Td/Tdap vaccine. In addition to these, you may need others based upon factors like your age, your job, underlying health conditions, lifestyle habits, and even travel plans. Vaccination doesn’t simply end with childhood.

You know, the whole process of aging starts at birth. So, you know, someone doesn't get old when they're 50 or 60. It's, it's really a life course. So we talk about a life course approach to vaccination. Um, and that approach really requires immunization schedules and access to vaccination to respond to everybody's stage of life, their lifestyle and their specific vulnerabilities. You know, older people with a weakened immune system are highly susceptible to vaccine preventable diseases such as

influenza and pneumonia. But also, and most importantly, many older people have chronic conditions such as diabetes, respiratory condition, heart failure. And when you've got these conditions, then you're at greater risk of these vaccine preventable diseases.

That's Jane Barratt. She's the Secretary General of International Federation on Ageing. IFA is an international non-governmental organization that provides expert consultation to the WHO and United Nations on aging related topics.

Jane highlights several vaccines which are of particular concern for older adults.

Generally, you know, adults with evidence of immunity don't need any further vaccines. You know, the vaccines that we're particularly concerned about, uh, influenza and pneumonia. Um, and of course, you know, the third major one is shingles.

According to the CDC, many adults have not received the vaccinations which are recommended to them. There are reasons why we don't see them getting vaccinated to the same degree as we see for children.

What we know is that there is, uh, a poor awareness in the adult population as to the importance of vaccination and what's more, um, awareness doesn't equal behavioral change. So you can be aware that there's a flu vaccine available or a vaccine for pneumonia, but that doesn't necessarily give you the kickstart to go and get the vaccination. IFA has found that, you know, poor education, low awareness, difficulty accessing, you know, the vaccines all build up to be actually impenetrable barriers for older people to go and get their vaccines. I think at the heart of the issue is that older people either don't think it's value. They may also think that they're healthy, so they don't need the vaccination.

That sounds a little bit like vaccine hesitancy – an issue we talked about on two previous podcast episodes, but as an issue that primarily revolves around childhood immunization.

So I asked Jane if vaccine hesitancy applies to adults too.

It's not as much hesitancy to get the vaccine, but things get in the way, life gets in the way and so someone with diabetes and heart failure may have a number of different medical appointments so they could go to the GP and the dermatologist and the cardiologist. And so getting around to get the vaccination for flu and pneumonia is just another layer. I think we also fail to appreciate that as we get older, you know, issues of transportation or the loss of a spouse or not being able to access information are also barriers that prevent someone from going to get their vaccination.

IFA understands that finding solutions to these issues are a part of a larger challenge to help society and governments prioritize and promote healthy aging.

Preventing serious infections in older adults, isn't just about reducing people's risk of dying – it's about optimizing the way people are living.

Jane shared a real-life example to demonstrate what this means.

Older people who have influenza or pneumonia, some of them may die. There's no question, but many of these people, um, whether they're hospitalized or not will suffer the most significant changes in their functional ability. You know, we're were aware of a gentleman who was 89. He was independent. He was driving his car, he was volunteering, you know, he didn't get the flu vaccine. Um, didn't get his vaccination. He was hospitalized, went into cardiac failure and he finally returned to home after nine months being in hospital. He hasn't ever been able to return to driving or volunteering and requires extensive amounts of services.

Just as Jane just described, it's possible that after someone recovers from an infection, they don't return to their original level of functioning.

The WHO has noted that for the first time in history, most people can expect to live into their 60's and beyond. An aging population can continue to play a valuable role within families, their communities and the world at large. But this does require policies and programs in place to promote healthy ageing.

The year 2020 is a critical year because the WHO and the UN will launch the decade of healthy aging. And there are four key elements, ageism, long term care, age friendly cities, and primary care. And we believe that we need to be looking at each of these three quadrants through the lens of a public health campaign on vaccination throughout life with particular attention to older people. You know, in 2050 there'll be 2.1 billion people over the age of 65. And what every government around the world is wanting is a healthy aging population. You know, without investment, that's not going to happen.
Life course immunization spans from the moment we are born to older age.

Jane Barratt, IFA and many others are actively addressing one end of the spectrum to ensure we all can age in the healthiest way possible.

There are also multiple efforts under way, which focus on the very beginning of the spectrum – protecting infants from day one of life through something called maternal immunization.

The idea of immunizing during pregnancy mimics a process seen in nature. During pregnancy, women can naturally pass along their immunity against infections to their developing fetus. They do this in the form of antibodies.

Dr. Carol J. Baker, is a professor of pediatrics, at the McGovern Medical School at the University of Texas Health Science Center in Houston. She has practiced pediatric infectious disease for many years and is considered a world expert on a very serious infection of infants called Group B Streptococcal disease.

She describes the passing along of protective antibody from mother to infant during pregnancy as immunologic gift.

So adult women, even if they're not immunized, have encountered antigens and may have antibodies naturally made. They may have had, you know, something in the past, uh, in my era measles, I had measles, I had chicken pox. And for those particular viral infections, you make protection and it's almost lifelong. So here comes a healthy 25-year-old mother and she's immune. She's not going to get measles again or chickenpox again. She has immunity in her blood. These antibodies go through the placenta and into the fetus. So it's the gift, the immunologic protection gift that mother gives her babies.

For certain infections like chickenpox or measles, this gift of immunity can naturally protect an infant for many months.

However, for other types of infections like pertussis, the immunity in the mother is short lived, putting herself and/or her infant at risk of becoming ill.

Mom herself can have whooping cough, but the immunity is short lived. And so if she gets pertussis again, even if you've had immunization, you can get whooping cough again.

Young adults aren't going to die from pertussis or be hospitalized, but it's a problem. If you're a pregnant woman, you may give pertussis to your baby. So what we want to give the baby rather than natural disease from grandmother, grandfather, father, mother, is to give that gift of antibodies by immunizing the pregnant woman against whooping cough during pregnancy. And that's why it's become a routine recommendation.

The CDC recommends that all pregnant women receive the Tdap vaccine, which protects against pertussis, during every pregnancy, between 27- and 36-weeks of gestation. This recommendation is meant to ensure that mothers are able to pass along enough of the right antibody at the right time.

Currently, Tdap is one of two vaccines which are recommended during pregnancy – the other being influenza. This is meant to protect both the mother and their infant from influenza and possible flu related pregnancy complications.

Today, there are several vaccines being designed specifically for use during pregnancy, in order to protect infants from serious infectious diseases including Respiratory Syncytial virus and Group B Streptococcus, also known as GBS. GBS became the central topic of Dr. Baker's research career. She describes what got her interested in this particular infection.

I became interested in GBS disease in newborn infants and infants going up to through the second month of life, when I was a pediatric resident. It was a very common disease. It was a brand-new bacteria. And uh, it didn't take me long with a mortality rate between 25 and 35%. It didn't take me long to think that prevention was better than treatment with that kind of mortality.

There is always a point in time where science is just discovering a germ. And at the very beginning, the questions may sound basic but the answers are complex and can take years to find.

So my first question I was in training was, you know, what is this? And basically the response of my professors, and I don't mean to be critical, is to put it in lay terms, they just blew me off. So I went to the microbiology lab and learned that these were gram-positive bacteria.

A bacteria can be generally classified as a gram positive or gram-negative bacteria based on the color it stains during testing.

It's one of the steps when trying to identify what kind of germ you are dealing with.

They had a certain look in the, in the laboratory that was completely the opposite of the one that was supposed to cause these fatal infections in, in newborns. And I wasn't very smart, but I thought this must be something new. And it was, it was brand new. GBS wasn't even taught in medical schools in 1969 and 70 as a cause of human disease. It was sought to be a cause of cattle disease. So I went to the library and I read there had been some human disease, little anecdotal case reports or a little series and one of the first series was interestingly in pregnant women in the United Kingdom. And then there was a case series from um, the Boston City hospital where I subsequently trained. Long story short, I got interested in learning more and more figured out that this was transmitted from mother to infant.

When an infectious disease is spread from a mother to a newborn baby during pregnancy or delivery – it's called vertical transmission. There are other examples of infections, which do this such as HIV, Zika and Syphilis to name a few.

Dr. Baker ended up studying GBS at Rockefeller University in New York City with the well-known microbiologist named Professor Rebecca Lancefield.

This insight I had is these organisms, these bacteria were covered by a capsule made of sugars. And it turned out that one of the most important, actually the most important component of the sugars. So one of the sugars was glucose, just simple sugar. Another was galactose. But the way that Lancefield and others had worked with these bacteria was to boil them in hot acid so that they could get this capsule off and study its components and what it might do.

Dr. Baker was trying to understand the structure of the GBS bacteria through the eyes of the infant immune system. She was essentially trying to find the part of the germ that the immune system considers to be the most important.

And I thought to myself, babies aren't going to see bacteria that had been boiled in hot acid. And that was the scientific, uh, breakthrough because I discovered the true capsule by basically taking something gentle, neutral in terms of acid. And the acid labile or the acid destroyed component was the key to the capsule. And by that I mean this is what the, the human being sees is that component. If that component is gone, it's not the real GBS, it's not the real bacteria. But the minute I got the capsule, I immediately thought, let's make a vaccine like other polysaccharide vaccines. And this was, uh, quite a novel suggestion in the 1970s.

Dr. Baker tested the first GBS vaccine trials in pregnant women. At the time, the vaccine was designed to target the sugar coat of the bacteria.

Vaccinologists refer to this as a polysaccharide vaccine.

Later on, Dr. Baker tried a different approach to designing a GBS vaccine. She notes, that at the time, it was difficult to find support to test vaccines in pregnant women.

And I did the first candidate, uh, conjugate vaccine trial in 2003 it was published, um, this was out without any commercial support. Dennis Casper and I, my collaborator, we visited various vaccine manufacturers and they heard the word pregnant women and sent us packing. They were not interested in a vaccine, for pregnant women, uh, no matter what the, what the focus was.

It took time, and unfortunately several serious disease outbreaks of flu and pertussis before people began to pay attention and prioritize maternal immunization as an important public health intervention.

While I was sort of waiting for maternal immunization to be something that might work, I ended up on a couple of, uh, policymaking committees and specifically, uh, through the advisory committee on

immunization practices to the Center for Disease Control. We began to see epidemics in the United States have whooping cough or pertussis, a huge outbreak in California, I believe in 2010.

In 2005, The Advisory Committee on Immunization Practice or ACIP, initially recommended something called a “cocoon strategy” to protect young infants from whooping cough.

At that time, uh, there were recommendations for having everybody around the newborn, uh, to be immunized with a booster vaccine for the whooping cough called tdap. And we began to immunize adolescents and, uh, other non-pregnant adults, but no recommendation for pregnant women because who would use a vaccine in a pregnant woman? It might be harmful, no theoretical scientific reason to think so, but that's where we were, so we cocooned everybody around the baby was supposed to get the vaccine.

That didn't always happen. And one of the people around the baby that didn't get the vaccine was the mother. So it was recommended that she get it as she was being discharged from the delivery hospital. But some of these women contracted pertussis during the two weeks that it takes to make immunity. Um, so they actually transmitted it to their babies.

According to the CDC, since 2010, there are between 10,000 and 50,000 cases of pertussis each year and the highest percentage of pertussis related hospitalizations and deaths occur in infants less than 2 months of age.

To better address the risk faced by the youngest of infants, in 2012 the ACIP opted to recommend the Tdap vaccine for each pregnancy. In this way, it could ensure that there is enough time for the woman to build up and pass her immunity along to her infant before it is born.

Meanwhile, the influenza pandemic of 2009 also called greater attention to the importance of maternal immunization.

And then, um, then pandemic flu came in 2009, it had been known since the 1918 influenza pandemic that pregnant women were five times more likely than same age, healthy non-pregnant women to die from influenza. It's still the same. And influenza vaccine had been recommended for pregnant women since 1964 because we knew this fact scientifically, but nobody was, was giving it during the pandemic, there was limited vaccine, you will probably remember. So who should we get the limited amount of vaccine to protect themselves? The number one on the list, this was an incredible policy breakthrough based on science, number one risk person was pregnant women. And that took the rate of flu vaccine uptake in pregnant women from about 12, maybe 15% or lower, up to 50% in 2009. That changed everybody's thought about giving a vaccine to pregnant women.

While the novel maternal vaccines in development today are still in testing stages, the road was paved by the experience and success of influenza and pertussis vaccination.

That's the great thing. Now there is abundant research to show these vaccines are safe for pregnant women and do good in preventing influenza in pregnant women and as well as in the young baby.

As our season of The Antigen comes to a close, it’s a good time to reflect on what exactly we’ve learned over the last several weeks.

First, back to the basics. Vaccines help to teach the immune system how to fight serious infections.

“What vaccines do is they prevent children and also adults from becoming infected with some of the worst infectious diseases known to humankind.”

Vaccines are critical to our local and global health. They can help determine the wellness of countries and communities, as well as vulnerable individuals in our society, through community immunity.

"Some of these mothers when they hear that mothers and other parts of the world are choosing not to vaccinate, I think it really makes them scratch their head because they, they have a very different feeling about vaccines. They see these diseases every day."

When it comes to vaccine hesitancy, it’s extremely important for health care professionals to be to listen, engage, and answer questions in a way that people can relate to and understand.

"We have those conversations, we build trust with families and they count on us to give them good information and to take care of their children. And believe me, if there was ever something that would hurt a child, the pediatrician would be the first to stop doing it. Our goal is to have healthy children."

…We have to be firm in combating misinformation and communicating scientific facts from trustworthy sources.

"You've got to get to the bottom of this by checking your facts, so you can make a confident decision before like me, it's too late and your kids end up suffering because of it."

There are lots of big problems to tackle. The scientific community is coming together to address things like Disease X, antibiotic resistance, low adult vaccination awareness and maternal immunization.

And you can help too, by getting vaccinated with recommend vaccines, staying aware, and getting involved in the conversation. If you’re interested in learning more about Covid-19, =keep an eye out for our special episode coming to you soon.

Thanks so much for listening to The Antigen. Please take time to rate and review -- it helps new listeners to find the show. Many thanks to all of our wonderful guests, the Pfizer Antigen Team and Wonder Media Network this series possible, including Ben Posnack, Chad Parizman, Caroline Forte, David Gargione, Edie Allard, Emily Rudder, Erica Chilson, Erica Santiago, Greg Musnick, Jeff Brand, Jenny Kaplan, Jessica Smith, Jimmy Goodman, Kate Reuter, Liz Smith, Marina Pearlman, Nanette Cocero, Shira Atkins, and Vanessa Gelman.

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