Vaccines 101

The very last day that I was a pediatric resident. Um, many years ago, a toddler walked into the emergency room and uh, and progressively got sicker and sicker.

That's Dr. Katherine Edwards, a world expert in pediatric infectious disease in vaccinology. She's also a professor of pediatrics at Vanderbilt university and she's been working on vaccines for 40 years. I did a spinal tap on her and realized that she had Haemophilus influenza, type B meningitis, Haemophilus influenza, type B or HIB is it bacteria normally found in our nose and throat that can lead to very serious life threatening infections and no matter what I did in that day and into the night in terms of prompt antibiotics and she'd just been sick a few hours and, and fluids and all the, you know, ventilators and all the best things that modern medicine, she died, the vaccine for hip was not available until the 1990s. And until it did become available, hip disease affected approximately 25,000 children each year with things like meningitis, pneumonia, and bloodstream infections.

And at that time in the hospital that I was practicing at any one time, there were generally five or six patients that had Haemophilus meningitis or invasive disease or some complication of this particular infection. And we knew that from the basic science that if you had antibody to the capsule or to the coat of the organism, that you were protected from disease. But we really didn't know how to make little kids make antibody.

Dr. Edwards is referring to the crux of how vaccines work, antibodies, small proteins, which the body uses to attack infection. We'll talk more about that in just a bit. One scientists were able to figure out how to make a vaccine against hip. Things changed dramatically. According to the children's hospital of Philadelphia has vaccine education center in 2014 less than 10 cases of hip in children under five were reported to the centers for disease control.

And now the vaccine is used all over the world and, and basically we no longer see this disease. So, you know, when I talk to the residents now in pediatrics about Haemophilus type B disease, they sort of roll their eyes and say, Oh, there she goes again. You know, she's talking about a dinosaur or something that's gone. And, and I think that's one of the problems that we have with vaccines is that when, when have really good vaccines that eliminate the disease, we are kind of fickle as humans and we think this isn't a problem anymore and, and it's no longer an issue and we don't have to worry about it.

Since the creation of the first vaccines, they've saved millions of lives, but they've also become victims of their own success. They've done such a good job that we've forgotten what serious infections like polio and diphtheria look like. We've essentially forgotten how to be afraid or worse. Some people have become afraid of the wrong things in an age that's rife with misinformation. As

many of the diseases have disappeared from our collective memory, vaccine hesitancy and anti-vaccination movements have risen over time. The reasons behind this trend are complicated. Claims that vaccines are linked to autism or other auto immune diseases reached a peak after big name celebrities came out with books and articles just crediting the medications.

Facebook said, quote, we've taken steps to reduce the distribution of health related misinformation on Facebook, but we know we have more to do. Pinterest is blocking searches related to vaccinations. The social media company says it wants to curb the spread of misinformation.

So how did we get to this point and where do we go from here? The way I see it, I think we need to learn as much as we can from the experts and as you listen to the next eight episodes, I'll be talking with vaccine experts like Dr. Edwards, about many important topics. We'll be talking about basic science and history to global health, impact of vaccine hesitancy and innovations in policy. This is the antigen I'm your host, just made a dusty.

I spend a lot of time thinking about and working with vaccines from many different angles. I'm a mother of two children. I'm trained as a pediatrician and I've conducted research on infectious diseases and now I work on viral vaccine programs at Pfizer. So let's begin with the basics. What is a vaccine?

So to the average person, I would say a vaccine is something that helps train our body to fight these infectious diseases. They prevent children and also adults from becoming infected with some of the worst infectious diseases known to humankind. I think of a vaccine being like a coat of armor because it a protective

Mechanism for children. A vaccine is a substance that stimulates your immune system to make a protein or a cell that when you come in contact with the natural wild virus or bacteria, that immune response that the vaccine has triggered will prevent disease. So it's a way to kind of make an anti disease. You inject something, your body makes an anti disease, and when that disease comes to your body, it's stopped in its tracks.

There are a lot of ways to describe what a vaccine is and a slightly more nerdy way of describing it is actually in the title of this podcast. The antigen. An antigen from the vaccinologist point of view is the key to making a good vaccine. It's the actual part, sometimes whole of the germ that your immune system targets with antibodies in order to get rid of the infection. We do this naturally, but the process of making a specific antibody to target a specific germ can take too long and sometimes it's not very effective, especially if it's the first time your body is seeing that infection. This is especially true if you're an infant. Getting a vaccine is like getting tickets to an advanced movie screening before the official release.

Let's all go to the lab.

The vaccine is letting your immune system see the most important part of the germ before you see it in real life after vaccination, your immune system remembers exactly what it needs to do and it can do it really quickly and really effectively when it needs to. Which brings us back to dr Edward's experience as a pediatrician before the hip vaccine was introduced in the 1990s

So prevention really is the best and so I think that that was a poignant example to me that that if you understood the science about the germ, if you understood the immunology about how to make an antibody or how to make something to fight the organism and if you could do it and administer it to all the world's children, that you could essentially eliminate a disease.

Sometimes the risk related to an infection is immediate and obvious like what was seen with HIB, but in other cases the risks can go beyond the infection itself. Measles is a great example of this. There were two recent studies in the Netherlands that showed that measles infections can actually cause something called immune amnesia. It's essentially wiping out a child's immune memory of how to fight other infections like flu. This essentially means that you need to relearn how to fight serious infections that your body wants, knew how to fight. So experts have pointed to these studies to reinforce that preventing the infection with vaccination is really important.

There are several different kinds of vaccines, but keep in mind that they're all designed to do the same thing. Teaching your immune system to make a specific kind of antibody. Currently there are four major kinds of vaccines. There are other types of vaccines or vaccine platforms that are being developed, but we'll get to that in another episode. So we have live attenuated vaccines alive. Attenuated vaccine is a vaccine that actually is still alive. That's Dr. Edwards again. It also, however, is different than the disease from which the vaccine came. The germ that causes the disease from which the vaccine came because it is attenuated, attenuated means weakened, and it's not capable of causing the disease that the virus caused in the very beginning. We have an activated vaccines and so those vaccines are, are inactivated and mean exactly that, that the virus is there. All of its parts are there, but it's killed.

It's inactivated. Um, and a classic example of that, um, is influenza vaccine. Now, there is some other flu vaccines that are made in slightly different ways, but the standard, um, flu vaccine that almost all of us get, the virus is grown in eggs and it's harvested. It's an activated or killed, and then it's purified. And that's given as the, as an injection, we have toxoid vaccines. So a toxoid vaccine is a vaccine that has taken a toxin that causes disease and treated it chemically to make it no longer active as a toxin, but a good antigen to make antibody to that protein that would destroy or counteract the toxin. So for instance, tetanus toxin is a potent neurotoxin. So you couldn't use that as

a vaccine because if you injected that, the patient would get the neurologic disease. So what has been done is that that particular toxin is, is treated and toxoid to make it not active, but to still allow it to retain its ability to function as an antigen and to make good antibody to the toxin. And we have subunit conjugate vaccines, so they take subunits of the germ. Those subunits are used as antigens and given as the vaccine, but they're purified subunits or sub parts of the vaccine so that the proteins that are made are purified and then those are given as subunits of vaccines. Most of the conjugate vaccines that are given, um, routinely to children consists of a protein and those proteins then are Arden linked for or joined or coupled with the sugar or the sugar coat of bacteria.

At this point we've explained what vaccines are and how they work to help protect us as individuals, but it's also important to note that for certain infections, which spread easily from person to person such as measles or polio, the protection goes far beyond the person who got the shot. You've probably heard others refer to this concept as herd immunity, but I actually prefer the way dr L LJ tan describes the concept. He's an immunologist and the chief strategy officer of the immunization action coalition. You know, we've used herd immunity for so long. I'm really trying to move it towards this rhyming community immunity casino and no one wants to be called a herd. I know we're all about communities, right? We're a community and what I get vaccinated, I'm, I'm hopefully, if I get people around me vaccinated, I'm protecting my community, so I'm definitely protecting the herd, but her to sounds, I don't know. I don't like the sound of it so I don't use it.

Community immunity only works when a certain percentage of the population is vaccinated and protected against a disease. We call that vaccine coverage. The more contagious a diseases, the higher vaccine coverage needs to be in order to stop infection from spreading. A very timely example are the recent series of measles outbreaks which occurred here in the United States. Dr Peter Hotez, professor of pediatrics and Dean of the national school of tropical medicine at Baylor university explains how measles reveals both the importance and the vulnerability of community immunity.

When you start to see a drop in vaccine coverage, bam, the first thing you see is measles and that's because measles is so highly contagious, is one of the most contagious viruses we know about.

The reproductive number for measles has been estimated to be between 12 and 18 this means one person with measles has the ability to infect between 12 to 18 unvaccinated people around them. Typically, these unvaccinated people are actually infants who have not yet received their measles vaccine. It's something we don't typically give until about one year of age. To provide some contrast, the Ebola virus has an estimated reproductive number of 1.3 to 4.7 in order to prevent the spread of measles in the U S the CDC recommends that MMR vaccine rates should be above or equal to about 95% and as a country overall, we came pretty close. If you look at the 2018 19 school year

with an estimated 94.7% of children, however, a high national vaccination rate doesn't quite explain how we ended up with one of the worst measles outbreaks we've seen in decades. It turns out you need to look more closely at pockets of local communities with unvaccinated or under vaccinated individuals.

Even isolated communities eventually intersect with the outside because people travel and infections like measles can travel right along with them. When vaccination rates fall below a certain threshold, community immunity falls apart. Well, you know, disease is kind of like a four way stop. Um, if everybody stops, there's no accidents, you know, if one person doesn't stop and everyone else does, then then there probably is not an accident. But then if two people don't, then we have a problem. One of the recent measles outbreaks which occurred in New York demonstrates what this can look like. We had a case of measles brought back by a returning us traveler and this one case led to an outcome break that lasted for nine and a half months and infected 702 people. This is according to the American Academy of family physicians. Community immunity is about protecting both ourselves and the people around us.

There are times in our lives when we may have to rely upon community immunity more than we can contribute to it. This is true for infants who are still too young to receive certain vaccines or have not yet completed all the vaccines they need to get. This is true for pregnant women who can receive some vaccines but not others. And this is especially true for people with underlying conditions that have weakened or greatly reduced their immune systems such as cancer or diabetes. Every vaccine that we have available to us was developed on the grounds that it's addressing a medical need, polio, HIB, pneumococcus, measles, pertussis. The list goes on. Preventing these diseases does more than just prevent the disease. It enables us to live healthier lives. Martha [inaudible], executive director of the United nations shot at life program explains how this idea has informed the work that they do, which is to ensure that vaccines reach children around the world.

I think vaccines are our hope. You know our name shot at life. It's giving people a sh a shot, a chance at having, having a life, getting to five-years-old, which we know is such a critical age and many countries for child mortality. It gives hope to mothers. Um, we did travel to one country where there were mothers who didn't name their children until they had gotten their full course of vaccines, so did not give a name to their children until they had had the full course of vaccines because in the past they had lost children and that was so devastating. I think a much larger way we could talk about vaccines is they they our hope for our community. They are opportunity. Children who do not get sick then can go to school and they can become productive members of society. Their parents don't have to miss work and take care of them.

They can grow and be contributing. Members of their community shot at life doesn't just help children around the world to gain access to vaccines. They also teach people to advocate for why vaccines matter. Currently they have over 2000 core grassroots advocates in all 50 States. I asked Martha to describe the kind of person who becomes a shot at life champion. We did a lot of research and surveys on who cares most about this issue? Who cares the most about children around the world? Children in the poorest countries having access to vaccines. And what we found, which I don't think will be surprising to anyone, is that it's particularly mothers, mothers, um, have a very protective sense about their own children and want, you know, relate to mothers in other parts of the world who may not be able to have the same access. So we focused a lot on mothers and at the time it was mommy bloggers, which was a very big category.

But what you know, we've also found is of course it's any parents, grandparents, aunts, uncles. So it's not limited to mothers. I think it's really anyone who cares about children advocating the importance of vaccines is a critical activity happening on local and global levels. It's a message that needs to be conveyed by many different kinds of people in many different roles. Parents, community leaders, healthcare providers, public health officials, just to name a few. While numbers and percentages help to convey the magnitude of a disease and the impact of its prevention. Personal stories resonate deeply. They help us to remember why vaccines matter. I spoke with someone who's experienced with personal tragedy, inspired her to get involved. My name is Cerise Marotta. I am currently serving as the chief operating officer for a national nonprofit organization called families fighting flu. I came to the organization about 10 years ago, almost following the loss of my son, my healthy five-year-old son to flu and flu was never on my radar, even though both of my children every year received their flu vaccines.

My son actually passed away during the H one N one pandemic. So the seasonal flu vaccine that year did not contain the pandemic H one N one strain. But I really never realized how dangerous flu was. And I think that's something that I always go back to. And so when people come to us with questions, you know, I kind of look at them as they were me 10 years ago. I didn't know then either. So we really try to be very compassionate and respectful in our conversations with other parents. But we really see ourselves as unbiased resource and we want people to be comfortable coming to us with those questions and we give them the answers that they're looking for. That's really the objective. Cerise continues to share her family's story with the hope of reducing flu related risks that starts with everyone receiving their annual flu shot. You always think this won't happen to me, you know? Um, unfortunately it does each and every year. And as a parent myself, you know, every year here we are entering flu season and there are already stories of loss coming in and it's heartbreaking as a parent because you feel like, gosh, there's so many more people I need to reach with these

stories and with this information. So that's really what, what keeps us going every day and motivates us.

And that's it for this week's episode of The Antigen. Stay tuned for future episodes where we'll cover how different countries and cultures view vaccines, the origins of the anti-vaccine movement, consequences of that movement, the politics and future science and innovation. But next up we're getting historical. We'll rewind back to vaccines, origin, what life was like beforehand, and ask, how did someone come up with the idea to create a suit of armor for our bodies? In the meantime, take a minute to rate, review and subscribe. It helps new listeners to find the show. Special thanks to the antigen team at Pfizer and wonder media network for producing this series. Talk to you next week.

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