

The Broken Vaccine

Whooping cough is on the rise, exposing a worrisome trend: The vaccine that holds it in check is losing its potency, and nobody is sure why.

BY MELINDA WENNER MOYER

SETH FIKKERT HAD A HEAD COLD. THE 30-YEAR-OLD worked in a hospital and had two kids, so he didn't think much of it. But after three weeks, he still felt short of breath, and his 2-year-old son was coughing a little, too. Fikkert, who resembles Jim from the NBC television show *The Office* in both his boyish good looks and his sharp sense of humor (he jokes about the mispronunciations his last name inspires), lived in Everett, Washington, which last summer was in the midst of one of the country's most serious whooping cough epidemics. So he thought it best to get tested.

"I just wanted to rule it out," Fikkert says. He had gotten his adult booster for pertussis, the bacterium that causes whooping cough, only a year before, so it was highly unlikely that he had the infection. On the morning of Thursday, June 28, he walked into the employee health clinic at Providence Regional Medical Center, where he worked, and asked for a test. The clinic did not take his concern lightly. Fikkert recalls that afterward, "they masked me up, sent me down for a Z-Pak [the antibiotic Zithromax] at the pharmacy, and sent me directly home."

And for good reason: Four days later, Fikkert learned he had tested positive. "It was a huge surprise," he says. His daughter also tested positive; his son tested negative, though if a test is administered more than two weeks after symptoms arise, it may yield a false negative. To keep the infection from spreading, the hospital and the local health department in Snohomish County gave anti-

biotics to 35 hospital patients and 77 employees that Fikkert had been in close contact with over the 28 days before his diagnosis, despite the fact that almost all of the staff had had boosters.

Before pertussis vaccines came into use in the 1930s, the infection killed about 4,000 Americans (mostly infants) a year—10 times as many as the number of people who died annually from measles and 12 times more than died from smallpox. Although infection rates dropped dramatically with the vaccine, pertussis has recently returned with dangerous fervor: 2012 was the country's worst year for pertussis since 1959, with more than 38,000 cases reported nationally, 16 deaths of infants and children, and large spikes in every state except California. Most health officials believe that because many cases go undetected, the actual infection numbers are far higher. Pertussis is now considered the most poorly controlled vaccine-preventable bacterial disease in the developed world.

The resurgence is not the fault of parents who haven't immunized their kids. "We don't think those exemptors are driving this current wave," Anne Schuchat, director of the National Center for Immunization and Respiratory Diseases at the Centers for Disease Control and Prevention (CDC), told reporters at a July press briefing. Indeed, 73 percent of kids aged 7 to 10 who caught pertussis last year in Washington State—where the infection hit particularly hard—had been fully vaccinated. And 81 percent of adolescents had not only had full childhood vaccinations, but also a booster shot.

The problem is the pertussis vaccine itself. In 1992, U.S. doctors began switching to a new formulation with fewer side effects. But the CDC, which monitors infectious disease outbreaks, is learning the hard way that it just doesn't work very well. "It wanes, and it wanes more quickly than we expected," says CDC epidemiologist Stacy Martin. Scientists are trying hard to find out why.

In the meantime, more than 228 million Americans—some kids and teens, as well as most adults—think that they are protected from whooping cough, but they are not.

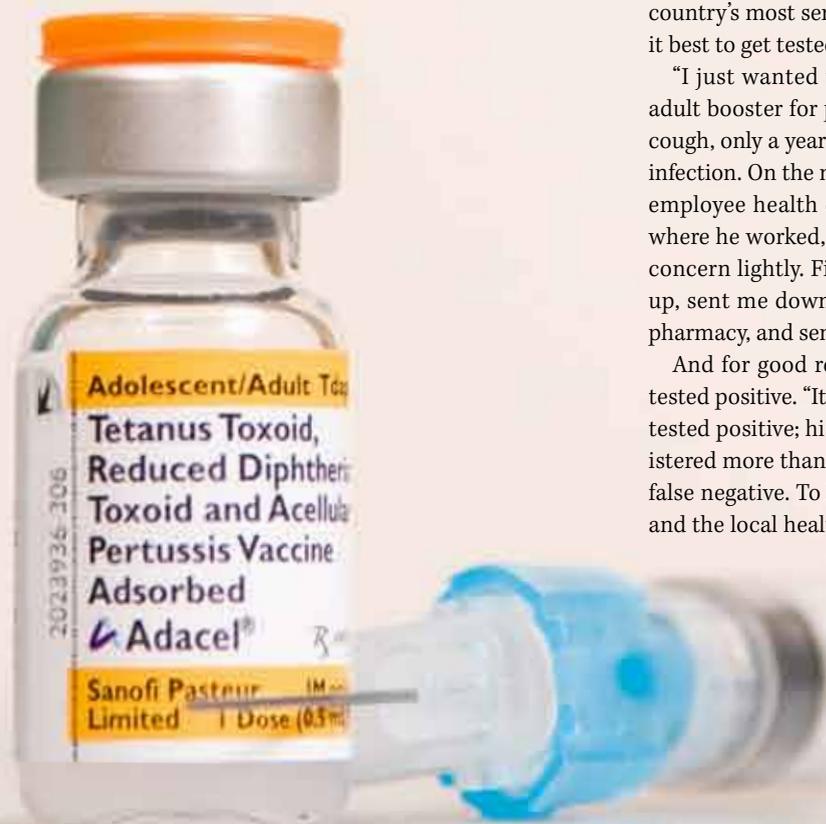
PERTUSSIS IS CAUSED BY *BORDETELLA PERTUSSIS*, A bacterium that has been around for at least 400 years. The microbes attach to tiny, hairlike structures in the lungs and release toxins that cause a terrible and persistent cough. Every outburst projects live bacteria into the air, and anyone within three feet can breathe them in and become infected. Often the relentless hacking causes people to throw up, or to have so much trouble catching their breath that they make a "whooping" sound while inhaling. Antibiotics stop a person from being contagious but do not always ease symptoms.

Babies younger than 3 months are particularly vulnerable. They can suffocate because of the cough, and since their immune systems are undeveloped, their white blood cells can spike so high that they literally clog the veins, obstructing blood flow and causing cardiovascular problems. Babies get their first pertussis vaccine at 2 months, but it provides only a small amount of protection.

Prior to 1992, children in the United States were inoculated with whole-cell pertussis vaccines, which were made using whole killed bacteria. These were quite effective but often caused side effects like local swelling, fevers, and, in rare instances, neurological problems.

That year, the CDC began recommending a new vaccine that contained two to five proteins isolated from *B. pertussis* rather than the entire bacterium. While these acellular vaccines, as they are called, cause fewer side effects, they do not seem to last very long. In 2010 California experienced a particularly devastating pertussis outbreak that sickened 9,000 people and killed 10 babies. At the time, David Witt, an infectious disease specialist at Kaiser Permanente Medical Center in San Rafael, assumed that most of the infected kids were unvaccinated; the very first patient he treated, for instance, was from a non-vaccinating family.

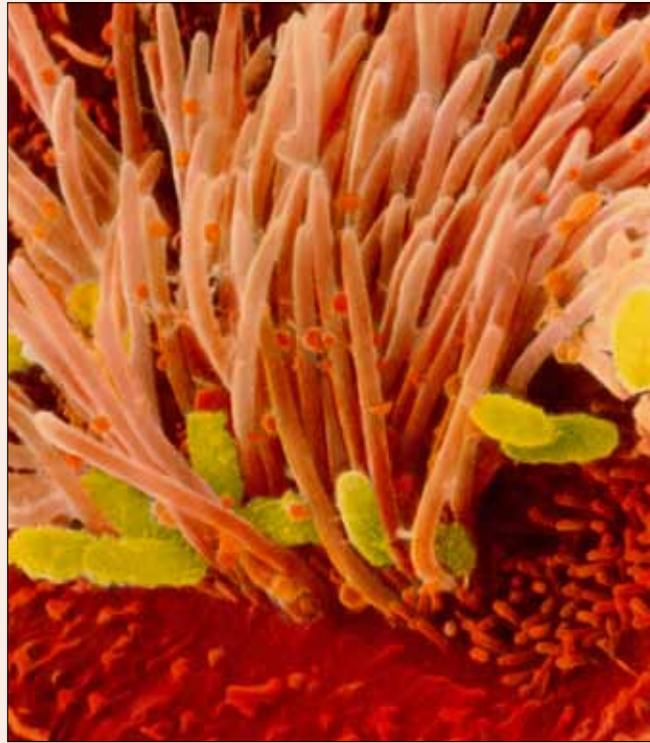
To confirm his suspicions, Witt assigned a project to his son, a University of California, Berkeley, public health major who was home for the Christmas holiday: Check the vaccination records of all of the kids the medical center had treated so far that year. "The original impetus was just to show how virulent an effect not



The drug Tdap boosts resistance to whooping cough—but only 8 percent of American adults have received it.

AMANDA MILLS/PODC

The vaccine's effectiveness begins to drop after one year. Five years after the final dose, it provides only 70 percent protection.



***Bordetella pertussis*, the bacterium that causes whooping cough (green in this colorized micrograph), infects the lungs and releases toxins that cause the relentless hacking that gave the disease its name.**

people were inoculated with the whole-cell vaccine—is more powerful. But the CDC's Martin notes that the United States will probably never use the whole cell vaccine again because of concerns about its possible side effects.

Frits Mooi, a molecular microbiologist at the Centre for Infectious Disease Control in the Netherlands, has a controversial theory about the acellular version: The pertussis bacteria may have adapted to it, much like bacteria become resistant to antibiotics. Mooi sequenced the genomes of today's *B. pertussis* strains and found they have acquired mutations in each of the proteins used to make the acellular vaccines. This means, he says, that our immune systems are being primed to fight an attacker that is slightly different from what they actually encounter. While Martin agrees that the vaccine does not precisely match today's circulating strains, she says it is unclear whether this mismatch is actually causing the observed vaccine failure.

JEAN ZAHALKA, A SOFT-SPOKEN PUBLIC HEALTH NURSE with shortly cropped gray hair, sat in a small office at the headquarters of the Snohomish Health District, conducting a phone interview with the mother of a 7-month-old baby who had just been diagnosed with whooping cough. Luckily, the little boy didn't attend daycare, which meant that he hadn't had many opportunities to infect others. And despite his persistent cough, he was holding up well, possibly because he'd already had two doses of DTaP, the childhood vaccine for diphtheria, tetanus, and pertussis.

But then the mom told Zahalka that the boy's 3-year-old sister was also coughing. Zahalka winced. Next, it came to light that the mother's 14-year-old niece had spent three days with the family earlier that week, which meant she was probably infected as well. The niece's mother had just lost her job and could not afford to buy antibiotics, so the health department was going to have to cover the cost of her treatment in order to curb the spread of the infection.

As health departments across the country are coming to learn, it is extremely difficult to monitor and control pertussis outbreaks. For one thing, many cases go undetected. "We're reporting just the tip of the iceberg," says Sandi Paciotti, communicable disease manager at the Skagit County Health Department, which tallied the most pertussis cases in Washington State in 2012. Paciotti estimates that three to five times more people have been infected than are reflected in her official numbers. One reason is that 15 percent of the Skagit County population is uninsured and unwilling to pay for the \$300 test. Teens are another overlooked pertussis reservoir; the director of the Skagit County Health Department, Peter Browning, says his 13-year-old son caught pertussis early in

the outbreak, but since he had been immunized, Browning didn't suspect it. "We don't stop loving our kids after age 13, but we don't rush them to the doctor, either," he says.

There are probably also thousands of adults who have suffered through the infection without seeking treatment. Adults who have been vaccinated, like Fikkert, often have milder symptoms, but they are still contagious. Some do go to the doctor but only after they have been sick for several weeks, at which point the test can come back negative even if they had the infection. And some doctors do not even consider pertussis when adults come in complaining of a persistent cough. "They don't think adults can get it," the CDC's Martin says.

With an infection so difficult to control, the best hope is prevention. But a better vaccine may be years, if not decades, away. "We just don't know what we should be targeting," says Martin, pointing out that no one knows what parts of the bacterium should be included in the vaccine to make it more effective. Scott Halperin, the director of the Canadian Center for Vaccinology in Halifax, believes that changing the immune-boosting chemicals, called adjuvants, in the vaccine could make a difference. Camille Loch, a microbiologist at Inserm and Institut Pasteur de Lille in France, is developing a live vaccine for newborns; he says it could give infants enough protection to survive until they get their childhood series, but so far he has tested the vaccine only in adults.

The CDC began recommending a tetanus, diphtheria, and pertussis (Tdap) booster shot for most people over age 11, including adults

up to age 64, in 2005. But as of 2010, only 8 percent of the adult population had actually received one. Moreover, an ongoing CDC investigation suggests that, like the childhood vaccine, the adult Tdap booster lasts only a few years at most. Yet with the exception of childbearing women, who are advised to get the booster during every pregnancy, Tdap is licensed only for one-time use in adults. "That probably isn't enough," says Amie Tidrington, the immunization clinic manager for the Skagit County Health Department.

Still, it is crucial to vaccinate as many people as possible, says Gary Goldbaum, the health officer of the Snohomish Health District in Everett. Unprotected people are much less likely to encounter the infection if most of the population is protected. Despite a slew of recent funding cuts, Goldbaum's district has held 20 vaccination clinics since the outbreaks started. Last spring the American Congress of Obstetricians and Gynecologists sent pertussis information packets to more than 33,000 of its members to increase awareness among doctors, and a joint program between the AmeriCares charity and pharmaceutical company Sanofi-Pasteur has given more than 117,000 free Tdap booster shots to health clinics around the country to immunize uninsured, low-income families. "If we are serious about trying to protect the most vulnerable," Goldbaum says, "the rest of us have to be fully protected too." **D**

Melinda Wenner Moyer is a Brooklyn-based science writer and an adjunct assistant professor at CUNY's Graduate School of Journalism.