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How Safe Are Vaccines?

By Alice Park

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Life, if you're a bacterium or virus, boils down to this: finding a pristine human home to provide for your every need, from food and nutrients to shelter against biological storms. As a microbial drifter, you can literally travel the world, hopping from host to host when the opportunity presents itself or when conditions at your temporary residence start heading south. There's no worry about taking along life's necessities either—viruses in particular are adept at traveling light; incapable of reproducing on their own, they think nothing of co-opting the reproductive machinery of their cellular sponsors to help them spawn generation after generation of freeloading progeny.

But ever since Edward Jenner, a country doctor in England, inoculated his son and a handful of other children against smallpox in 1796 by exposing them to cowpox pus, things have been tougher on humans' most unwelcome intruders. In the past century, vaccines against diphtheria, polio, pertussis, measles, mumps and rubella, not to mention the more recent additions of hepatitis B and chicken pox, have wired humans with powerful immune sentries to ward off uninvited invasions. And thanks to state laws requiring vaccinations for youngsters enrolling in kindergarten, the U.S. currently enjoys the highest immunization rate ever; 77% of children embarking on the first day of school are completely up to date on their recommended doses and most of the remaining children are missing just a few shots.

Yet simmering beneath these national numbers is a trend that's working in the microbes' favor—and against ours. Spurred by claims that vaccinations can be linked to autism, increasing numbers of parents are raising questions about whether vaccines, far from panaceas, are actually harmful to children. When the immune system of a baby or young child is just coming online, is it such a good

idea to challenge it with antigens to so many bugs? Have the safety, efficacy and side effects of this flood of inoculations really been worked through? Just last month the U.S. government, which has always stood by the safety of vaccines, acknowledged that a 9-year-old Georgia girl with a preexisting cellular disease had been made worse by inoculations she had received as an infant, which "significantly aggravated" the condition, resulting in a brain disorder with autism-like symptoms.

Though the government stressed that the case was an exceptional one, it provided exactly the smoking gun that vaccine detractors had been looking for and vaccine proponents had been dreading. More and more, all this wrangling over risks and benefits is leading confused parents simply to opt out of vaccines altogether. Despite the rules requiring students to be vaccinated, doctors can issue waivers to kids whose compromised immune system might make vaccines risky. Additionally, all but two states allow waivers for children whose parents object to vaccines on religious grounds; 20 allow parents to opt out on philosophical grounds. Currently, nearly one-half of 1% of kids enrolled in school are unvaccinated under a medical waiver; 2% to 3% have a nonmedical one, and the numbers appear to be rising.

Parents of these unimmunized kids know that as long as nearly all the other children get their shots, there should not be enough pathogen around to sicken anyone. But that's a fragile shield. Infectious-disease bugs continue to travel the globe, always ready to launch the next big public-health threat. Pockets of intentionally unvaccinated children provide a perfect place for a disease to squat, leading to outbreaks that spread to other unprotected kids, infants and the elderly. Ongoing measles outbreaks in four states are centered in such communities; one originated with an unimmunized boy from San Diego who contracted the virus while traveling in Europe—where the bug was thriving among intentionally unimmunized people in Switzerland. Dr. Anne Schuchat, director of the National Center for Immunization and Respiratory Diseases at the Centers for Disease Control and Prevention (CDC), says, "We are seeing more outbreaks that look different, concentrated among intentionally unimmunized people. I hope they are not the beginning of a worse trend."

If they are, it's possible that once rampant diseases such as measles, mumps and whooping cough will storm back, even in developed nations with robust public-health programs. That is forcing both policymakers and parents to wrestle with a dilemma that goes to the heart of democracy: whether the common welfare should trump the individual's right to choose. Parents torn between what's good for the world and what's good for their child will—no surprise—choose the child. But even then, they wonder if that means to opt for the vaccines and face the potential perils of errant chemistry or to decline the vaccines and face the dangers of the bugs. There is, as yet, no simple solution, but answers are emerging.

The Autism Riddle

More than any other issue, the question of autism has fueled the battle over vaccines. Since the 1980s, the number of vaccinations children receive has doubled, and in that same time, autism diagnoses have soared threefold. In 1998, British gastroenterologist Dr. Andrew Wakefield of London's Royal Free Hospital published a paper in the journal the *Lancet* in which he reported on a dozen young patients who were suffering from both autism-like developmental disorders and intestinal symptoms that included inflammation, pain and bloating. Eight of the kids began exhibiting signs of autism days after receiving the MMR vaccine against measles, mumps and rubella. While Wakefield and his co-authors were careful not to suggest that these cases proved a connection between vaccines and autism, they did imply, provocatively, that exposure to the measles virus could be a contributing factor to the children's autism. Wakefield later went on to speculate that virus from the vaccine led to inflammation in the gut that affected the brain development of the children.

Like the initial tremor that triggers a massive earthquake, Wakefield's theories resonated throughout the autism community, where vaccines had been regarded with suspicion for another reason as well. Ever since the 1930s, a mercury compound known as thimerosal had been included in some vaccines—though not the measles inoculation—as a preservative to keep them free of fungi and bacteria. Thimerosal can do serious damage to brain tissue, especially in children, whose brains are still developing. It was perhaps inevitable that parents would make a connection between the chemical and autism, since symptoms typically appear around age 2, by which time babies have already received a fair number of vaccines. That link could be merely temporal, of course; babies also get their first teeth after they get their first vaccines, but that doesn't mean one causes the other.

In 2001, however, a U.S. Food and Drug Administration study revealed that a 6-month-old receiving the recommended complement of childhood vaccinations was exposed to total levels of vaccine-based mercury twice as high as the amount the EPA considers safe in a diet that includes fish. By the end of that year, thimerosal-free formulations of the five inoculations that included it—hepatitis B, diphtheria, tetanus and pertussis and some versions of *Haemophilus influenzae* type b (Hib)—had replaced the older versions. The result was a drop in mercury exposure in fully immunized 6-month-old babies from 187.5 micrograms to just trace amounts still found in some flu vaccines. Yet there's been no effect on autism rates. In the seven years since the cleaned-up vaccines were introduced, new cases of autism continue to climb, reaching a rate of 1 in every 150 8-year-olds today. That trend suggests that other factors, including heightened awareness of the condition and possible genetic anomalies or environmental exposures, are behind the climbing rates. What's more, in the decade since Wakefield's watershed paper, 10 of its 13 authors have retracted their hypothesis, admitting that the study did not produce solid enough evidence to support a connection between the measles virus in the MMR vaccine and autism.

But the damage had been done. Parents, already uneasy about immunizations, now felt betrayed by government health authorities and a vaccine industry that simply kept the shots coming, with today's kids receiving up to 28 injections for 14 diseases, more than double the number of shots required in the 1970s. "There is no doubt in my mind that my child's first cause of autism is the mercury in vaccines," says Ginny DeLeo, a New York science teacher whose son Evan, born in 1993, was developing normally until he was a year old. The day the boy received his fourth dose of Hib vaccine, DeLeo had to rush him to the hospital with tremors and a 104 deg F (40 deg C) fever, which later led to seizures. Evan recovered, and several months later he received the first of two MMR shots. Within months, he stopped talking, and autism was diagnosed.

So, is there a link? In 2003, a 15-person committee impaneled by the CDC and the National Institutes of Health analyzed the available studies on thimerosal and its possible connections to autism and concluded that there was no scientific evidence to support the link. In a further show of confidence, the committee noted that it did "not consider a significant investment in studies of the theoretical vaccine-autism connection to be useful." Instead, the panel recommended that studies focus on less explored genetic or biological explanations for the disease.

There is also little evidence to support the claim made by antivaccine activists that the battery of shots kids receive can damage the immune system rather than strengthen it. Experts stress that it's not the number of inoculations that matters but the number of immune-stimulating antigens—or proteins—in them. Thanks to a better understanding of which viral or bacterial proteins are best at activating the immune system, that number has plummeted. The original smallpox injection alone packed 200 different immune-alerting antigens in a single shot. Today there are only 150 antigens in all 15 or so shots babies get before they are 6 months old. "The notion that too many vaccines can overwhelm the immune system is just not based on good science," says Dr. Paul Offit, chief of infectious diseases at Children's Hospital in Philadelphia.

My Child, My Choice

If the push-back against vaccines were only about the science, doctors might have an easier time making their case. But there's more going on than that. Parents object to the mandatory nature of the shots—and the fact that their child's access to education hinges on compliance with the immunization regulations. There's also the simple reality that the illnesses kids are being inoculated against are rarely seen anymore. When diseases like polio ran free in the early 1900s, the clamor was less about why we needed vaccines than about why there weren't more of them. Once you've seen your neighbor's toddler become paralyzed, you're a lot more likely to worry that the same thing will happen to yours. "The fact is," says Offit, "young mothers today never grew up with the disease."

What worries him and others is that young mothers of tomorrow will—and that could be disastrous. CDC officials estimate that fully vaccinating all U.S. children born in a given year from birth to adolescence saves 33,000 lives, prevents 14 million infections and saves \$10 billion in medical costs. Part of the reason is that the vaccinations protect not only the kids who receive the shots but also those who can't receive them—such as newborns and cancer patients with suppressed immune systems. These vulnerable folks depend on riding the so-called herd-immunity effect. The higher the immunization rate in any population, the less likely that a pathogen will penetrate the group and find a susceptible person inside. As immunization rates drop, that protection grows thinner. That's what happened in the current measles outbreaks in the western U.S., and that's what happened in Nigeria in 2001, when religious and political leaders convinced parents that polio vaccines were dangerous and their kids should not receive them. Over the next six years, not only did Nigerian infection rates increase 30-fold, but the disease also broke free and ranged out to 10 other countries, many of which had previously been polio-free.

As long ago as 1905, the U.S. Supreme Court recognized the power of the herd and ruled that states have the right to mandate immunizations, not for the individual's health but for the community's. That principle, say vaccine proponents, should still apply. "The decision to vaccinate is a decision for your child," says Dr. Jane Seward, deputy director of viral diseases at the CDC, "but also a decision for society."

Some parents have taken to cherry-picking vaccines, leaving out only the shots they believe their children don't need—such as those for chicken pox and hepatitis B—and keeping up with what they see as the life-or-death ones. But that can be a high-stakes game, as Kelly Lacey, a Pennsylvania mother of three, learned. She stopped vaccinating her 2-month-old son Matthew when her chiropractor raised questions about mercury in the shots. Three years later, she came home to find the little boy feverish and gasping for breath. Emergency-room doctors couldn't find the cause—until one experienced physician finally asked the right question. "He took one look at Matthew and asked me if he was fully vaccinated," says Lacey. "I said no." It turned out Matthew had been infected with Hib, bacteria that causes meningitis, swelling of the airway and, in severe cases, swelling of the brain tissue. After relying on a breathing tube for several days, Matthew recovered without any neurological effects, and a grateful Lacey immediately got him and his siblings up to date on their immunizations. "I am angry that people are promoting not getting vaccinated and messing with people's lives like that," she now says.

Health officials are angry too. Encouraged in part by the government report that seemed to clear vaccines of the autism charges, they are beginning to take a harder line with parents who submit

vaccine exemptions for nonmedical reasons. In Maryland, where unvaccinated students are not permitted in school, officials last November threatened to take parents to court for truancy violations if their kids did not get all their shots so that they could be cleared for class. On Long Island, N.Y., vaccine objectors are called in for what some parents call "sincerity" interviews with school officials and school-board attorneys to determine how genuinely the vaccines conflict with religious convictions.

Even in cities where such interviews are not required, the tensions are palpable. Says Sue Collins, a New Jersey mother who has not had either of her two sons vaccinated: "Things are getting so nasty. People are calling us bad parents, saying it's child abuse if we don't vaccinate our children." In an effort to avoid potential conflicts, some parents are bypassing the school system altogether, preferring to homeschool their kids so they won't be forced to vaccinate them.

Common Ground

That still leaves the broader community at risk. So, is there room between public health and personal choice? Science may eventually provide a way out. Most people agree that there may be kids with genetic predispositions or other underlying conditions that make them susceptible to being harmed by vaccines. The Georgia girl in the recent vaccine case is the first such documented child, but her story suggests there could be others. Though CDC director Julie Gerberding was quick to insist that the case should not be considered an admission that vaccines can cause autism, some parents will surely take it as just that. "In rare instances, there could be some gene-vs.-exposure interaction that in theory could lead from the vaccine to autism," says Dr. Tracy Lieu, director of the center for child-health-care studies at Harvard Medical School. "The future of vaccine-safety research lies in trying to answer questions of genomic contributions to responses to vaccines." Screening for genetic profiles that are most commonly associated with immune disorders, for example, would be a good place to start.

Whether tests like these, combined with detailed family histories, will make a difference in the rates of developmental disorders like autism isn't yet clear. But such a strategy could reveal new avenues of research and lead to safer inoculations overall. Parents concerned about vaccine safety would then have stronger answers to their questions about how their child might be affected by the shots. Vaccines may be a medical marvel, but they are only one salvo in our fight against disease-causing bugs. It's worth remembering that viruses and bacteria have had millions of years to perfect their host-finding skills; our abilities to rebuff them are only two centuries old. And in that journey, both parents and public-health officials want the same thing—to protect future generations from harm.

An Old Scourge Returns.

Measles cases are on the rise as growing numbers of families forgo immunization

In the first four months of this year, 64 confirmed cases of measles were reported in the U.S., scattered across 11 hot spots. This is the most by this date for any year since 2001; 54 cases had links to other countries, and only one of the 64 patients had been vaccinated. The outbreaks in Arizona and San Diego can be traced to travel to and from Switzerland, where many people choose not to be vaccinated.

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The original version of this article incorrectly stated that Hib is a virus. In fact it is a bacteria.

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