

A shot of fear

Spooked by reports that vaccines might cause diseases such as autism, many parents choose not to vaccinate their kids. But when their decision endangers others, asks Virginia Hughes, should the government step in?

On 15 May 2005, a 17-year-old girl from Indiana returned home after a church mission trip to Romania. She had been home-schooled throughout her childhood, and, afraid of vaccines' side effects, her parents had chosen not to get her immunized.

While visiting a Romanian orphanage, the girl unknowingly picked up measles. On 16 May, with only a few cold-like symptoms, she went to a church gathering of 500, of whom about 50 were also unvaccinated. That same day, 16 of them got measles. Within six weeks, the toll had risen to 34. The incident was the largest documented measles outbreak in the US in a decade, and cost \$167,685 (*N. Engl. J. Med.* 355, 447–455; 2006).

At 98%, Indiana's vaccination rate for measles is among the highest in the US. "But a high overall state rate does not mean that there aren't small pockets of people susceptible to the disease," says Saad Omer, assistant scientist at the Johns Hopkins Bloomberg School of Public Health. "If you reach a critical mass of nonvaccinated individuals, then you're going to have a high likelihood of an outbreak."

In recent years, controversial scientific reports that vaccines may be linked to autism, asthma and multiple sclerosis have given some parents pause. In most of Europe, where vaccines are voluntary, the reports have led to periodic tumbles in vaccination rates, followed by spikes in disease outbreaks.

In the US, children who attend school must be vaccinated, so the levels tend to stay high. But nearly every state grants nonmedical vaccination exemptions for religious or personal reasons. In October, Omer reported that states with lax vaccination laws grant more exemptions and have higher rates of pertussis, or whooping cough (*JAMA* 296, 1757–1763; 2006). "I think these results, with some caution, can be generalized to several other vaccine-preventable diseases," he says.

The finding creates an uncomfortable tension between individual rights and public good—with no easy answers.

Dissenting parents say vaccine mandates infringe on civil liberties and that some vaccines cause adverse effects. Choosing not to vaccinate for those reasons is all very well, but not at the risk to others, counters Omer.

"If you don't want to vaccinate your children, fine, you don't have to," he says. "But if you bring your kid to the school and pose a risk to other kids, that's not fine."

Conspiracy theories

Three years ago, a prominent local politician in Nigeria claimed that polio vaccines are part of a Western conspiracy to sterilize African women. At the time, polio was nearly on its way out. But the scare was enough to create an immunity gap and set off a cascade of outbreaks, spreading to neighboring countries and even to Indonesia.

"It's hard to believe that one speech could have such an incredible impact," says Kim Mulholland, an infectious disease expert at the London School of Hygiene and Tropical Medicine. "It's been a catastrophe—one of the single worst events in modern public health history."

Fears that vaccines are dangerous—most notoriously they have been linked to autism—pose one of the biggest challenges in public health, says Paul-Henri Lambert, chair of the World Health Organization's Global Advisory Committee on Vaccine Safety.

"Every month," Lambert says, "we hear new allegations that vaccines are leading to adverse effects."

Particularly in the West, parents who choose not to vaccinate their kids—like those in Indiana—are well educated and have plenty of access to information. According to a 2004 study, most of the 17,000 unvaccinated children in the US are white and wealthy, and have a married mother with a college degree (*Pediatrics* 114, 187–195; 2004).

Many parents are concerned that the vaccines might actually cause the disease or that they might be harmful, causing developmental disorders such as autism. Still others believe that it's more natural to acquire immunity by contracting the disease.

Ironically, vaccine scares are more common in countries where diseases are infrequent. "If the public does not see the disease any more, all they see are the problems that are supposedly linked with the vaccine," notes Lambert.

Mercury rising

The biggest concerns related to vaccine safety stem from an alleged link between the diphtheria-pertussis-tetanus (DPT) and measles-mumps-rubella (MMR) vaccines and autism. Physicians began recommending the DPT vaccine—which contained the mercury preservative thimerosal—in 1985. In the decade that followed, some doctors raised concerns that the vaccines were causing mercury toxicity in a few patients, triggering neurological damage that looked similar to that in autistic patients.

Though these claims were still unproven, the FDA in 1999 "put out a rather quiet invitation to manufacturers" to produce vaccines with much lower levels of thimerosal, says neuropharmacologist Richard Deth of Northeastern University in Boston. Most vaccines now contain only trace amounts of the preservative, but there could be other dangers we simply haven't yet discovered, he says.

"Are we fully aware of the consequences or downsides of the use of vaccines?" Deth asks. "Or is it possible that we are simply enamored with their public health benefit?"

Deth says public health officials might not want to acknowledge claims of vaccine dangers to prevent public panic—but maybe also for legal and financial reasons. "They may want to avoid the negative implications of any responsibility for contributing to the rise of the autism and related disorders," he says.

But Deth is a rare figure among scientists. Most public health officials dismiss claims of vaccines' dangers.

"This is the kind of thing that we hear about all the time," Lambert says. "We see the situation in Europe even more acutely than it is being seen in the US."

The WHO committee was created in 1999



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partly in response to claims in France that the hepatitis-B vaccine could cause multiple sclerosis. Around the same time, a controversial report in *The Lancet* suggested a link between the MMR vaccine and autism, setting off a media frenzy (*Lancet* 351, 637–644; 1998). Over the next four years, vaccination rates in Britain fell from 91% to 85% and measles outbreaks grew larger and spread faster.

“The common feature in all of the allegations we’ve seen is that none were based on scientific data,” says Lambert. “None have been confirmed.” The Institute of Medicine, the WHO and 10 of the 13 authors of the original *Lancet* report have all debunked the MMR-autism link (*Lancet* 362, 1498–1499; 2003).

Because vaccines are given to healthy children, they are rigorously tested for safety, Lambert adds. Although abnormal vaccine reactions can occur, “the risk is much lower than the risk of getting the disease,” he says. “Even on a purely individual basis, the benefit is there.”

Herd mentality

Epidemiologists have known for years that these fears influence vaccination rates. In 2004, applied mathematician Chris Bauch and a colleague charted parents’ behavioral patterns using mathematical models based on game theory (*Proc. Natl. Acad. Sci. USA* 101, 13391–13394; 2004), which explains how people make decisions based on others’ actions.

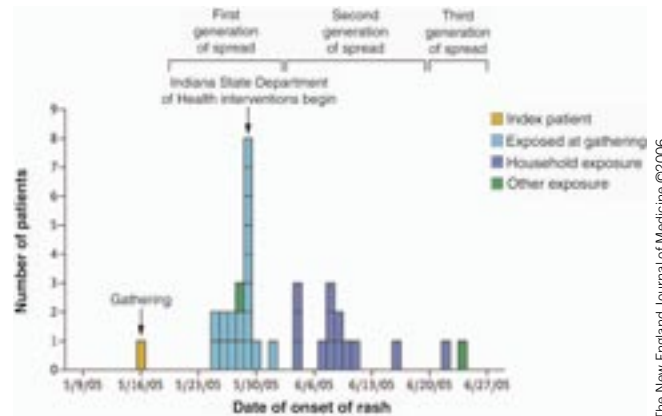
In this game, he says, “you’re trying to maximize the health of your children, while at the same time minimizing the risk, perceived or otherwise, from the vaccine and the disease.”

Bauch’s models simulate populations in which immunizations are voluntary and are based on the idea that a parent’s decision to vaccinate is influenced largely by what other parents decide.

In countries where the disease is rare and most people are vaccinated, there is herd immunity: the critical point—usually around 95%—at which enough of the population has been vaccinated to stop the disease from spreading. “People think, ‘why should I vaccinate when everyone else is providing the protection?’” he says.

His models show that vaccination rates drop dramatically after a scare and rise after the scare is over, perhaps after a strong public awareness campaign. But, to the chagrin of public health officials, the rates fall much faster than they eventually rise.

That’s consistent with history. Vaccination rates in Britain dropped 30 years ago after a study claimed a small number of children suffered



Chain of infection: A single case of measles led to the largest outbreak in the US in a decade.

limpness and seizures after receiving the whole-cell pertussis vaccine. The scare influenced vaccination rates for the next five years, triggering several outbreaks of whooping cough and dozens of deaths (*Vaccine* 21, 4003–4010; 2003).

“If we look at developing countries,” Lambert says, “we see exactly the same situation, with a different set-up and for completely different reasons.”

Public health officials worry about even small numbers of unvaccinated people, because, as with the case in Indiana, those people usually form clusters. A herd immunity rate of 95% will only keep a disease from spreading if unvaccinated individuals are spread out equally. But if a disease is introduced to a cluster of unvaccinated individuals, it runs rampant. The risk unvaccinated individuals pose to public health is particularly high when a disease isn’t circulating in a population.

“Even when the numbers of nonvaccinated individuals are small,” says Mulholland, “they go up each year that the disease isn’t around.” And the longer a community goes disease free, he adds, the more vigilant public health officials must be to get people vaccinated. “As the Indiana measles example shows,” he says, “98% [vaccinated] is not good enough.”

Weighing risk

In the US and the UK, dozens of grassroots and non-profit ‘vaccine awareness’ groups encourage parents to get vaccine exemptions.

“Mandating any medical procedure, especially vaccines, where we cannot even begin to understand the long-term effects, is just appalling,” says Dawn Winkler, executive director of the California-based group Health Advocacy in the Public Interest. Winkler’s daughter died as an infant. Although doctors said the cause was sudden infant death syndrome, Winkler maintains she died of mercury poisoning from vaccines.

Winkler says the dangers of vaccination

outweigh the risks of disease, especially when the disease—such as whooping cough or mumps—isn’t usually life threatening. What’s more, she says, because some people’s bodies won’t accept a vaccine after one dose—or sometimes even two—vaccine efficacies are usually around 90%. “And if something’s not 100% effective,” she says, “maybe I’m not willing to take the risk.”

People might argue about an individual’s risk of adverse health effects from vaccination, but the benefits of vaccination to the community as a whole are indisputable.

Vaccination efforts, after all, eliminated small pox, polio and measles from the Western world.

Doctors and public health researchers have suggested several ways to increase rates of immunization while still respecting parental autonomy.

Though a mandatory vaccination system has generally succeeded in the US, Omer says he would not automatically recommend it for other countries. “You should think of the long-term consequences,” he says. “If you impose something in a draconian manner now, you’re going to turn people off later.”

One way to increase vaccine coverage in Britain or other countries with voluntary systems might be to offer financial incentives—such as free vaccinations, tax breaks or even a small stipend.

Omer and his co-authors on the *JAMA* paper propose a compromise—similar to that used with conscientious objectors during military drafting—that focuses on the strength of the individual’s conviction.

“We’re not saying that you become a totalitarian state and start taking away people’s freedoms,” Omer says. “But it should not be easier to get an exemption than to get vaccinated.”

In the meantime, Winkler’s group and others are backing the Vaccine Safety and Public Confidence Assurance Act, introduced to the House on 25 July, which would create an independent government agency to oversee vaccine safety research. The bill has not yet been scheduled for committee discussion.

But Omer says creating a new government agency for research isn’t going to change the results of the slew of studies that have found vaccines to be safe. “What we give credence to is science and in terms of looking at vaccine safety questions,” Omer says, “we feel that science should lead the way.”

Virginia Hughes is a freelance writer based in New York.