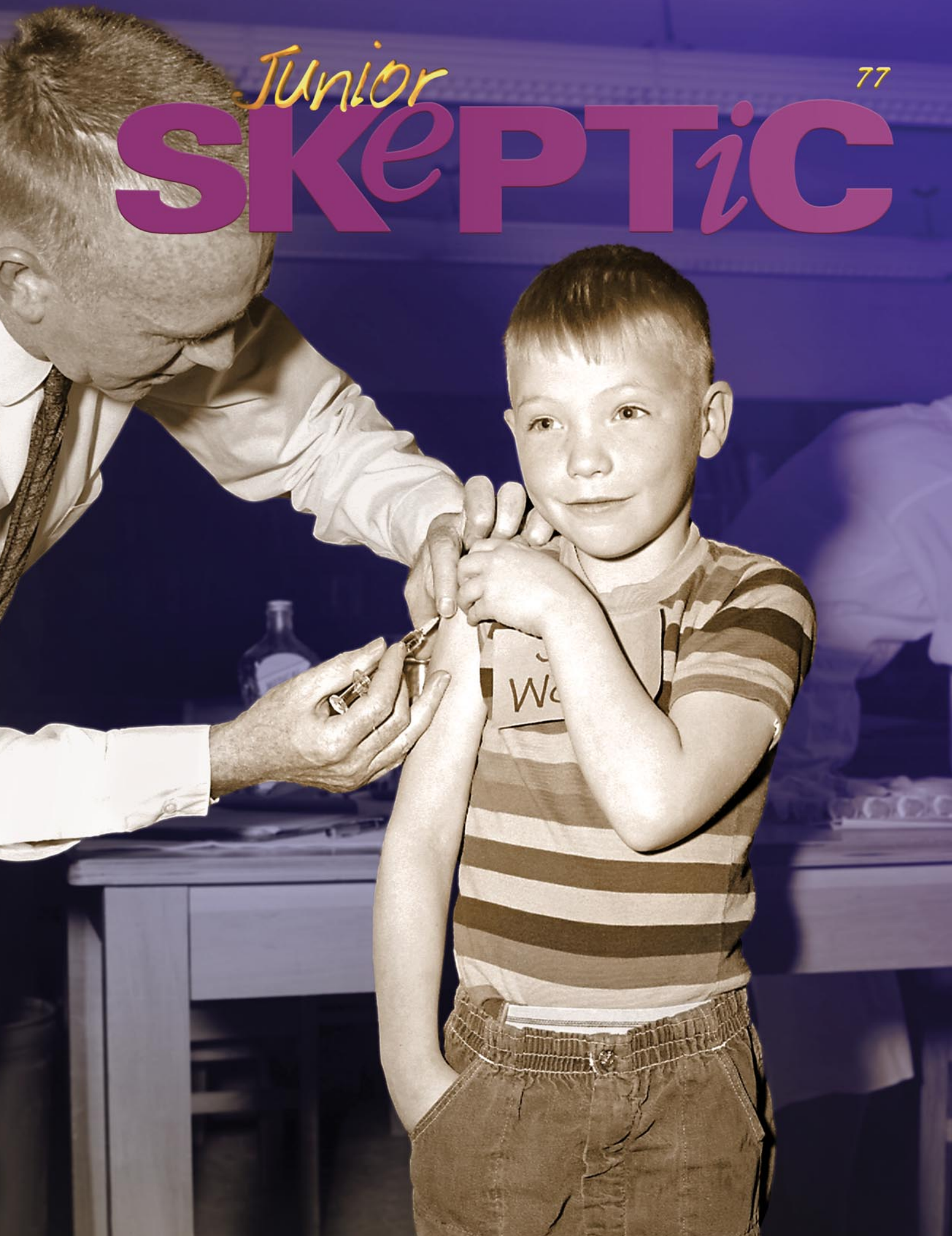
Junior
SKEPTIC
77

Junior Skeptic

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This Issue's Cover features a schoolboy receiving a measles shot in Atlanta, Georgia in 1962. (Courtesy of the CDC.)

THE HONEST TRUTH ABOUT VACCINES

HELLO!

"Vaccines" are medicines we take when we're healthy to prevent us from getting sick later. Nobody loves getting their shots. But vaccines protect you, your family, and your community.

Vaccines have helped us control many serious diseases. Right now, scientists are racing to develop a safe, effective vaccine to make us immune to Covid-19. However, some people claim that a Covid vaccine might not be safe, or even that it might be some sort of trick to control us. Others say vaccines are more dangerous than doctors admit. What is the truth? Are vaccines safe or risky? Or might the truth be something in between?

Let's find out!

CENTURIES OF SORROW

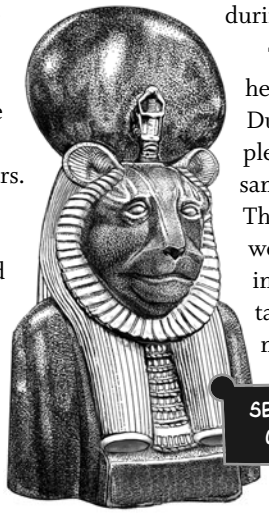
We're going to learn how vaccines were discovered, how they work, and how they save lives. We'll bust scary myths and conspiracy theories about vaccines. And, we'll explore the darker side of vaccine history—because no matter how safe something is, things can still go wrong.

Let's start at the beginning. Imagine for a moment what life was like thousands of years ago, before there were any vaccines. Contagious diseases were everywhere. If you lived in ancient times, your life might be threatened by deadly disease epidemics every few years. Your family might survive one plague, only to sicken and die in the next. Almost everyone carried the sadness of losing loved ones to contagious diseases.

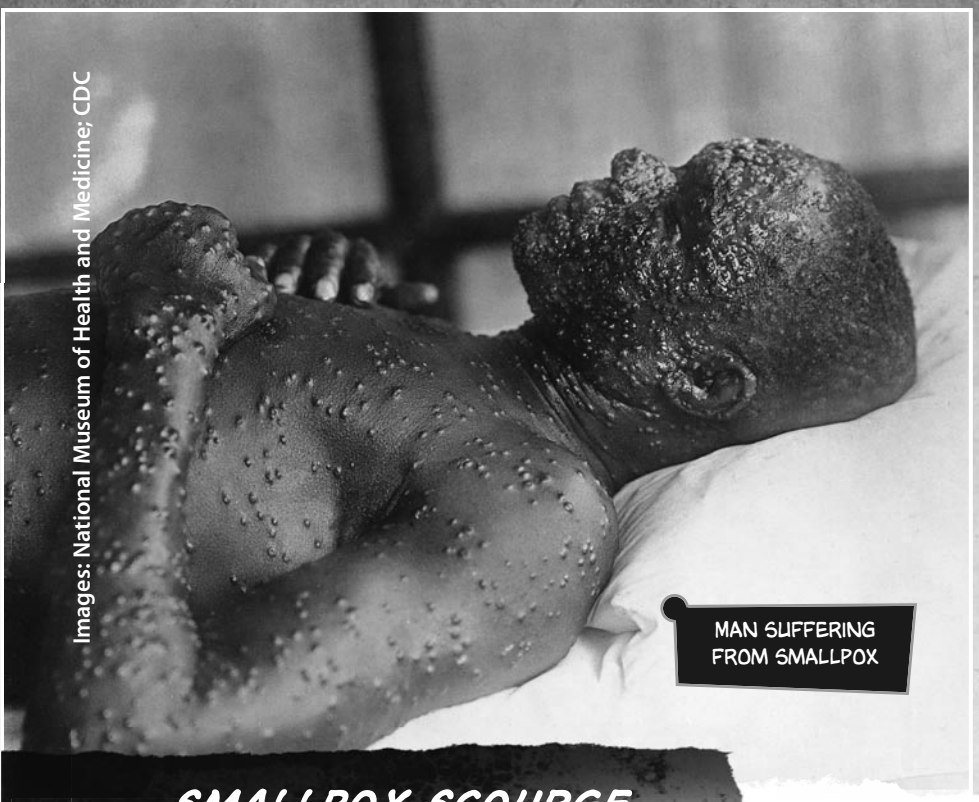
Worse, ancient people didn't know why plagues kept happening. Nobody knew that germs existed. They guessed instead that the gods must be angry. They imagined that plagues were sent to punish humanity.

How helpless and scared people must have felt! How could anyone defend themselves from the wrath of the gods? And yet, people discovered some ways to do that. For example, they could stay away from sick people. That's what leaders in ancient Sumeria recommended during plagues.

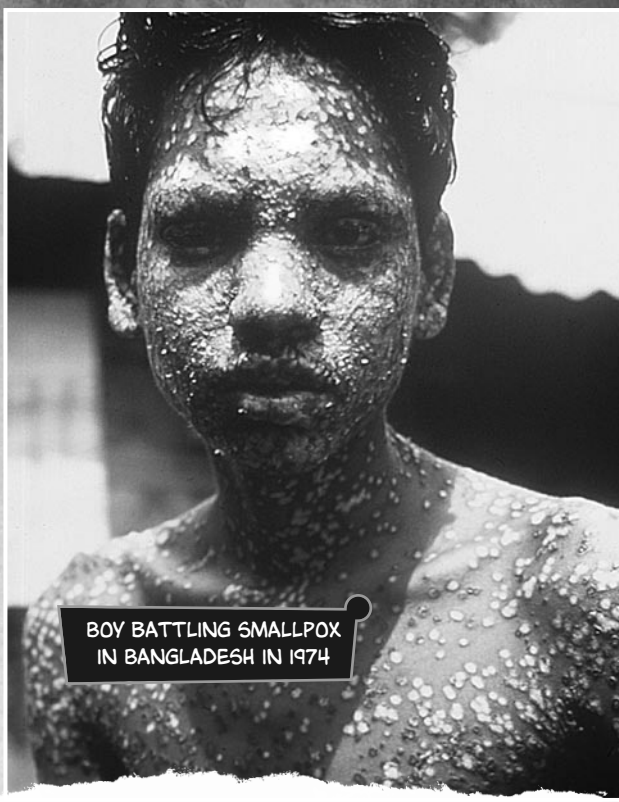
The ancients also noticed something that held the key to defeating infectious disease. During one plague in ancient Greece, people noticed the "disease did not attack the same person twice, at least not fatally." Those who got sick and then recovered were immune! Centuries later, that insight led to one of the most important discoveries of all time: a way to make people immune to diseases!



SEKHMET, THE EGYPTIAN GODDESS OF WAR, PLAGUES, AND HEALING



MAN SUFFERING FROM SMALLPOX



BOY BATTLING SMALLPOX IN BANGLADESH IN 1974

Images: National Museum of Health and Medicine; CDC

SMALLPOX SCOURGE

Smallpox was one of the deadliest and most devastating diseases ever known to humanity. From ancient times until the 20th century, smallpox epidemics killed countless millions. People lived in helpless terror of smallpox. The disease made people incredibly sick and covered their bodies with horrifying blisters. Those who recovered carried terrible scars for life. Some also lost their eyesight. They were the lucky ones! Up to 30 percent of smallpox victims died.

Several hundred years ago, people in China and India knew there was at least one benefit from catching smallpox: survivors became immune. This gave them a wonderful, terrible, dangerous idea: *what if they gave themselves smallpox on purpose*? Could they make themselves immune?

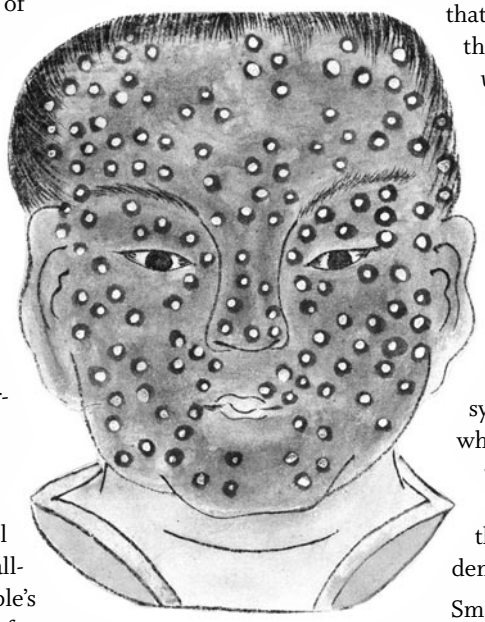
In medieval China, people took small amounts of pus from the blisters of smallpox victims and blew it up healthy people's noses. In India, they scratched material from smallpox blisters into the skin on people's arms.

What happened when people were deliberately infected with smallpox in this way? Well, they got sick, of course! They were *infected with smallpox!* They showed symptoms of the disease and became contagious. Worse, about one out of fifty died.

Nevertheless, these crazy experiments actually worked! Yes, it was dangerous. However, it turned out that those infected through a scratch on their arm were *much more likely to survive* than those who caught smallpox naturally! Accidental infections were about 15 times deadlier than getting the scratch.

"Inoculation" is the word for this practice of deliberately putting full strength infectious germs into someone's body to create immunity. People who were inoculated against smallpox usually had mild symptoms. Most important, those who recovered were fully immune to smallpox for the rest of their lives, just as they would be if they recovered from an accidental infection.

Smallpox inoculation worked. No one knew why at the time, but it did. This risky but lifesaving discovery slowly spread to other lands in the Middle East and Africa.



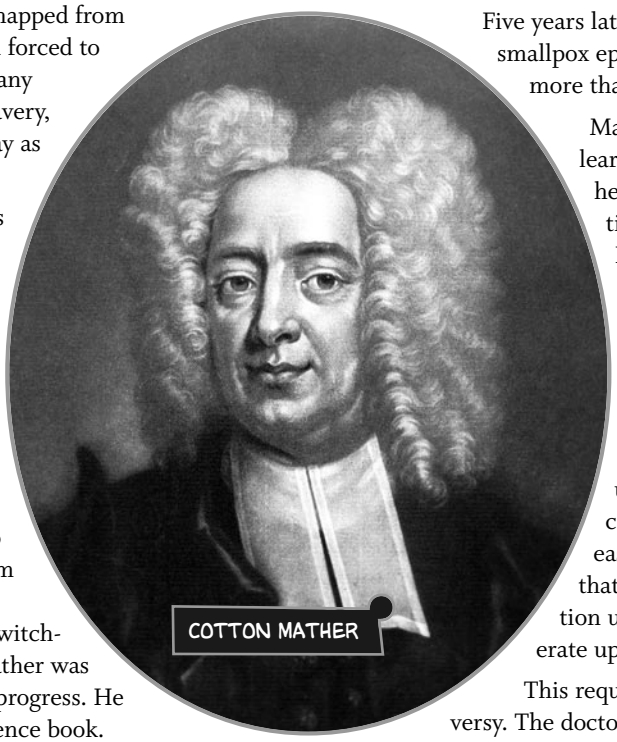
SMALLPOX SHOWN IN JAPANESE MEDICAL MANUAL FROM THE 1700S

Image: Wellcome Collection

INOCULATING AMERICA

America's first experiment with inoculation took place during a smallpox epidemic that raged through Boston in 1721 and 1722. Americans first learned about inoculation from an African slave who taught the technique to his White owner.

The American colonies needed a lot of workers. To meet that need, people were kidnapped from Africa, then sold into slavery and forced to work in America. At the time, many White Americans approved of slavery, even though we recognize it today as one of history's biggest crimes.


COTTON MATHER

In 1706, no one thought it was weird when a Boston preacher received an African man as a gift from members of his church. The preacher, Cotton Mather, was a smart, complicated man with some terrible mistaken ideas and also some good ones. For example, his writings about the supposed threat of imagined witches led to the horrors of the infamous Salem witch trials. Numerous innocent people were falsely convicted of witchcraft and executed. However, Mather was also very interested in scientific progress. He wrote America's first popular science book.

Mather was perfectly happy to "own" a human being. He put his slave to work as a household servant. However, Mather seems to have behaved fairly decently toward the man he renamed "Onesimus." Mather taught his slave to read and write, and later allowed him to marry and earn his own money. Eventually Mather released his slave to "enjoy and employ his whole time for his own purposes, and as he pleases."

The two men didn't always get along (not surprisingly), but Mather found Onesimus interesting to talk to. As it happened, one of their conversations wound up making history.

Mather recalled asking "Onesimus, who is a pretty intelligent fellow, whether he ever had the smallpox; he answered, both, Yes, and No; and then told me, that he had undergone an operation, which had given him something of the smallpox, and would forever preserve him from it."

Onesimus described the scratch-in-the-arm inoculation technique invented centuries earlier in India. He showed his scar to Mather, and explained that the process was common in the region of Africa where he was born. In his homeland, "whoever had the courage to use" the dangerous technique "was forever free from the fear of the contagion."

This sure caught Mather's attention! Smallpox was as dreaded in America as it was in Europe. Was it possible that an African slave knew more about fighting smallpox than the best White doctors? Mather then "met with a considerable number of these Africans," who all agreed that inoculation was a "common practice" and a "constant success."

Epidemic Emergency

Five years later, Boston was struck by a severe smallpox epidemic. It would soon infect more than half the town.

Mather remembered what he learned from Onesimus. Mather had heard that descriptions of inoculation had also started to reach Europe from Africa. He wondered, "how many lives might be saved by it, if it were practiced" during the Boston outbreak?

Mather wrote to Boston's doctors about the technique. He urged them to "warily" test it in case it could help fight the disease. "Gentlemen, my request is, that you would meet for a consultation upon this occasion, and to deliberate upon it," Mather asked.

This request set off a firestorm of controversy. The doctors were not impressed with what sounded like a crackpot idea that a "credulous vain preacher" heard from a slave. To begin with, Mather was suggesting that doctors respond to a deadly disease epidemic by *infecting more people on purpose*. That sounded insane! It also seemed morally wrong. "I reckoned it a sin against society," said one leading critic. This "novel and dubious practice" was also totally untested by science. The doctors were also offended by the notion that African folk medicine knew more than they did.

Daring Experiment

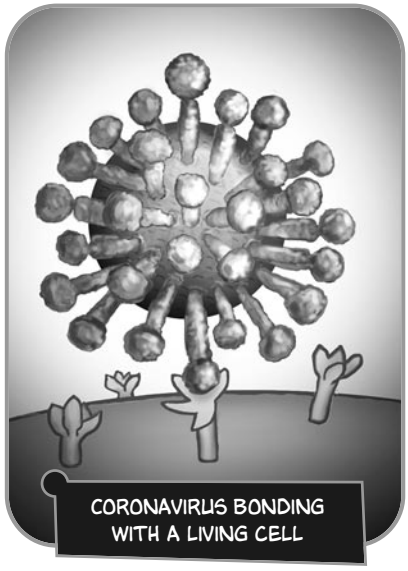
Not every doctor thought inoculation sounded crazy. One doctor named Boylston believed it would work. To find out, he first inoculated his own son and servants. He then began inoculating patients in the community.

Other doctors, town leaders, and members of the public were furious about Boylston's seemingly reckless experiments. Boylston complained that the "rage of the people against" inoculation was "so violent, that I was put into a very great fright." Mather got his own share of the town's fury. He marveled at the "strange possession of the people on this occasion. They rave, rail, they blaspheme; they talk not only like idiots but also like frantics."

Mather's critics hurled more than insults. One night around three in the morning, "some unknown hands" threw a bomb into Mather's house! Thankfully, the bomb did not explode. The lit fuse fell out when it landed. A note was found attached to the bomb: "Cotton Mather, you dog, damn you! I'll inoculate you with this, with a pox to you."

Despite everything, it eventually turned out that Onesimus, Mather, and Boylston were right. In some ways, so were their critics.

Boylston inoculated 286 patients. Two percent of them died. Of the 5,989 Bostonians who caught smallpox by accident, 14 percent died. In fact, eight percent of the town's total population died. Boylston complained that the controversy kept "hundreds, if not thousands, from coming into the practice of inoculation, which might have saved many valuable lives." (We can estimate that inoculating the whole town might have saved more than 600 people.)



Inoculation's fiercest medical opponent eventually agreed that smallpox received through inoculation "is not so fatal and the symptoms frequently more mild, than in the accidental contagion." He agreed inoculation could be useful, but warned it was very dangerous.

He was right about that. After all, inoculation *killed* one out of 50 patients! This is why it was such a hard decision decades later when General George Washington ordered his commanders to "inoculate your men as fast as they are enlisted" during the American War of Independence.

Why It Worked

To understand why inoculation worked—and why it was so risky—we need some scientific knowledge nobody had in Cotton Mather's day.

Let's talk about germs. Today we know that two types of germs cause most contagious diseases: bacteria and viruses. Bacteria are microscopic living things. Some kinds of bacteria can thrive and multiply inside human bodies, making their hosts sick.

Viruses are even smaller and simpler than bacteria. Viruses are so simple they don't really even count as "alive." They're just microscopic bundles of genetic instructions (DNA or RNA). Viruses can't do anything by themselves. They can't move, think, or even reproduce. They just sit there like tiny little bricks.

That is, unless a virus touches the surface of a living cell it evolved to attack. Then the genetic instructions carried by the virus slip inside the cell and trick the cell into making copies of the virus. Those virus copies go out and infect more cells, which make more copies. Multiplying viruses make us sick when they attack more and more of our cells.

Smallpox was caused by one virus; Covid-19 is caused by another. Both spread the same way. Smallpox victims coughed out droplets loaded with particles of smallpox virus. If someone else inhaled those droplets, the virus could invade their lungs and spread throughout their body.

Now, I'm happy to tell you, human bodies are far from helpless. We've evolved an amazing immune system to defend against germs. We need it because there are germs in every breath of air, every bite of food, and every surface we touch. Our immune system stops most of those germs before they cause any trouble.

When we *do* get sick, it's a bit like a race: can our bodies kill invading germs faster than those germs can multiply? If yes, we get better; if not, we get sicker. Our immune system is very quick to fight germs it has encountered before. Old enemies get attacked on sight. However, it isn't as quick to attack new germs. When a new germ gets into our bodies for the first time, it only has to get past our weaker first lines of defense. It takes time for our immune system to react to the threat, sound the alarm, and make antibodies to attack the new germ.

This gives unfamiliar new germs a head start. An aggressive virus like smallpox could infect cells throughout a victim's body before their immune system could mount a counterattack—and the counterattack had to be ferocious to beat the widespread virus. Victims' bodies became battlegrounds. Almost a third of patients died. Those who recovered became immune because their immune systems could now recognize smallpox.

Inoculation *also infected people with the full strength smallpox virus*. The virus invaded cells; the immune system fought back. Recovered patients became immune. The only difference between inoculation and natural infection was *where the virus entered the body*.

Smallpox evolved to invade lungs, not arms. It *could* infect skin, but introducing the virus through the skin slowed it down. This gave patients' immune systems time to catch up. Most inoculated people—98 percent—were able to fight off the virus before it could make them sick enough to die.

Others weren't so lucky. Inoculation saved many lives at the price of taking a few. That's a high price to pay. Humanity needed to find a safer way to fight smallpox and other diseases.

EDWARD JENNER VACCINATING HIS FAMILY WITH COWPOX WHILE A COW LOOKS ON IN THE BACKGROUND

Image: Wellcome Collection

COWS TO THE RESCUE!

For seven decades after the Boston experiments, inoculation remained humanity's best medicine against smallpox. It was also extremely hazardous. Finally, in 1798, a doctor named Edward Jenner announced a safer new way to fight the dreaded disease. He found his solution on farms in the English countryside.

Jenner was puzzled when he noticed that smallpox inoculation didn't always work on farmers and milkmaids. When he scratched their arms and introduced smallpox germs, they didn't get sick. In fact, nothing happened at all. They appeared to already be immune to smallpox, even though they'd never had smallpox before. How was that possible?

Jenner learned that farm workers were sometimes infected with an illness they caught from their cows. "Cowpox" made people sick and produced a small number of blisters, but it wasn't deadly. Jenner wondered if recovering from cowpox made people immune to smallpox? To find out, Jenner tried smallpox inoculation on several people who previously had cases of cowpox. None of them became infected with smallpox.

Then he tried inoculating people with material from cowpox blisters. Those people caught very mild cases of cowpox with "slight symptoms." When they recovered, Jenner tried inoculating them with smallpox. Nothing happened. They were immune!

Jenner concluded that cowpox inoculation "leaves the constitution in a state of perfect security from the infection of the smallpox." Even better, no one died from it. Jenner very sensibly asked if cowpox inoculation should replace smallpox inoculation?

At first doctors and scientists doubted Jenner's results, but they soon realized he was right: cowpox inoculation made people immune to smallpox, and it was much safer than smallpox inoculation. The new technique was named "vaccination," from the Latin word for "cow." The practice of vaccination quickly spread across England and Europe and over to the United States.

Birth of the Anti-Vaccination Movement

There are people today who are fiercely opposed to vaccines. We'll learn more about them later in our story, but opposition to vaccines isn't a new thing. In fact, the anti-vaccine movement began almost the second Jenner's vaccine was discovered.

A ferocious debate broke out between doctors who promoted the safer new vaccination technique, and those who insisted "known, certain, and long-experienced smallpox inoculation" was better. This was such an important public health matter that both sides quickly became furious with the other. As one 1806 book noted, "both those who approve, and those who disapprove of vaccination, have accused each other of murdering their patients."

Some people objected to the very idea of vaccination. They said it was disgusting and unnatural to put material

Image: Library of Congress

1802 ANTI-VACCINE SOCIETY CARTOON MAKING FUN OF THE "WONDERFUL EFFECTS OF THE NEW INOCULATION"

from diseased animals, "filthy in their very nature," into human bodies. People worried that cowpox would make them less human. Some claimed vaccination could turn a healthy child into an "idiotic ape, a hideous foul-skinned cripple: a diseased burlesque on mankind." People even feared that cowpox vaccination would literally *turn them into cows*. Quack doctors claimed vaccination made kids look like cows, and even made them moo and grow horns!

Anti-vaccine doctors warned of countless supposedly "dreadful effects of Cow-pox inoculation." They blamed vaccination for almost any ailment their patients might have. Itchy skin? Sores of any kind? These symptoms must be "the effects of the diseases of brute beasts incorporated into the human constitution" through vaccines. Others said vaccination caused brain damage or created entirely new diseases.

These wild claims left the public badly confused. Were they keeping their children safe by vaccinating, or putting their children in danger? The answer become clearer with time. As more people got vaccinated, smallpox deaths started to drop. According to modern vaccine expert and medical doctor Paul Offit, "between 1810 and 1820 Jenner's vaccine halved the number of deaths from smallpox." People got used to vaccines. Opposition died down.

Health authorities were thrilled. Vaccination was a very powerful tool to protect people. The government of England wanted to make every kid safe from smallpox. They passed laws during the 1850s and 1860s that required everyone to vaccinate their children. The laws included penalties for parents who refused to cooperate.

Vaccinating everyone was a great idea. There was just one problem: people get mad when they feel bossed around! People hated "compulsory" (forced) vaccination. The anti-vaccination movement came roaring back, bigger and angrier than ever. New groups such as The Anti-Vaccination Society raged against "the cruel, despotic tyranny of forcing cowpox misery on the innocent babes of the poor—a gross violation of religion, morality, law, and humanity." Up to 100,000 people joined one massive protest rally against vaccines. The anti-vaccination movement soon spread across the sea to North America as well.

Strangely, one of England's greatest scientists joined the anti-vaccination movement. Alfred Russel Wallace was a co-discoverer (with Charles Darwin) of evolution by natural selection. He was also a big supporter of bogus ghost photographs and false claims about vaccines. According to Wallace, "vaccination is a gigantic delusion" which "has never saved a single human life." Wallace claimed vaccination "has been the cause of so much disease, so many deaths, such a vast amount of utterly needless and altogether undeserved suffering" that it was a "crime against liberty, against health, and against humanity…." Wallace believed that everyone would soon consider vaccination "one of the foulest blots on the civilization of the nineteenth century."

He was badly mistaken about all of that. Instead, vaccination would later rescue humanity from smallpox once and for all—and go on to protect us against numerous other terrible and deadly diseases.

During the late 19th and 20th centuries, medical scientists raced to develop vaccines against numerous killer viruses and bacteria. Vaccines were desperately needed. As Paul Offit explains,

> *In the early 1900s…Americans could expect that every year diphtheria would kill twelve thousand people, mostly young children; rubella (German measles) would cause as many as twenty thousand babies to be born blind, deaf, or mentally disabled; polio would permanently paralyze fifteen thousand children and kill one thousand; and mumps would be a common cause of deafness.*

Before the whooping cough (or pertussis) vaccine, Offit adds, "about three hundred thousand cases of whooping cough caused seven thousand [American] deaths every year, almost all in young children." Whooping cough is a horrible sickness. Children sometimes cough so hard they break ribs or suffer brain damage! "Before the vaccine," Offit goes on, "measles infected as many as four million American children, causing a hundred thousand to be hospitalized and five hundred to die every year."

There were frequent epidemics. In 1916, for example, a polio epidemic broke out in New York City. This strain of polio killed up to a quarter of everyone infected. Over two thousand people died in the city alone. Thousands more died as the disease spread to other states.

Vaccine Victories—and Risks Along the Way

Today, all those diseases and others have been controlled or even eliminated by vaccines that prevent infection. This is one of the humanity's greatest success stories. Most people in rich countries barely remember diseases that used to inflict millions with terror, sickness, and death. The most spectacular success is smallpox vaccination. Jenner's discovery empowered us to completely eradicate this ancient enemy. Thanks to vaccines, smallpox is extinct in the wild! Humanity no longer suffers from this horrifying disease.

Those victories didn't come easily. There were setbacks and even disasters along the way. To understand vaccines—and to learn which vaccine risks are real and which are imagined—we will need to look at the hard lessons scientists learned on their quest to conquer deadly diseases.

Modern vaccines are incredibly safe…because medical scientists have learned from a century of mistakes and accidents. Vaccines used to be riskier than they are now.

The first and most obvious risk from the earliest inoculation treatments was that full strength disease germs make people sick. That's why the medieval smallpox inoculation technique was so hazardous. Even Jenner's vaccine used full strength cowpox virus. It had more side effects than modern vaccines.

To make safer vaccines, scientists had to find ways to make germs weaker. For example, they discovered ways to kill the germs with heat or chemicals before injecting them. Our immune system could still learn to recognize the dead germs, but dead germs can't cause infections. (Strictly we should say viruses are "deactivated" because they're not exactly alive to begin with.)

Contaminated Vaccines

Another very serious early risk was that vaccines could be contaminated with other kinds of germs. During an American smallpox epidemic in 1898–1904, for example, governments in some cities and states made laws that people had to get vaccinated. However, *there were no laws that vaccines had to be safe or effective*. Anyone could make and sell vaccines! No one checked to see if they did a good job.

Smallpox vaccines were made from blisters on cows. The vaccines were often contaminated with bacteria that lived in the cows' filthy stables. In one heartbreaking 1901 case, dozens of American children died from tetanus bacteria lurking inside their vaccines. After this tragedy, the United States government decided to write laws that required vaccines to be made safely.

However, accidents can happen even when people are careful and responsible. In 1928, doctors were very relieved to finally have a vaccine against diphtheria (a disease that could literally choke children to death). Sadly, one Australian doctor caused an accidental tragedy when he vaccinated his young patients. The vaccine was made properly, but it came in a large vial with doses for numerous people. At some point, a deadly kind of bacteria got inside his bottle of vaccine and started multiplying. Twelve children died from his contaminated vaccine.

This horrible accident exposed another serious vaccine risk. Health officials realized they needed a way to keep bacteria from growing inside bottles of vaccine. They soon settled on a preservative called "thimerosal." It seemed like a great choice. Thimerosal killed bacteria without damaging the vaccine. It was considered safe for people. From the 1930s until the late 1990s, thimerosal was successfully used to make vaccines safer. Then a new controversy erupted, which we'll learn about later in our story.

Hitchhiking Viruses

Vaccines are made from germs.* If you want to make a vaccine against a virus, you need to grow a lot of that virus. Problem is, viruses can only reproduce inside living cells. Smallpox vaccine was originally grown inside living cows. Modern flu vaccines are typically grown inside eggs. (That's a risk for people with egg allergies.)

In the late 1950s, polio virus for vaccines was grown inside

* SOME NEWER VACCINES ARE MADE USING GENETICALLY ENGINEERED PROTEINS THAT REPLICATE THE SURFACE OF A VIRUS. THESE DO NOT CONTAIN ACTUAL GERMS.

living monkeys. Monkeys were first infected with polio and then killed. Polio virus was filtered from their kidneys. Everyone thought this was safe until one government scientist decided to double check. She injected hamsters with polio virus samples taken from monkey kidneys. A whopping 70 percent of the hamsters developed tumors. It turned out that the samples also included a monkey virus called SV40 which causes cancer in hamsters. In 2013, the U.S. Centers for Disease Control and Prevention estimated "10–30 million Americans could have received an SV40 contaminated dose of vaccine." No one knows for sure whether SV40 is harmful to humans.

Image: Public Health Image Library

Modern vaccines do not have this risk. Scientists changed how vaccines were made as soon as they learned about the monkey virus. Vaccine viruses are typically now grown in a laboratory using clean, safe cell cultures grown from human tissue.

Deadly Mistakes

Improving knowledge led to safer, more effective vaccines against more and more diseases. But safe vaccines still have to be made properly.

In the early 1950s, polio was the disease that Americans feared most. Polio mostly attacks children. The virus is easily transmitted. Most infected people don't even realize they have it. However, severe cases cause paralysis, deformed limbs, and death. Every year, thousands of kids were paralyzed and confined in "iron lung" machines just to keep them breathing.

When a successful polio vaccine was finally announced, the whole country burst into celebration. Church bells rang. People wept for joy. It was front page news across the nation. "Science has enriched mankind with one of its finest gifts," proclaimed *The New York Times*.

The new vaccine had been carefully tested on nearly two million volunteers. It worked great. Side effects were rare. People joyfully lined up to take it immediately.

Two weeks later, something horrible happened. Yes, the vaccine was safe…*if it was made correctly*. It used "dead" (deactivated) polio virus. This could not infect anyone. However, several companies had permission to make the vaccine—and one of those companies messed up. Badly. Their batches of the vaccine were accidentally contaminated with infectious "live" polio virus!

It was a disaster. The contaminated vaccine gave 70,000 children polio. Two hundred kids were permanently paralyzed. Ten died.

All batches of the vaccine were quickly recalled while scientists fixed the problem. Those responsible for the accident were punished. Stricter new safety laws were written to make sure such an accident could never happen again.

Despite this tragedy, polio vaccines have proven so effective that the disease has now been completely eradicated from most of the planet. Today, only a handful of cases turn up each year in remote places. World health authorities are hopeful that vaccination will soon make polio extinct everywhere, once and for all.

Side Effects

Like any medicine, vaccines can cause side effects. Vaccines must be thoroughly tested to find out what those might be. Experimental vaccines are first tested on a small number of volunteers in case they have severe or common side effects. If the first trials seem safe, the vaccine is then tested on larger numbers of people. Vaccines must be tested on very large numbers to find any rare side effects. Only when they're proven safe do vaccines get permission for public use. Doctors then keep track of *any* health problems patients might have soon after receiving a vaccine, just in case those health problem could be connected to the vaccine. Most regular childhood vaccines have been in use for many years. Their possible side effects are very well known.

The most common side effects include low fever and soreness at the injection site. Allergic reactions are one of the most dangerous risks of modern vaccines. Some people are severely allergic to ingredients in certain vaccines (such as eggs or glycerin). To manage this risk, doctors ask patients about allergies. They may ask patients to wait after their shots in case they have any unexpected reaction.

To remain in use, vaccines must be safer than the risk of not vaccinating. Side effects must be mild or extremely rare. When the risks from diseases change, health authorities change the list of recommended vaccines. For example, Americans no longer receive smallpox vaccine because smallpox is extinct. Similarly, the United States switched to a less effective but safer polio vaccine in 1998. It was safe to make this change because polio had become rare.

Modern vaccines are extremely safe. Most people should get all of their recommended doses at the recommended times. This protects us, and also protects people who cannot take certain vaccines (such as babies, organ transplant patients, and people with severe allergies to vaccine ingredients).

Unfortunately, anti-vaccine rumors continue to scare people. You may know someone who feels uneasy about vaccination. Some even feel strongly opposed to vaccines. There has been an anti-vaccine movement for more than 200 years. Strangely, that movement has rarely complained about the small but real risks of vaccines. Instead, they've usually scared people about *imagined* risks (such as smallpox vaccine turning children into cows).

Rumors about vaccine dangers often come from misunderstandings. In one gruesomely exaggerated example in 1972, an anti-vaccine pamphlet claimed that one polio vaccine was made from the blood of babies. "YOUR CHILD'S NEXT IMMUNIZATION SHOT MAY BE CANNIBALIZED FROM A SLAUGHTERED BABY," the pamphlet warned. This wasn't true, of course. The vaccine was made using human cells grown in a lab. The activist who wrote the pamphlet later admitted he was wrong. He apologized to the scientist who created the vaccine. However, the damage was already done. The pamphlet's claims were repeated for years in church bulletins and newspapers.

Other frightening vaccine rumors were based on coincidences. Developmental problems such as autism sometimes appear in children around the same time that kids receive childhood vaccines. If a child develops a condition *after* taking a vaccine, parents may suspect that the shot *caused* the condition. They may join anti-vaccine activists who share their suspicions. Those groups spread scary rumors in newspaper stories, television, and the internet.

Rumors and Panic

It's helpful to know that similar anti-vaccine accusations have been made against different vaccines at different times. In 1973, for example, a doctor in England claimed that the whooping cough (pertussis) vaccine caused brain damage. As Paul Offit explains, this claim is now known to be "utterly incorrect." However, people believed it.

The brain damage claims caused a media frenzy. News media love stories that seem both surprising and important. "Whooping Cough Vaccine Risks Concealed, Say Victims' Parents," one headline claimed. "Boy's Brain Damaged in Vaccine Experiment," said another. Headlines even claimed that the whooping cough vaccine should be abandoned.

People stopped vaccinating their kids. Many British doctors stopped recommending the DPT vaccine (which protects against three diseases: whooping cough, tetanus, and diphtheria). The result was a whooping cough epidemic. A hundred thousand British kids caught a truly terrible preventable illness *which can itself cause brain damage!* Thousands wound up in the hospital. It's been estimated that about 600 kids died.

Even after that epidemic, media continued to spread the rumor around the world. In 1983, a TV program called *DPT: Vaccine Roulette* shocked American audiences with images of brain damaged children. The show claimed the whooping cough vaccine caused "damage to a devastating degree." Parents freaked out. Families sued the companies that made whooping cough vaccine. Judges ordered the companies to pay billions of dollars.

To stay in business, companies had to charge 35 times more for the vaccine—an increase from twelve cents per dose in 1982 to $4.29 three years later. They still lost money. Two of the three American companies that made the vaccine stopped. Then in 1986, the last remaining company said they too would stop making the DPT vaccine! Companies that made other vaccines also started getting out of the business.

The U.S. Federal government had to step in to save vaccines from disappearing. The vaccine program protects the whole nation, so the nation would also pay for any harm caused by vaccines. From now on, any American injured by any vaccine could apply to a new national "vaccine court" for compensation.

The whooping cough vaccine actually did have a lot of side effects. It was an early, crude vaccine that was later replaced by a safer version. Nevertheless, the evidence from several large studies showed that whooping cough vaccine did *not* cause permanent brain injuries. For example, one study in England compared 134,700 kids who received whooping cough vaccine to 133,500 who didn't. The study found "no convincing evidence" that the rumors were true.

Measles, Mercury, and Autism

In 1998, another British doctor named Andrew Wakefield started a worldwide panic about a totally different vaccine. He published a paper and held a press conference claiming that the measles vaccine harmed children's brains, causing autism. Wakefield told reporters, "I cannot support the continued use" of the MMR vaccine that protects against measles, mumps, and rubella. Measles is a serious illness that used to infect four million American kids every year, killing 500 and putting a hundred thousand in the hospital.

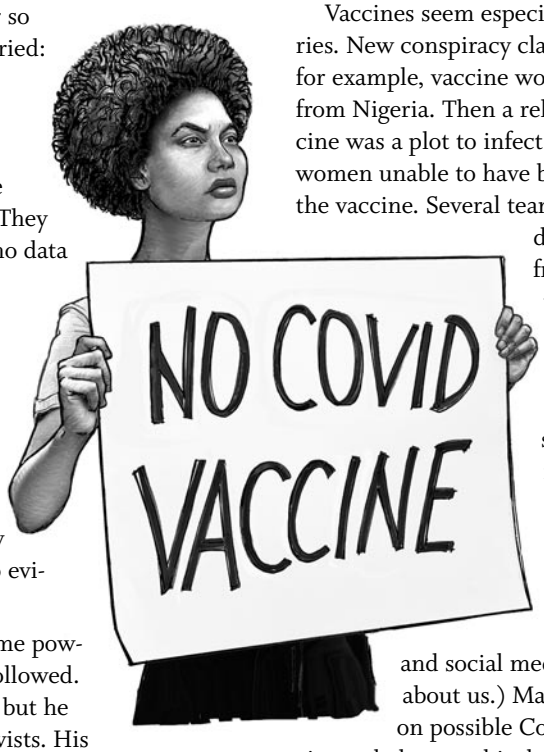
We now know for a scientific fact that the measles vaccine does *not* cause autism. Wakefield's "research" was completely bogus. His paper was later retracted as a fraud. Wakefield even lost his license to practice medicine.

However, Wakefield's false claims made headlines around the world. "Doctors Link Autism to MMR Vaccination," announced one London paper's front page headline. This

idea took hold in the public imagination, inspiring two decades of furious anti-vaccine activism, hearings in Congress, and countless books and news stories about the supposed "dangers" of vaccines. Parents were confused and alarmed. Nothing's scarier for parents than thinking their decisions could harm their kids. Parents of autistic children were heartbroken—and angry!

Then something else made the whole mess worse. U.S. government agencies were busy checking their safety standards regarding mercury (a highly toxic metal). Doctors at the Food and Drug Administration (FDA) knew that the thimerosal preservative in some vaccines contained tiny amounts of a relatively safe form of mercury. Thimerosal had been used safely in vaccines for several decades. But government doctors suddenly realized that kids got a *lot more vaccines than they used to*. Could those shots possibly add up to an unsafe level of mercury exposure? Doctors were shocked to realize they simply didn't know.

"There was no safety data" about that, recalled one of the experts involved, because it had never even occurred to anyone to study! After all, everything seemed fine. But was it? Big problems would be obvious after so many years of use. Still, doctors worried: what if thimerosal had subtle health effects no one had noticed? Further research was needed.



Health officials decided to tell the public exactly what was happening. They reassured everyone that there was "no data or evidence of any harm" from thimerosal. Nevertheless, out of an abundance of caution, they decided "thimerosal-containing vaccines should be removed as soon as possible." The public did not react well to this news. If there was no danger, why were they removing thimerosal? Or if there *was* some danger, why were authorities saying there was no evidence of harm?

The anti-vaccine movement became powerful and popular in the years that followed. Wakefield's claims were discredited, but he remained a hero to anti-vaccine activists. His claims about the measles vaccine blended with unrelated claims about thimerosal. Even after thimerosal was removed from vaccines, conspiracy theories falsely claimed "there are no safe vaccines!" According to one prominent anti-vaccine activist, the "childhood vaccination program endured by American families is…the single greatest threat this country has ever faced." (That's saying a lot in a country that endured a Civil War and two World Wars!)

None of these claims were true. Unfortunately, media helped to spread misinformation. For example, one study of news stories from 2002 about the MMR vaccine revealed that 70 percent of stories mentioned a supposed link to autism. Only 11 percent mentioned the vaccine's actual safety record. Years of widespread anti-vaccine misinformation scared parents. Many stopped vaccinating their kids. Inevitably, falling vaccination rates led to a series of outbreaks of diseases such as measles and whooping cough.

The vaccine panic was unnecessary and tragic. Scientists around the world have repeatedly tested the thimerosal and MMR claims, and always find the same thing: vaccines definitely do not cause autism. Numerous studies have compared hundreds of thousands of vaccinated and unvaccinated kids. Both groups had the same rates of autism. This finding was predictable from the beginning. After all, as one anti-vaccine author admitted, "Some children with autism were never exposed to thimerosal, and the vast majority of people who received mercury in vaccines show no evidence of harm whatsoever."

Conspiracy Theories and Covid-19

Vaccines seem especially vulnerable to conspiracy theories. New conspiracy claims pop up all the time. In 2003, for example, vaccine workers were trying to eliminate polio from Nigeria. Then a religious leader claimed the polio vaccine was a plot to infect people with AIDS and make women unable to have babies. People became scared to take the vaccine. Several teams of vaccine workers were murdered. Then a polio epidemic spread from Nigeria to twenty other countries. Five thousand people were paralyzed—and all because of a false rumor.

Today, there are dangerous conspiracy rumors about the experimental Covid vaccines that scientists are racing to develop and test. For example, some people claim Covid vaccines are a plot to implant people with tracking chips. That's silly. (Smart phones and social media already know almost everything about us.) Many teams of scientists are working on possible Covid vaccines because we need a vaccine to help stop this deadly pandemic. Don't be distracted by fake rumors. Do learn from the complicated history of vaccines. As one or more Covid vaccines become available, we'll need medical experts to tell us: How effective is it? How well is has it been tested? How long does it last? And, what are the side effects? Vaccines are amazing, but never perfect. We may find that the first Covid vaccine is soon replaced by a better one. Scientists will continue to make vaccines safer and more effective to better protect us all.

Junior Skeptic # 77 (www.skeptic.com/junior_skeptic/issue77) was originally published in *Skeptic* magazine 25.4 in 2020..
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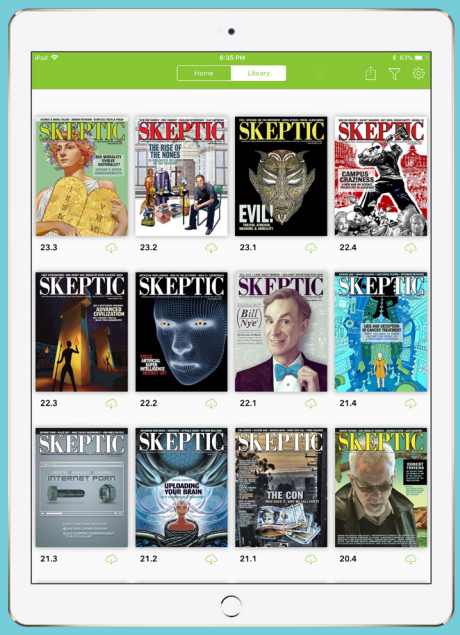

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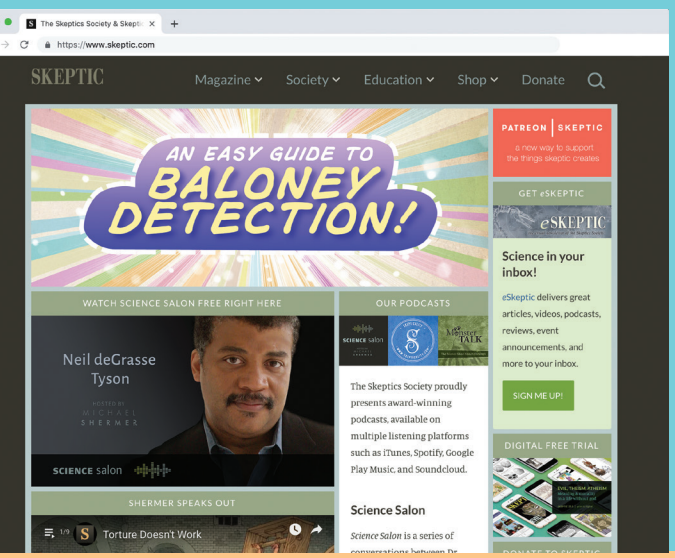

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