A JOURNALIST'S GUIDE TO COVERING

OUTBREAKS OF VACCINE-PREVENTABLE DISEASE

from the producers of

the PBS-NOVA special

Vaccines—Calling the Shots

TANGLED BANK STUDIOS
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Dear Journalist,

Outbreaks of vaccine-preventable diseases are occurring in the United States more often today than they did a generation ago. This guide, written as a companion to the PBS-NOVA documentary *"Vaccines—Calling the Shots,"* is intended as a resource for reporters and others with an interest in such outbreaks. It contains background information and resources (current as of late 2014) gathered in the course of making the film. We hope you find it useful.

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I. OVERVIEW

Diseases largely eliminated in the United States a generation ago are once more gaining a foothold,[1] as our collective memory regarding the devastation that infectious illness can cause fades. Americans are again getting sick and even dying from preventable diseases thought to be a thing of the past—including measles, mumps and whooping cough.[2]

Why are outbreaks occurring again, when vaccines have long been available to help protect us from these once-common contagious diseases?

According to public health officials, clusters of unvaccinated individuals are a key reason for these recent outbreaks.[3] When the percentage of vaccinated individuals in a community falls below a certain threshold (which varies, depending on the disease and the vaccine), it results in the breakdown of a phenomenon known as "herd immunity," or protection at a level high enough to shield an entire community from that disease.

For more information, see:

"What is Herd Immunity?" (PBS-NOVA; text)

"Herd Immunity" (College of Physicians of Philadelphia; text and interactive animation)

What exactly *is* an outbreak? It is not (or at least not necessarily) a lot of cases of a given disease. As defined by the World Health Organization, an outbreak is an "occurrence of cases of disease **in excess of what would normally be expected** in a defined community, geographical area or season" [emphasis added].

In recent years, in communities across the United States, there have been more cases of vaccine-preventable diseases than expected based on numbers of cases in previous years. For example, more than 900 cases of mumps were reported in the first nine months of 2014; 533 of the cases occurred in Ohio—more than were reported nationwide in all of 2013.[4] There have also been recent outbreaks of measles[5] and whooping cough, also known as pertussis.[6]

These outbreaks have occurred despite the fact that all three diseases are among those preventable by vaccination. Today, it is recommended that American children receive up to 28 shots, including those to prevent diseases such as chickenpox, rubella and pertussis, before their second birthday.[7] Some of these shots deliver a combination vaccine, targeting more than one disease, such as the so-called MMR shot, which protects against measles, mumps and rubella. A committee of the U.S. Centers for Disease Control and Prevention (CDC) regularly reviews and recommends a schedule of vaccinations for the country, and the Food and Drug Administration oversees vaccines' safety and effectiveness,[8] but it is the individual states that set vaccination requirements for admission to day care or school.[9]

While national compliance with the CDC schedule has remained steady, with levels for most recommended vaccinations at about 90 percent, certain communities show much lower rates.[10] Some parents in these locales may have chosen not to have their children vaccinated, while others may have had their children vaccinated, but be unsure of the facts or confused by conflicting opinions on the subject.[11] A 2011 analysis by the journal "Health Affairs" of parents' attitudes toward vaccination showed that one in four was worried that vaccines are not safe and one in three felt that too many vaccines are given in the first two years of life.[12, 13]

Many of these doubts can be traced back to a 1998 paper in the British medical journal "The Lancet."[14] The paper proposed a link between the MMR vaccine and autism, though that conclusion has since been thoroughly debunked.[15] The vast majority of experts now agree that autism begins during fetal development as a result of both genetic and environmental influences.[16] But seeds of doubt had been planted and remain today, thanks in good measure to the ease with which misinformation persists in the Internet age.[17]

The vast majority of experts now agree that autism begins during fetal development as a result of both genetic and environmental influences.

For more information, see:

"The Autism-Vaccine Myth" (PBS-NOVA; text, graph and timeline)

"Contrary to Popular Perception, Autism Rates Haven't Increased" (PBS-NOVA; text)

"MMR Vaccine and Autism" (American Academy of Pediatrics; text)

II. KEY FACTS

Note: The facts, statistics and links in this guide are from highly reputable sources, but they are current only as of late 2014.

Vaccination simply jump-starts the body's own immune system.
The body's immune system has the job of fighting off pathogens. One of the ways it does so is by generating antibodies—molecules that tag disease-causing agents for destruction—and then by creating so-called memory cells, which "remember" how to generate that particular antibody if the same pathogen ever invades again.[18] Surviving an infectious disease is one way an individual's immune system can learn to make antibodies and memory cells; that, however, comes with the risks of the disease itself. Another way to arm the immune system, without it coming into contact with an actual disease agent, is via vaccination. A dead, weakened or fragmentary pathogen is introduced into the body, usually by injection. The exposure is sufficient to trigger the development of antibodies and memory cells, but since there is no actual pathogen, the vaccine does not cause disease.[19] This basic premise was recognized in Asia more than a thousand years ago, long before Edward Jenner's "invention" of vaccination in the late 1700s.[20]

However, no vaccine is 100 percent effective, so in rare cases a fully vaccinated person can still be vulnerable. For example, the current formulation of the MMR vaccine is about 88 percent effective against mumps after two doses.[21] The effectiveness of some vaccines also diminishes over time, which is why an additional pertussis vaccine booster is now given during the preteen years.[22]

For more information, see:

"A History of Vaccination" (PBS-NOVA; video, 4:48, and transcript)

"Understanding How Vaccines Work" (CDC; text)

Vaccination is very safe.
There is an exceedingly small chance of having a severe adverse response to a vaccine, such as a life-threatening allergic reaction. The incidence of reported and substantiated events of this nature varies from vaccine to vaccine, but in most cases these events occur once per 100,000 doses to once per million doses.[23] It is the responsibility of the **Vaccine Adverse Event Reporting System (VAERS)**, a joint project of the CDC and the Food and Drug Administration (FDA), to collect and analyze reports of adverse events associated with vaccines licensed in the United States. Experts determine which events have a causal link to a vaccination (many events that at first appear to be linked to a vaccination turn out, on careful study, not to be) and disseminate safety information about vaccines to the public and to health care providers.[24]

Mild side effects, such as a slight fever or tenderness at the injection site, occur much more often[25]—but these are actually positive signs that the immune system is responding to the vaccine.

For more information, see:

"Frequently Asked Questions: Vaccine Safety" (American Academy of Pediatrics; text Q&A)

"Vaccine Safety Datalink" (CDC; text)

"Vaccine Safety Facts for Parents" (California Immunization Coalition; text Q&A)

Vaccination saves lives.
The decline in the incidence of most vaccine-preventable diseases, from the prevaccine era to today, ranges from 72 to 100 percent.[26] And as the incidence of such diseases has declined, so has the annual death toll attributable to them. The measles, for example, caused an average of about 450 deaths a year in the United States between 1956 and 1960. The measles vaccine was introduced in 1963; by 1998, only 100 cases and no deaths were reported nationwide.[27] In April 2014, the CDC estimated that vaccines administered to children born in the past 20 years will prevent more than 700,000 deaths.[28]

But the decline in the incidence of vaccine-preventable diseases doesn't mean that the threat they pose has gone away. The only human disease that has been eradicated worldwide is smallpox.[29] The pathogens that cause the other once-common communicable diseases still exist, and being unvaccinated dramatically increases one's risk of infection; an individual who is not vaccinated against measles, for example, has a 22-fold greater chance of contracting the disease.[30] And unfortunately, the consequences of these diseases remain serious. For example, a pregnant woman who contracts rubella in her first trimester has a likelihood as high as 51 percent of having a baby with profound disabilities or even of having a stillbirth.[31]

The benefits of vaccination are also illustrated by the HPV (human papillomavirus) vaccine. HPVs are a group of about 120 viruses, some of which cause cancer; they are the only known cause of cervical cancer, a leading killer of women worldwide, and also a major cause of oral cancers, which affect both men and women.[32] (Other strains of HPV, however, cause only common warts.[33]) The first of three HPV vaccines, both of which target the most common cancer-causing HPVs, was approved in 2006.[34] The vaccines are administered in a series of three shots over the course of six months.[35, 36] Because HPVs are often transmitted sexually, administration of the vaccine is recommended beginning at age 11 or 12, before sexual activity might begin. Since the vaccines were introduced, the prevalence of the HPV strains that they target has dropped by 56 percent among U.S. females aged 14 to 19.[37, 38]

For more information, see:

"Why Immunize?" (CDC; text)

"Vaccine Basics" (Vaccines.gov; text)

"Preventing HPV-Caused Cancers" (PBS-NOVA; text)

Diseases largely eradicated a generation ago are resurgent.
Some recent examples, in addition to the 2014 mumps outbreak noted above, include the following:

- More than 48,000 cases of whooping cough, also known as pertussis, were reported in 2012—more than in any year since 1955—and 20 people died of the disease.[39] The number of cases dropped to under 30,000 in 2013,[40] but that was still far more than the annual incidence several decades ago, when case counts were less than 10,000 annually.[41] And 2014 saw high numbers of cases again; in July 2014, the California Department of Public Health declared a pertussis epidemic.[42]
- More than 600 cases of measles were reported in 23 separate outbreaks in 2014; a majority of those diagnosed were unvaccinated.[43] This is the highest number of cases since 2000, when public health officials declared that measles had been eliminated in the United States.[44]

For more information, see:

"What Would Happen If We Stopped Vaccinations?" (CDC; text and graphic)

Vaccinations protect communities, not just individuals.
The greater the number of vaccinated individuals in a community, the greater the protection for people in that community, whether they are vaccinated or not. In a community that has reached a threshold level of vaccination (a percentage that varies, depending largely on how transmissible a given disease is and how effective the vaccine against it is), that disease is unable to gain a foothold and spread, even if an occasional case occurs. This phenomenon is known as "herd immunity." To reach the herd immunity threshold, vaccination rates may need to be as high as 95 percent, especially for highly infectious diseases like measles.[45]

There are some medically valid reasons for being unvaccinated, such as age or immunocompromised status.[46] Other reasons that people may not be fully vaccinated include cost, access, misinformation and personal choice.[47] The principle of herd immunity means that the more people there are who choose or fail to be fully vaccinated, the less likely it is that the shield of herd immunity can protect those medically unable to be vaccinated.

For more information, see:

"What Is Herd Immunity?" (PBS-NOVA; text and graphics)

"Community Immunity (Herd Immunity)" (Department of Health and Human Services; text and graphic)

"Herd Immunity" (College of Physicians of Philadelphia; text and interactive animation)

Despite the safety and effectiveness of vaccines, misinformation persists. Many parents have questions and concerns about vaccinations; they may worry about the pain of the needle stick or wonder why their child is getting so many shots in a single visit.[48] In addition, some parents' feelings and/or misperceptions about vaccines lead them to be deeply opposed to or reluctant to even consider vaccinations, despite their low risk and proven effectiveness at preventing serious infectious diseases.

These are some of the key factors in the continuing "controversy" regarding vaccination:

- As noted above, much of the doubt about the risk-benefit ratio of vaccination arose from a 1998 study in *The Lancet*, a British medical journal, that claimed an association between the MMR vaccine and the onset of autism. That claim has since been completely disproven; the paper was fully retracted by *The Lancet* in 2010, and its primary author was sanctioned by the British General Medical Council.[49, 50] But it was many years before the flawed and apparently even falsified nature of the 1998 paper was made clear by numerous rigorous studies, involving millions of children, none of which found any association between vaccines and autism.[51] In the meantime, however, the 1998 paper triggered alarm among parents. And even though its conclusion and its author have since been completely discredited, a small, vocal minority continues to believe in an MMR-autism link. The overwhelming scientific consensus, however, is that autism is linked to an interaction among genetic and environmental factors and is initiated before a child is born.[52]
- Some people believe that the presence in some vaccines of thimerosal, a preservative containing mercury, could lead to developmental neurologic diseases, including autism. Numerous studies have been conducted, but none have been able to demonstrate a link between early exposure to thimerosal and such problems.[53] Nevertheless, in 2001, out of an abundance of caution, while additional safety reviews were still being conducted, thimerosal was eliminated or reduced to trace amounts in all routine childhood vaccines licensed in the United States, except for some flu vaccines.[54]
- Some parents worry about the number of shots their infants and toddlers receive at once. As many as six injections may be administered during a single visit.[55] According to the American Academy of Pediatrics, "this does not increase the risk of side effects. In addition, the scientific data show

that receiving multiple vaccines has no harmful effect on a healthy child's immune system."[56] Furthermore, administering several vaccinations at the same time both gets children immunized more quickly during their earliest, vulnerable months and minimizes the number of office visits required.[57]

- Controversy of a different sort has affected the rate of vaccination against HPVs (human papillomaviruses); see **"Vaccination Saves Lives"** above for more about HPVs and the HPV vaccines. Because the HPV vaccines target sexually transmitted diseases, it is recommended that children receive them before their teenage years.[58] That has led some people to worry that receiving the vaccine might encourage sexual activity at a young age. Studies have shown these fears to be unfounded.[59] Nevertheless, such concerns have dampened the vaccination rate in the United States among the target population. As of 2013, only about a third of girls and 14% of boys aged 13 to 17 were fully vaccinated, despite the vaccines' demonstrated effectiveness.[60] Still, the limited uptake has had an impact; a 2013 study showed that the prevalence of infections caused by the HPVs targeted by the vaccines had dropped 56 percent among females since the introduction in 2006 of the first HPV vaccine.[61] The director of the CDC has pointed out that if the United States had an HPV vaccination rate of 80 percent, 50,000 girls alive today would be saved from developing cervical cancer during their lifetimes.[62]

For more information, see:

"The Autism-Vaccine Myth" (PBS-NOVA; text, graph and timeline)

"Concerns about Autism" (CDC; text)

"Immunization Safety Review: Vaccines and Autism" (Institute of Medicine; report)

"Frequently Asked Questions About Thimerosal" (CDC; text Q&A)

"Frequently Asked Questions about Multiple Vaccinations and the Immune System" (CDC; text Q&A)

"Top 20 Questions about Vaccination" (College of Physicians of Philadelphia; text Q&A)

There are great challenges involved in vaccine development.

Experts have estimated that developing and testing a single vaccine takes more than 10 years on average and costs hundreds of millions of dollars.[63, 64] And that's before commercial production and distribution have even begun.

Developing and testing a single vaccine takes more than 10 years on average and costs hundreds of millions of dollars.

Seasonal influenza illustrates one of the problems vaccine developers face. There *is* a flu vaccine, but seasonal flu—which causes or contributes to as many as 49,000 deaths a year in the United States—results from many variations of the influenza virus, different strains of which are prevalent from year to year.[65] This is why the flu shot must be administered every year.[66]

Other pathogens present an even more intractable challenge. For example, scientists have been trying to develop a vaccine against HIV, the virus that causes AIDS, for 30 years. They've made progress in understanding how the virus works, but in part because the virus changes so readily, a viable vaccine appears to still be many years away.[67]

In other cases—such as that of Ebola, much in the news during 2014—the interest of drug companies in researching a vaccine is affected by factors such as the incidence of the disease and the populations it affects (diseases most prevalent in poor countries don't present a strong commercial incentive for drug development).

For more information, see:

"Challenges in Designing HIV Vaccines" (National Institutes of Health; text)

"Why there's no Ebola treatment or vaccine yet, in one chart" (Public Library of Science; text and chart)

III. WHO, WHAT, WHERE

The federal government—specifically, the CDC—makes recommendations regarding an overall vaccination regimen for children and adults in the United States.[68] But it is left to the individual states to set specific vaccination requirements, primarily before children are allowed to attend school or day care.[69] (In recent years, states have begun to set some vaccination requirements for health care workers, too.[70]) All states permit exemptions from these requirements for medical reasons (such as allergies or compromised immune status), and most also allow exemptions based on religious principles and/or philosophical or personal beliefs.

As of 2014, exemptions from childhood vaccination requirements were allowed as follows[71]:

- Two states allowed exemptions only for medical reasons (West Virginia and Mississippi).
- Three states allowed exemptions for both medical reasons and philosophical/personal beliefs (California, Louisiana and Minnesota).
- Twenty-eight states and Washington, D.C., allowed exemptions for both medical reasons and religious principles.
- Seventeen states allowed all three kinds of exemptions—for medical reasons, religious principles and philosophical/personal beliefs.

In addition, the states differ in terms of how difficult or easy they make it for parents to obtain exemptions.[72] Here are some points regarding that variation:

- Some states require only an annual letter of appeal from a parent, while other states have multiple requirements, including a letter from a doctor.
- Researchers at Emory University reported in February 2014 in "JAMA: The Journal of the American Medical Association" on recent trends in state legislatures regarding efforts to tighten or loosen exemption requirements. They found that between 2009 and 2012, 36 bills were introduced in 18 states. None of the 31 bills that would have relaxed requirements were enacted.[73]
- During that same time, three states—Vermont, California and Washington state—tightened requirements. For example, parents in California who file for personal-belief exemptions must now provide a statement from their child's doctor certifying that he or she "provided the parent … with information regarding the benefits and risks of the immunization and the health risks of specified communicable diseases."[74]
- Tougher exemption standards do seem to have a positive impact on vaccination rates. After Washington state passed a law in 2011 requiring a clinician's signature on exemption forms, for example, the rate of vaccination exemptions for nonmedical reasons dropped 25 percent.[75]

For more information, see:

"Exemptions Permitted for State Immunization Requirements" (Immunization Action Coalition; chart)

"Legislative Challenges to School Immunization Mandates, 2009-2012" (Journal of the American Medical Association; text and tables)

"What Drives Vaccination Rates?" (PBS-NOVA; text and maps)

What is the national rate of vaccination compliance?

According to the CDC, in 2013, 90 percent or more of American children received the recommended MMR (measles, mumps and rubella), varicella (chickenpox), polio and hepatitis B vaccinations on time.[76] The rates for most other recommended childhood vaccinations were close to 90 percent. Less than 1 percent of children were not vaccinated at all.

Compliance with the recommended vaccinations for adults is generally lower; for example, in 2012 only about 60 percent of adults were up-to-date on their tetanus vaccine.[77] And, for influenza, less than half of all adults receive the flu vaccine each year.[78]

For more information, see:

"Fast Stats: Immunization" (CDC; charts)

Are vaccination figures available on a state-by-state basis?

The CDC tracks statewide vaccination rates for all recommended vaccines; it also monitors vaccination rates in some large metropolitan areas.[79] State health departments routinely post statistics and analyses regarding vaccination rates, trends and patterns within their borders. Rates are typically broken down by county, or sometimes by even smaller units, such as city, ZIP code or school. Here are examples of the kind of information available from a few states:

California

Ohio

Washington state

Is there a central collection point for data about outbreaks within the United States?

The CDC assembles a regular report on nationwide patterns of illness and death called the "Morbidity and Mortality Weekly Report" and also maintains historical data on disease outbreaks. The CDC's statistics are updated frequently and are considered extremely reliable.

For more information, see:

"Morbidity and Mortality Weekly Report" (CDC; text)

"National Notifiable Diseases Surveillance System" (CDC; text)

What about outbreak data on a state-by-state or local basis?
Most state health departments also collect and post information about infectious disease outbreaks within their borders. In addition, some large cities, such as New York City, collect and report information on outbreaks. Here are examples of the kind of information available from a few states:

Michigan Disease Surveillance System

Texas Infectious Disease Control Reporting

Virginia Reportable Disease Surveillance Data

Who is responsible for tracking the origins and causes of an outbreak?
Epidemiologists at the CDC collaborate with local and state public health officials in the effort to identify and control suspected outbreaks of communicable diseases.[80] They determine their cause and their source, trace individuals who may have been infected, and try to halt the spread of the pertinent pathogen. In other words, epidemiologists function like "disease detectives." In addition, epidemiologists also try to determine how future outbreaks can be avoided.

One of an epidemiologist's first tasks during an outbreak is to identify the "index case," or the first person known to have been infected. This person, once identified, is also known as "patient zero." Perhaps history's most famous index case is Mary Mallon, popularly known as "Typhoid Mary." Mallon was a cook in New York City in the early 1900s. Though healthy herself, she was a carrier of the pathogen that causes typhoid fever, and she infected dozens of people with the disease by contaminating food she handled.[81]

Another key step is known as "contact tracing," or identifying anyone who has come into contact with infected individuals, in an effort to keep the pathogen from spreading further.[82] Contact tracing is especially important for diseases with a long incubation period. This allows epidemiologists to identify individuals who had contact with an infected person, so that they can monitor themselves for symptoms and immediately report to health care officials if they become symptomatic, thereby preventing those individuals from infecting still others.

Health care providers are critical partners in these steps. They are required to alert local—and sometimes federal—public health officials whenever they diagnose a patient with certain communicable diseases.[83] This information then allows authorities to chart the path of the disease and understand where interventions are needed to stop its spread.

Yet another important avenue of investigation takes place in the lab.[84] There, scientists search for the unique molecular characteristics of the pathogen in question so that they can identify the strain causing a given outbreak. Identifying the particular strain (or, sometimes, strains) involved in an outbreak can help scientists track where the disease began and trace its chain of infection.

Depending on many factors—such as the incubation period of the pathogen in question, the method by which it is transmitted (such as air, water, body fluids, etc.), and the population most at risk—public health officials may recommend, or sometimes require, an array of actions. Such measures may range from more frequent handwashing or the use of protective masks to keeping unvaccinated children out of school or even quarantining infected individuals.[85]

For more information, see:

"What is Contact Tracing?" (CDC; infographic)

"Tracking Disease Outbreaks" (PBS-NOVA; text and graphics)

"CDC Detectives Respond to Disease Outbreaks" (CDC; text)

"Two Countries, One Deadly Disease" (PBS-NOVA; text)

What are elected officials doing to improve vaccination rates?

To protect the public's health, several states have recently passed laws aimed at increasing vaccination rates, including the establishment of more stringent requirements to receive a personal-belief exemption, for example.[86] Given the number of states that have experienced recent outbreaks of measles, mumps and whooping cough—and, on the other hand, the demonstrated positive impact of tightening exemption requirements[87]—there is likely to be a rise in the number of legislatures that decide to revisit and revise their laws and regulations regarding vaccinations.

Several states have recently passed laws aimed at increasing vaccination rates.

For more information, see:

"Legislators Act on Outbreaks" (NOVA-PBS; video, 4:36, and transcript)

IV. LAND MINES

Covering communicable disease outbreaks can be daunting, even for veteran science reporters. Health officials may be guarded about sharing information regarding an evolving situation, scientific studies relevant to an outbreak may be challenging to decipher, and the best experts may be difficult to identify under deadline pressure. The advice below about ways to approach these stories—without stumbling on some common landmines—comes from these seasoned experts:

Robert Bazell: adjunct professor of molecular, cellular and developmental biology, Yale University; former chief science and health correspondent, NBC News

Ira Flatow: science reporter; executive producer, host, Public Radio International's Science Friday

Laurie Garrett: senior fellow for global health, Council on Foreign Relations; author, lecturer and journalist

Amy Maxmen: science journalist, editor and photographer

Joe Neel: deputy senior supervising editor and correspondent, NPR's Science Desk

Brendan Nyhan: assistant professor of government, Dartmouth College; researcher, commentator and blogger on the media, politics and health care

Renata Simone: director, producer and writer, PBS Frontline's "Endgame: AIDS in Black America"

Their advice

Define your story

- Don't limit your coverage to the number of cases reported and the voices of concerned parents. Include a discussion of the basic questions: Why did this happen? How did it start? Why does it persist? (Garrett)
- Keep the big picture in mind and don't get sidetracked by controversy. Ask about the potential damage from this outbreak for the community where it's occurring. (Maxmen)
- Remember that infectious diseases and their prevention don't happen in a vacuum. They take place in the context of family, community and society. You can best help your viewers or readers understand what is happening, as well as what impact their own choices may have, by uncovering contributing factors and issues. From the personal experiences of patients and parents, to the development of public health policies and laws, to the knowns and unknowns in the scientific data, each dimension is important on its own and exerts influence on the other dimensions as well. (Simone)

Source your story

- If you are struggling to understand the science behind an outbreak, go to the nearest "school of public health and ask the PR department if there is anybody who can explain it." (Garrett)
- "Pediatricians are a terrific source of information. Ask [colleagues] for recommendations and start cold calling." (Garrett)
- Be prepared by knowing which doctors in your community can knowledgably discuss outbreaks and explain the complicated science. (Neel)
- When an outbreak occurs, "work within the framework that your audience is comfortable trusting." In other words, interview local health officials and local communicable disease experts. (Nyhan)
- "Avoid being judgmental" about people who are reluctant to vaccinate their children, but "set the facts out by relying on experts in the community," such as pediatricians. Be aware that once an outbreak occurs, "people will be scared and will pay attention to what officials say." (Bazell)
- Find the "right people in local universities and large hospitals to get clarification" on details of the outbreak, including the disease itself. (Flatow)
- "There are spectacular databases online" that, once mined, will give your reporting more context. Organizations that post reliable, informative databases include the **CDC**, the **American Academy of Pediatrics** and an international collaborative known as **Gavi: The Vaccine Alliance**. (Garrett)
- At the first sign of an outbreak, check for current information on the **CDC website**, "because they post quickly," and then check in with local health officials. (Maxmen)
- For information during an outbreak, "state health departments are closest to the ground, and the CDC is a trusted source of information as well. Don't rely on other news reports" in lieu of seeking out experts yourself. (Neel)
- If a local public health official will speak to you only off the record, agree to the ground rule because the interview "will give you all the leads you need." (Garrett)
- Rely on primary sources. So if you want to use information from a scientific paper, read the paper itself, not a "blog item about the paper or some other secondary source." If you have questions about a primary source, you can contact its author. (Maxmen)
- Be wary of using social media as a source of information. Such reports "have a way of mushrooming, so you may want to acknowledge" their existence, but tell your audience you are working on getting official confirmation. (Neel)

- Find a local, older doctor, who remembers when outbreaks were routine, to learn about what takes place in a community during a public health crisis. (Flatow)

Avoid false debates

- If a controversy over vaccine usage erupts as part of an outbreak, "don't go for the false equivalence" by interviewing dueling experts. "Sometimes there really is only one side of the story." (Flatow)
- "It's important for reporters not to present a 50-50 story, or a 'he says, she says'" story regarding vaccine safety, when the science is so weighted toward vaccines being safe, except in rare instances. (Neel)
- Avoid the land mine of "falsely balancing the debate" about vaccine safety, since the overwhelming body of evidence shows that vaccines are generally safe, except in rare instances. (Nyhan)

Consider legal issues

- Be knowledgeable about HIPAA, the Health Insurance Portability and Accountability Act of 1996. Some health care organizations will "use the regulations as a wall" so as not to answer certain questions. Understand what can and cannot be discussed. (Neel)
- Before interviewing, photographing or videotaping a minor, "ask moms and dads" for permission. (Bazell)

For more information, see:

"Understanding HIPAA: A Brief Overview" (Association of Health Care Journalists; text Q&A)

"HIPAA Boot Camp" (Association of Health Care Journalists; PowerPoint slides)

"Vaccines at the Crossroads: Outbreaks on the Rise Across America" (National Press Club Journalism Institute Forum; video, 1:27:53)

V. GLOSSARY

Acellular vaccine: A vaccine that does not contain complete cells, only fragments of cells.

Active immunity: Protection against a disease that occurs when the body produces antibodies after receiving a vaccine or being infected with a pathogen. Typically, once this process occurs, a person is permanently protected through the creation of memory cells. (See also *Passive immunity*.)

Adjuvant: A substance in a vaccine that increases the immune response to the antigen in that vaccine. An adjuvant is not something the body mounts an immune response to or "remembers" later when a pathogen enters the body.

Adverse event (or Adverse reaction): A negative occurrence caused by administration of a vaccine (or a drug). Suspected adverse events are investigated to determine whether or not the vaccine played a causative role; in many instances, the event turns out not to be causally linked to the vaccine and therefore not a true adverse reaction.

Anaphylaxis: A serious, life-threatening allergic reaction.

Antibody: A protein produced by the immune system in response to a foreign substance, such as a disease-causing pathogen or a dead, weakened or fragmentary pathogen in a vaccine. Antibodies bind to these substances and tag them for destruction, thus protecting the individual from the disease.

Antigen: A substance that is recognized by the immune system and induces an immune response, including the development of antibodies that bind specifically to that substance.

Attenuated (or Live) vaccine: A vaccine that contains a weakened but live virus that will trigger an immune response without causing the disease itself. Such vaccines currently in use in the United States include those for measles, mumps, rubella and chickenpox.

Autism: A developmental condition, typically diagnosed in toddlers, with a broad spectrum of symptoms, such as problems with social interactions, communication difficulties and repetitive behaviors. (There is *no* scientific evidence linking vaccines to autism. The overwhelming consensus is that autism is linked to genetic heritage and begins before a child is born.[88])

Booster (shot): An additional dose of a vaccine given to increase the immune response. Depending on the vaccine, booster shots may or may not be needed.

Breakthrough infection: An infection that develops after a person has received a vaccine to protect against it; this occurs only in very rare instances.

Chain of infection: A series of links that transfer a pathogen between an infected host and a new, susceptible host; any interruption in these links can break the transmission of a disease-causing agent to new hosts.

Combination vaccine: A vaccine that targets more than one disease. For example, the MMR vaccine protects against measles, mumps and rubella.

Communicable (or Contagious) disease: An illness or condition that is caused by organisms such as bacteria or viruses and that can spread from one person to another, directly or indirectly. (See also *Infectious disease*.)

Confirmed case: An instance of a disease that has been substantiated through laboratory tests.

Conjugate vaccine: A vaccine in which the antigen is attached to another molecule to increase the body's immune recognition of and response to that antigen.

Contraindication: A condition that renders the administration of a particular vaccine inadvisable (or other medical treatment). For example, pregnancy is a contraindication for the varicella vaccine, meaning that pregnant women should not receive that vaccine.

Elimination: A reduction to zero in the incidence of a disease within a given region; continued measures are needed to keep the disease from becoming re-established. (See also *Eradication*.)

Endemic: Regular occurrence of a disease in a particular population or region. (See also *Epidemic*, *Outbreak*, and *Pandemic*.)

Epidemic: Widespread occurrence of a disease within a community or geographic area, in excess of what is considered normal. The dividing line between an epidemic and an outbreak can be a fine one, but an epidemic generally affects a larger number of people and includes a recent and substantial increase in the number of cases. (See also *Endemic*, *Outbreak*, and *Pandemic*.)

Epidemiology: The field of medical science that examines the causes, incidences, and control of diseases and other health conditions.

Eradication: A permanent reduction to zero in the incidence of a disease within a given region; no further measures are required to keep the disease from becoming re-established. A few diseases have been eradicated in certain countries or have come close to being eradicated globally, but the only human disease that has been eradicated worldwide is smallpox. (See also *Elimination*.)

Etiology: The cause or causes of a particular disease.

Febrile seizure: A seizure caused by a fever. Most seizures caused by vaccination are febrile seizures, which are typically singular events with no lasting harm.

Herd (or Community) immunity: A level of immunity to a given disease in a defined community that is sufficient to protect even unvaccinated and undervaccinated individuals within that community. It is achieved when a certain percentage of the community's population (a threshold that varies, depending on the disease and the vaccine) has attained immunity, so that the disease agent is unable to maintain a chain of infection.

Immune system: The components of the body that identify foreign substances and mount a defense against them.

Immunity: The state of being resistant to a pathogen. Once someone has been vaccinated against (or has survived) a disease and thus has developed antibodies and memory cells to fight it off, the person is typically immune to that disease, meaning that they cannot be infected by the same type of pathogen again. (See also *Active immunity* and *Passive immunity*.)

Immunization: The biological process by which a person achieves resistance to a disease. (The term is often used interchangeably with vaccination, but the words don't have exactly the same meaning: vaccination, or administration of a vaccine, results in immunization, or the reaction to the vaccine by the body's immune system.)

Immunocompromised: Having a weak or nonfunctional immune system. Being in an immunocompromised state is a contraindication for many vaccines.

Inactivated (or Killed) vaccine: A vaccine composed of pathogens that have been killed, usually by heat or chemicals. Because the pathogen is dead, properly made inactivated vaccines cannot cause disease.

Incidence: The frequency with which a disease occurs in a given population.

Index case: The first known case in an outbreak.

Infectious disease: A disease caused by an organism that invades the body; an infectious disease may or may not be communicable from one person to another. (See also *Communicable* or *Contagious Disease*.)

Killed vaccine: See *Inactivated vaccine*.

Live vaccine: See *Attenuated vaccine*.

Memory cells: Cells of the immune system that "remember" prior exposure to viruses or bacteria and respond quickly when these organisms again threaten the body. Their creation can be triggered by vaccination or by infection with a pathogen.

Morbidity: An incidence of a potentially life-threatening disease.

Mortality: An incidence of a disease that results in death.

Outbreak: Occurrence of a disease in a community or geographic area in excess of what is considered normal. Even a single case of a communicable disease may be considered an outbreak. (See also *Endemic*, *Epidemic*, and *Pandemic*.)

Pandemic: Occurrence of a disease across national borders in a wide geographic area, affecting an exceptionally high proportion of the population. (See also *Endemic*, *Epidemic*, and *Outbreak*.)

Passive immunity: Immunity to a disease conferred by administration of premade antibodies. Because no memory cells are created, passive immunity does not result in permanent immunity to a disease.

Pathogen: A biological agent, such as a virus or bacterium, which can cause disease.

Seroconversion: The development of antibodies (and their corresponding memory cells) to an antigen. Because it takes time for the immune system to recognize and respond to a particular pathogen or vaccine, seroconversion can occur days to weeks after an initial infection (or vaccination).

Serotype (or Strain): A particular variation of a pathogen, characterized by its ability to be recognized by distinct antibodies. Because different serotypes of a pathogen are each recognized by different antibodies, the immune system must respond to each one discretely and cannot rely on immunologic memory. Different serotypes are the reason that a person can get a cold or the flu more than once; infection with each serotype does not confer immunity to other serotypes.

Thimerosal: A mercury-based preservative used in vaccines in the United States beginning in the 1930s. Because of concern about possible adverse reactions to the mercury in thimerosal, even though studies have found it harmless, most vaccines produced in the United States since 2001 have contained only trace amounts of thimerosal or none at all.

Vaccine: A substance that contains a weakened, dead or fragmentary disease-causing microbe that, when introduced into the body, produces immunity and thus protection from the disease that the microbe causes.

Vaccination: The administration of a vaccine, usually by injection, although oral and mist vaccines are also available for some diseases. (The term is often used interchangeably with immunization, but the words don't have exactly the same meaning: vaccination, or administration of a vaccine, results in immunization, or the reaction to the vaccine by the body's immune system.)

Variolation: An immunization technique whereby a patient is exposed to a crude extract of a weakened pathogen from another patient.

Waning immunity: A decrease in immunological memory over time. For vaccines where waning immunity is an issue, booster shots are often recommended.

Sources: Centers for Disease Control and Prevention, Kaiser Family Foundation, National Network for Immunization Information, World Health Organization

For additional glossaries, see:

Centers for Disease Control and Prevention

U.S. Department of Health and Human Services

College of Physicians of Philadelphia

VI. RESOURCES

General Background Information

The PBS-NOVA documentary on vaccines, "Vaccines–Calling the Shots," offers a thorough but accessible overview of the subject:

"Vaccines–Calling the Shots" (PBS-NOVA; video, 53:10)

"The History of Vaccines–Timelines" (The College of Physicians of Philadelphia)

"State of the World's Vaccines and Immunization" (World Health Organization; reference text)

Myths and Misperceptions

General

"What Are Some of the Myths—and Facts—About Vaccination?" (World Health Organization; online)

"Misconceptions about Vaccines" (The College of Physicians of Philadelphia; text)

Autism

"The Autism-Vaccine Myth" (PBS-NOVA; text, timeline and graphics)

"Contrary to Popular Perception, Autism Rates Haven't Increased" (PBS-NOVA; text)

"Autism and Vaccines" (Autism Science Foundation; text and reference list)

Information About Diseases

General

"Epidemiology and Prevention of Vaccine-Preventable Diseases" (CDC; reference text)

Measles

"Two Countries, One Deadly Disease" (PBS-NOVA; text)

Pertussis (Whooping Cough)

"Why is Whooping Cough Back?" (PBS-NOVA; text and chart)

Polio

"Polio Vaccines: Then and Now" (PBS-NOVA; video, 13:47)

Human Papillomavirus (HPV)

"HPV Vaccination" (CDC; text)

"Preventing HPV-Caused Cancers" (PBS-NOVA; text and graphics)

"Fighting HPV in Bhutan" (PBS-NOVA; video, 6:19)

Information About Vaccine Policy

"State Information" (Immunization Action Coalition; list of resources)

"What Drives Vaccination Rates?" (PBS-NOVA; text and graphs)

"Legislators Act on Outbreaks" (PBS-NOVA; video, 4:36)

"Vaccinating Children: Public Trust and Health" (Harvard School of Public Health; video, 55:29)

"Vaccines at the Crossroads: Outbreaks on the Rise Across America" (National Press Club; video, 1:27:53)

Visual Resources

The website for the PBS-NOVA documentary includes a number of short video and graphics resources on the subject:

"Immunity and Vaccines Explained" (PBS-NOVA; video, 2:11)

"A History of Vaccination" (PBS-NOVA; video, 4:48)

"Tracking Disease Outbreaks" (PBS-NOVA; text and graphics)

"Brushes with Death" (PBS-NOVA; video, 2:27)

"What is Herd Immunity?" (PBS-NOVA; text and graphics)

"Vaccine-Preventable Outbreaks" (Council on Foreign Relations; interactive map)

"FluView" (CDC; interactive map)

"Surveillance Atlas of Infectious Diseases" (European Centre for Disease Prevention and Control; interactive maps and graphs)

Infographic: "Refusing Vaccines Can Lead to Outbreaks" (Tangled Bank Studios; image)

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