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Measles Cases Rebounding in Affluent Society

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A case of measles was once a rite of passage for every child, and a route to the grave for about one in every 300.

Worldwide, there are still 30 million to 40 million cases a year, and 745,000 deaths, mostly in Africa. In the affluent world, however, measles has been as good as gone for a generation. But it is coming back in an unlikely place.

In England, the number and size of measles outbreaks is steadily climbing. In 1996, the country recorded 112 cases. Last year, there were 308. This follows a steady drop in the proportion of children fully immunized against the virus by their second birthday. In 1996, it was 92 percent. By last year, it had fallen to 84 percent.

This trend is the product of fears that a measles vaccine, especially in its current formulation as one-third of the measles-mumps-rubella (MMR) shot, increases a toddler's risk of developing autism, a devastating neurological disease. In the late 1990s, a physician named Andrew Wakefield, then at London's Royal Free Hospital, published research suggesting a connection. Although the great majority of experts believe the link he drew is spurious, the number of parents refusing to vaccinate their children appears to be growing.

The faltering public confidence in the measles vaccination has British public health officials very worried, because the population of England and Wales is approaching a tipping point. It is about to lose "herd immunity" against one of childhood's most dangerous infections.

If vaccine coverage continues to fall, sometime soon the unvaccinated children will no longer be able to "hide" in the larger crowd of vaccinated ones. Instead, there will be enough of them to become exactly what the measles virus is looking for, metaphorically speaking. They will be a group of susceptible hosts (with new ones being born all the time) large enough for the bug to set up a self-sustaining chain of person-to-person transmission. The "herd immunity" now protecting tens of thousands of children will disappear.

The term was coined in 1923, and its definition has evolved. Today, "herd immunity" typically refers to a situation in which so much of a population is immune to a given disease that the few scattered "susceptibles" are as good as immune to it. That is because an invading microbe is unable to gain a toehold. In the rare case when it encounters one of the few susceptibles, that person is so surrounded by protected brethren that there is no one nearby to become infected. The chain of transmission breaks, and the infection disappears.

If England loses herd immunity to measles, it will not be without precedent.

Fear of rare but severe reactions to the pertussis (whooping cough) vaccine in the 1970s led to a drop in vaccination and loss of herd immunity to the disease in both the United Kingdom and Japan. The introduction of a far safer vaccine later boosted coverage rates to more than 90 percent. Similarly, several parts of the

former Soviet Union lost herd immunity to diphtheria after that country and its public health system collapsed.

Just last week, the U.S. Centers for Disease Control and Prevention (CDC) reported that measles had broken out in the Republic of the Marshall Islands for the first time since 1988. There have been 647 cases and three people have died, including two adults, in a population of 25,000 people. Before health authorities launched a crash immunization campaign, less than 75 percent of children younger than 13 had gotten a single dose of MMR vaccine.

The islanders had lost their herd immunity.

The idea that a population's immune status could affect an individual's risk was recognized as early as the 1840s by astute observers of the effects of smallpox vaccination, according to a review of herd immunity published in 1993 by Paul E.M. Fine, an epidemiologist at the London School of Hygiene and Tropical Medicine.

That, in turn, helped lead to a crucial insight -- namely that epidemics stop not because a pathogen ceases to be dangerous, as many had thought, but because of a complicated interplay among a microbe's biology, the number of susceptible members of a population, and how much contact they have with each other.

The fraction of a population that must be vaccinated for herd immunity to kick in is something public health authorities like to know, for obvious reasons. The "herd immunity threshold" differs from disease to disease. It can be observed, but it can also be calculated.

Intuition suggests that the more contagious a disease, the greater is the percentage of the population that must be immune to achieve herd immunity. This turns out to be the case.

The reason is that herd immunity threshold is mathematically related to another key concept in epidemiology called the "basic reproductive number." Expressed as R_0, this is the average number of people each newly infected person will infect in a population when everyone is susceptible. In practical terms, this means the average number of new cases produced by each victim in the first few rounds of infection, because in later rounds there will be significant numbers of people who have natural immunity and are no longer susceptible.

An infection's basic reproductive number is not hard and fast. It depends not only on a microbe's innate biology, but also on conditions that can change. Social factors, such as how many people sleep in a room and whether children attend school, and seasonal and geographical conditions also affect an infection's R_0. Nevertheless, the number for each disease tends to fall into a consistent range.

Once a population has a large number of people who are immune, the key question becomes: If the microbe finds a susceptible person in this mixed population, how many additional people is that victim likely to infect?

That number is called the "effective reproductive number." When it is less than 1, an outbreak will disappear spontaneously because the victims in each round of infection will not "replace" themselves with new victims. However, if the number is more than 1, the outbreak will sustain itself or grow.

In a paper published last month in the journal Science, Vincent A. A. Jansen of Royal Holloway, University of London, reported that in England's recent measles outbreaks, the "effective reproductive number" has been rising -- a very ominous sign.

In the outbreaks from 1995 to 1998, the number was 0.47. For those from 1999 to 2002, it was 0.82.

If it reaches 1, measles will be able to find enough new victims to keep the infection moving through the population -- at least until something is done to raise the percentage of people who are immune. Herd immunity will be gone.