

## Why Vaccines Might Not Be Able to Eliminate Covid-19

Jason Gale, *Bloomberg*, January 28, 2021

The road to eliminating Covid-19 is long and paved with uncertainty. Many countries are counting on vaccines to build sufficient immunity in their populations so that SARS-CoV-2 isn't able to find susceptible people to infect, causing transmission of the coronavirus to slow and eventually stop. But even with the rollout of highly effective vaccines, immunization coverage may not reach that level -- the so-called herd immunity threshold

-- a nytime soon. For one thing, it's not known what level of immunity is required and whether vaccines will be potent enough to achieve it. There's also the threat of emerging coronavirus variants that may weaken the effectiveness of immunizations.

Can Covid-19 be eradicated?

No. So far, only one human disease -- smallpox -- has been officially eradicated; that is, reduced to zero cases and kept there long-term without continuous intervention measures. Smallpox was stamped out thanks to a highly effective vaccine and the fact that humans are the only mammals that are naturally susceptible to infection with the variola

virus that causes the disfiguring, sometimes deadly disease. Humans are the only known reservoir of poliovirus, yet it still spreads in a few countries, causing paralyzing disease, despite the widespread use of effective immunizations and a 32-year-old global

eradication effort. SARS-CoV-2 is thought to persist in nature in horseshoe bats, and has been known to infect minks, cats, gorillas and other animals. Wiping out the virus would require banishing it from every susceptible species, which isn't feasible. In countries that have successfully suppressed Covid-19 cases, disease elimination has been proposed instead.

What's elimination?

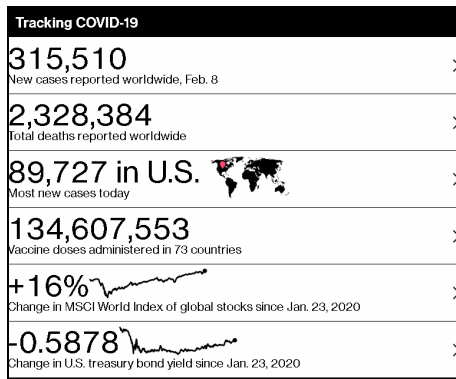
It's when efforts to suppress an outbreak have resulted in zero new cases of a disease or infection in a defined area over a sustained period. There's no official definition of how long that should be. One proposal is to make it 28 days, corresponding to twice as long as the outer range of SARS-CoV-2's incubation period -- the time between infection and the appearance of symptoms. Some countries, such as New Zealand, have achieved zero new cases for lengthy periods using border closures, lockdowns and diligent case detection and

isolation. During a pandemic, which is an outbreak of a new infection across continents,

sustaining elimination of any infectious disease nationwide is challenging, if not impossible, because of the threat of the virus re-entering the country from infected international travelers.

Will vaccines eliminate Covid-19?

It's hard to say. It's not known what proportion of the population needs to have immunity to stop the coronavirus from circulating, or whether even the most potent vaccines will be able to prevent it from spreading. One study estimated that to stop transmission, 55% to 82% of the population would need to have immunity, which can be achieved either by recovering from an infection or through vaccination. However, herd immunity wasn't achieved in Manaus, the capital of Amazonas state in Brazil, even after an estimated 76% of the population had been infected. Still, there's reason to believe mass inoculations will have a more powerful effect because vaccines appear to elicit stronger and more durable protection than a prior infection.



### How effective will vaccines be?

There's good evidence that vaccines will be effective at preventing recipients from developing Covid-19, with clinical trials of the Pfizer Inc.-BioNTech SE and Moderna Inc. shots demonstrating as much as 95% efficacy. However, there's insufficient data available to gauge the ability of vaccines to prevent people from developing asymptomatic infections or transmitting the virus to others. The quantity of infectious virus people "shed," or emit in respiratory particles, is an indicator of their propensity to spread it. In Israel, the country with the highest proportion of citizens vaccinated, researchers found vaccinated individuals who tested positive for SARS-CoV-2 had a lower viral load, probably making them less infectious and less likely to experience severe illness.

### Is that encouraging?

Yes, because the gold standard in vaccinology is to stop infection as well as disease -- providing so-called sterilizing immunity. But it's not always achieved. The measles vaccine, for instance, prevents infection so that vaccinated people don't spread the virus, whereas the vaccine for whooping cough does a good job protecting against serious disease but is less effective at stopping new infections. Encouragingly, a study of Moderna's Covid vaccine in monkeys suggested that it will reduce, if not completely prevent, onward transmission of the virus. Clinical trials using AstraZeneca Plc's vaccine indicate it may be less than 60% effective at stopping infections -- making it unlikely to achieve herd immunity even if everyone in a population received two doses.



Am often asked about different vaccines and their efficacy. Here's one set of data to track. In a simple table [pic.twitter.com/9m2OBgqcla](https://pic.twitter.com/9m2OBgqcla)

Vaccine trial	Approximate # of people who received the vaccine	Of people vaccinated in the trial		
		# hospitalized for COVID	# who died from COVID	# who died from the vaccine
Moderna	15,000	0	0	0
Pfizer	18,600	0	0	0
Novavax*	13,000	0	0	0
Astra-Zeneca	5,800	0	0	0
J&J*	22,000	0	0	0

## How do variants of the virus factor in?

The more SARS-CoV-2 circulates, the more opportunity the virus has to mutate in ways that enhance its ability to spread and stick around longer and to evade immunity from natural infection and vaccination. That makes stopping transmission even more challenging. In recent months, variants first reported in the U.K., South Africa and Brazil -- where Covid-19 epidemics have been particularly severe -- have proliferated and spread internationally, causing growing concern. Studies suggest they are more contagious, and there is emerging evidence that some newly developed vaccines may be less protective against these strains. Scientists say the shots should still work at stopping severe disease, but some may be less effective at protecting against mild infections caused by at least one variant. Researchers have warned that inoculations may need to be updated periodically to maintain their efficacy, and several vaccine makers have begun working on new versions.

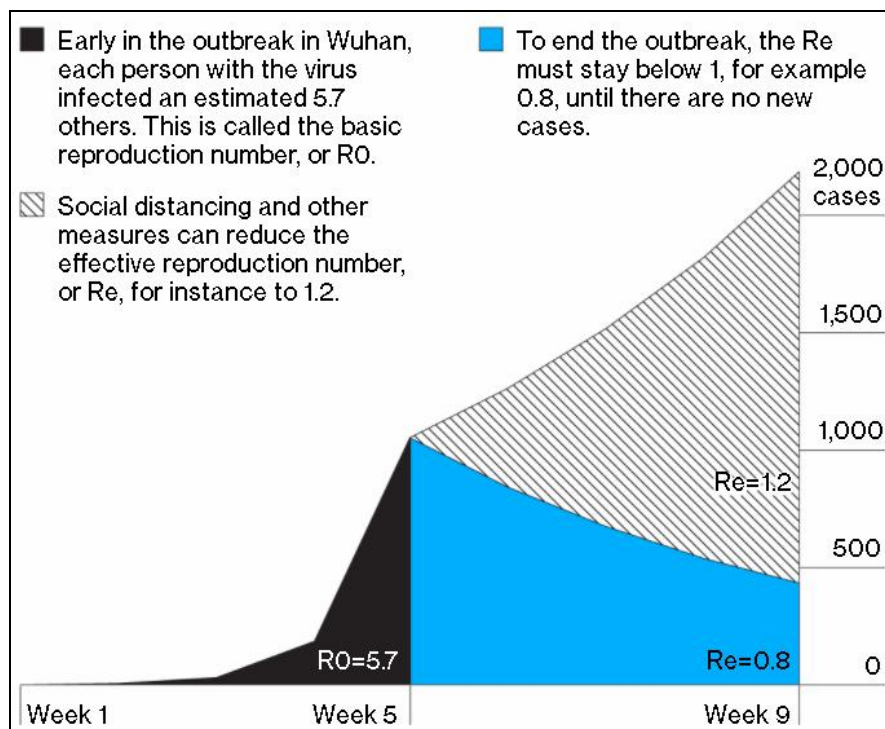
## Do Covid-19 vaccines have to prevent infection to curb cases?

No. Vaccines don't have to be perfect to have a public health benefit. New Zealand vaccinologist Helen Petousis-Harris points to rotavirus and chickenpox as examples of diseases that have been "virtually eliminated using vaccines that are very good at preventing severe disease, quite good at preventing any disease, but that do not completely prevent infection in everyone." Since SARS-CoV-2 spreads through respiratory particles from an infected person's throat and nose, a vaccine that reduces the amount of virus in the respiratory tract or how often an infected person coughs may decrease the likelihood of it being transmitted to others and lower the effective reproduction number ( $Re$ ), which is the average number of new infections estimated to stem from a single case.

Mike Ryan, head of the World Health Organization's emergencies program, told reporters Jan. 25 that rather than focusing on eliminating SARS-CoV-2, success should be seen as "reducing the capacity of this virus to kill, to put people in hospital, to destroy our economic and social lives."

## Explosion to Elimination

A model of how it can work



Source: Los Alamos National Laboratory (Wuhan  $R_0$  and serial interval)

Note: Based on a serial interval of roughly a week

## What if Covid-19 isn't eliminated?

David Heymann, chair of the WHO's Strategic and Technical Advisory Group for Infectious Hazards, warned at the end of 2020, "it appears the destiny of SARS-CoV-2 is to become endemic." Viruses that are endemic continuously circulate in the community, often causing periodic spikes when disease characteristics and human behavioral patterns favor transmission. Examples include norovirus, the notorious cause of gastroenteritis on cruise ships, and the myriad of viruses, including four coronaviruses, that cause the common cold, especially over the winter.

## What might the implications be?

People who have survived Covid-19 and those vaccinated against it will probably be protected against the disease for some time. Scientists at the Fred Hutchinson Cancer Research Center in Seattle found blood sera collected from patients who had recovered from a SARS-CoV-2 infection early in the pandemic displayed "generally weak" neutralizing ability against the virus 4-8 months later. But a single immunization with a so-called mRNA vaccine from either Moderna or Pfizer-BioNTech boosted immunological memory, with the concentration of neutralizing antibodies increasing about a thousand fold. Importantly, they found those antibodies appeared potent against the South African variant. It's likely that re-exposure to the virus via a natural infection will also bolster protection. As more and more people develop immunity, the virus will find those who are not yet immune, so long as herd immunity isn't established to protect them. That will mean that people who can't get vaccinated -- because their immune systems are compromised, or they have allergies to vaccine ingredients, or are too young (none of the vaccines authorized in Western countries have been approved for children) -- will remain vulnerable. Some scientists have predicted that, once the endemic phase is reached and primary exposure to the virus is in childhood, SARS-CoV-2 may be no more virulent than the common cold.

## The Reference Shelf

The University of Edinburgh's Devi Sridhar and Deepti Gurdasani detail the difficult lessons learned from a largely uncontrolled Covid-19 epidemic in Manaus, Brazil.

The University of New South Wales' Anita Heywood and Raina MacIntyre explain disease eradication, elimination, and suppression, and what elimination of Covid-19 would look like. MacIntyre also presents principles of vaccine programs for Covid-19 control.

Harvard University on vaccines and herd immunity.

The World Health Organization's bulletin on the benefits of vaccinations.

Related QuickTakes on how vaccine hesitancy threatens to delay the pandemic's end, why delaying the second shot of a Covid-19 vaccine is messy, why the mutated variants are so worrisome, how the coronavirus is transmitted, the vaccine rollout, whether you can be forced to get vaccinated, coronavirus treatments and the unanswered questions about the virus.

(Updates section 4 with research from Israel showing effect of vaccination on propensity to spread virus; and section 9 with research showing the immune-bolstering effects of vaccine on recovered Covid-19 patients.)