The difference between COVID vaccines' 'efficacy' and 'effectiveness' explained

Jonathan Gornall|

The development of anti-COVID vaccines has forced countries to make swift decisions about which ones to go for – choices that are based more on availability than absolute knowledge of their efficacy. But now concerns are being raised that some of these potential life-savers might not be as effective as we have been led to expect. As more details emerge of the research findings behind several of the new coronavirus vaccines, the suspicion is dawning that those choices are creating a lottery in which there might be winners and losers.

For example, Saudi Arabia, which began inoculating its population on Dec. 17, was the first country in the Arab world to deploy the Pfizer-BioNTech vaccine, now widely used in Europe and the US. Meanwhile, its neighbor, the UAE, signed up to the vaccine developed by the Chinese state-owned company Sinopharm, and has been administering it since Dec. 14. In Dubai residents can choose either one.

Public attention has been drawn to the relative "efficacy" of the various vaccines by news of trials in Brazil of another Chinese-made vaccine, developed by Beijing company Sinovac and adopted by countries including Turkey and Indonesia. Those trials indicate that the Sinovac vaccine has an efficacy rate of just over 50 percent – considerably lower than the 78 percent previously claimed.

This sounds bad, especially compared to the 95 percent efficacy rates published for both the Pfizer-BioNTech and Moderna vaccines. But such comparisons are invidious, unnecessarily alarming and, if they undermine confidence in national inoculation programs, potentially dangerous.

Weighing the relative benefits of vaccines is a complex business. There is no long-term data to go on and no certainty yet about whether the drugs hamper the spread of the virus in addition to reducing the severity of its impact. Even the word "efficacy," a term widely touted in the media, is largely misunderstood and widely confused with "effectiveness."

Efficacy is a measure of a drug's performance in a trial in which half the subjects are given the vaccine and half a placebo. In the Pfizer vaccine's case, 170 out of more than 43,000 trial subjects contracted COVID-19. Pfizer's claim of 95 percent efficacy is based on the fact that only eight of those 170 had received the real vaccine.

This does not mean that 95 percent of people who have the jab will be protected. What it does mean is that in the Pfizer trial, those who received the vaccine were 95 percent less likely to contract COVID-19 than those who weren't inoculated.

Effectiveness, on the other hand, is how the vaccine works in practice. Because trial subjects are never a perfect match for any population at large, other factors creep in, meaning it is almost certain that none of the new vaccines will be as effective in the real world as they were found to be efficacious in their trials.

But could a vaccine with a lower trial efficacy really be as effective? The simple and perhaps surprising answer is yes, depending on a range of complex interacting factors.

In November, researchers at the Yale School of Public Health ran a series of computer models comparing the real-world effectiveness of a range of vaccines, looking at "preventive benefit" (the vaccine's ability to reduce viral transmission) and "disease-modifying benefit" (how it affected the severity of the disease and the chance of dying from it).

They examined three categories of vaccine: one that reduced susceptibility to infection; one that reduced the impact of disease, leading to fewer deaths and reduced infectiousness; and a third that combined the attributes of the first two.

Crucially, the computer model also took into account other factors not considered in clinical trials, including the pace at which vaccines are manufactured and distributed and the reach of inoculation programs.

The results were surprising. For a start, they found that “the potential benefits of even the most optimistically effective vaccine are diminished if it is introduced into a more severe pandemic.” In other words, the higher the reproduction, or R number (the average number of people one infected person will infect) at the time the vaccine is introduced, the less effective the vaccine.

An R number of between 1.2 and 1.3 means that on average every 10 infected people will infect between 12 and 13 others. The Yale team found that a disease-modifying vaccine with 50 percent population coverage and an inoculation rate of 1 percent of the population a day prevented 82, 58 or 35 percent of infections depending on whether the R number was 1.5, 1.8 or 2.1.

The researchers concluded that “the benefits of any COVID-19 vaccine, whether highly, moderately or modestly efficacious by any trial-defined outcome, will depend at least as much on how swiftly and broadly it is implemented and the epidemiological environment into which it is introduced as it will on the vaccine’s physiological properties, as shown through clinical trials.”

There are two clear messages from these findings.

The first is that, even with vaccines rolling out, it is vital for countries to maintain basic protective measures, such as mask wearing, hand washing and social distancing.

The second is that waiting for a supposedly “better” vaccine to come along before vaccinating a population is a dumb and dangerous public health move.

So, whichever vaccine your government has opted for, if your country is already inoculating people, then consider yourself lucky and get that jab as soon as you can. And then remind your family, friends and neighbors that, no matter how efficacious the chosen vaccine appeared to be in trials, the faster and more widely it is administered the more effective it will be – and the world can start returning to normality.

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