# Answering questions while dispensing shots at a COVID-19 vaccine clinic

September 2 2021, by Ehsan Misaghi

Credit: Unsplash/CC0 Public Domain

As a medical student working with Alberta Health Services to vaccinate people against COVID-19, I have been asked my fair share of questions about the COVID-19 vaccines—from the need for booster doses to rare side effects.

A few days ago, I told an individual who was about to receive her second dose of the Moderna vaccine, "We are expecting about 95 percent immunity two weeks from today." She paused and asked, "What does that even mean?"

That scenario has repeated itself a few more times since then. I usually respond with, "It means you have 95 percent less chance of developing COVID-19 two weeks after you have been vaccinated with the second dose of an mRNA vaccine."

But what's the long story behind that?

## mRNA vaccines

There are multiple vaccines against COVID-19. I'll focus on the Moderna and Pfizer-BioNTech mRNA vaccines used in Canada. They both received emergency use authorization from the U.S. Food and Drug Administration (FDA) and Health Canada in December 2020. The Pfizer-BioNTech vaccine also received full FDA approval in August 2021. Now that it is fully approved, the Pfizer-BioNTech vaccine is also known by a brand name—Comirnaty—but it's the exact same vaccine that's been in use since December 2020.

Both the Moderna and Pfizer-BioNTech vaccines require two doses given at least three to four weeks apart. The mRNA (or messenger RNA) in the vaccines contains the instructions for how to make the now-well-known spike protein on the surface of SARS-CoV-2, the virus that causes COVID-19.

Once it is injected into a muscle in the upper arm, this mRNA gives the muscle's cells the instructions to make the spike protein. The immune system practices combating this protein and learns how to react when it recognizes something that has that spike protein on it.

Down the line, if we are exposed to the actual SARS-CoV-2 virus, our body knows how to defend against the virus because it has built immunity by making antibodies against the spike protein on the surface of the virus. These antibodies are our bodies' protective proteins against SARS-CoV-2.

## Efficacy vs. effectiveness

The Pfizer-BioNTech and the Moderna vaccines are extremely efficacious and effective against COVID-19. But what do efficacious and effective mean in the context of a vaccine?

Vaccine efficacy is defined as the reduction in the rate of developing disease in vaccinated people compared to unvaccinated people. First, we would calculate the difference in cases between the two groups and then divide it by the rate of unvaccinated cases. For example, if eight out of 21,830 vaccinated people and 162 out of 21,830 unvaccinated people develop the disease, the efficacy of that vaccine would be calculated as:

*(162 / 21830—8 / 21830) / (162 / 21830) = 95 percent*

These numbers are the actual numbers out of the Pfizer-BioNTech trial, which reported 95 percent efficacy in its clinical trials. Moderna reported a similar number (94.5 percent efficacy) in its trials.

Vaccine efficacy is usually measured under specific controlled environments and in the setting of double-blind randomized controlled trials (RCTs). A double-blind RCT is a study in which the participants are randomly assigned to either a placebo (no vaccine) or intervention (vaccine) group and neither the researchers nor the participants are aware which group they are assigned to. This setting reduces bias and increases the accuracy of the studies.

Now that we know how efficacy is measured, let's see what 95 percent efficacy really means. In simple terms, 95 percent efficacy means that vaccinated people have a 95 percent lower chance of developing COVID-19. So, if out of 10,000 unvaccinated people, 100 people get the disease, out of 10,000 vaccinated people, only five people might get the disease.

## Real-world effectiveness

Vaccine effectiveness, however, is different from efficacy. Effectiveness is how well a vaccine works in reducing the rate of disease in vaccinated people compared to unvaccinated people under real-world conditions.

It's worth noting that most studies have defined developing disease as testing positive for COVID-19 and having at least one symptom. The efficacy numbers can change based on the circumstances under which the vaccines are tested. For example, the location of testing, the method of testing, the presence of specific strains or variants of a disease-causing virus and the diversity of the participants can affect the efficacy numbers. That's why demographic information is collected in clinical trials, including Moderna's and Pfizer-BioNTech's vaccine trials.

This means we can't directly compare the efficacy of one vaccine to another if they have not been tested under the exact same conditions.

## How well are the mRNA vaccines working?

With more than five billion doses administered around the world, we are at a point where we can also look at the effectiveness of the COVID-19 vaccines. Preliminary studies have shown that both mRNA vaccines are about 90 percent effective in the real world against COVID-19. The

Alberta government has reported 93 percent effectiveness from the Moderna and 90 percent effectiveness from the Pfizer-BioNTech vaccine.

And why does it take two weeks to develop that level of immunity? The process of a vaccine making our bodies immune against a disease has multiple steps. Remember the protective proteins called antibodies? One of the last steps in the immunity process is making those antibodies.

Based on the studies done by the vaccine makers, at around 14 days after the second dose, our bodies have made enough antibodies to recognize and fight SARS-CoV-2, hence the two-week rule before you are considered fully vaccinated.

One important statistic that needs to be mentioned is that both mRNA vaccines have been shown to prevent hospitalizations and deaths. This means that even in the rare case of a vaccinated individual developing COVID-19, the likelihood of them being hospitalized or dying is very much lower than if they hadn't been vaccinated.

## How do COVID-19 vaccines compare to others?

Another question I've been asked is how the effectiveness from the COVID-19 vaccines compares to the vaccines made for other diseases. Well, the MMR vaccine is 97 percent effective against measles and rubella and 88 percent against mumps. The effectiveness of the DTaP vaccine (diphtheria, tetanus, acellular pertussis) is between 80-85 percent. The effectiveness of the flu vaccine hovers between 10–60 percent depending on the year, the strains the vaccine protects against each year and the actual strains causing influenza and influenza-like diseases.

These numbers all reflect the reduction in the rate of disease between

vaccinated and unvaccinated people. So next time you hear a vaccine is 95 percent effective, that doesn't mean five percent of the people who got the vaccine will develop the disease; it means that vaccinated people have 95 percent less chance of developing the disease compared to unvaccinated people.



Provided by The Conversation