What we know about vaccines and what comes next

First, the very good news. In less than a year, there are five vaccines being deployed in western countries, and another five being deployed in other parts of the world. It's a moment to celebrate the awesome technical powers of modern medicine, and the thousands of scientists that worked to get us here.

The Covid-19 Vaccine Tracker website provides a way to track the status of all 248 vaccines in development in the world, and in a paper for *Science*, Harvard and University of Florida researchers explain how vaccine efficacy is measured and tested.

Another part of the story is what it took to ramp up production of the vaccines. In *Science*, a drug discovery chemist explains the six-step process of producing vaccines, and why it is so difficult to increase production by bringing new manufacturers online. Also see this wonderful blog post about the "ingredients list" of the vaccines.

The world's first general purpose vaccine platform

One of the big scientific breakthroughs was the invention of a new type of vaccine, using "messenger ribonucleic acid" (mRNA). *MIT Technology Review* provides a good explanation of how this technology works:

Unlike traditional vaccines, which use live viruses, dead ones, or bits of the shells that viruses come cloaked in to train the body's immune system, the new shots use messenger RNA—the short-lived middleman molecule that, in our cells, conveys copies of genes to where they can guide the making of proteins.
The message the mRNA vaccine adds to people's cells is borrowed from the coronavirus itself—the instructions for the crown-like protein, called spike, that it uses to enter cells. This protein alone can't make a person sick; instead, it prompts a strong immune response that, in large studies concluded in December, prevented about 95% of Covid-19 cases

Two of the first vaccines, BioNTech's and Moderna's, use this technique. *The Australian* tells the story of Katalin Kariko, the scientist who has worked on this idea since 1978. In *The Spectator*, the science writer Matt Ridley explains how mRNA vaccines can become a general purpose "vaccine platform" that can be quickly adapted to protect against viruses.

The mutations

We have all become very worried about the ways that Covid-19 could evolve – mutations that make it more infectious or able to evade the vaccines. *The Sydney Morning Herald* has a good overview of the major known variants at this point.

The B.1.1.7 variant sometimes called the 'UK variant' has been replacing the original Covid-19 strain in places like Denmark, and likely much of the world, for the simple reason it is more infectious.

The Pfizer vaccine appeared to work better against the current variants. However, one early study found the Oxford/AstraZeneca vaccine, which makes up the bulk of Australia's supply, only 10% effective against the so-called 'South African variant' (although many epidemiologists expect the actual efficacy to be higher with a larger sample).

The major vaccine producers are already working on booster shots that can work against the new strains.

Tomas Pueyo, in "Variants v. Vaccines" is optimistic that eventually vaccines will manage to win against Covid-19, even as it continues to evolve.

What it means for Australia

Australia and our governments have been successful in managing the pandemic, from a public health and economic perspective. But we have been slower than many other countries to begin vaccinations.

Within a matter of days, shots will begin, starting with people who work in the quarantine program.

Australia has 20 million doses of the Pfizer vaccine (enough for 10 million people). This is the vaccine developed by researchers at Oxford, which relies on mRNA technology, and it appears to work well against the known variants.

However, that leaves 15 million Australians who will need to be vaccinated and, at this point, the only option is the AstraZeneca vaccine – the one that does not appear to work well against the South African variant.

Australia has also purchased 51 million doses of the Novavax vaccine, which will require approval before it can be put into use here.

In the short run, the key focus for government is the successful roll-out of the Pfizer vaccine to quarantine workers, followed by older people and health care workers – working through the priority list until all 20 million doses are used. The faster this can be completed, the sooner the most vulnerable people can be protected. Here's a good explainer on the phasing and mechanics of the Australian vaccine rollout.

In the medium run, there is a big question about everyone else. Will the evidence show the AstraZeneca vaccine provides sufficient protection against the variants of the virus in circulation? How soon will AstraZeneca come up with a booster shot that works better on the South African variant? When will Novavax or other vaccines become available to Australians?

In sum, we will likely find ourselves in a situation in which the most vulnerable people in Australia have been given a vaccine with high efficacy, but perhaps not the bulk of the population, for some unknown period of time.

Meanwhile, the vaccine will continue to evolve, with new strains emerging.

It is very possible that Covid-19 will become like the flu – a disease in permanent circulation among human populations, killing people every winter, and requiring annual shots. The path it takes to get there is challenging to predict, argues *Nature*, but society does have some control over it.

As we begin to contemplate the possible new normal of Covid-19 as an endemic virus, big questions emerge about how Australia will choose to change to a new footing, when "fortress

Australia" is no longer the obvious right answer. It won't make sense to lock down society each time someone catches Covid-19. And yet the disease may have higher mortality rates than other flus. How will the country manage the trade-off between safety and re-opening to the world?

Immunity passports to reliably tell authorities who has been vaccinated are being discussed for Australia and other parts of the world.

Some of this depends on how well the world does at vaccinating people in lower income countries, because failure there means more chances for continued mutation of Covid-19. A *New York Times* column argues, "no one is safe until everyone is safe," and some Australian health experts believe it will be six years before the world is vaccinated.

More frequent

Much of human history has been a "battle against the microbes" – historian Kyle Harper reviews the meaning of a plague that devastated Rome between 165 and 180 AD for our own time – and there have long been predictions of a global pandemic like Covid-19. Re-watch the movie 'Contagion' from 2011 for an eerily prescient reminder.

In recognising the limits of their power in the face of nature, we can also acknowledge our own. It is a lesson we would do well to heed. The Antonine Plague wasn't the last lethal pandemic the Romans faced. And Covid-19 won't be ours.

This last question, how frequent pandemics like COVID will be in the future, is one we cannot know the answer to yet.