COVID VACCINES SLASH VIRAL SPREAD – BUT DELTA IS AN UNKNOWN

Studies show that vaccines reduce the spread of some variants of SARS-CoV-2 by more than 80%.

By Smriti Mallapaty

Many vaccines have been shown to provide strong protection against COVID-19. Now, growing evidence finds that they also substantially reduce the risk of passing on the virus SARS-CoV-2 – crucial information for governments making decisions about how best to control the pandemic.

However, the studies were done before the Delta variant became prevalent – and scientists say it might be more easily spread by vaccinated people than are earlier variants.

Two studies[1,2] from Israel, posted as preprints on 16 July, find that two doses of the vaccine made by pharmaceutical company Pfizer, based in New York City, and biotechnology company BioNTech, based in Mainz, Germany, are 81% effective at preventing SARS-CoV-2 infections. And vaccinated people who do get infected are up to 78% less likely to spread the virus to household members than are unvaccinated people. This equals very high protection against transmission, say researchers.

The studies reflect population-level trends, say researchers. "It's good news," says Natalie Dean, a biostatistician at Emory University in Atlanta, Georgia. "But it's not quite good enough," she notes, because it means that vaccinated people can still occasionally spread the infection.

And the highly transmissible Delta variant is a major source of uncertainty. The Israeli studies and others are based on the circulation of earlier variants, in particular Alpha, but research suggests that vaccines offer slightly reduced protection against Delta.

The studies "help us understand why cases were falling in most highly vaccinated populations before the emergence of the Delta variant", says Marm Kilpatrick, an infectious-disease researcher at the University of California, Santa Cruz. "If that variant hadn't arisen and spread, it's likely that case burdens would be very, very low in many countries" with high rates of vaccination, he says.

> **"Both papers provide good evidence of a substantial reduction in infectiousness."**

The studies provide robust estimates for various aspects of transmission that had previously been inferred through multiple studies, says Kilpatrick.

The first study[1], co-authored by researchers in Israel and France, looked at transmission in 210 households of infected people who worked at the Sheba Medical Center near Tel Aviv, which is Israel's largest hospital. The data come from between December 2020 and April 2021 – a time when a massive vaccination drive in Israel was competing with a surge in cases driven by Alpha.

The second study[2], co-authored by researchers in Israel and the United States, was based on a retrospective analysis of data from about 66,000 multi-person households with at least one infected member, collected by Maccabi Healthcare Services, a large health-care provider based in Tel Aviv, between June 2020 and March 2021.

Both studies found that two doses of the Pfizer–BioNTech vaccine were 81% effective at preventing infections. Those who did get infected were also less likely to pass the infection to household members than were unvaccinated individuals.

The first study saw a drop of 78%, and the second 41%, in infectiousness – with the difference in numbers perhaps explained by the fact that the estimates are based on tiny number of vaccinated people who were infected and then infected others.

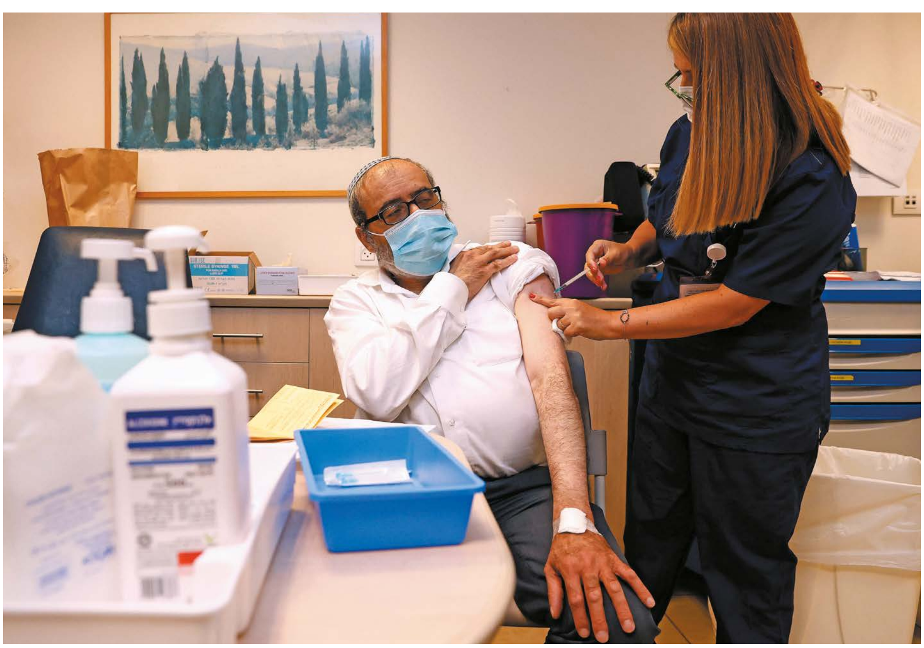
Nevertheless, "both papers provide good evidence of a substantial reduction in infectiousness", says Elizabeth Halloran, a biostatistician at the Fred Hutchinson Cancer Research Center in Seattle, Washington.

And whereas the studies provide an insight into transmission within households, the protection could be even higher outside the home, where people might be exposed to smaller doses of virus, notes Kilpatrick.

Although most of the benefit is because vaccines prevent infection, "the fact that they also reduce the infectiousness of breakthrough cases is important", says Virginia Pitzer, an infectious-diseases modeller at Yale School of Public Health in New Haven, Connecticut, and co-author of the Israel–US study[2].

The results correspond well with studies conducted elsewhere. An analysis[3] of some 365,000 households in the United Kingdom, estimated that infected individuals were 40–50% less likely to spread the infection if they had received at least one dose of the Pfizer–BioNTech vaccine or that developed by the University of Oxford, UK, and pharmaceutical company AstraZeneca, based in Cambridge, UK, at least three weeks previously.

A study[4] from Finland found that spouses of infected health-care workers who had received one dose of the Pfizer–BioNTech vaccine or that produced by Moderna in Cambridge, Massachusetts, were 43% less likely to get infected than spouses of unvaccinated health workers.



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A dose of vaccine is administered at the Sheba Medical Center near Tel Aviv, Israel.

But studies on Alpha and other variants cannot be easily generalized to Delta, says Steven Riley, an infectious-diseases researcher at Imperial College London.

So far, there are no published data on how vaccines affect infections and infectiousness with Delta, but a UK study[5] published on 21 July shows that the Pfizer–BioNTech and Oxford–AstraZeneca vaccines both protect slightly less well against symptomatic disease caused by Delta than against that caused by Alpha. This could also mean a drop in how well they protect against transmission of Delta, but there is still a lot of uncertainty, says Dean.

And case numbers have risen sharply in Israel since Delta's arrival, despite more than 60% of the population being fully vaccinated. This hints at what might happen elsewhere, say researchers.

Even if vaccines are just as effective at preventing infections with Delta as with earlier variants, if Delta is more infectious, transmission in households could still increase, says Dean.

1. Layan, M. *et al*. Preprint at medRxiv https://doi.org/10.1101/2021.07.12.21260377 (2021).
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3. Harris, R. J. *et al. N. Engl. J. Med*. https://doi.org/10.1056/NEJMc2107717 (2021)
4. Salo, J. *et al*. Preprint at medRxiv https://doi.org/10.1101/2021.05.27.21257896 (2021).
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WATER TRANSFORMED INTO SHINY, GOLDEN METAL

Droplet of sodium and potassium donates electrons that make water metallic.

By Davide Castelvecchi

If you can't turn water into gold as a good alchemist would, the next best thing might be to transform it into a shiny, metallic material. Researchers have achieved that feat by forming a thin layer of water around electron-sharing alkali metals.

The water stayed in a metallic state for a only few seconds, but the experiment did not require the high pressures that are normally needed to turn non-metallic materials into electrically conductive metals.

Co-author Pavel Jungwirth, a physical chemist at the Czech Academy of Sciences in Prague, says that seeing the water take on a golden shine was a highlight of his career. The team published its findings on 28 July in *Nature*[1].

"This is a most important advance," says Peter Edwards, a chemist at the University of Oxford, UK. "Who would have thought it … bronze, metallic water?"

Metallic non-metals

In theory, most materials are capable of becoming metallic if put under enough pressure. Atoms or molecules can be squeezed together so tightly that they begin to share their outer electrons, which can then travel and conduct electricity as they do in a chunk of copper or iron. Geophysicists think that the centres of massive planets such as Neptune or Uranus host water in such a metallic state, and that high-pressure metallic hydrogen can even become a superconductor, able to conduct electricity without any resistance.

Turning water into a metal in this way would require an expected 15 million atmospheres of pressure, which is out of reach for current laboratory techniques, says Jungwirth. But he suspected that water could become conductive in an alternative way: by borrowing electrons from alkali metals. These reactive elements in group 1 of the periodic table, which includes sodium and potassium, tend to donate their outermost electron. Last year, Jungwirth and his colleague Phil Mason — a chemist who is also known for making science videos on YouTube — led a team that demonstrated a similar effect in ammonia[2]. The fact that ammonia can turn shiny in such conditions was known to the British chemist Humphry Davy in the early nineteenth century, Edwards points out.

Electrons from sodium and potassium diffuse onto water, turning it golden.

The team wanted to try the same approach with water instead of ammonia, but faced a challenge: alkali metals tend to react explosively when mixed with water. The solution was to design an experimental set-up that would dramatically slow the reaction so that it would not be explosive. The researchers filled a syringe with sodium and potassium, a mixture that is liquid at room temperature, and placed it in a vacuum chamber. They then used the syringe to form droplets of the metal mixture and exposed them to small amounts of water vapour. The water condensed onto each droplet and formed a layer one-tenth of a micrometre thick. Electrons from the droplet then quickly diffused into the water — together with positive metallic ions — and, within a few seconds, the water layer turned golden.

Timing is crucial

Experiments at a synchrotron X-ray source in Berlin confirmed that reflections from the sample produced the signatures expected of metallic water. The key to avoiding an explosion, Jungwirth says, was to find a window of time in which the diffusion of electrons was faster than the reaction between the water and the metals. "They have managed to get to a quasi-steady state such that the physics of metallization wins over chemical decomposition," Edwards says.

"We were not sure at all that we would find it," Jungwirth says. "It was amazing, like [when] you discover a new element."

Jungwirth says the experiment was a refreshing break from his day job, which is to run computer simulations in organic chemistry, and a reminder that science can be fun. "It's not something you can get grant money for, but something you can do on your weekends," he says. It's not the first time he has collaborated with Mason on a practical experiment: in 2015, the two researchers and their colleagues revealed the mechanism that makes sodium explode when it touches water[3] — an experiment they set up on a balcony at their institute, because they didn't have access to a lab. "That pissed everybody off, because that was where people went smoking," he recalls. "We said: could we have the balcony for explosions?"

PHILIP E. MASON

1. Mason, P. E. *et al. Nature* https://doi.org/10.1038/s41586-021-03646-5 (2021).
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