UC SANTA BARBARA

THE Current

March 1, 2021

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COVID-19 Prevention and Intervention

The arrival and rollout of the first COVID-19 vaccines has sparked numerous questions about how they work and about their safety and efficacy. In an hourlong virtual discussion and Q&A session, a panel of UC Santa Barbara scientists shared their expertise regarding the vaccines and other, non-pharmaceutical interventions that help mitigate the spread of SARS-CoV2, the virus that causes COVID-19.

“It’s a really fast-moving area,” said Scott Grafton, M.D, the campus’s COVID-19 coordinator, and a distinguished professor in the Department of Psychological and Brain Sciences. “We’re all trying to keep abreast of how good these vaccines really are. And I think the news overall is very, very good.”

The discussion also featured virologist Carolina Arias and microbiologists Stu Feinstein and Chuck Samuel, all faculty members in the Department of Molecular, Cellular and Developmental Biology; and Joe Incandela, a professor of physics and the campus’s vice chancellor for research.

According to Grafton, evidence from the massive clinical trials and the roughly 51 million people in the United States who have been vaccinated to date demonstrates that the vast proportion of short-term effects from the mRNA vaccines have been benign, while providing effective protection from both symptomatic and

asymptomatic transmission. Johnson & Johnson's single-shot vaccine has just over the weekend received emergency use authorization from the U.S. Food and Drug Administration.

He noted that all three of the vaccines available are more than 90% effective in protecting against severe disease, hospitalization and death.

Yet with the arrival of new COVID-19 variant strains from the U.K., South Africa and Brazil — as well as a homegrown Southern California variant — dominating the community, questions and concerns abound over whether the vaccines will be up to the task.

"I think that these vaccines are going to be one of our best lines of defense," Arias said. "They're going to offer protection even from other variants, even if it's not exactly the variant that was used for the development of the vaccine." While variants are an expected outcome of infection, the sooner we become immune and stop transmitting, the quicker we can gain a foothold on the virus.

An additional benefit of the mRNA vaccine, Arias said, is that it can be easily modified to compensate for decreased effectiveness. Moderna's variant-specific vaccine, targeting the version found in South Africa, has just begun Phase I clinical trials with the National Institutes of Health.

Though relatively new to the broader population, the mRNA vaccines are actually the result of decades of research.

"For the past 50 years or so, the National Institutes of Health and many other funding organizations have made major investments in basic biomedical research," Feinstein said. That, and the last couple of decades that have been spent optimizing mRNA technology has made it possible to develop the Pfizer and Moderna vaccines in record time.

Other COVID-19 vaccine related topics covered by the panelists include the differences between the mRNA and live-attenuated vaccines, the breadth of clinical trials across race and ethnicity, the progress toward clinical trials for children and teens, boosters, an increased vigilance toward the local variant, and a possible springtime surge. Bottom line, according to microbiologist Samuel, the sooner we all get protection from COVID-19, the sooner we can achieve herd immunity, which occurs when 70-80% of the population has gained immunity, effectively shielding

those who aren’t immune by blocking transmission.

“We can get there by immunization or infection, and given the outcome that you can have by infection — this week we’re over half a million deaths in the U.S. — we certainly want to achieve this protection by immunization, and not infection,” Samuel said.

But until we reach the necessary level of collective immunity, we must remain vigilant in our COVID-related behavior, Incandela said. That includes not only the 6-foot social distancing practice with people outside our households and the use of one, maybe two, masks, but also adequate ventilation indoors at home, where poor airflow allows aerosolized viruses to accumulate.

“We’ve all been in situation where we’re in a room, we’re talking to people and the room gets stuffy,” Incandela said. “That’s a very bad sign in this circumstance. Get outdoors, get the windows open, reduce the density. Always be aware of these things.”

Registrants and attendees were invited to submit questions to the panel, several of which were answered during the Q&A session. Unfortunately, the number of questions was limited due to time constraints. Following are some of those the experts were not able to address.

Q: The Oxford Astra-Zeneca and the Johnson & Johnson vaccines use an adenovirus to deliver the spike protein’s DNA or genetic instructions to the nucleus of the vaccinated person’s cells so the cell can make mRNA to build its own spike protein. These two vaccines do indeed enter the cell’s nucleus to insert DNA for the spike protein. Please expound on how this genetic engineering is safe from long-term negative effects in those vaccinated, particularly as the cell nucleus is affected by receiving the spike protein DNA.

Stu Feinstein: The viral vector is adenoviral vector for both the Johnson & Johnson and the Astra-Zeneca vaccines. It is not a live virus. It is mutated by deletion of the adeno gene required for replication. The virus does not replicate. Adenoviruses do not insert their DNA into the host genome. Rather, they exist for a short while as an “extra-chromosomal element,” promote the synthesis of the COVID-19 spike protein for a while and are then degraded. As a result, there is no effect on the host genome and no long-term genetic consequences.

Chuck Samuel: The Johnson & Johnson vaccine (and also the Oxford Astra-Zeneca vaccine) is base on a viral vector modified to deliver DNA to express CoV2 viral spike protein that triggers protection against CoV2-caused COVID disease. As I recall, both Johnson & Johnson and Astra-Zeneca express complete spike.

Q: The Pfizer and Moderna vaccines use mRNA, which does not reach the cell's nucleus. However, when our cells read the mRNA instructions to build their own spike proteins that migrate to the surface of our cells, a situation is created where our immune cells learn to attack otherwise healthy cells that have now created the spike protein. How can this process not create long-term autoimmune disorders in some otherwise healthy vaccinated persons? Which human cells receive the mRNA instructions to build and produce the spike protein on their surface after being vaccinated? Can these mRNA genetic instructions migrate to organ tissue cells where they then build a spike protein and hence become attacked by the immune system?

Scott Grafton: The mRNA vaccines are injected into the deltoid muscle of the arm. The mRNA enters local muscle cells; it does not circulate throughout the body. Spike protein is generated in the muscle cells at the site of the injection. It is expressed on the surface of those cells and the immune system learns to recognize this spike as foreign. A small fraction of muscle cells are lost in the process. The virus spike protein is fundamentally different from proteins on the surface of human cells. Thus, the risk of cross-reactivity between an immune response to the virus and one to cells of the self, while theoretically possible, is, in reality, exceedingly unlikely.

Q: How does the effectiveness of the vaccines compare to the immunity in people whose bodies have already neutralized the virus?

SG: This is currently under study. In terms of real-world data collected before the vaccine roll-out and arrival of variants, there are a few small studies suggesting that about 5% of people who have had COVID-19 can catch symptomatic illness again. Thus, 95% are protected from symptomatic re-infection. In the clinical trials with the mRNA vaccines, there is strong evidence of protection from symptomatic illness 95% of the time as well. So the effectiveness is quite similar for protection from symptomatic illness. What we don't know is whether they are similar for preventing spread of asymptomatic disease and how all this changes with the new variants.

Q: We know the Pfizer and Moderna vaccines provide functional immunity. Do they also provide sterilizing immunity? The reference to the data from Israel means the Pfizer vaccine has 90% "sterilizing immunity," which implies 10% "functional immunity"?

SG: This is a difficult question to answer because of the emergence of the variants. We know that all of the vaccines are outstanding at performing their most important task: to prevent major illness and death. So far, the evidence suggests this is also true for the most common variants. What is less clear is how well the vaccines accomplish a secondary task: to reduce the spread of disease, particularly in asymptomatic infection. So far, data from Israel with the Pfizer-BioNTech vaccine is very promising that it is also accomplishing this goal. Nevertheless, determining this kind of population immunity for each vaccine and in the U.S. is extremely challenging because it requires extensive COVID testing of the general population. It also requires knowledge of what variants are present in the population. This is one of the reasons UC Santa Barbara has teamed with Cottage Health to perform genetic sequencing to identify variants in samples obtained in the local community.

Q: Does blood type have anything to do with the transmission of COVID-19?

SG: There is a comprehensive study from five Boston hospitals demonstrating the following: Patients with blood types B and AB who received a COVID test were more likely to test positive and blood type O was less likely to test positive. Rh+ patients were more likely to test positive. Of those admitted to hospital with critical illness, neither blood type nor Rh+ were associated with risk of intubation or death in patients with COVID-19.

Q: Does the data indicate a significant effect if the first and second doses are from different vaccines?

SG: There are no data. The matching of the manufacturer between first and second dose is a mandatory regulatory requirement set by the FDA.

Q: What do you say to people who have refused the vaccine, claiming that because they’re young (in their 30s) they don’t need it?

SG: At the personal level, without the vaccination there is a worrisome chance that a young person who acquires the viral illness will become quite sick. If they do develop symptoms, there’s a 30% chance they will develop chronic problems (loss of

smell, fatigue, cardiac complaints, headaches). At a community level, by receiving a vaccination they are contributing to a global effort to blunt the spread of a dangerous disease.

Q: Can family members who aren’t part of the same household get together if some are vaccinated and some are not? Does it depend on the exposure of those vaccinated, of those not, or both?

SG: There is a risk, albeit modest, that the person who has been vaccinated can harbor the virus in the mucosa of the nose. Thus, they could “shed” virus and potentially infect a non-vaccinated person. There is a theoretical risk that a person wh has been vaccinated could become infected from a non-vaccinated infected individual. This could occur because the vaccine did not develop a strong immunity to start with or because the infected transmitter has a new variant the vaccine did not cover in the receiver. We do not know how often these kinds of transmissions in one direction or the other occur. To be on the safe side, non-pharmacological measures such as masks, distancing and hand washing continue to be recommended.

Q: How safe is outdoor dining? And should outdoor dining venues that are fully enclosed by impermeable barriers be treated as indoor spaces?

SG: Dining remains challenging because the masks come off. There are two aspects of risk to consider. Anytime you sit across the table from a maskless infected person who is talking, eating and breathing, you run the risk of breathing in aerosol from them. Sitting at big tables and not directly facing each other can help reduce this risk.

Completely outdoors, an aerosol diffuses and it is difficult for the concentration of the virus to reach infectious levels. There are exceptions, of course. Activities where people are in each other's faces — running directly behind an infected person, dining across from each other — are all conditions where an infectious aerosol cloud could be hazardous. In partially enclosed dining venues, the safest layouts are designed to make it difficult for an aerosol to concentrate over time. As an analogy, imagine you are in your favorite dining spot and someone at the other side of the enclosed area is smoking a cigar. How long would it take for the air in the room to become intolerable? A larger enclosed area, with more fresh air, whether by windows and other openings or high-performance filtered air conditioning, will all help to slow the

rising concentration of smoke. The same general rule applies to aerosols. If the space is relatively small, has impermeable walls and limited fresh air, you clearly need to be concerned.

Q: What is the current understanding regarding how long the virus can live on a surface?

SG: Early laboratory experiments suggested that the virus could last anywhere from 2 to 6 days. These studies have come under criticism because they used extremely high concentrations of samples, far greater than what would be encountered in the real world. More recent studies performed under more realistic scenarios suggest a survival of 3 to 6 hours, depending on surface material, and after drying, as brief as 1 hour. While we need to continue to err on the side of caution, it is possible to find practical solutions that work in a time frame of hours rather than days. These views are summarized here.

Q: The explanation of the risk associated with the accumulation of aerosol droplets indoors was very helpful. It's easy to understand the risk of breathing in the virus in this type of environment. How would you characterize the risk of infection via the eyes? In addition to wearing masks over our noses and mouths, should we also be concerned with covering our eyes?

SG: While infection from an aerosol is most strongly associated with the virus contracting the mucosa of the respiratory tract, the eyes are also a potential route of infection. There are case reports of patients with conjunctivitis due to the virus. It is also possible to detect the virus in the tears of some infected persons with or without conjunctivitis.

In hospital workers, there is strong evidence that eye protection (goggles/face shields) reduce the risk of acquiring viruses like SARS-CoV2 from patients. In a community setting, it is difficult to estimate how often people acquire the disease because of inoculation to the eyes. Indirectly, there is data to suggest that protecting the eyes can help reduce the risk. For example, there is an interesting study from China of hospitalized patients with COVID-19. In this cohort study of patients hospitalized in Suizhou, China, the proportion of inpatients with COVID-19 who wore glasses for extended daily periods (greater than eight hours per day) was smaller than that in the general population, suggesting that daily wearers of eyeglasses may be less susceptible to COVID-19. This benefit could be because

eyeglass wearers don’t touch their faces or rub their eyes as much or because less aerosol reaches the eyes.

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