COVID-19 Delta Variant and Vaccine Efficacy

Executive Summary

SARS-CoV-2, the novel coronavirus that causes COVID-19, has infected over 896,000 Missourians, resulting in over 14,600 fatalities as of November 2021. Roughly 50% of Missourians have been vaccinated against COVID-19. The recent emergence and surge of the Delta variant has increased the number of infections nationwide, including in Missouri. Various medical, industry, and government entities are exploring methods for mitigating the ongoing spread; strategies include the combination of vaccines, masking, and frequent testing.

Highlights

- The Delta variant is highly contagious compared to the original SARS-CoV-2 virus; both mask wearing and vaccinations help to reduce the infection rate and severity of COVID-19 infections.
- Both mRNA and adenovirus-based COVID-19 vaccines greatly reduce the probability of hospitalization and death against all forms of SARS-CoV-2, including the Delta variant.
- Entities at the federal, state, local and industry levels have enacted various forms of masking and/or vaccination requirements.

Limitations

- Research investigating long-term vaccine efficacy is still ongoing. Lasting immunity measures will need to be continuously monitored to guide vaccine updates.
- Long-term symptoms of COVID infections have only begun to be studied; more research examining the long term medical and psychological effects of recovered patients is needed.

Research Background

COVID-19 Delta Variant

Infectious viruses, including SARS-CoV-2, the novel coronavirus responsible for COVID-19, naturally mutate over time so long as there are viable hosts. The Delta variant, which was first detected in late 2020, contains genetic mutations that increase the the levels of viral replication by a factor of ~100 compared to the original strain of SARS-CoV-2.[1] These increased levels of replication, along with mutations that decrease the neutralizing effectiveness of antibodies, have made the Delta variant approximately twice as infectious as the original strain; it is now the cause of 98% of all new U.S. infections.[2] In addition, the Delta variant causes higher rates of

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hospitalization and death than the original strain.[3] Fatality rates due to the Delta variant are approximately 11 times higher for unvaccinated individuals than for vaccinated people.[4]

COVID-19 Vaccines and Effectiveness Against Delta

SARS-CoV-2 functions via a "lock-and-key" mechanism, with spike proteins (keys) that attach to cellular receptors (locks) on the surface of the upper respiratory tract to enter the body. Vaccines cause the body to generate SARS-CoV-2 spike proteins (but not other parts of the virus that allow it to cause disease), leading to the production of antibodies that physically block the lock-and-key interaction.[5] To date, three vaccines have been approved in the U.S. for use in the prevention of COVID-19 infection and disease. States with the lowest rates of vaccination have reported some of the highest infection case loads over the course of the pandemic (Figure 1).

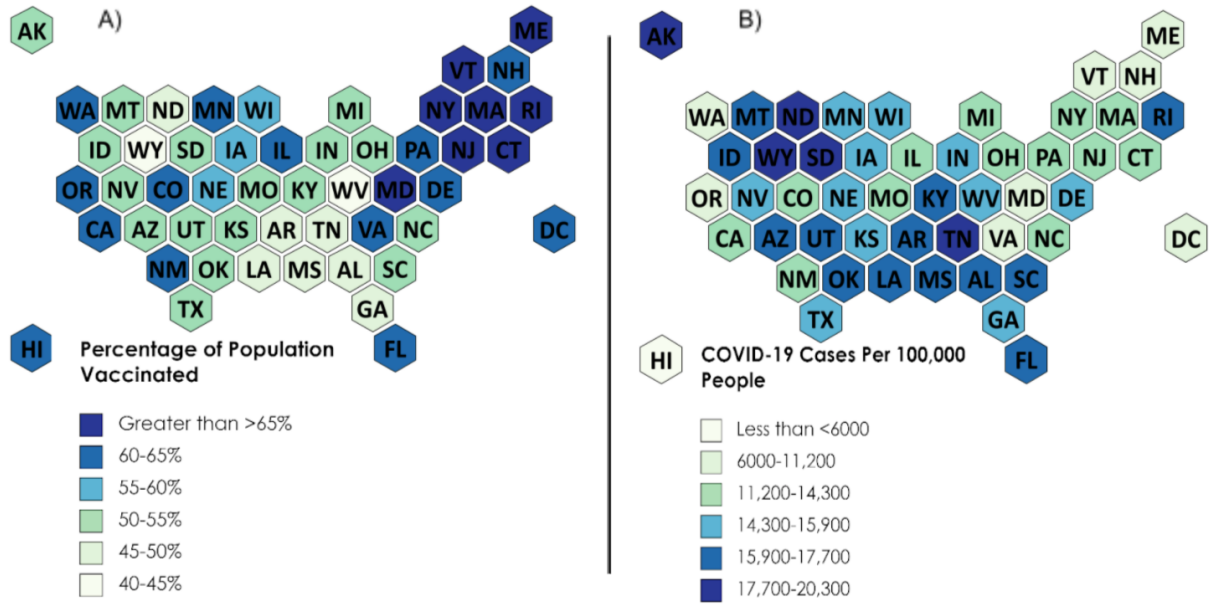

Figure 1: Comparison of vaccination rates and cases of COVID-19 in the US. A) Map of states (represented as hexagons) with colors related to level of vaccination; lighter colors indicate lower levels of immunization. B) Mapping of documented COVID-19 cases; darker colors indicate higher rates of infection.[2] Map made with PresentationGo.com using CDC data.

Messenger RNA (mRNA) vaccines have been in development since the early 1990s to treat various diseases, including cancer, HIV, and Ebola.[6] Moderna and Pfizer mRNA vaccines provide a genetic blueprint to create viral spike protein, and then the mRNA dissolves. The Janssen (Johnson & Johnson) adenovirus-vaccine uses a deactivated cold virus to deliver the genetic blueprint for creating the spike protein.[7]

COVID-19 vaccines were designed for the original SARS-CoV-2 virus first detected in Fall 2019. These vaccines were measured to be 92-95% (Pfizer), 94% (Moderna), and 66% (Janssen), effective at preventing symptomatic infection.[8] Side-effects including fever, fatigue, headaches, irritation at the injection site, and extremely rare events such as myocarditis (~2 per million)

have been documented.[9] Further, the efficacy rates for preventing hospitalization and death were roughly 98-100% for all vaccines, indicating that "breakthrough infections" (infections after vaccination) are less severe than infections in unvaccinated people.[8]

Early estimates put protection from infection by the Delta variant at 41-44% (Pfizer), 56-59% (Moderna), and 9-16% (Janssen), respectively, and prevention against hospitalization and death were measured at approximately 71-81% for all three vaccines.[10] Individuals with a previous SARS-CoV-2 infection are approximately 5.5 times more likely to get reinfected compared to individuals who have been vaccinated.[11]

Vaccinated individuals who experience a breakthrough infection carry similar viral loads as unvaccinated people, suggesting that they may be similarly infectious while they are symptomatic. However, vaccinated individuals appear to spread the virus for a shorter period of time than unvaccinated people.[3] The infectiousness of vaccinated people with asymptomatic breakthrough infections is not yet fully understood.

Patients hospitalized for COVID-19 pneumonia in 2020 have been documented to have severe lung impairment at least 12 months after discharge.[12] While "long-haul" symptoms (such as fatigue, headache, shortness of breath, persistent cough, chest/abdominal pain, and brain fog that persist for more than 28 days post-infection) after a COVID-19 breakthrough infection have also been documented, the risk of long-haul symptoms and hospitalization appears to be reduced in vaccinated individuals compared to unvaccinated individuals.[13]

Children and COVID-19

Due to the recency of vaccine approval for children (EUA granted for 5-11 year olds Nov. 2021), the least is known about long-term vaccine efficacy in this group. However, COVID can still cause severe illness in children; while children have the lowest rate of COVID-related hospital admittances, hospitalizations of this cohort rose ten-fold during the spring and summer of 2021, when the Delta variant became the dominant strain.[14] Children who are infected with COVID may also still spread the virus.

The ongoing pandemic has posed significant obstacles for children, including disruption in education and seeking of mental health services (*see our previously published Science Note:* Covid-19, Mental Health and Substance Abuse). Further, the effects of social disruptions from COVID-19, such as the loss of a parent/guardian, are only beginning to be understood.[15]

Efficacy of Mask Use in Mitigating COVID-19 Spread

SARS-CoV-2 is spread primarily through secretions from the oral and nasal linings, including through airborne particles that are generated during everyday talking, singing, coughing and sneezing and can remain in the air.[16] In July 2020, the CDC recommended universal mask-wearing (after it was documented to provide protection),[16] as well as social distancing and conducting activities in ventilated spaces to reduce aerosol transmission.

The efficacy of mask usage is largely dependent on the type of mask used and the level of adherence by peers in one's immediate vicinity. Studies have determined that mask efficacies can vary depending on the materials used, ranging from 95% transmission reduction with an N95, 60-80% with a surgical mask, and 2-38% with a cloth mask.[17,18] Further, studies on cloth masks determined protection was largely dependent on the tightness of fit and the number of layers.[19]

State and Federal Policies on Masking and Vaccination Standards

Twenty-two states (CA, CO, CT, DE, DC, HI, IL, ME, MD, MA, MN, NV, NJ, NM, NY, NC, OR, PA, RI, VT, VA, WA), require vaccinations (with medical and religious exemptions) or frequent testing for workers in various industries, including those employed by the state, in education, and in health or congregate care systems. Eighteen states (CA,CT, DE, DC, HI, IL, LA, MD, MA, NV, NJ, NM, NY, OR, PA, RI, VA, WA) have also required the use of masks in all school settings. Additionally, various localities and school districts have required masks when there is no state-level policy.[20] Several studies suggest adherence to masking is associated with a statistically significant decrease in cases and deaths. A study from 2020 of 857 counties from all 50 states showed that county mask mandates resulted in statistically significant reductions in hospitalizations and deaths.[21]

Federal policies have enacted mask requirements for individuals (age 2 years old and up) on all forms of public transportation, including airplanes, trains, and buses. Additional policies require vaccination or frequent testing on all federal and federally-contracted workers. The CDC has continued to recommend widespread use of masks in all hospital settings, congregate facilities, and schools. The CDC and FDA also recently approved the use of vaccine boosters for all adults. Compared to a two-dose mRNA vaccine regimen, a Pfizer booster has been found to provide 93% efficacy at preventing hospitalization, 92% efficacy at preventing severe disease, and 81% efficacy at preventing death from the Delta variant as soon as seven days after the third dose.[22]

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