UNIVERSITY of VIRGINIA
BIOCOMPLEXITY INSTITUTE

UVA COVID-19 MODEL WEEKLY UPDATE

VDH VIRGINIA DEPARTMENT OF HEALTH

December 3rd, 2021

KEY TAKEAWAYS

- Cases and testing are slightly down after the holiday break, similar to the downtick seen last year following holidays. We expect a rebound later this week.
- Across the Commonwealth, activity remains mixed, with 18 of the 35 health districts in slow growth, and another 10 in decline.
- Current model projections suggest a flattening case trajectory in the near-term, with gradual growth starting in the new year.
- Seasonal factors and holiday travel may shift trajectories towards more rapid growth as seen in the "FallWinter" modeling scenario.
- The models have been updated to more accurately account for differing immunity profiles. This will be key to modeling the new Omicron variant, which has not yet been detected in Virginia.

16 per 100k
Average Daily Cases Week Ending Nov. 28, 2021

(43 per 100k)
*Adaptive Scenario Forecast Average Daily Cases **Already Peaked** on September 19, 2021*

7,378/ 3,946
Average Daily 1st / 2nd Doses Nov. 28, 2021

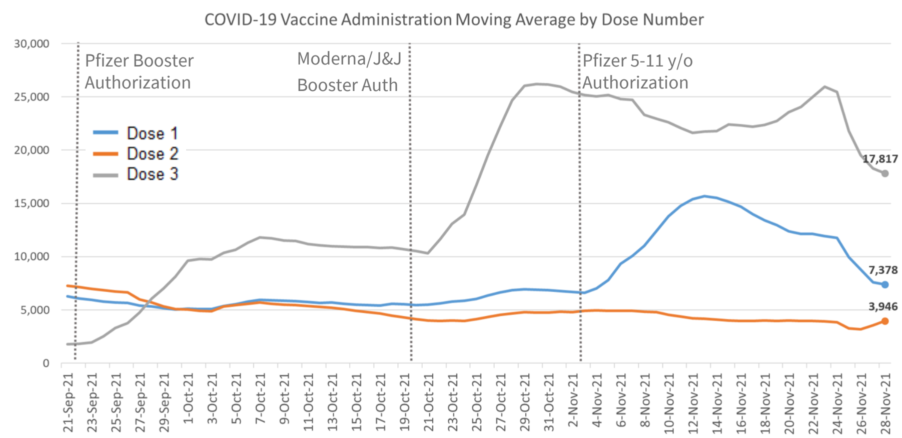
17,817
Average Daily Boosters Nov. 28, 2021

KEY FIGURES

Reproduction Rate (Based on Confirmation Date)

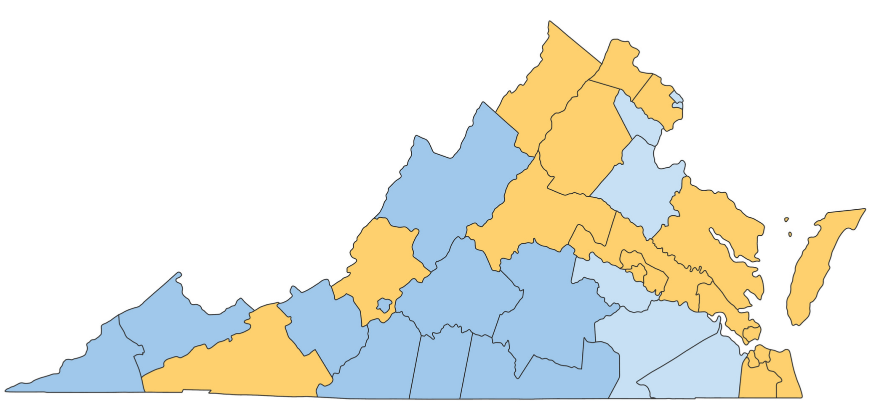
Region	R_e Nov 29th	Weekly Change
Statewide	**0.904**	**0.000**
Central	0.924	-0.011
Eastern	0.972	-0.053
Far SW	0.790	-0.063
Near SW	0.844	-0.052
Northern	0.869	-0.020
Northwest	0.899	-0.030

Vaccine Administrations



Growth Trajectories: No Health Districts in Surge

Status	# Districts (prev week)
Declining	10 (5)
Plateau	7 (8)
Slow Growth	18 (20)
In Surge	0 (2)



THE MODEL

The UVA COVID-19 Model and these weekly results are provided by the UVA Biocomplexity Institute, which has over 20 years of experience crafting and analyzing infectious disease models. It is a county-level **S**usceptible, **E**xposed, **I**nfected, **R**ecovered (SEIR) model designed to evaluate policy options and provide projections of future cases based on the current course of the pandemic. The Institute is also able to model alternative scenarios to estimate the impact of changing health behaviors and state policy.

COVID-19 is a novel virus, and the variant mix changes constantly. The model improves as we learn more.

THE SCENARIOS

Updated: The models use various scenarios to explore the path the pandemic is likely to take under differing conditions. The **"Adaptive"** scenario takes the current course of the pandemic at the county level, including the impact of the Delta variant and vaccines, and projects it forward. The **"SurgeControl"** scenario shows the likely impact of prevention and mitigation efforts (masking, social distancing, testing and isolating, etc.) by employing a 25% reduction in transmission rates starting next week. The **"FallWinter"** scenario captures the transmission drivers of the entire 2020 holiday season and projects them forward. In this scenario, transmission rates from December 2021 to February 2022 are manually set to reflect the transmission rates from the same time period last year, but boosted by Delta's enhanced transmissibility.

All models use COVIDcast surveys to estimate county-level vaccine acceptance. They then assume that vaccination uptake continues in each county until this value is reached. The new **"HighBoost"** scenario modifier is meant to examine the impact of an optimistic increase in booster doses for adults. This should not be confused with the older "VaxOpt" scenario modifier which imagined a significant boost in *first-time* adult vaccinations. Current models assume that 40% of vaccinated individuals will receive a booster. The HighBoost modifier increases this figure to 70%, and doubles the rate of deployment.

MODEL RESULTS

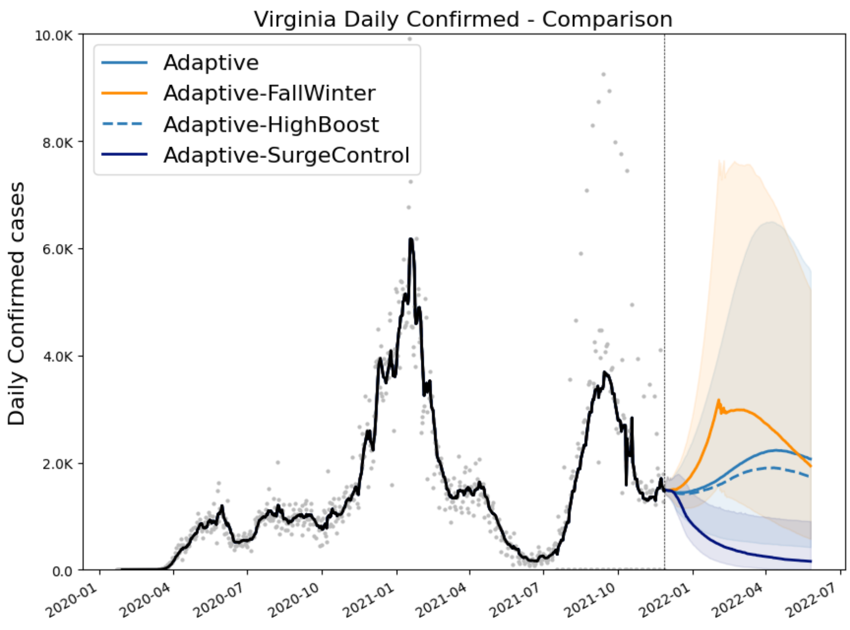
Updated: The "present course" Adaptive scenario (blue) now shows a flat trajectory in the short-term, with a gradual rise in cases starting in early 2022 and peaking in April.

The FallWinter scenario (shown here in orange), projects a rise in case rates, potentially rivaling the recent September surge with a peak in February of 2022.

The HighBoost (dashed blue line) scenarios shows that in the long-run, increased booster coverage could prevent thousands of cases.

The SurgeControl (indigo) scenario forecasts a quick drop-off of case rates, now reaching Summer-2021 lows by March or early April.

Please do your part to stop the spread and continue to **practice good prevention**, including indoor masking, social distancing, and self-isolating when sick, and **get vaccinated** and boosted as soon as possible.

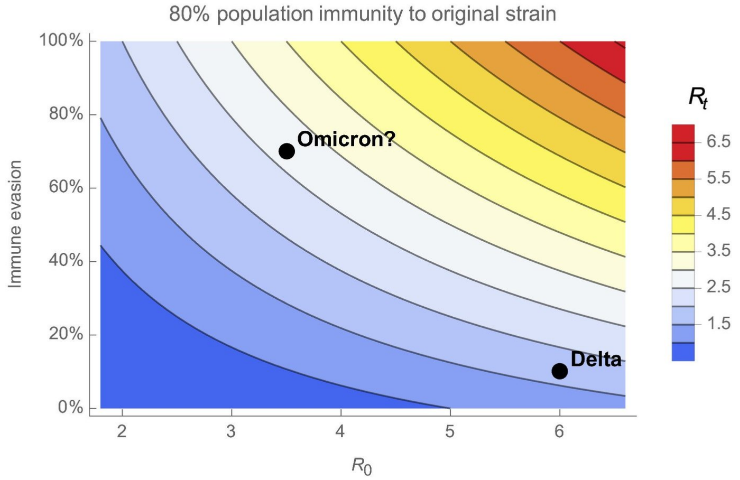


Date of Latest Model Run: 2021-11-30

PREPARING TO MODEL OMICRON

The newly discovered B.1.1.529 (Omicron) variant is making headlines across the world, but we still know very little about it. The variant is heavily mutated with over 30 changes to its spike protein, potentially allowing it to spread more quickly and escape prior immunity. Early studies suggest it may be three times more likely than ancestral strains to reinfect those who recovered from an earlier strain.

The most concerning thing about Omicron was the speed with which it spread across the South African province of Gauteng. Early estimates have suggested it may spread even faster than the Delta variant. But this may be misleading.



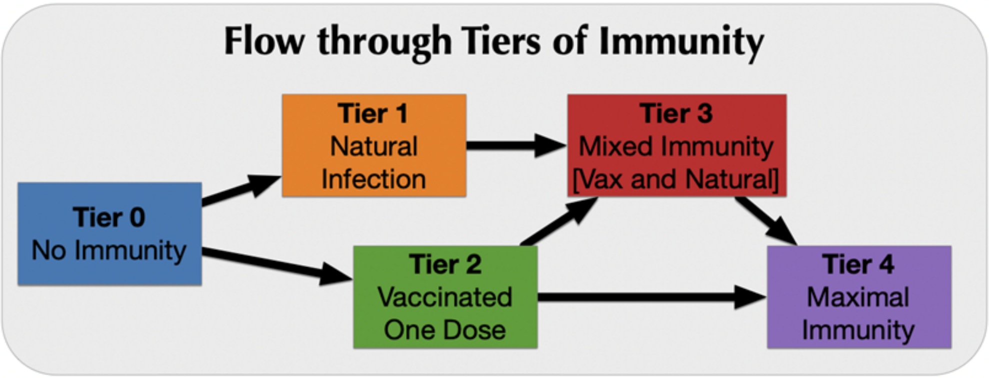
Effective reproductive number as a function of R0 and immune escape. Source: Dr. Trevor Bedford (Fred Hutchinson Cancer Research Center)

In a population with some level of preexisting immunity, the rate at which a virus spreads is a function of both its basic reproductive rate and its ability to bypass prior immunity. This is illustrated in the graph above. The x-axis shows the basic reproductive number (R_0), which measures the rate of spread in an immunologically naive population. The y-axis shows immune escape, the variant's ability to bypass existing immunity. The colored bands show the effective reproduction number (R_t), measuring the rate of spread in an area where 80% of the population has immunity to an earlier strain. It is possible that the Omicron variant is not more transmissible than the Delta variant, but simply better able to evade natural and vaccine-induced immunity, thus giving the appearance of a higher basic rate of spread. The bad news is that this variant has the potential to spread across the Commonwealth despite our strong population-level immunity. The good news is that early evidence suggests that vaccines are still effective in protecting against severe illness.

Maximal Immunity

Plans to upgrade the models to better account for varying levels of immunity were set before Omicron made its debut, but the new variant has certainly hastened them. Though the details of Omicron's immune escape are still being investigated it is likely that waning immunity plays a significant role in breakthrough cases, as is already the case for the Delta variant. In order to properly model Omicron it is vital that we account for differences in efficacy of vaccines, booster doses, natural immunity, waning immunity, and various combinations of the above.

To this end, UVA has added five tiers representing various levels of immunity to the models. Tier 0 represents immunologically naive individuals with no exposure to the virus. Tier 1 represents those infected previously with natural immunity. Tier 2 represents those partially vaccinated with a single dose. Tier 3 represents a combination of prior infection and a single dose. Tier 4, "maximal immunity", represents fully vaccinated individuals, including a booster after six months. The degree of protection afforded against each strain, both against infection and against hospitalization, can be set for each tier. The rate at which immunity wanes, the incubation period, the duration of infection, and the infectiousness of the infected can also be set separately for each tier as new epidemiologic data comes in.



Not only will this improve the realism and accuracy of models, it will also allow improved estimation of future hospital burdens, and help forecast strain prevalence as Omicron begins to compete with Delta.