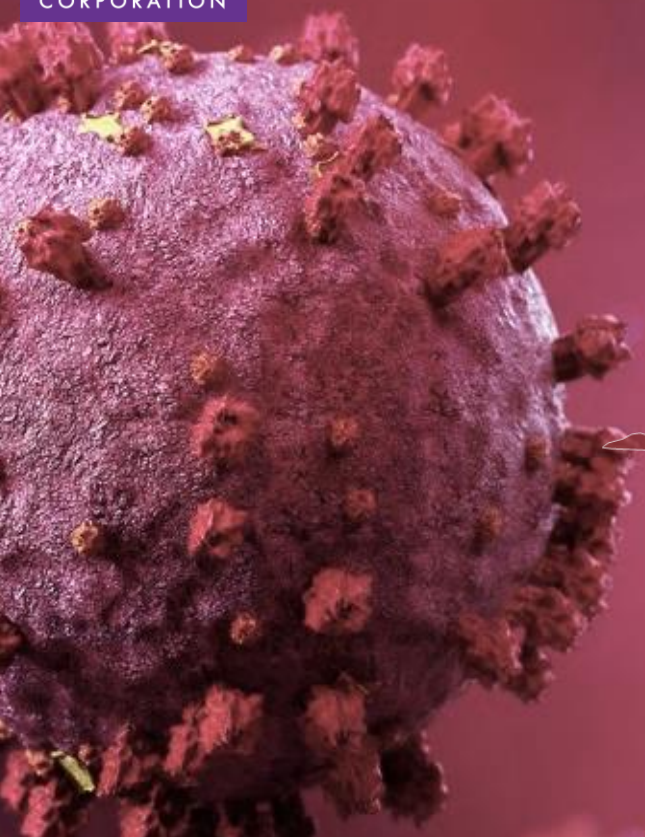
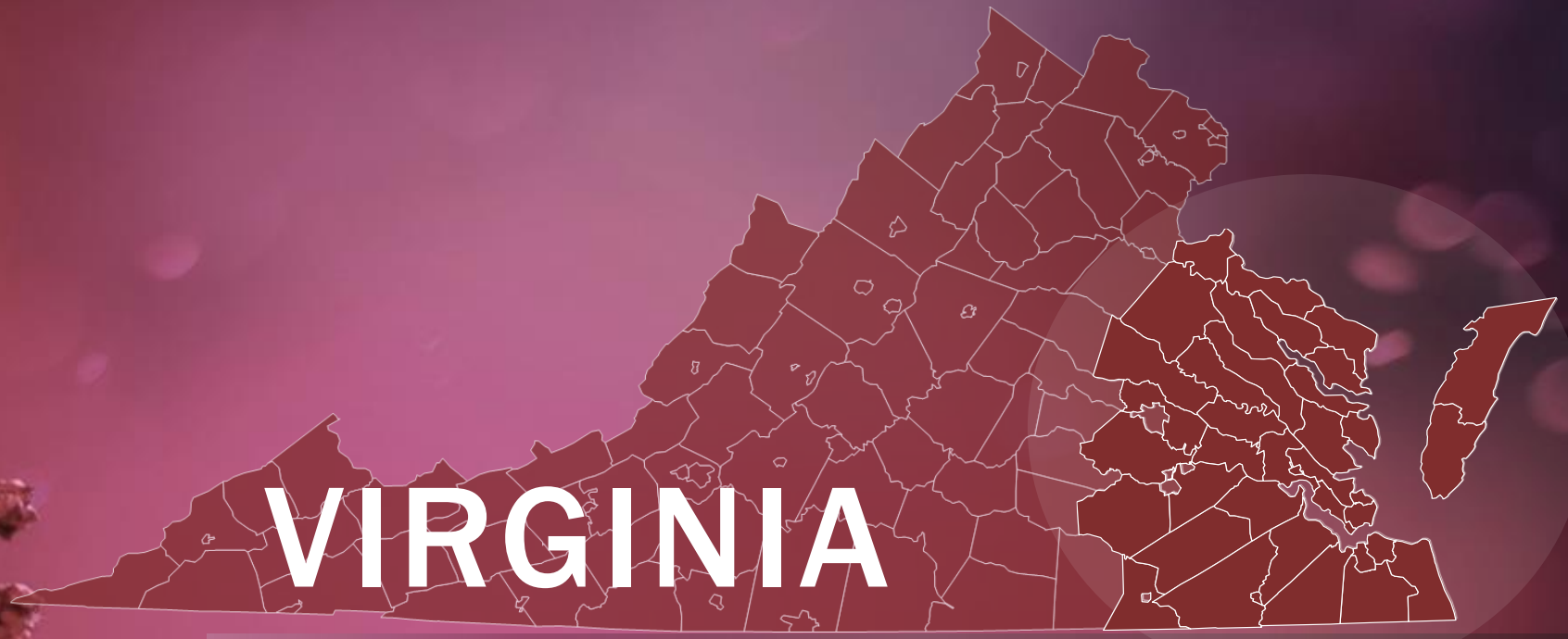




VIRGINIA

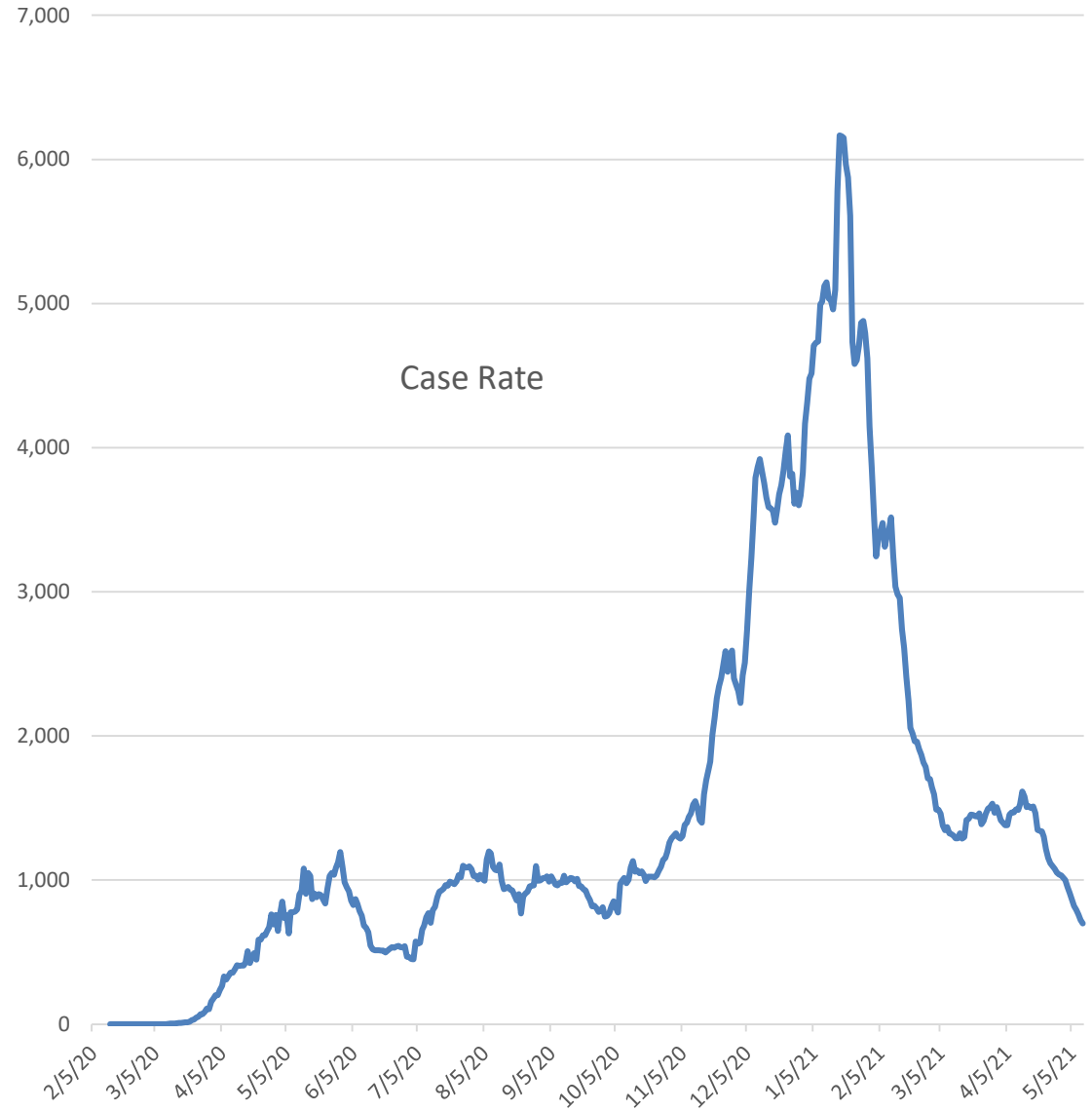
COVID-19 Update May 13th, 2021

Carter C. Price, Ph.D.

A team of RAND researchers was asked by the Commonwealth of Virginia to review available information on COVID-19 models of the Commonwealth to determine the strengths and weaknesses of each model and their relevance to decisionmaking. The information in this presentation is intended to keep policymakers abreast of the latest findings of the research team.

This research was sponsored by the Commonwealth of Virginia and conducted by the RAND Corporation. RAND is a research organization that develops solutions to public policy challenges to help make communities throughout the world safer and more secure, healthier and more prosperous. RAND is nonprofit, nonpartisan, and committed to the public interest. For more information, visit www.rand.org.

Bottom Line Up Front



Confirmed cases have declined from last week to 619 per day (-27%)

- This is 45 percent lower than the previous low of 2021 and 42 percent below the summer highs of 2020

COVID hospitalizations have decreased to 799 (-11%)

Vaccination is continuing to increase rapidly with at least 35 percent of the population fully vaccinated (+3.1 percentage points)

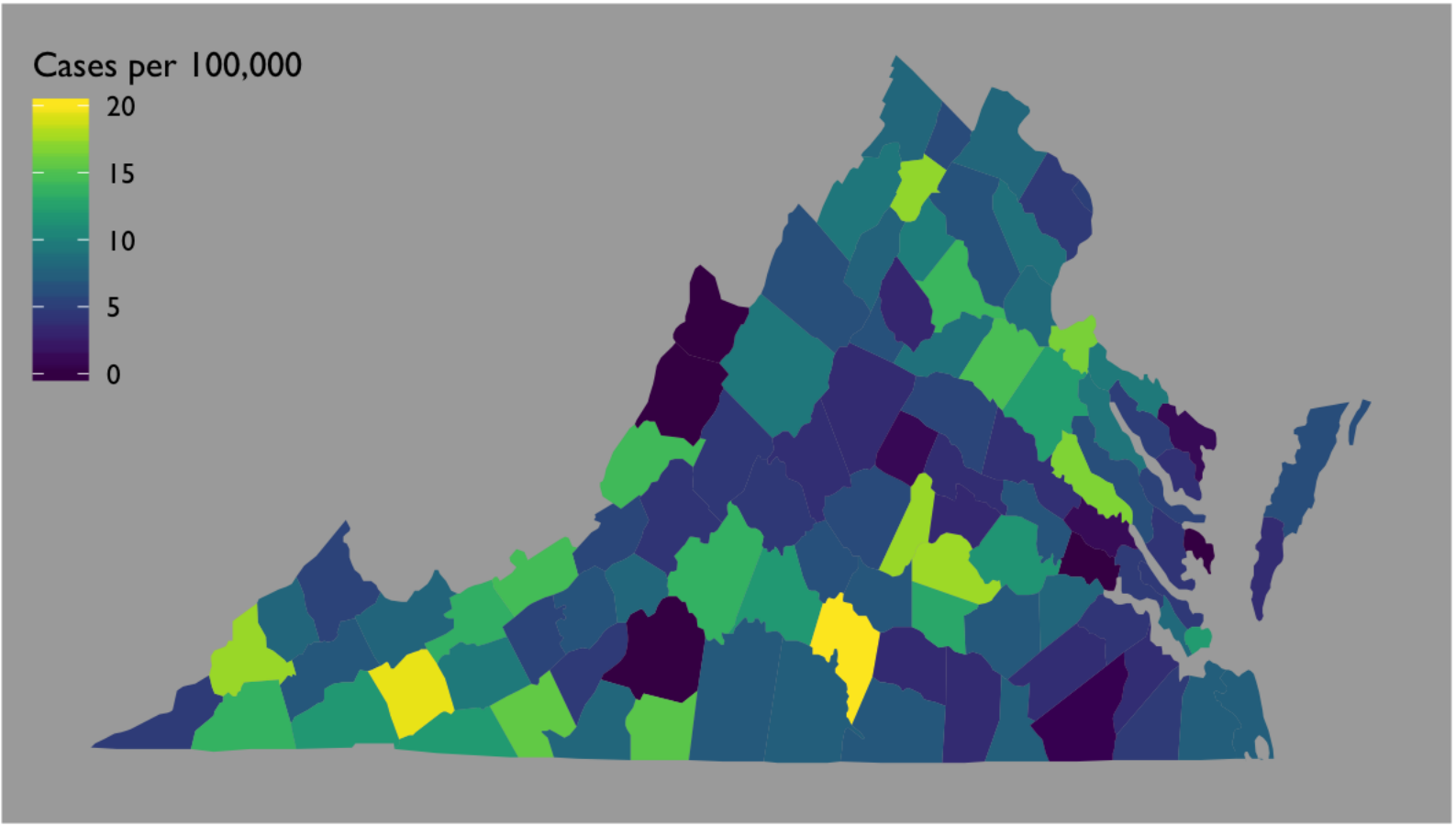
Case rates are approaching the lows of 2020, and the decline over the last few weeks may indicate that the vaccines are slowing the spread

- Virginia has been trending toward a sustained decline
- However, this trend may be fragile because the variants of concern and higher movement could still increase the case numbers among the unvaccinated

Cases broadly declined across the Commonwealth

CASE COUNT

Source: VDH



Yellow indicates at least 20 cases per 100,000

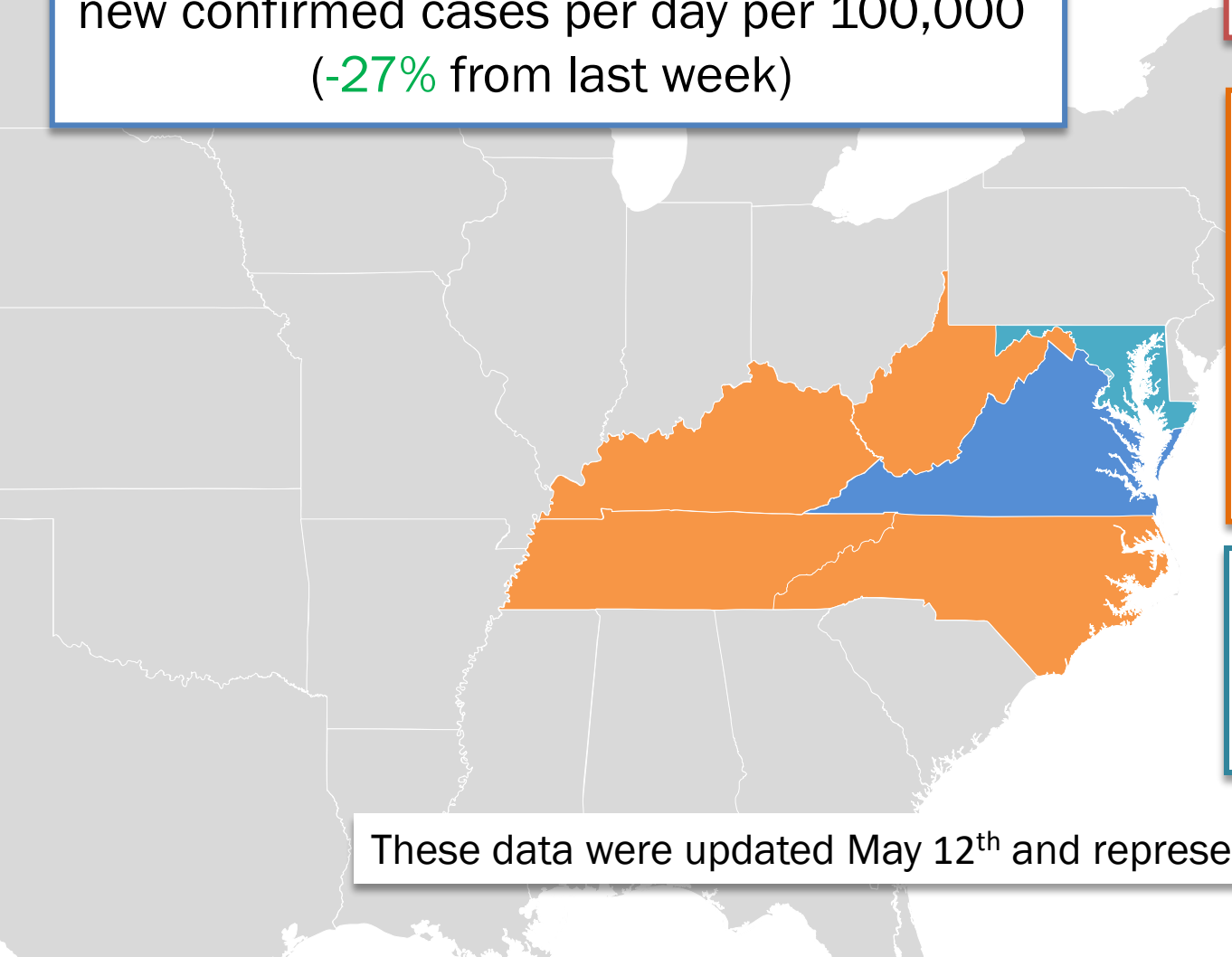
Case levels have drifted lower across the Commonwealth

- 98 percent of counties have fewer than 20 cases per 100,000 (91 percent last week)
- 71 percent of counties have fewer than 10 cases per 100,000 (46 percent last week)

These data were updated May 12th and represent a seven-day average of the previous week

Case level trends for neighboring states were down across the board last week

Over the last 7 days, Virginia had 8.2 new confirmed cases per day per 100,000 (-27% from last week)



Very high case loads (>20):

High case loads (10-20):

- West Virginia (19.2 new cases per 100k, -5% from last week)
- North Carolina (13.5, -15%)
- Kentucky (11.7, -15%)
- Tennessee (12.0, -25%)

Lower case loads (<10): None

- Maryland (9.0, -22%)
- District of Columbia (5.9, -14%)

These data were updated May 12th and represent a seven-day average of the previous week

Variants could increase the rate of spread

The CDC has Identified five variants of concern that spread more rapidly than the baseline variant and may also bypass immune protection from vaccines or previous infection

- All five variants of concern have been detected in Virginia

The CDC has projections of the current prevalence for HHS Region 3 (DE, DC, MD, PA, VA, and WV) based on genomic testing from April 11th to April 24th

- B.1.1.7 (“U.K. variant”) is estimated to be 66.5 percent of cases in the region
- P.1 (“Brazilian variant”) is estimated to be 1.6 percent of cases
- B.1.351 (“South African variant”) is estimated to be 0.9 percent of cases
- B.1.427/B.1.429 (“California variants”) are estimated to be 0.8 percent taken together

Additionally, there are several variants of interest that have been detected in the region

- B.1.526/B.1.526.1 /B.1.526.2 (“New York variants”) are estimated to be 10.5 percent, 5.0 percent, and 3.9 percent respectively
- B.1.617.1-3 (”Indian variants”) are estimated to be 0.5 percent of the cases in the region

35 percent of Virginians are fully vaccinated, and an additional 11 percent are partially vaccinated

Age	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80+	Total
Fully Vaccinated	0	76,759	301,959	385,511	430,589	531,791	600,861	440,358	210,473	2,978,301
% Full	0.0%	7.0%	26.2%	32.9%	40.0%	47.2%	61.5%	71.7%	67.6%	34.9%
Partially Vaccinated	0	78,830	156,688	162,425	158,653	169,227	127,511	63,090	34,681	951,105
% with Partial	0.0%	7.2%	13.6%	13.8%	14.7%	15.0%	13.1%	10.3%	11.1%	11.1%
Confirmed Cases	31,450	72,277	127,779	107,757	96,882	94,919	64,561	34,626	24,721	654,972
% Confirmed Cases	3.1%	6.6%	11.1%	9.2%	9.0%	8.4%	6.6%	5.6%	7.9%	7.7%

Source: VDH, May 12th

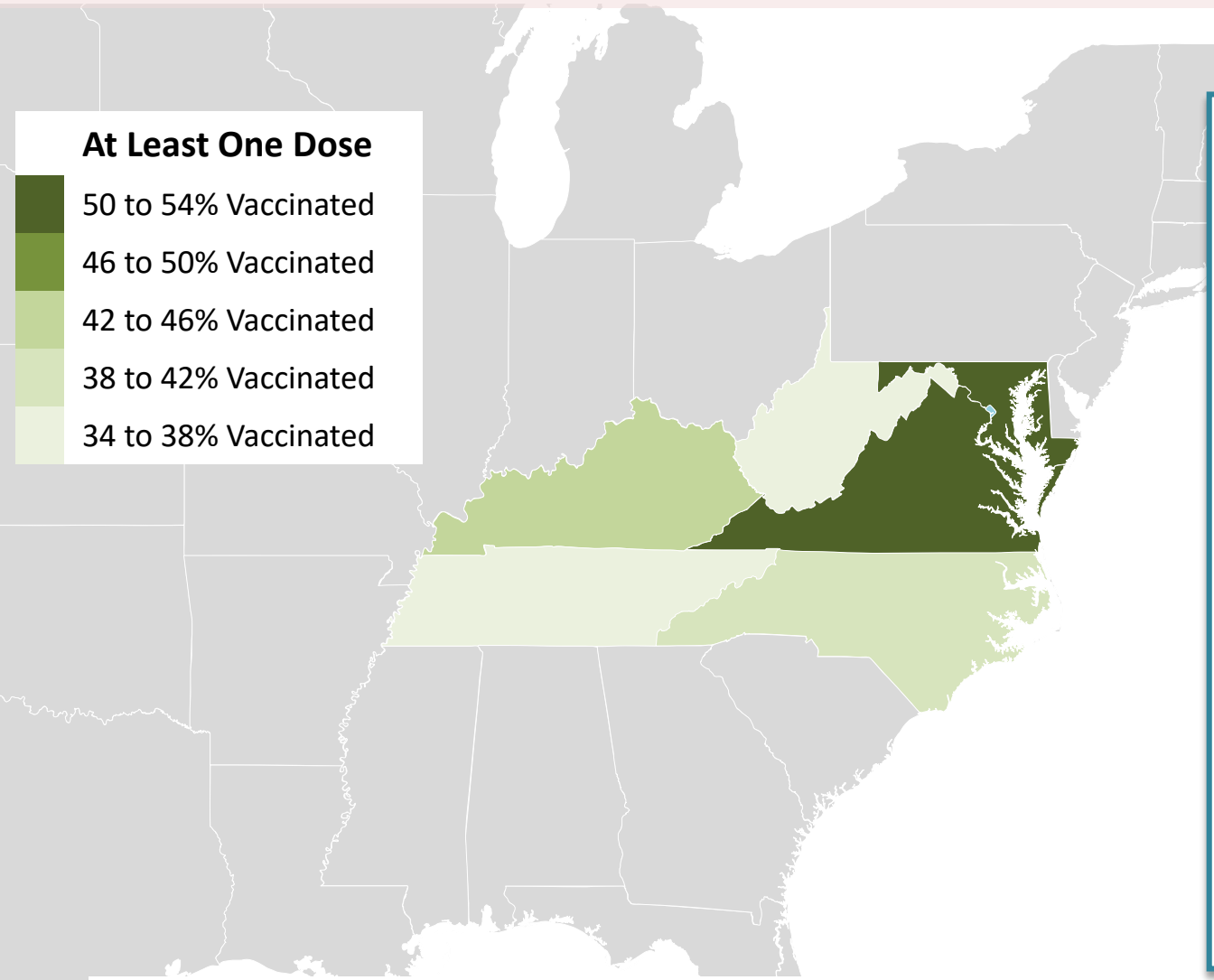
Vaccinations are slowing

- As of May 12th, 8,402,515 doses have been distributed and 6,876,455 doses have been administered
- Over the last seven days, Virginia has averaged 47,741 doses per day (-26% from last week)

A Kaiser Family Foundation poll from April indicated hesitancy has declined

- There is a small but consistent portion of the population resistant to receiving a vaccine (roughly 19 percent)
- The gaps in vaccination rates and hesitancy have closed between white, Black, and Hispanic populations
- If access to vaccinations is a barrier, targeted vaccination sites with extended hours and no requirement for an appointment may be more useful than mass vaccination sites

Vaccination rates among neighboring states vary substantially



	Partially Vaccinated*	Fully Vaccinated*
Nationwide	**11.0%**	**35.4%**
D.C.	15.8%	36.6%
Kentucky	7.8%	35.1%
Maryland	11.7%	40.2%
North Carolina	7.7%	33.0%
Tennessee	7.8%	28.4%
Virginia**	**11.8%**	**38.5%**
West Virginia	4.9%	32.3%

* Total population, includes out-of-state vaccinations
**Differs from previous slide because all vaccination sources (e.g., out-of-state) are included

Source: https://covid.cdc.gov/covid-data-tracker/#vaccinations
These data were updated May 12th

We've been monitoring recent, relevant literature

Wynberg et al. studied the long-term symptoms of COVID patients using data from 301 cases in the Netherlands

- The authors found 42 percent of cases had at least one symptom more than nine months after onset
- This implies that a sizeable portion of the recovered population will need continued care
- Research by Iwasaki et al. finds that vaccinations may reduce the symptoms of "long COVID"

Wu et al. studied the use of a vaccine booster against the B.1.351 and P.1 variants six to eight months after initial doses of the Moderna vaccine

- The authors found that individuals had antibodies that were more effective against B.1.351 and P.1 two weeks after receiving the booster than their antibodies prior to the booster
- These types of boosters may be needed if new variants can break throughimmune protection or if immunity wanes before the pandemic is suppressed

Courtemanche et al. examined the effect of school reopening on the spread of COVID in Texas

- In the fall of 2020, Texas reopened all schools at the same time as a high community rate of spread
- Using county level prevalence and mobility data, the authors estimate that the reopening led to 43,000 additional cases and 800 fatalities
- However, they estimate that the increased spread was caused primarily by parents spending more time away from home with their children out of the house, rather than spread directly related to schools

What is next for modeling and analysis?

Pandemic modeling has greatly evolved over the last year

- Initially, there was a dearth of high-quality data and the models were typically either SEIR-based or statistical
- As behaviors and policies changed, the models grew in complexity and hybrid/ensemble models are also used now
- Growing immunity, behavioral changes, and other factors will make modeling for the purpose of producing accurate forecasts particularly challenging in the coming months

At this stage of the pandemic, modeling and data analysis will be useful for addressing specific types of questions:

- How might the spread change as new variants enter Virginia?
- Which segments of the population remain the most vulnerable?
- As vaccinations increase and case levels decline, which NPIs can be relaxed and when?
- Are there early warnings or triggers that should be monitored to help inform policy?

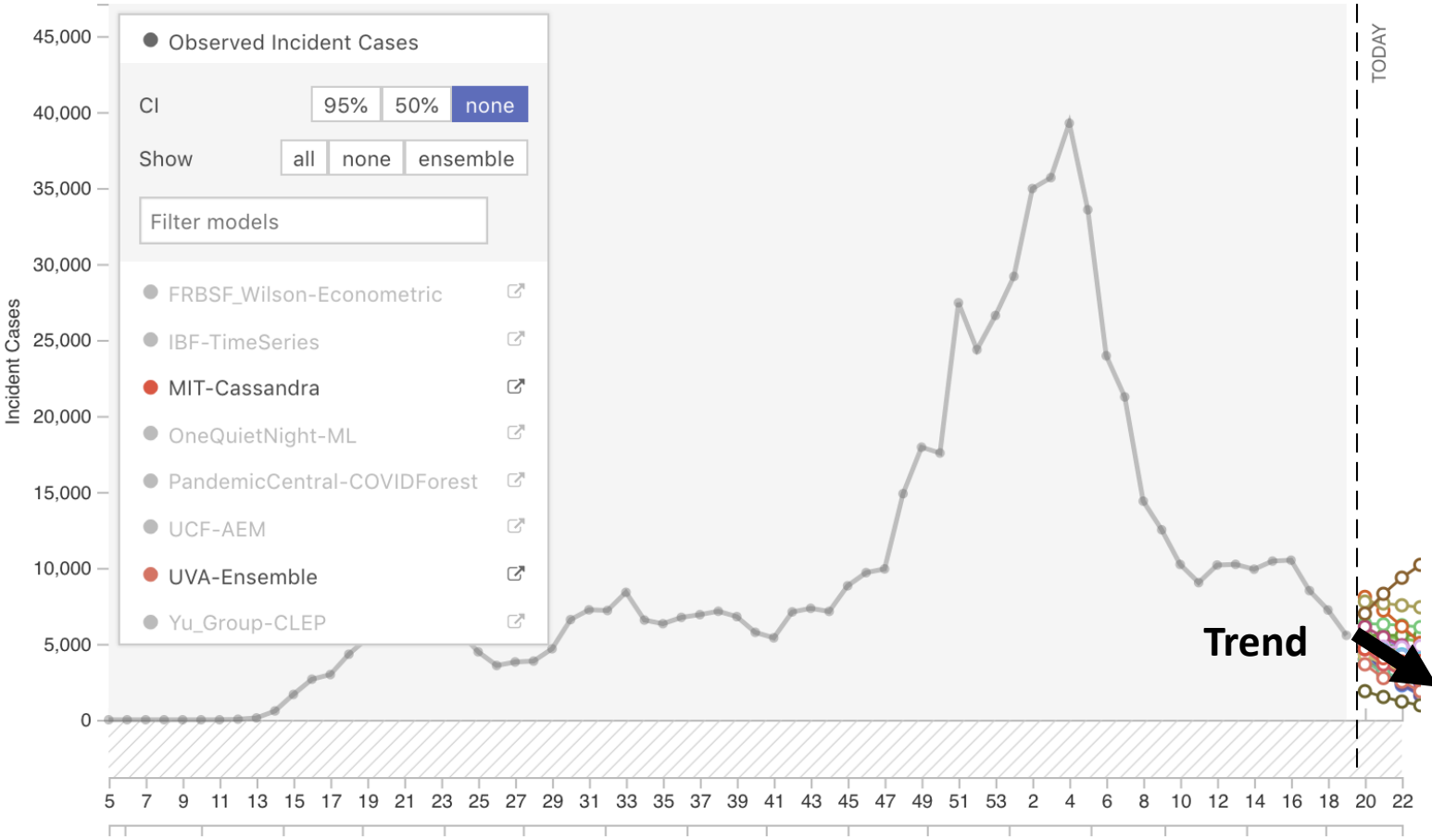
For other questions, surveillance is likely to be more useful:

- How widespread are the variants in Virginia?
- How many cases should we expect in the next few weeks?

Robust, integrated testing programs are necessary to conduct effective surveillance

- Data on the sampling approaches are useful to understand which areas and populations are well-covered versus under-covered
- Improving external access to data sources like wastewater testing or genomic sequencing could improve analysis

The model forecasts broadly agree on a sustained decline in cases



The model estimates generally forecast a substantial decrease

- With a couple of exceptions, the models broadly agree there will be a substantial decline in cases

Many of the model predictions lag the data

- This means that they match the trends in retrospect but not as forecasts

Source: COVID-19 Forecast Hub, https://viz.covid19forecasthub.org/
Accessed May 12th

What are the tradeoffs of resuming in-person schooling?

Children have historically been less severely affected by COVID than older age cohorts (Zimmermann 2020; CDC 2021)

- Also likely pose low risk to the broader community – outbreaks in schools have occurred in the absence of NPIs (e.g., In Israel, see Stein-Zamir 2020), but in-school transmission is generally less than in the surrounding community (Lessler 2021; ECDC 2020)

However, the increased transmissibility of B.1.1.7 variant of concern could qualitatively change the nature of the spread (Day 2021; Ratmann 2021)

- Proportion of cases occurring in children in the U.S. has risen from ~3% a year ago to ~22% today (Chappell 2021)
- More research and surveillance is required to determine the degree to which the age distribution of cases is shifting due to dominance of B.1.1.7 or other factors (e.g., vaccination rates in older adults)

COVID has the potential to cause serious physical and mental consequences in children

- Multisystem inflammatory syndrome in children (MIS-C, resembling Kasawaki Disease; Ionescu 2021), myocarditis (Witz 2020), and long COVID (Ludvigsson 2020) have been reported, but are not yet well understood
- The pandemic, and school closures in particular, have been associated with increased rates of depression, anxiety, and social isolation (Krass 2021)

Vaccination for children may be possible before the new school year, but measures such as targeted testing (Moghadas 2021), vaccination of school staff, and continuation of in-school NPIs could allow in-person schooling to resume safely

- Clinical trials in children are under way; 100% efficacy with Pfizer demonstrated in children 12-15 (Mahase 2021; Callaway 2021; Pfizer 2021) and the FDA has issued an Emergency Use Authorization for its use in that population
- Greatest risk of transmission seems to be to and from staff rather than students; encouraging vaccination for school staff could be an effective strategy (Ismail 2020; Vlachos 2021)

The pandemic characteristics will change over the summer and fall

The state of the pandemic in Virginia this summer and fall will depend on vaccination take up

- The number of hospitalizations and deaths will likely not surpass last year's levels because the elderly, the most vulnerable population, have a vaccination rate near 80 percent
- The rate of take up among the 18-to-65-year-old population is not currently on track for community immunity targets to be reached by the summer
- Additionally, there are likely to be substantial unvaccinated populations in the Far Southwest and among those under 30 years of age

Previous infections offer some protection, but it does not appear to be as effective as vaccination

- Several studies (e.g., Hansen, 2021 and Letizia, 2021) indicate that prior infection is about 80 percent effective in preventing future infection versus 94 percent or higher for Pfizer and Moderna (Tenforde, 2021)
- The durability of naturally acquired antibodies is not yet known, but they may wane (Hansen, 2021)
- Further, the efficacy of naturally acquired antibodies may be lower against the new variants

In this environment, there will be occasional waves of COVID cases, potentially tied to super-spreader events and seasonal changes/events (e.g., holidays or school calendars), but deaths and hospitalizations are not likely to spike

- Activities that increase vaccination take up (Bogart, 2021) make community immunity more attainable
- Decisionmakers should monitor variants that might break out of the immune protection in case a new strategy is needed
- If the durability of naturally acquired antibodies is only a few months, long-run cases could be reduced by encouraging those who have recovered from COVID to get vaccinated

There will be long-term consequences from COVID

As of May 12th, 668,147 Virginians had been diagnosed with COVID, and 55,440 had been hospitalized for it

- As many as one third of cases (223,000) result in “long COVID” with a range of physical effects
- Further, based on the Mishra et al. study, we would expect 200,000 Virginians to have had neurological issues associated with their case and more than 1,100 strokes to occur due to COVID
- Many of these people will have lingering physical and mental health consequences from their infections

Beyond those who survived COVID infections, there will be long-term repercussions from the pandemic

- Patients with chronic conditions may suffer long-term consequences due to delayed care
- Stress among health care providers has substantially lowered morale and may lead to additional attrition
- Further, distress and mental illness have risen substantially in the broader public and may require additional capacity to treat appropriately

Efforts to ensure adequate capacity for timely care could mitigate the effects of these consequences

- Access to telemedicine could be improved by additional training for providers and family members (Cantor, 2021)
- Increased investment in mental health care and substance abuse programs may be necessary to meet demand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