Analysis of COVID-19 in Virginia

July 21\textsuperscript{th}, 2021
(data current to July 18\textsuperscript{th} – July 20\textsuperscript{th})

Biocomplexity Institute Technical report: TR 2021-079
About Us

• Biocomplexity Institute at the University of Virginia
  • Using big data and simulations to understand massively interactive systems and solve societal problems
• Over 20 years of crafting and analyzing infectious disease models
  • Pandemic response for Influenza, Ebola, Zika, and others

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Model Development, Outbreak Analytics, and Delivery Team

Overview

• **Goal:** Evaluate indicators of change to guide future analyses and simulations

• **Approach:**
  • Visualizations of existing data
  • Statistical analyses to test hypotheses
  • Synthesis of multiple data sources and interpretation

• **Outcomes:**
  • Inform future analytic and simulation based studies
  • Improve awareness of evolving trends and novel elements
  • Foster discussion
Key Takeaways

Projecting future cases precisely is impossible and unnecessary. Even without perfect projections, we can confidently draw conclusions:

- **Case rates in Virginia have risen more broadly, some districts with rapid growth return to high case rates**
- VA mean weekly incidence slightly up to 4.4/100K from 2.8/100K, US up to 10/100K (from 7.2/100K)
- Vaccination rates continue to be slow while measured acceptance among unvaccinated remains steady
- Delta variant continues to grow, causing surges in several states and increased hospitalizations

The situation continues to change. Models continue to be updated regularly.
Situation Assessment
Case Rates (per 100k) and Test Positivity

County level test positivity from RT-PCR tests.

**Green:** <5.0%
(or with <20 tests in past 14 days)

**Yellow:** 5.0%-10.0%
(or with <500 tests and <2000 tests/100k and >10% positivity over 14 days)

**Red:** >10.0%
(and not "Green" or "Yellow")
District Trajectories

**Goal:** Define epochs of a Health District’s COVID-19 incidence to characterize the current trajectory

**Method:** Find recent peak and use hockey stick fit to find inflection point afterwards, then use this period’s slope to define the trajectory

<table>
<thead>
<tr>
<th>Trajectory</th>
<th>Description</th>
<th>Weekly Case Rate (per 100K) bounds</th>
<th># Districts (prev week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declining</td>
<td>Sustained decreases following a recent peak</td>
<td>below -0.9</td>
<td>5 (2)</td>
</tr>
<tr>
<td>Plateau</td>
<td>Steady level with minimal trend up or down</td>
<td>above -0.9 and below 0.5</td>
<td>6 (23)</td>
</tr>
<tr>
<td>Slow Growth</td>
<td>Sustained growth not rapid enough to be considered a Surge</td>
<td>above 0.5 and below 2.5</td>
<td>22 (9)</td>
</tr>
<tr>
<td>In Surge</td>
<td>Currently experiencing sustained rapid and significant growth</td>
<td>2.5 or greater</td>
<td>2 (1)</td>
</tr>
</tbody>
</table>
## District Trajectories – last 10 weeks

<table>
<thead>
<tr>
<th>Status</th>
<th># Districts (prev week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declining</td>
<td>5 (2)</td>
</tr>
<tr>
<td>Plateau</td>
<td>6 (23)</td>
</tr>
<tr>
<td>Slow Growth</td>
<td>22 (9)</td>
</tr>
<tr>
<td>In Surge</td>
<td>2 (1)</td>
</tr>
</tbody>
</table>

Curve shows smoothed case rate (per 100K) Trajectories of states in label & chart box
Case Rate curve colored by Reproductive
Estimating Daily Reproductive Number

July 20\textsuperscript{th} Estimates

<table>
<thead>
<tr>
<th>Region</th>
<th>Date Confirmed $R_e$</th>
<th>Date Confirmed Diff Last Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>State-wide</td>
<td>1.175</td>
<td>0.128</td>
</tr>
<tr>
<td>Central</td>
<td>1.105</td>
<td>0.178</td>
</tr>
<tr>
<td>Eastern</td>
<td>1.167</td>
<td>0.051</td>
</tr>
<tr>
<td>Far SW</td>
<td>0.989</td>
<td>-0.013</td>
</tr>
<tr>
<td>Near SW</td>
<td>1.248</td>
<td>0.248</td>
</tr>
<tr>
<td>Northern</td>
<td>1.201</td>
<td>0.043</td>
</tr>
<tr>
<td>Northwest</td>
<td>1.167</td>
<td>0.092</td>
</tr>
</tbody>
</table>

**Methodology**

- Wallinga-Teunis method (EpiEstim\textsuperscript{1}) for cases by confirmation date
- Serial interval: updated to discrete distribution from observations (mean=4.3, Flaxman et al, Nature 2020)
- Using Confirmation date since due to increasingly unstable estimates from onset date due to backfill

Hospitalizations across the US

Hospitalization rates remain low in VA but rapid change is possible as seen in other states

- Hotspot states see rapid rise in hospitalizations especially among the younger age groups
Recent case rate and Vaccination coverage

Vaccination coverage vs. recent case rate (per 100k) shows some correlation
• Most vaccinated currently remain at low levels, below 50% vaccinated has much more diversity
• Central and Near SW have highest case rates
• Interactive plot allows for further exploration
Vaccination Administration Slows

Regional Vaccine courses initiated per day:
- Total counts of first dose of vaccines across regions

Shipments have slowed with decreased demand
Vaccinations Shift to Younger Populations
Vaccine Acceptance in Virginia - COVIDcast

Acceptance remains high:
• Proportion of Virginians that have already or would definitely or probably accept vaccination if offered today
• Survey respondents are reporting high levels of vaccination of ~80% reflecting bias of the mechanism
• Top reasons for hesitancy: side effects, distrust (increasing), unnecessary (increasing)
• More likely to take if recommended by: doctors and friends
• Reasons unnecessary: Not serious, not high risk, or other

Data Source: https://covidcast.cmu.edu
Vaccine Acceptance by Region- COVIDcast

Levels of Acceptance and potential acceptance in flux:
• Nearly all the “Definitely Yes” have been vaccinated, yet there are 5-10% remaining across the regions
• Northwest and Southwest (to lesser degree) see growth in “probably not”, seemingly from “definitely not”

Data Source: https://covidcast.cmu.edu
SARS-CoV2 Variants of Concern

**Delta δ - Lineage B.1.617.2 and related subvariants**

- Delta plus δ+ lineage which contains the K417N mutation is emerging as a sub-variant that is even more transmissible. Declared a VoC in India
- Strain shows continued growth in Europe and across US, predicted to predominate in coming weeks (July 2nd in VA), Scotland now experiencing highest daily case counts, driven by delta.
- Several studies estimate B.1.617.2 to have 100% faster growth than B.1.1.7, and a UK study suggests a 13% advantage over B.1.1.7; we are roughly tracking what seems to be a ~60% growth rate advantage in VA
- More studies show limited immune escape similar to B.1.351, however, many studies still suggest protection remains for vaccinated, especially 2 doses and mRNA vaccines
- PHE study shows limited efficacy of Astra-Zeneca with only one dose, efficacy returns following 2nd dose, also stronger with a followup Pfizer
- Public Health Scotland study in Lancet suggests Delta is 2x more likely to cause hospitalization than Alpha
- New study shows evasion of natural and of Pfizer vax (though weak) also shows transmissibility boost comes from more efficient fusion and lung cell entry
Substantial increases in estimated R effective in California counties [https://ca-covid-r.info/]

BNT162b2 and mRNA-1273-elicited antibodies showed modest neutralization resistance against Beta, Delta, Delta plus and Lambda variants whereas Ad26.COV2.S-elicited antibodies from a significant fraction of vaccinated individuals were of low neutralizing titer (IC50<50) [https://www.biorxiv.org/content/10.1101/2021.07.19.452771v1.full.pdf]

[https://www.nytimes.com/2021/07/20/health/coronavirus-johnson-vaccine-delta.html]

Study of serosurvey from Vo Italy, shows estimated antibody decay rate after 9 months [https://www.nature.com/articles/s41467-021-24622-7]

[https://twitter.com/EricTopol/status/141712854965018632]
Variant of Concern Trajectories

United States

United State

5% - May 21; 50% - July 2nd

Virginia
2021-05-20

Prevalence


Prevalence


other
P.1
B.1.617.2
B.1.617.1
B.1.526
B.1.429
B.1.351
B.1.1.7

other
P.1
B.1.617.2
B.1.617.1
B.1.526
B.1.429
B.1.351
B.1.1.7
Other State Comparisons

Trajectories of States

• Lots of new growth with 6 states in surge and many others with upward trajectories.

Virginia and her neighbors

• VA and neighbors are all in plateau with moderate growth
References


NSSAC. PatchSim: Code for simulating the metapopulation SEIR model. [https://github.com/NSSAC/PatchSim](https://github.com/NSSAC/PatchSim)


Google. COVID-19 community mobility reports. [https://www.google.com/covid19/mobility/](https://www.google.com/covid19/mobility/)

Questions?

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