Estimation of COVID-19 Impact in Virginia

February 10th, 2021
(data current to February 8th – 9th)

Biocomplexity Institute Technical report: TR 2021-018
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

Points of Contact

Bryan Lewis
brylew@virginia.edu

Srini Venkatramanan
srini@virginia.edu

Madhav Marathe
marathe@virginia.edu

Chris Barrett
ChrisBarrett@virginia.edu

Biocomplexity COVID-19 Response Team

Overview

• **Goal:** Understand impact of COVID-19 mitigations in Virginia

• **Approach:**
  • Calibrate explanatory mechanistic model to observed cases
  • Project based on scenarios for next 4 months
  • Consider a range of possible mitigation effects in "what-if" scenarios

• **Outcomes:**
  • Ill, Confirmed, Hospitalized, ICU, Ventilated, Death
  • Geographic spread over time, case counts, healthcare burdens
Key Takeaways

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

• **Case rate growth in Virginia continues to decline**
  - VA mean weekly incidence down to 39/100K from 45/100K, US levels decline (to 29 from 37 per 100K)
  - Case rates are still high, 46% of VA counties still report weekly incidence above half of their peak
  - Projections are down across commonwealth

• Recent updates:
  - Further refinement to Variant B.1.1.7 scenarios to incorporate recent data
  - Impact of transmission boosting from Variant B.1.1.7 added to control-based scenarios
  - Further updates to vaccination schedules, with fitting now down on partially vaccinated population and future vaccinations based on current levels instead of goals

• The situation is changing rapidly. Models continue to be updated regularly.
Situation Assessment
Case Rate (per 100k) by VDH District

Declines continue across the commonwealth

- Majority of districts have decreasing rates
- Rates remain high in many districts
Weekly changes in test positivity by district

• Rates continue to decline
• Many fewer counties (85) over 10% (as of Feb 3rd)

County level test positivity rates for RT-PCR tests.

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

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

Red: >10.0% and not meeting the criteria for “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>33 (29)</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>0 (1)</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>2 (4)</td>
</tr>
<tr>
<td>In Surge</td>
<td>Currently experiencing sustained rapid and significant growth</td>
<td>2.5 or greater</td>
<td>0 (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>33 (29)</td>
</tr>
<tr>
<td>Plateau</td>
<td>0 (1)</td>
</tr>
<tr>
<td>Slow Growth</td>
<td>2 (4)</td>
</tr>
<tr>
<td>In Surge</td>
<td>0 (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

Feb 7th Estimates

<table>
<thead>
<tr>
<th>Region</th>
<th>Date Confirmed R&lt;sub&gt;e&lt;/sub&gt;</th>
<th>Date Confirmed</th>
<th>Diff Last Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>State-wide</td>
<td>0.780</td>
<td>-0.162</td>
<td></td>
</tr>
<tr>
<td>Central</td>
<td>0.816</td>
<td>-0.148</td>
<td></td>
</tr>
<tr>
<td>Eastern</td>
<td>0.786</td>
<td>-0.080</td>
<td></td>
</tr>
<tr>
<td>Far SW</td>
<td>0.739</td>
<td>-0.082</td>
<td></td>
</tr>
<tr>
<td>Near SW</td>
<td>0.789</td>
<td>-0.163</td>
<td></td>
</tr>
<tr>
<td>Northern</td>
<td>0.768</td>
<td>-0.256</td>
<td></td>
</tr>
<tr>
<td>Northwest</td>
<td>0.738</td>
<td>-0.161</td>
<td></td>
</tr>
</tbody>
</table>

Methodology

- Wallinga-Teunis method (EpiEstim<sup>3</sup>) for cases by **confirmation date**
- Serial interval: 6 days (2 day std dev)
- Using Confirmation date since due to increasingly unstable estimates from onset date due to backfill

Changes in Case Detection

<table>
<thead>
<tr>
<th>Timeframe (weeks)</th>
<th>Mean days</th>
<th>% difference from overall mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>May (17-21)</td>
<td>5.7</td>
<td>-19%</td>
</tr>
<tr>
<td>June (22-25)</td>
<td>5.8</td>
<td>-19%</td>
</tr>
<tr>
<td>July (26-30)</td>
<td>6.2</td>
<td>-13%</td>
</tr>
<tr>
<td>Aug (31-34)</td>
<td>4.9</td>
<td>-30%</td>
</tr>
<tr>
<td>Sept (35-38)</td>
<td>4.5</td>
<td>-36%</td>
</tr>
<tr>
<td>Oct (39-43)</td>
<td>4.5</td>
<td>-37%</td>
</tr>
<tr>
<td>Nov (44-47)</td>
<td>4.5</td>
<td>-37%</td>
</tr>
<tr>
<td>Dec (48-49)</td>
<td>4.2</td>
<td>-41%</td>
</tr>
<tr>
<td>Jan (00-02)</td>
<td>3.8</td>
<td>-46%</td>
</tr>
<tr>
<td>Overall (13-03)</td>
<td>7.1</td>
<td></td>
</tr>
</tbody>
</table>

Testing levels continue to slow as seen in the chart for July with 6.2 days and December with 4.1 days.

Days from Onset to Diagnosis and Test Positivity - Weekly

- **July**: 6.2 days
- **Aug**: 4.9 days
- **Sept**: 4.6 days
- **Oct**: 4.5 days
- **Nov**: 4.5 days
- **Dec**: 4.1 days
- **Jan**: 3.8 days

Test positivity vs. Onset to Diagnosis:
- Positivity remains high but is down overall.
Mask usage in Virginia

State level mask usage as reported via Facebook surveys has shown steady increase over past three months
- ~88% (early Nov) to ~94% (mid Jan)
- Some variance across the commonwealth
- ~3000 daily responses from VA

Data Source: https://covidcast.cmu.edu

Correlations seen among VA counties between mask use and case rate are now stronger due to surging growth
Slope: - 2.7; for every % we see a ~3/100K case rate difference
Vaccine Acceptance

Facebook administered survey:
Percent of people who would definitely or probably choose to receive a COVID vaccine if offered today

VA typically achieves 50-60% coverage with seasonal influenza vaccine (typically over the course of 3 months)

Data as of Jan 31st
Data issues prevented update this week

Acceptance slightly up over the course of January:
Over ¾ of Virginians are likely to choose to be vaccinated

COVIDcast Data Explorer
Source: https://covidcast.cmu.edu
Case Rates among health workers compared to population in last week

- Based on census counts of patient-facing health care workers (Practitioners and Technologists)
Age-Specific Case Rates

Proportion of cases by age-group for last 10 weeks

- Some districts showing increasing proportions in younger age groups, overall steady

- Proportion of cases missing a reported age increased significantly in recent weeks and is censored to better reveal patterns
Recent Changes in Race and Ethnicity Rates (per 100k)

- Two week change in population level rates
- Black, Latinx and 2 or more races populations have much higher changes in rates; disparity is more pronounced in some districts than others
- Based on 2019 census race-ethnicity data by county
Rates per 100K of each Racial-Ethnic population by Health District

- Each Health District’s Racial-Ethnic population is plotted by their Hospitalization and Case Rate
- Points are sized based on their overall population size
- Overlapping labels removed for clarity
Impact across Density and Income

All zip codes show back into growth, wealthiest zip code now lags the rest significantly

Full evolution of pandemic, shows shifts from denser and wealthier zip codes to poorer and less dense zip codes
Other State Comparisons

Trajectories of States

- All states are declining (26) or plateaued (28)
- Rates still remain relatively high

Virginia and her neighbors

- VA and her neighbors are all declining or plateaued
- Rates remain high in most states however
Current Week vs. Highest Week

For all counties in the US

Recent Incidence Compared to Worst Week by County

- 19% of US counties have a weekly case rate over 50% of the worst weekly case rate

Virginia’s counties

Recent Incidence Compared to Worst Week by County

- 46% of VA counties have a weekly case rate over 50% of the worst weekly case rate
Case Rates in the last week by zip code

- Fewer prisons are in the top ten, most prisons seem to have intense rates for 2 to 3 weeks
- Concentrations of high rates in central and northwest regions
- Some counts are low and suppressed to protect anonymity, those are shown in white
Risk of Exposure by Group Size

Case Prevalence in the last week by zip code used to calculate risk of encountering someone infected in a gathering of randomly selected people (group size 25)

• Assumest 3 undetected infections per confirmed case (ascertainment rate from recent seroprevalence survey)
• On left, minimum size of a group with a 50% chance an individual is infected by zip code (eg in a group of 14 in Hanover, there is a 50% chance someone will be infected)
• Some zip codes have high likelihood of exposure even in groups of 25

Based on zip code point prevalence for week ending 2021-01-30

Based on zip code point prevalence for week ending 2021-02-06
New variants of SARS-CoV2

Emerging new variants will alter the future trajectories of pandemic and have implications for future control

- Current evidence supports that new variants can:
  - Increase transmissibility
  - Increase severity (more hospitalizations and/or deaths)
  - Limit immunity from prior infection and vaccination

**Lineage B.1.1.7**

- B.1.1.7 has been detected in Virginia as well as in at least 932 cases across 34 states as of Feb 9th (avg delay of 10-20 days from isolation to reporting), will continue to grow rapidly
- **Updated estimates based on US growth rates** estimate it will predominate (eg reach 50% frequency) by mid to late March and is 35%-45% more transmissible.
- **A recent study** suggests this variant may have higher mortality
- **Bioinformatic study by PHE** shows E484K mutation as is found in B.1.351 has arisen multiple times in UK based B.1.1.7, also in this report household secondary attack rate is 25% greater

NIH-NIAID Bacterial-Viral Bioinformatics Resource Center

<table>
<thead>
<tr>
<th>Variant</th>
<th>Reported Cases in US</th>
<th>Number of States Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.1.1.7</td>
<td>932</td>
<td>34</td>
</tr>
<tr>
<td>B.1.351</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>P.1</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

Emerging Variant Cases in the United States

Andersen et al.

U.S. is on a similar trajectory as other countries where B.1.1.7 rapidly became dominant
New variants of SARS-CoV2

Lineage B.1.351

- Emerging strain predominantly South Africa shows signs of vaccine escape, currently 9 reported cases in 3 states as of Feb 9th
- Some Experiments have demonstrated reduced potency of convalescent sera, while a recent study showed a strong response to spike proteins engineered with similar mutations
- Moderna and Pfizer vaccine demonstrated to have robust response to this variant, and thus likely to remain highly effective
- Another study demonstrated that while natural immunity may be limited, a single boosting dose of Pfizer or Moderna vaccine provided a robust neutralizing response
- Novovax and Johnson & Johnson vaccine demonstrated reduced efficacy in arm conducted in South Africa when this strain was circulating

Lineage P.1 (similar mutations as in B.1.1.7 and B.1.351)

- First case reported in Minnesota on Monday Jan 25th, now 3 cases in 2 states
- Resurgence of hospitalizations in Manaus, Brazil continues this despite estimated ¾ of the population infected

Lineage B.1.429 (similar mutations as in B.1.1.7 and B.1.351)

- Initially found in Southern California, coincided with surge in Nov and Dec
- Found in over half of sequenced samples in LA

Immune escaping mutations have arisen independently

E484K mutation found in South African (B.1.351) and Brazilian (B.1.1.28) variants has arisen 3 times independently in the B.1.1.7 strain. Nextstrain.org – Phylogeny of 484,501,570

Convergent evolution towards more transmissible variants currently being observed recreated through in vitro evolution, may provide picture of next mutations to look for: “we project that the Q498R mutation will appear in the future”
Model Update – Adaptive Fitting
Adaptive Fitting Approach

Each county fit precisely, with recent trends used for future projection

- Allows history to be precisely captured, and used to guide bounds on projections

**Model:** An alternative use of the same meta-population model, PatchSim

- Allows for future “what-if” Scenarios to be layered on top of calibrated model
- Eliminates connectivity between patches, to allow calibration to capture the increasingly unsynchronized epidemic

**External Seeding:** Steady low-level importation

- Widespread pandemic eliminates sensitivity to initial conditions
- Uses steady 1 case per 10M population per day external seeding
Using Ensemble Model to Guide Projections

Ensemble methodology that combines the Adaptive with machine learning and statistical models such as:

• Autoregressive (AR, ARIMA)
• Neural networks (LSTM)
• Kalman filtering (EnKF)

Weekly forecasts done at county level.
Models chosen because of their track record in disease forecasting and to increase diversity and robustness.

Ensemble forecast provides additional ‘surveillance’ for making scenario-based projections.
Also submitted to CDC Forecast Hub.
Seroprevalence updates to model design

Several seroprevalence studies provide better picture of how many actual infections have occurred

• Virginia Serology Study estimated 2.4% of Virginians estimated infected (as of Aug 15th)

• CDC Nationwide Commercial Laboratory Seroprevalence Survey estimated 4.6% [3.0% – 6.6%] seroprevalence as of Nov 12th – 26th up from 4.1% a month earlier

These findings are equivalent to an ascertainment ratio of ~3x, with bounds of (1x to 7x)

• Thus for 3x there are 3 total infections in the population for every confirmed case

• Uncertainty design has been shifted to these bounds (previously higher ascertainment as was consistent earlier in the pandemic were being used)

https://covid.cdc.gov/covid-data-tracker/#national-lab

Virginia Coronavirus Serology Project
Interim findings by region and statewide - July 22, 2020

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of participants</th>
<th>Number antibody positive</th>
<th>Crude prevalence per 100 participants</th>
<th>Weighted prevalence*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central</td>
<td>400</td>
<td>8</td>
<td>2.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Central</td>
<td></td>
<td></td>
<td></td>
<td>(0.5, 5.5)</td>
</tr>
<tr>
<td>East</td>
<td>707</td>
<td>9</td>
<td>1.3</td>
<td>1.5</td>
</tr>
<tr>
<td>East</td>
<td></td>
<td></td>
<td></td>
<td>(0.2, 3.2)</td>
</tr>
<tr>
<td>Northern</td>
<td>819</td>
<td>36</td>
<td>4.4</td>
<td>4.2</td>
</tr>
<tr>
<td>Northern</td>
<td></td>
<td></td>
<td></td>
<td>(2.5, 5.9)</td>
</tr>
<tr>
<td>Northwest</td>
<td>756</td>
<td>11</td>
<td>1.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Northwest</td>
<td></td>
<td></td>
<td></td>
<td>(0.2, 1.6)</td>
</tr>
<tr>
<td>Southwest</td>
<td>431</td>
<td>3</td>
<td>0.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Southwest</td>
<td></td>
<td></td>
<td></td>
<td>(0.2, 2.1)</td>
</tr>
<tr>
<td>Virginia</td>
<td>3,113</td>
<td>67</td>
<td>2.2</td>
<td>2.4</td>
</tr>
<tr>
<td>Virginia</td>
<td></td>
<td></td>
<td></td>
<td>(1.4, 3.1)</td>
</tr>
</tbody>
</table>

* Weighted prevalence is reweighted by region, age, sex, race, ethnicity, and insurance status to match census population.

Calibration Approach

• **Data:**
  - County level case counts by date of onset (from VDH)
  - Confirmed cases for model fitting

• **Calibration:** fit model to observed data and ensemble’s forecast
  - Tune transmissibility across ranges of:
    - Duration of incubation (5-9 days), infectiousness (3-7 days)
    - Undocumented case rate (1x to 7x) guided by seroprevalence studies
    - Detection delay: exposure to confirmation (4-12 days)
  - Approach captures uncertainty, but allows model to precisely track the full trajectory of the outbreak

• **Project:** future cases and outcomes generated using the collection of fit models run into the future
  - Mean trend from last 7 days of observed cases and first week of ensemble’s forecast used
  - Outliers removed based on variances in the previous 3 weeks
  - 2 week interpolation to smooth transitions in rapidly changing trajectories
Scenarios – Seasonal Effects

- Variety of factors continue to drive transmission rates
  - Seasonal impact of weather patterns, travel and gatherings related to holidays, fatigue with infection control practices
- Plausible levels of transmission can be bounded by past experience
  - Assess transmission levels at the county level since May 2020
  - Use the highest and lowest levels experienced (excluding outliers) as plausible bounds for levels of control achievable
  - Transition from current levels of projection to the new levels over 2 months
- New planning Scenarios:
  - Best of the Past: Lowest level of transmission (10th percentile)
  - Fatigued Control: Highest level of transmission (95th percentile) increased by additional 5%
Scenarios – Novel Variants

- Several novel variants of SARS-CoV2 are being tracked
  - Some are more transmissible, some may escape immunity from previous natural infection and/or vaccination, others may be more severe
- New Variant B.1.1.7 is best understood and is in Virginia
  - **Transmission increase:** Several different studies have estimated the increase in transmission to be 30-55%, we use 40% increase from the current baseline projection
  - **Emergence timing:** Gradually assumes predominance over the next 6 weeks, reaching 50% frequency in late March as estimated in a recent MMWR report from CDC and refined by Andersen et al.
- Variant planning Scenario:
  - **VariantB117:** Current projected transmissibility increases gradually over 4 months to level 40% more transmissible
Scenarios – Vaccines

• Vaccination has started, and efforts are underway to increase its pace
  • Exact achievable rollouts and level of coverage are unknown, though coming into focus

• Vaccine efficacy varies over course of vaccine
  • FDA EUAs show 50% efficacy achieved 2 weeks after 1\textsuperscript{st} dose, and 95% 2 weeks after 2\textsuperscript{nd} dose
  • Assuming 3.5 week (average of Pfizer and Moderna) gap between doses

• Vaccine hesitancy poses a future problem
  • Currently demand far outpaces supply so we assume all courses will be administered until we reach the hesitancy threshold, for 50% this is several months in the future.

Current rollouts and scenarios inspired by MIDAS Network COVID-19 Scenario Hub: https://github.com/midas-network/covid19-scenario-modeling-hub

VA Vaccination Rates

Lines represent 1M & 2M total doses administered a day (rate of 303/100K & 606/100K)

Accessed 8:30am February 10, 2021
Scenarios – Vaccines

• Administration schedule uses actual administration and expected for the future
  • Use history of state-specific doses administered as captured by Bloomberg (up to Jan 19th) and CDC (Jan 20th and on)
  • Adjustments made to make the vaccine specific for each county (as obtained through VDH dashboard) vax data in data package.
  • Future courses based on sustaining daily average of most recent week
    • **Rate:** 354 doses per 100K per day (~30K total per day)
    • **Location:** Per capita distribution across all counties

Scenarios – Seasonal Effects and Vaccines

Three scenarios combine these seasonal effects and use the updated vaccine schedule

- **Adaptive**: No seasonal effects from base projection
  - If things continue as they are

- **Adaptive-FatigueControl**: Fatigued control seasonal effects
  - If we revert to slightly worst transmission experienced in last 6 months

- **Adaptive-BestPast**: Best of the past control seasonal effects
  - If we revert to best control experienced in last 6 months

- **Adaptive-VariantB117**: Boosting of transmissibility from the emergence of B.1.1.7
  - If new variants begin to predominate and boost transmission, this assumes current seasonal affects remain the same (eg like Adaptive)

- **Adaptive-FatigueControl-VariantB117**: Fatigued control and txm boost from B.1.1.7
- **Adaptive-BestPast-VariantB117**: Best of the past control vs. txm boost from B.1.1.7

Counterfactuals with no vaccine (“NoVax”) are provided for comparison purposes
Model Results
Outcome Projections

**Confirmed cases**
Virginia Daily Confirmed - Comparison

- Adaptive-BestPast-VariantB117
- Adaptive-BestPast
- Adaptive-FatigueControl-VariantB117
- Adaptive-FatigueControl
- Adaptive-VariantB117
- Adaptive

**Estimated Hospital Occupancy**

**Daily Deaths**
Virginia Daily Death - Comparison

- Adaptive-BestPast-VariantB117
- Adaptive-BestPast
- Adaptive-FatigueControl-VariantB117
- Adaptive-FatigueControl
- Adaptive-VariantB117
- Adaptive

**Daily Hospitalized**
Virginia Daily Hospitalized - Comparison

- Adaptive-BestPast-VariantB117
- Adaptive-BestPast
- Adaptive-FatigueControl-VariantB117
- Adaptive-FatigueControl
- Adaptive-VariantB117
- Adaptive
District Level Projections: Adaptive

Adaptive projections by District

• Projections that best fit recent trends
• Daily confirmed cases rate (per 100K) by Region (grey with 7-day average in black) with simulation colored by scenario
District Level Projections: Adaptive-BestPast

Adaptive projections by District

• Projections that best fit recent trends
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• Projections that best fit recent trends
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Adaptive projections by District

- Projections that best fit recent trends
- Daily confirmed cases rate (per 100K) by Region (grey with 7-day average in black) with simulation colored by scenario

District Level Projections: Adaptive-FatigueControl-VariantB117
Hospital Demand and Bed Capacity by Region

Capacities* by Region – Adaptive-FatigueControl
COVID-19 capacity ranges from 80% (dots) to 120% (dash) of total beds

If Adaptive-FatigueControl scenario persists:
- Surge bed capacity is unlikely to be reached in coming 4 months

* Assumes average length of stay of 8 days

https://nssac.bii.virginia.edu/covid-19/vmrddash/
## Weekly Cases and Hospitalizations

### Weekly confirmed cases

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>2/7/21</td>
<td>25,130</td>
<td>25,130</td>
<td>25,130</td>
<td>25,130</td>
<td>25,130</td>
</tr>
<tr>
<td>2/14/21</td>
<td>22,323</td>
<td>22,315</td>
<td>22,309</td>
<td>22,376</td>
<td>22,390</td>
</tr>
<tr>
<td>2/21/21</td>
<td>19,062</td>
<td>19,048</td>
<td>19,045</td>
<td>19,426</td>
<td>19,449</td>
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<tr>
<td>2/28/21</td>
<td>16,102</td>
<td>16,074</td>
<td>16,070</td>
<td>16,839</td>
<td>16,859</td>
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<tr>
<td>3/7/21</td>
<td>13,416</td>
<td>13,463</td>
<td>13,372</td>
<td>14,516</td>
<td>14,619</td>
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<tr>
<td>3/14/21</td>
<td>11,003</td>
<td>11,670</td>
<td>10,783</td>
<td>12,542</td>
<td>13,425</td>
</tr>
<tr>
<td>3/21/21</td>
<td>8,939</td>
<td>10,617</td>
<td>8,400</td>
<td>10,904</td>
<td>13,159</td>
</tr>
<tr>
<td>3/28/21</td>
<td>7,071</td>
<td>9,784</td>
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<td>9,498</td>
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### Weekly Hospitalizations

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Key Takeaways

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

• **Case rate growth in Virginia continues to decline**
  - VA mean weekly incidence down sharply 45/100K from 54/100K, as national levels continued to decline (to 37/100K from 45/100K)

• Projections are mixed across commonwealth with declines far outpacing growth

• Recent updates:
  - Scenarios expanded to add impact of transmission boosting from Variant B.1.1.7 to control-based (best of past and fatigued) scenarios
  - Further updates to vaccination schedules, with fitting now down on partially vaccinated population and future vaccinations based on current levels instead of goals

• The situation is changing rapidly. Models will be updated regularly.
References


Biocomplexity page for data and other resources related to COVID-19: https://covid19.biocomplexity.virginia.edu/
Questions?

Biocomplexity COVID-19 Response Team

Aniruddha Adiga, Abhijin Adiga, Hannah Baek, Chris Barrett, Golda Barrow, Richard Beckman, Parantapa Bhattacharya, Andrei Bura, Jiangzhuo Chen, Patrick Corbett, Clark Cucinell, Allan Dickerman, Stephen Eubank, Arindam Fadikar, Joshua Goldstein, Stefan Hoops, Ben Hurt, Sallie Keller, Ron Kenyon, Brian Klahn, Gizem Korkmaz, Vicki Lancaster, Bryan Lewis, Dustin Machi, Chunhong Mao, Achla Marathe, Madhav Marathe, Fanchao Meng, Henning Mortveit, Mark Orr, Joseph Outten, Akhil Peddireddy, Przemyslaw Porebski, SS Ravi, Erin Raymond, Jose Bayoan Santiago Calderon, James Schlitt, Aaron Schroeder, Stephanie Shipp, Samarth Swarup, Alex Telionis, Srinivasan Venkatramanan, Anil Vullikanti, James Walke, Amanda Wilson, Dawen Xie

Points of Contact

Bryan Lewis
brylew@virginia.edu

Srini Venkatramanan
srini@virginia.edu

Madhav Marathe
marathe@virginia.edu

Chris Barrett
ChrisBarrett@virginia.edu
Supplemental Slides
Estimating Daily Reproductive Number

Jan 30th Estimates

<table>
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<tr>
<th>Region</th>
<th>Date of Onset $R_e$</th>
<th>Date Onset Diff Last Week</th>
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Methodology

- Wallinga-Teunis method (EpiEstim²) for cases by date of onset
- Serial interval: 6 days (2 day std dev)
- Recent estimates may be unstable due to backfill

Agent-based Model (ABM)

**EpiHiper: Distributed network-based stochastic disease transmission simulations**

- Assess the impact on transmission under different conditions
- Assess the impacts of contact tracing

**Synthetic Population**

- Census derived age and household structure
- Time-Use survey driven activities at appropriate locations

**Detailed Disease Course of COVID-19**

- Literature based probabilities of outcomes with appropriate delays
- Varying levels of infectiousness
- Hypothetical treatments for future developments
ABM Social Distancing Rebound Study Design

Study of "Stay Home" policy adherence

- Calibration to current state in epidemic
- Implement “release” of different proportions of people from "staying at home"

Calibration to Current State

- Adjust transmission and adherence to current policies to current observations
- For Virginia, with same seeding approach as PatchSim

Impacts on Reproductive number with release

- After release, spike in transmission driven by additional interactions at work, retail, and other
- At 25% release (70-80% remain compliant)
- Translates to 15% increase in transmission, which represents a 1/6th return to pre-pandemic levels