

Network Systems
Science & Advanced
Computing
Biocomplexity Institute
& Initiative
University of Virginia

Foresight and Analysis of Infectious Disease Threats to Virginia's Public Health

February 8th, 2024

(data current to January 30th – February 6th)

Biocomplexity Institute Technical report: TR BI-2024-10



BIOCOMPLEXITY INSTITUTE

biocomplexity.virginia.edu

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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Overview

- **Goal:** Understand impact of current and emerging Infectious Disease threats to the Commonwealth of Virginia using modeling and analytics
- **Approach:**
 - Provide analyses and summaries of current infectious disease threats
 - Survey existing forecasts and trends in these threats
 - Analyze and summarize the current situation and trends of these threats in the broader context of the US and world
 - Provide broad overview of other emerging threats

Key Takeaways

COVID-19 indicators show a recent peak and continued declines

- Hospitalization and Diagnosed COVID remain in slow decline
 - Hospitalizations peaked ~20% lower than last year, and continue to decline
- Wastewater continues to show high viral loads (currently lag other indicators)
- Together this suggest continued declines or plateaued activity.

Influenza is declining in VA and across the US

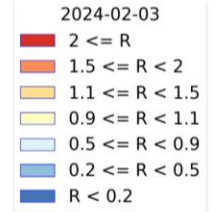
RSV hospitalizations have started to decline while ED visits continue to decline

COVID-19 Surveillance

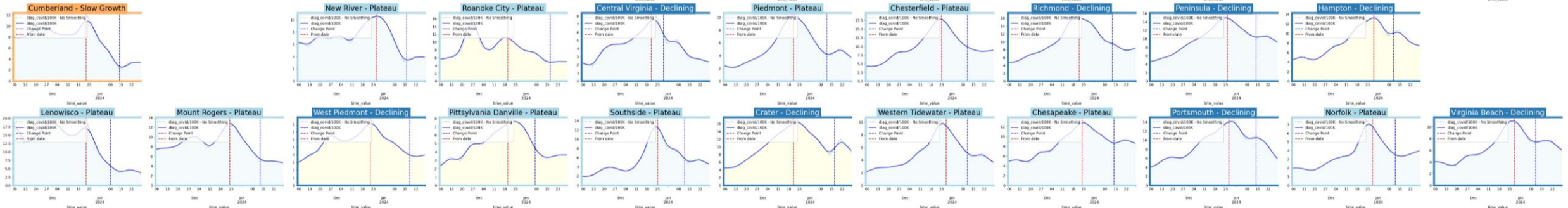
District Diagnosed COVID Trajectories – last 10 weeks

Status	Number of Districts	
	Current Week	Last week
Declining	13	31
Plateau	20	4
Slow Growth	2	0
In Surge	0	0

As of Feb 3rd



Curve shows smoothed Emergency Dept and Urgent Care visits with Diagnosed COVID-19 rate (per 100K) in each District
Trajectories of states in label & chart box
Curve colored by Reproductive number



District Hospital Trajectories – last 10 weeks

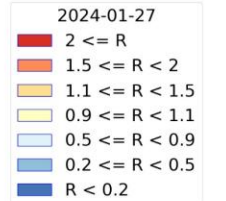
Rt estimates from EpiNow2

Status	Number of Districts	
	Current Week	Last week
Declining	30	(28)
Plateau	5	(7)
Slow Growth	0	(0)
In Surge	0	(0)

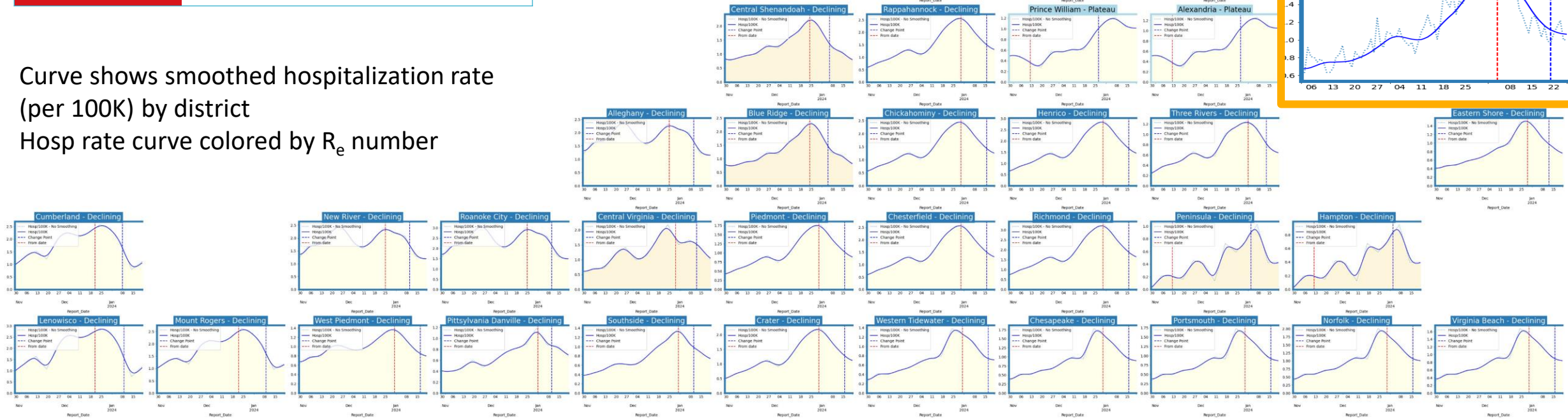
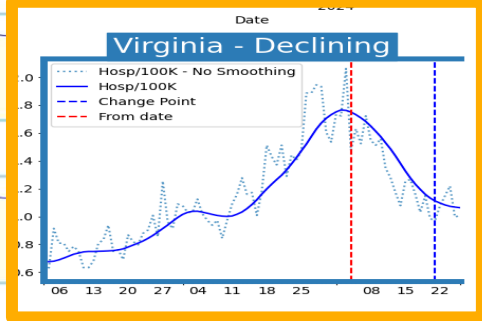
Hospitalization by county inferred from Facility data mapped to counties through Hospital Referral Regions.

As of Jan 27th

Curve shows smoothed hospitalization rate (per 100K) by district
Hosp rate curve colored by R_e number



State level Time Series



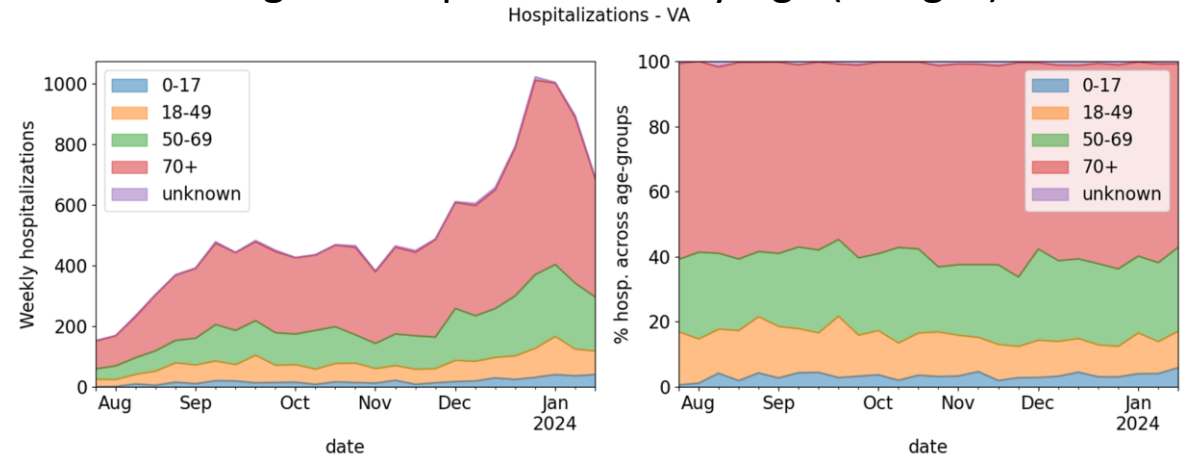
Hospitalizations in VA by Age

Age distribution in hospitals showing slight shift towards younger age groups

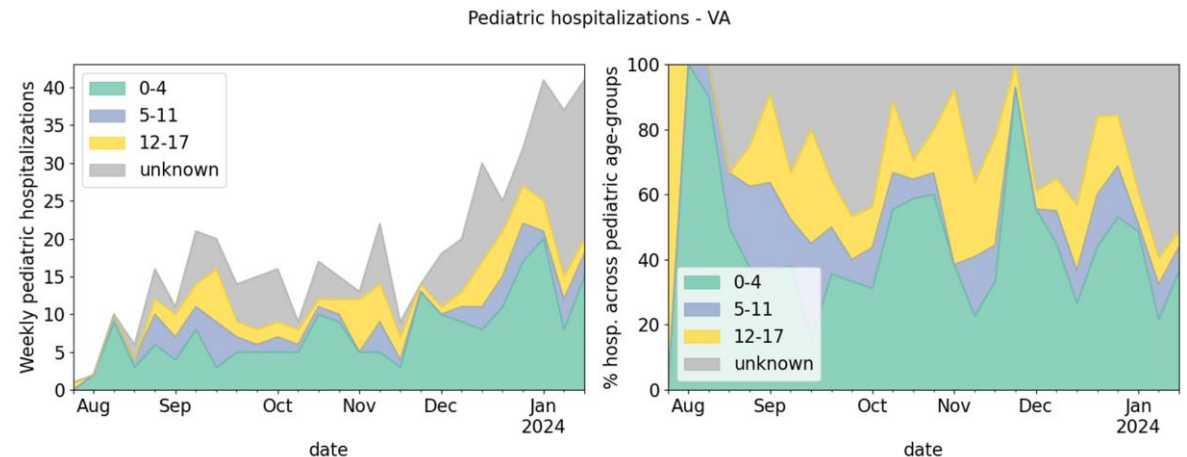
- Overall hospitalizations stable across all age groups
- Pediatric hospitalizations remain high compared to summer

Note: These data are lagged and based on HHS hospital reporting

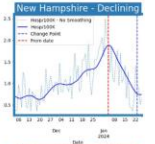
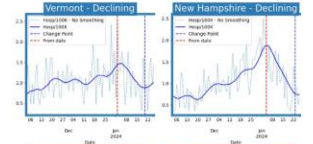
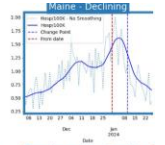
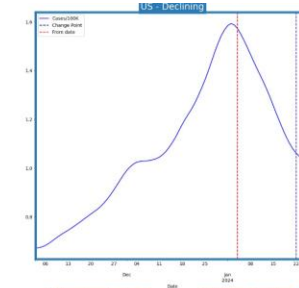
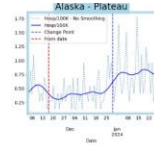
Virginia Hospitalizations by Age (all ages)



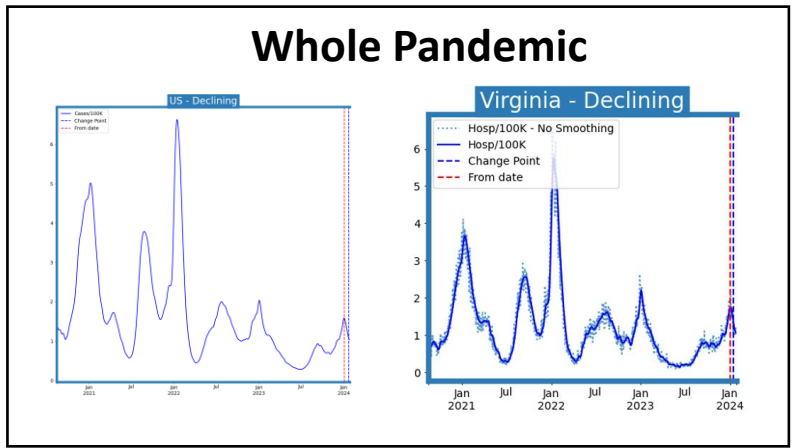
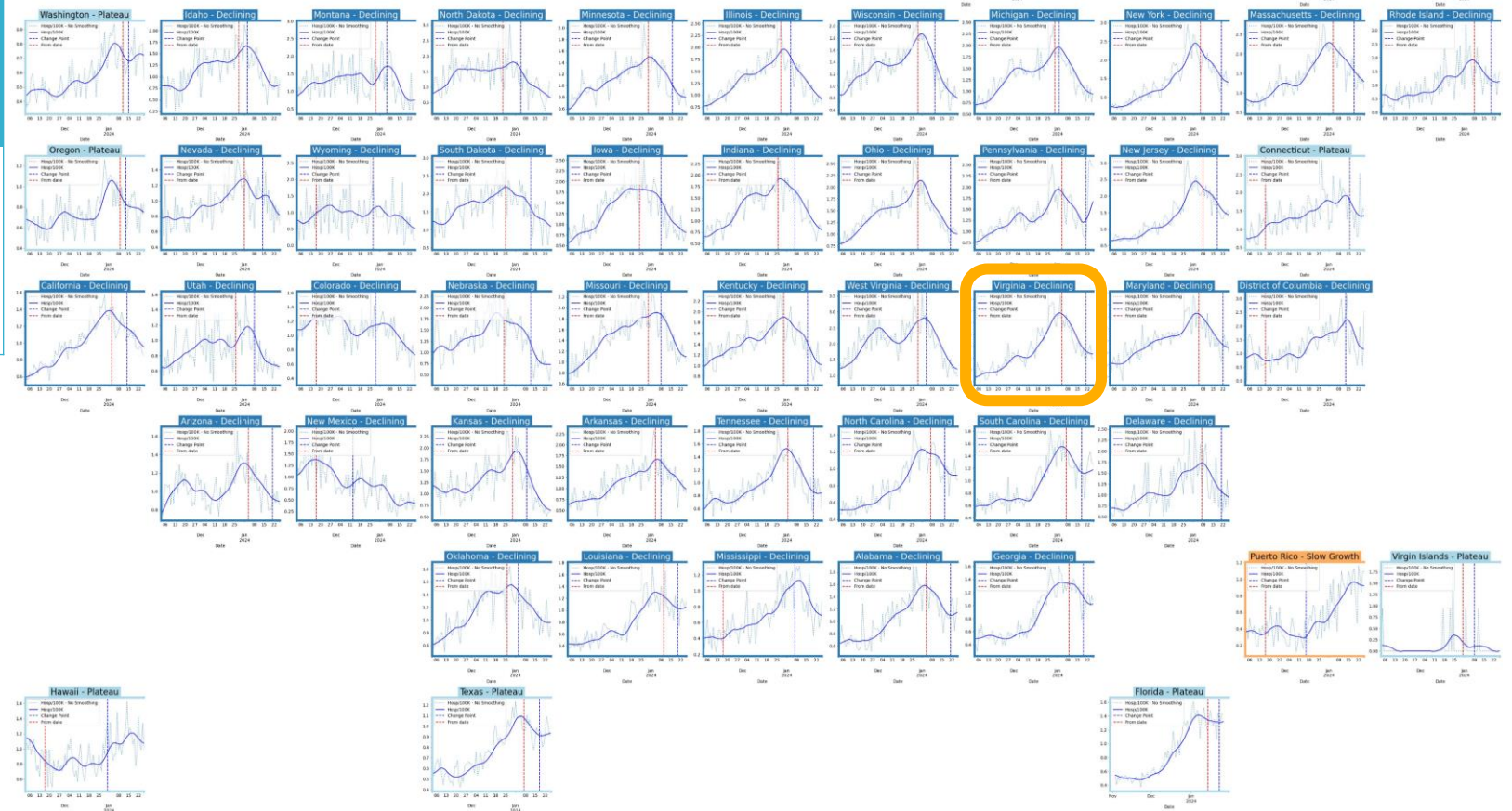
Pediatric Hospitalizations by Age (0-17yo)



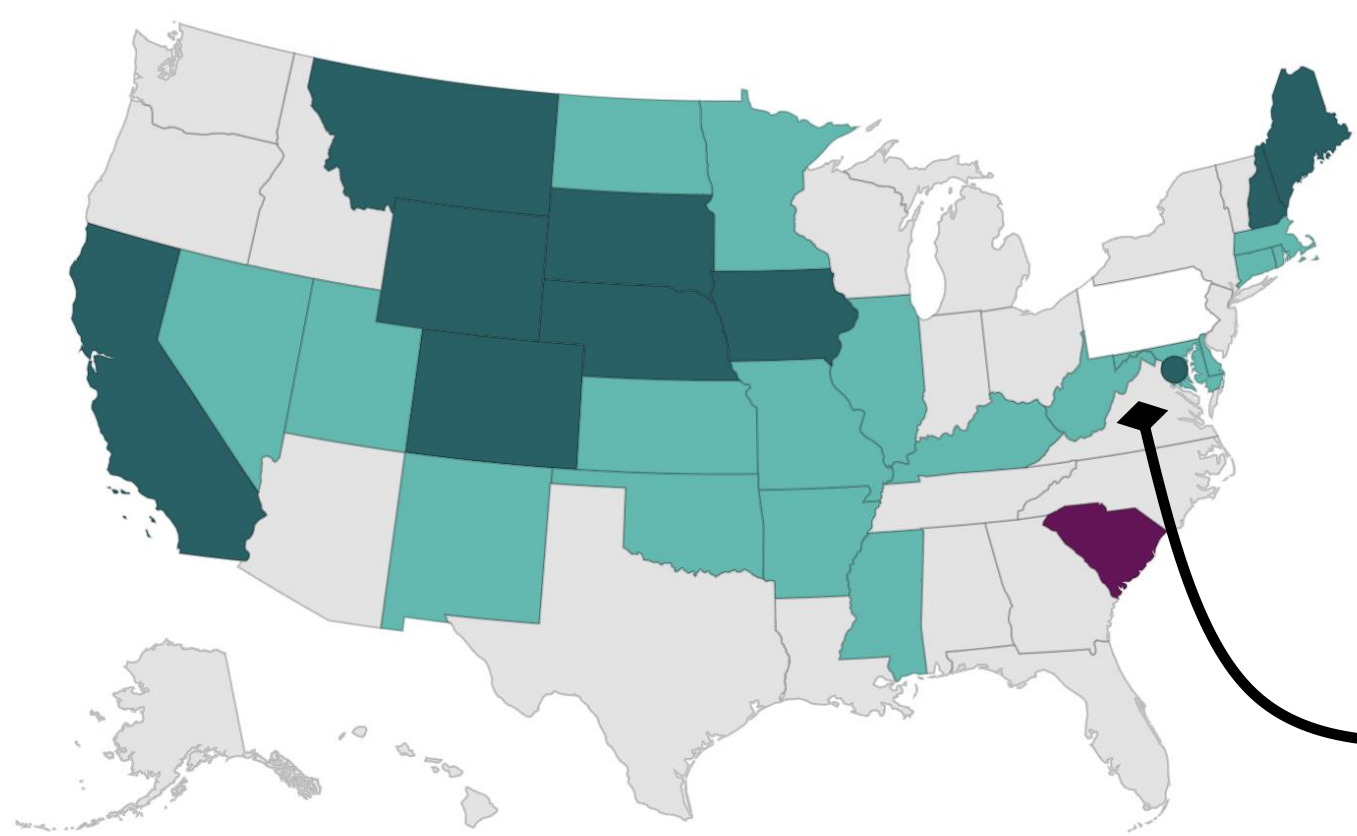
United States Hospitalizations



Status	Current Week	Last Fortnight
Declining	44	(38)
Plateau	8	(8)
Slow Growth	1	(7)
In Surge	0	(0)



COVID-19 Hospitalizations – Epidemic Growth



Epidemic Status

- Growing
- Likely Growing
- Stable or Uncertain
- Likely Declining
- Declining
- Not Estimated

Virginia
Probability Epidemic Is Growing: 0.6035
Epidemic Status: Stable Or Uncertain

Data as of 1/27/24

Territories **PR** **VI**



[CDC – CFA Epidemic Growth](#)



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Estimating Daily Reproductive Number – EpiNow2 estimation

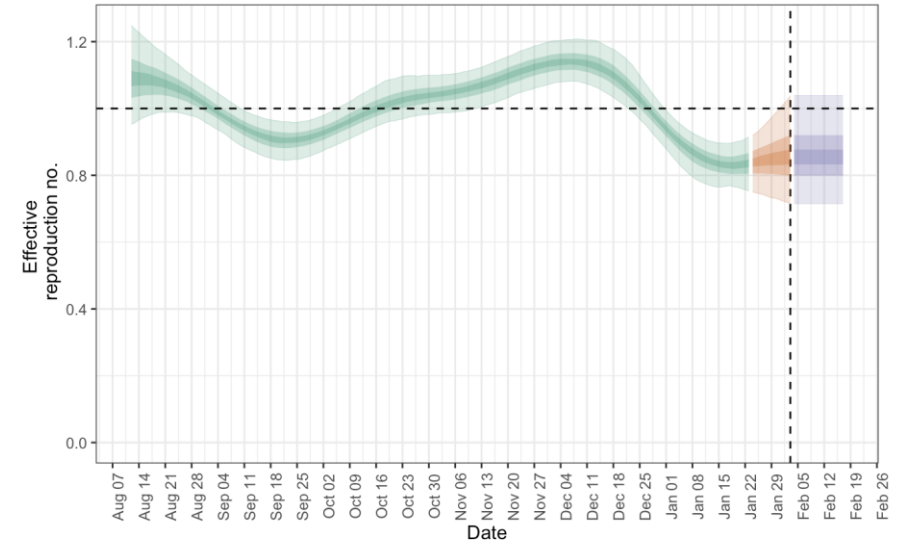
Reproductive Estimate Summary, per data as of February 3rd, 2024

Region	Reproductive number estimate	Credible Interval	Trend forecast
State-wide	0.88	(0.72 – 1.1)	Likely decreasing
Central	0.99	(0.87 – 1.1)	Stable
Eastern	0.95	(0.86 – 1.1)	Likely decreasing
Northern	0.90	(0.75 – 1.1)	Likely decreasing
Northwest	0.91	(0.79 – 1.1)	Likely decreasing
Southwest	0.96	(0.88 – 1.1)	Likely decreasing

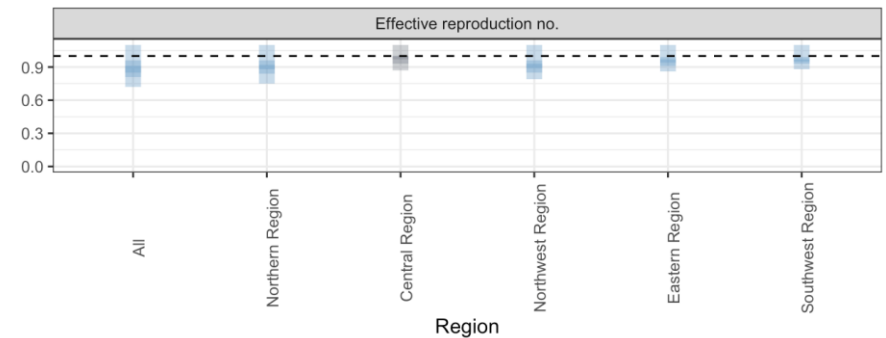
Methodology

- Sam Abbott, Joel Hellewell, Katharine Sherratt, Katelyn Gostic, Joe Hickson, Hamada S. Badr, Michael DeWitt, Robin Thompson, EpiForecasts, Sebastian Funk (2020). **EpiNow2**: Estimate Real-Time Case Counts and Time-Varying Epidemiological Parameters. doi:10.5281/zenodo.3957489.
- COVID disease model parameters (including generation time and delay distributions) per CDC CFA blog: https://www.cdc.gov/forecast-outbreak-analytics/about/technical-blog-rt.html#anchor_01204
- Uses confirmation date but report date biases are accounted for; estimated date of infection is inferred using Bayesian smoothing techniques and used to produce Rt estimates.
- Source data: https://data.virginia.gov/Government/VDH-COVID-19-PublicUseDataset-CLI_By-HealthDistric/nchp-nti3/data

R_e per confirmed ED diagnosis (last 6 months)



Type ■ Estimate ■ Estimate based on partial data ■ Forecast



Expected change in daily cases ■ Increasing ■ Stable ■ Decreasing
■ Likely increasing ■ Likely decreasing

Wastewater Monitoring – NWSS

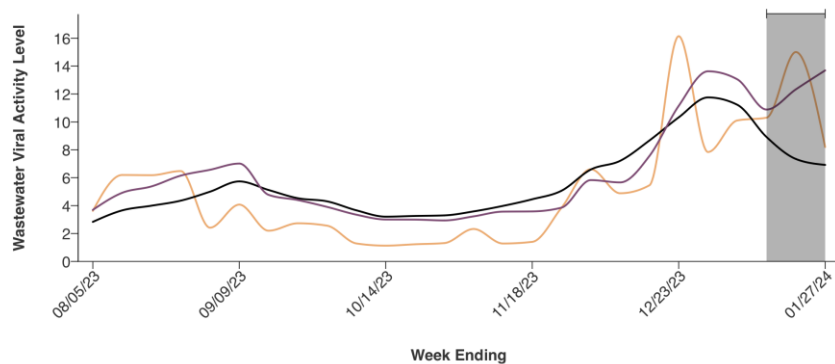
Wastewater provides a coarse estimate of COVID-19 levels in communities

- VA in “Very High” again after dipping to “Moderate”

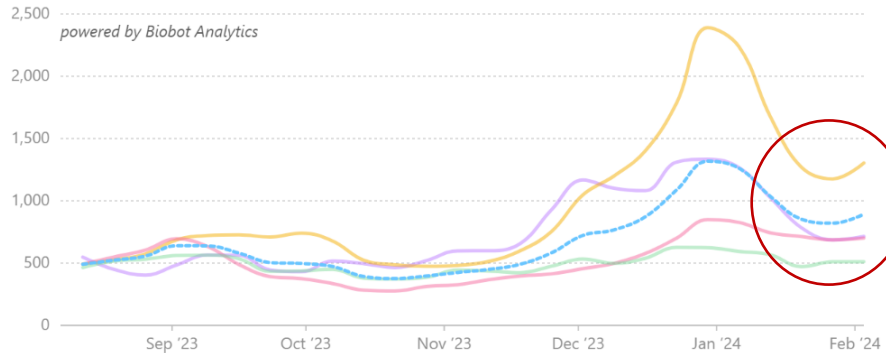
VA – Last 6 months



Virginia has 35 site(s) reporting in the past week, and 3 (9%) of its site(s) with less than six months of data. Sites with less than six months of data will tend to have larger week-to-week changes in Wastewater Viral Activity Level than those with more than six months of data.



Wastewater: Effective SARS-CoV-2 virus concentration (copies / mL of sewage)



Midwest
 Feb 03, 2024: 715 copies/mL

Nationwide
 Feb 03, 2024: 893 copies/mL

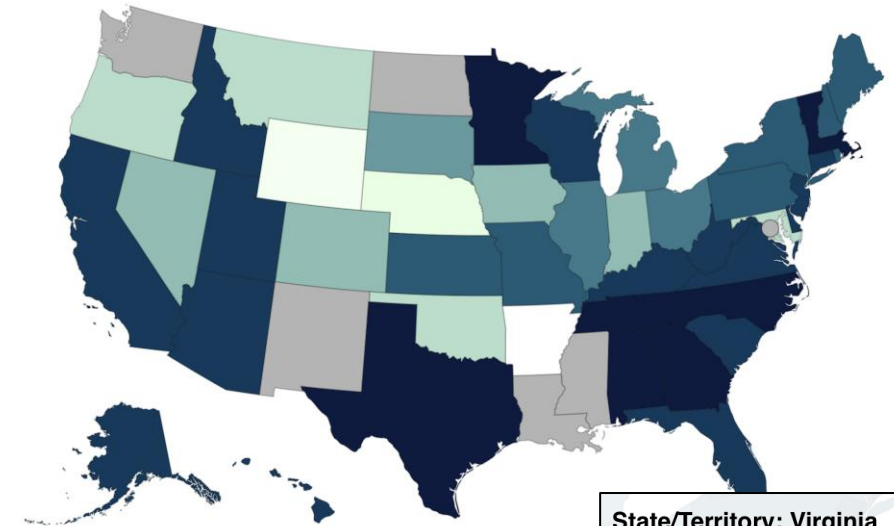
Northeast
 Feb 03, 2024: 1,304 copies/mL

South
 Feb 03, 2024: 702 copies/mL

West
 Feb 03, 2024: 511 copies/mL

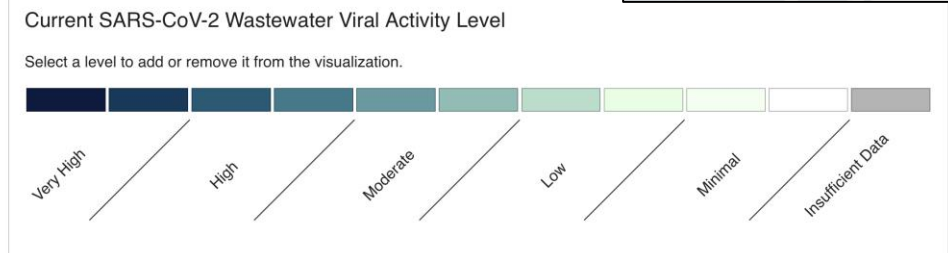
Source: Wastewater data from Biobot Analytics

<https://biobot.io/data/>



State/Territory: Virginia
 Viral Activity Level: Very High
 Sites Currently Reporting: 35

Territories GU PR VI

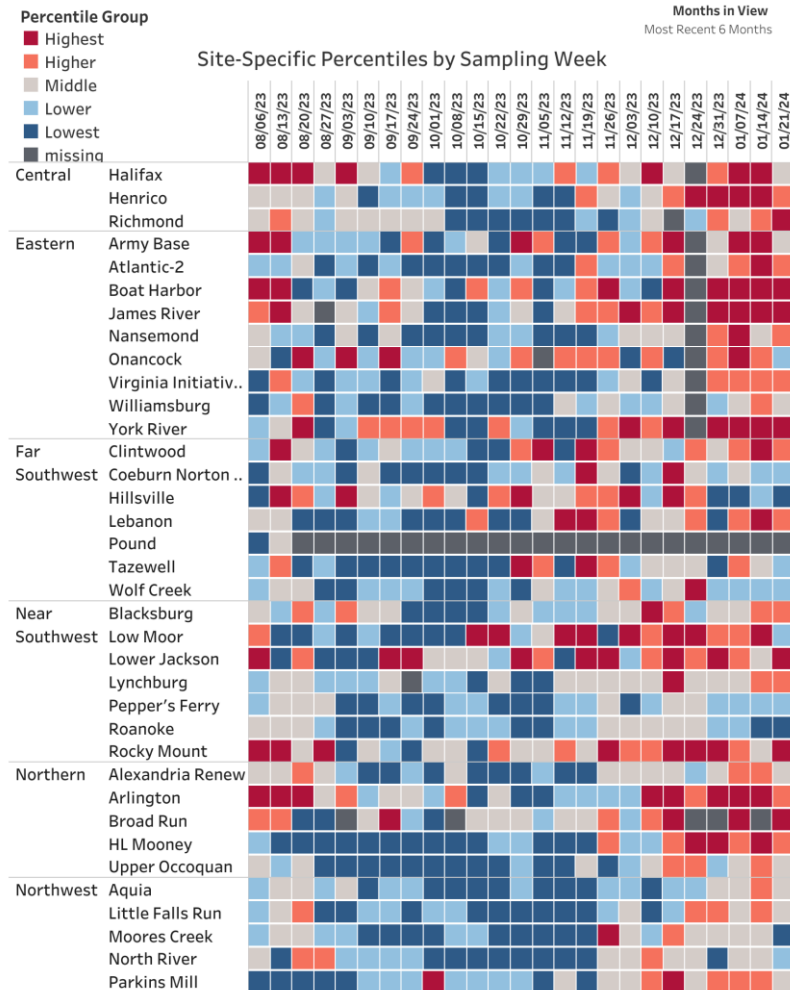


Data Source: [CDC Data Tracker](https://www.cdc.gov/data-tracker/)

Wastewater Monitoring – VA Sites

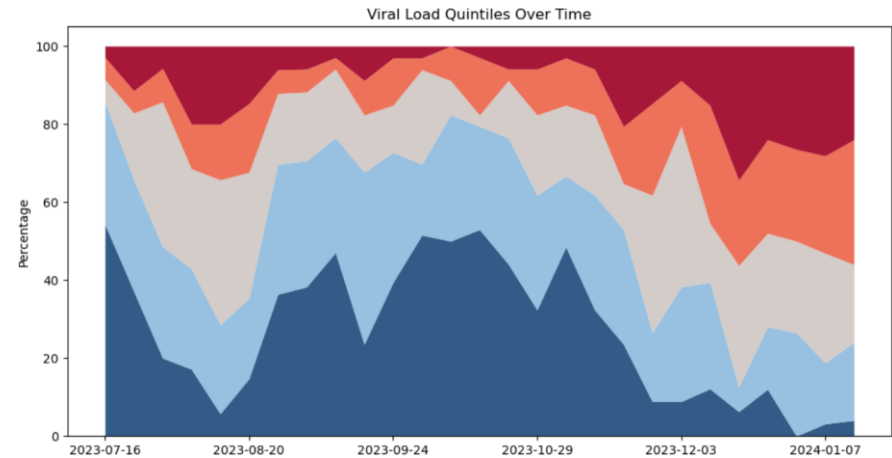
Wastewater provides a coarse early warning of COVID-19 levels in communities

- Some VA sites (esp. Eastern) are starting to shift to higher quintiles in wastewater percentile groups



Quintile proportions over time
Middle and higher are growing in past couple weeks

Last data point: January 21st



Start of Sample Collection Week
January 21, 2024

Trend

- Increase
- Plateau
- Decrease
- Below Detection

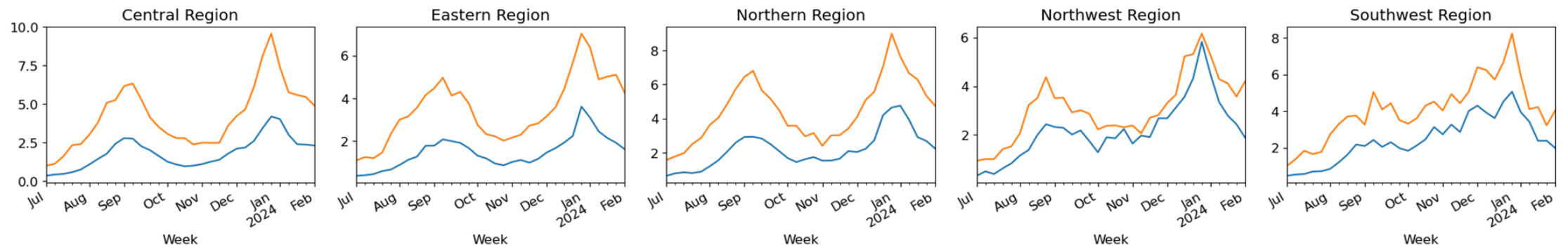
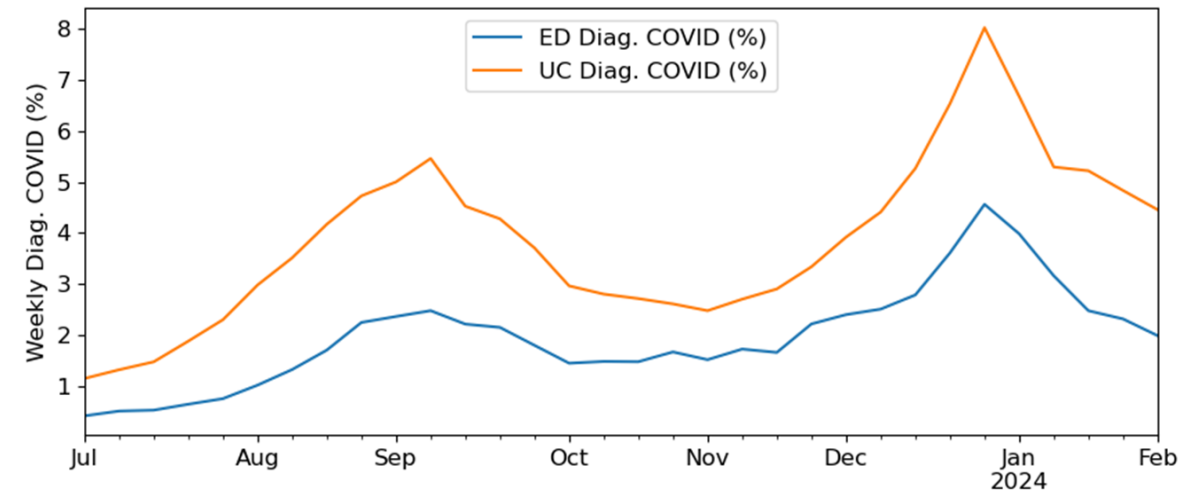


ED & UC Visits with Diagnosed COVID-19

National Syndromic Surveillance Program (NSSP) reports diagnosed COVID-19 from multiple healthcare settings

- Week ending February 6th, 2024
- Diagnosed visits are a smoother more specific indicator than COVID-like Illness
- **After 2 months of growth, Diagnosed visits show signs of receding, and may be leveling off**

Virginia Visits with Diagnosed COVID-19

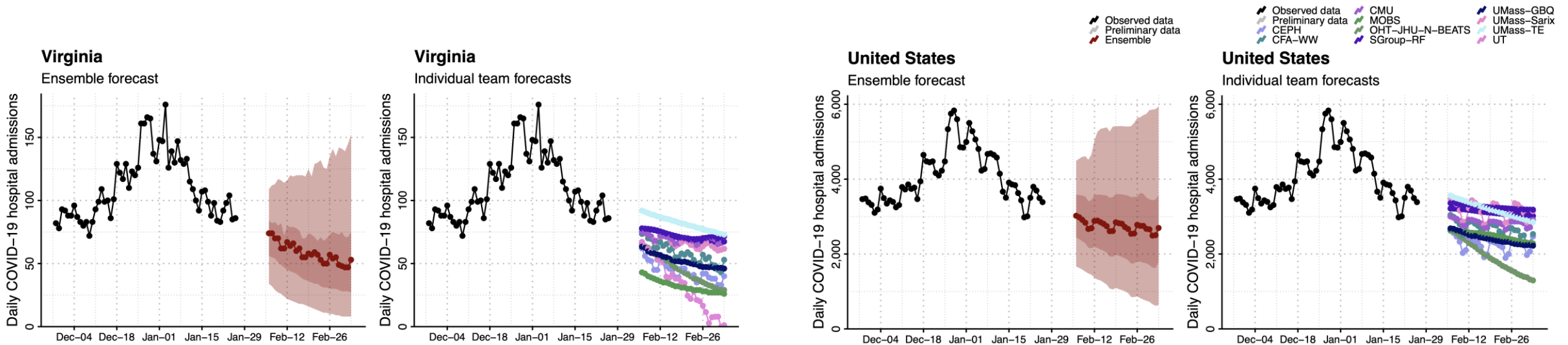


Current COVID-19 Hospitalization Forecast

Statistical models for submitting to CDC COVID Forecasting Hub

- Uses a variety of statistical and ML approaches to forecast weekly hospital admissions for the next 4 weeks for all states in the US

Hospital Admissions for COVID-19 and Forecast for next 4 weeks (CDC COVID Ensemble)



COVID-19 Spatial Epidemiology

ZIP Code Level Case Rates Since Last Meeting

New cases per 100k in the last four weeks

- Divide rates by **four** to calculate average weekly incidence.
- No change in color scale from last meeting.
- Case rates continue to decline across the Commonwealth.
- Rates remain elevated in Southwest and Southside, and especially on the Eastern Shore.
- State Farm is the only ZIP code with a prison in this week's top 10.

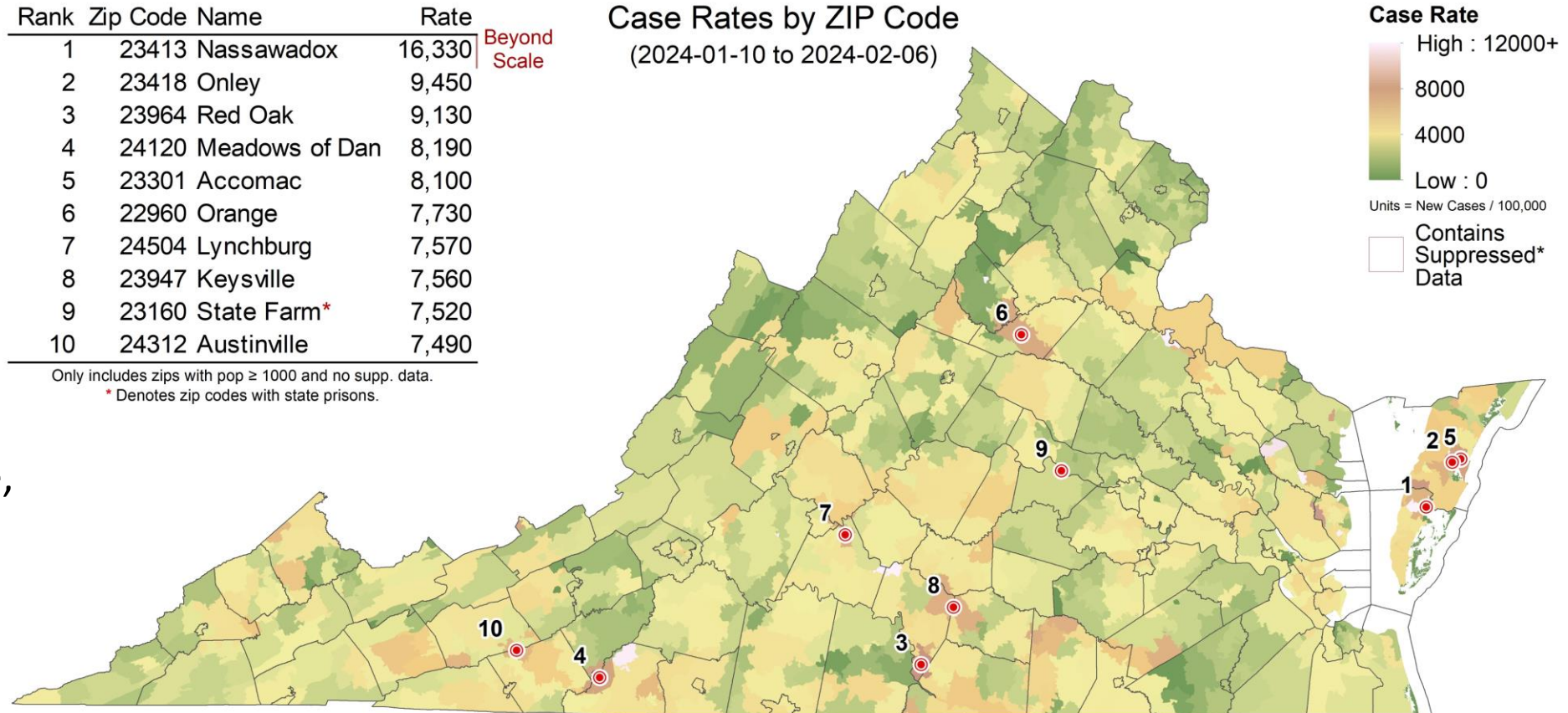
Rank	Zip Code	Name	Rate
1	23413	Nassawadox	16,330
2	23418	Onley	9,450
3	23964	Red Oak	9,130
4	24120	Meadows of Dan	8,190
5	23301	Accomac	8,100
6	22960	Orange	7,730
7	24504	Lynchburg	7,570
8	23947	Keysville	7,560
9	23160	State Farm*	7,520
10	24312	Austinville	7,490

Beyond Scale

Only includes zips with pop ≥ 1000 and no supp. data.

* Denotes zip codes with state prisons.

Case Rates by ZIP Code
(2024-01-10 to 2024-02-06)



Case Rate
High : 12000+
8000
4000
Low : 0
Units = New Cases / 100,000
Contains Suppressed* Data

Based on Spatial Empirical Bayes smoothed case rates, with an 8:1 ascertainment ratio, for four weeks ending 2024-02-06.

Risk of Exposure / Spatial Clusters and Hot Spots

Case rates since last meeting by ZIP code used to calculate risk of encountering someone infected in a gathering of randomly selected people and find spatial hot spots

- **Group Size:** Assumes **8 undetected infections** per confirmed case (ascertainment rate from recent seroprevalence survey) and shows minimum size of a group with a 50% chance an individual is infected by ZIP code (e.g., in a group of 14 in Nassawadox, there is a 50% chance someone will be infected).
- **Spatial Clustering:** Getis-Ord G_i^* based hot spots compare clusters of ZIP codes with **four-week** case rates higher than nearby ZIP codes to identify larger areas with statistically significant deviations. SaTScan was used to corroborate this analysis and determine relative risk for identified clusters.

Rank	Zip Code	Name	Size
1	23413	Nassawadox	16
2	23418	Onley	28
3	23964	Red Oak	29
4	24120	Meadows of Dan	32
5	23301	Accomac	33
6	22960	Orange	34
7	24504	Lynchburg	35
8	23947	Keysville	35
9	23160	State Farm*	35
10	24312	Austinville	36

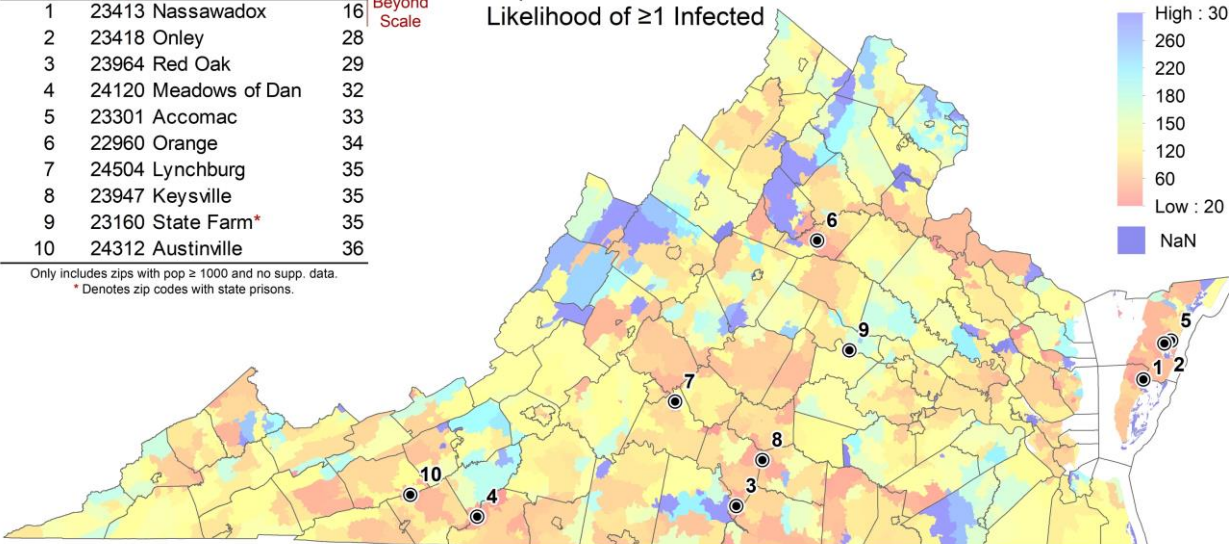
Only includes zips with pop ≥ 1000 and no supp. data.
* Denotes zip codes with state prisons.

Group Size Needed for 50% Likelihood of ≥1 Infected

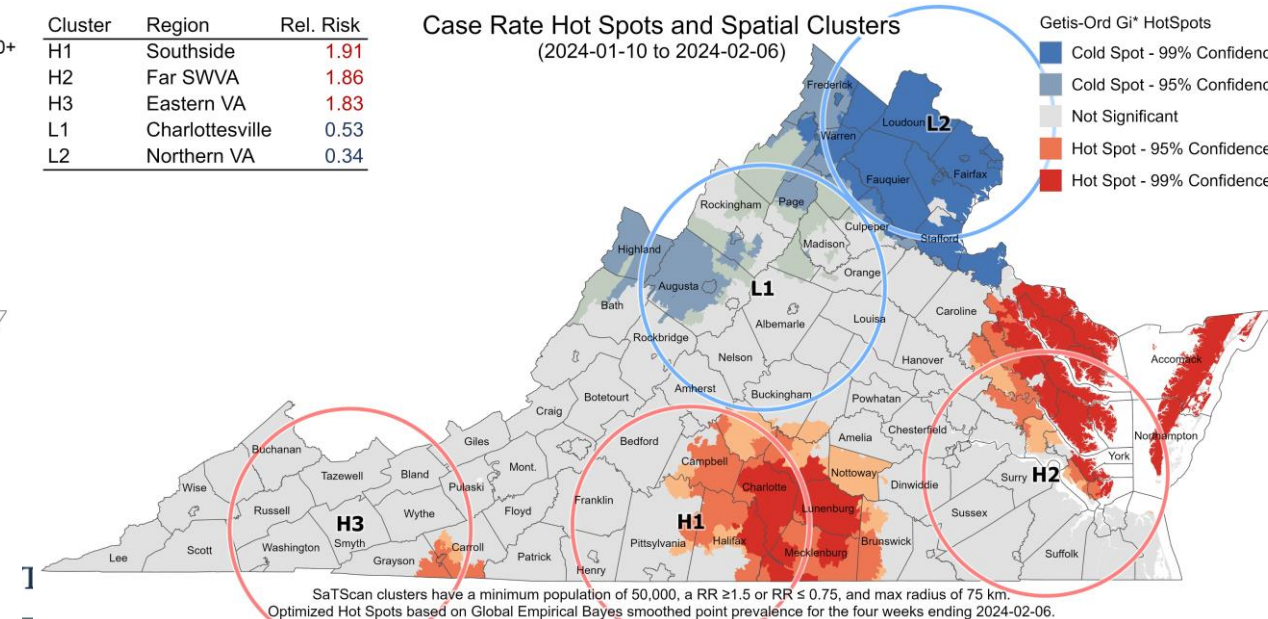


Cluster	Region	Rel. Risk
H1	Southside	1.91
H2	Far SWVA	1.86
H3	Eastern VA	1.83
L1	Charlottesville	0.53
L2	Northern VA	0.34

Case Rate Hot Spots and Spatial Clusters (2024-01-10 to 2024-02-06)



Based on Spatial Empirical Bayes smoothed point prevalence, with an 8:1 ascertainment ratio, for four weeks ending 2024-02-06.



SaTScan clusters have a minimum population of 50,000, a $RR \geq 1.5$ or $RR \leq 0.75$, and max radius of 75 km. Optimized Hot Spots based on Global Empirical Bayes smoothed point prevalence for the four weeks ending 2024-02-06.

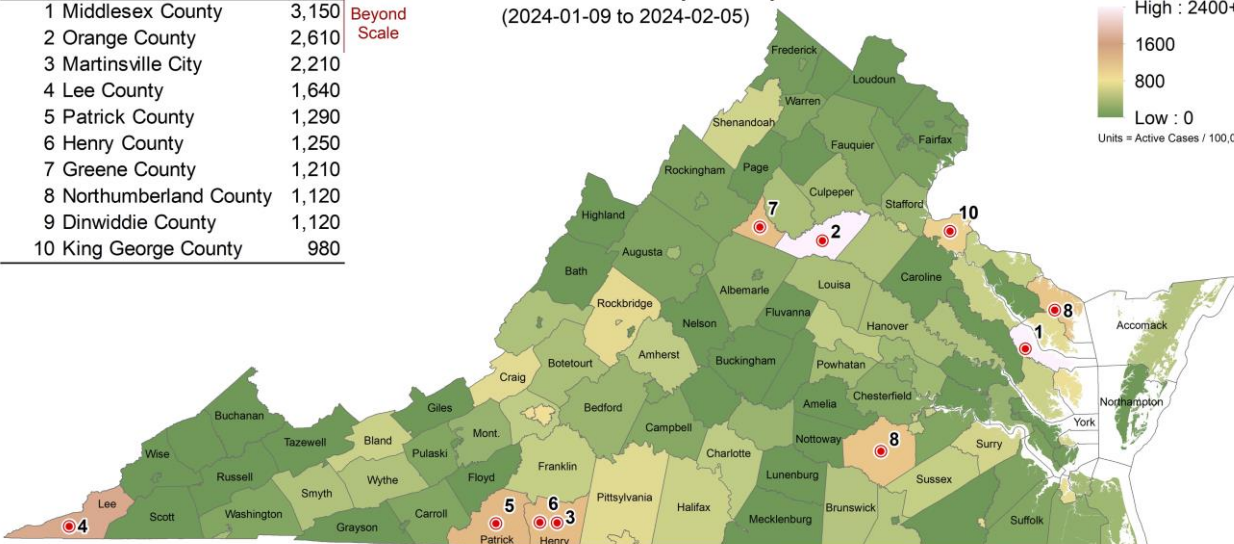
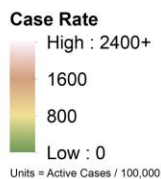
COVID-19 among Healthcare Workers

COVID-19 case rates for the public and for healthcare workers (HCW) were compared to find regions where HCW suffered unusually high burdens of disease

- **HCW Rate:** Case rate among health care workers (HCW) over a four-week period ending January 8, 2024.
- **HCW Ratio:** Case rate among health care workers (HCW) over the same period using patient facing healthcare workers as the numerator, and the population’s case rate as the denominator.
- The healthcare case to public case ratio is above one in a handful of sporadically counties. But, only a few of these counties also show an elevation in HCW cases (e.g. Patrick, Henry, Orange, and Greene Counties).

Rank	Name	Prev
1	Middlesex County	3,150
2	Orange County	2,610
3	Martinsville City	2,210
4	Lee County	1,640
5	Patrick County	1,290
6	Henry County	1,250
7	Greene County	1,210
8	Northumberland County	1,120
9	Dinwiddie County	1,120
10	King George County	980

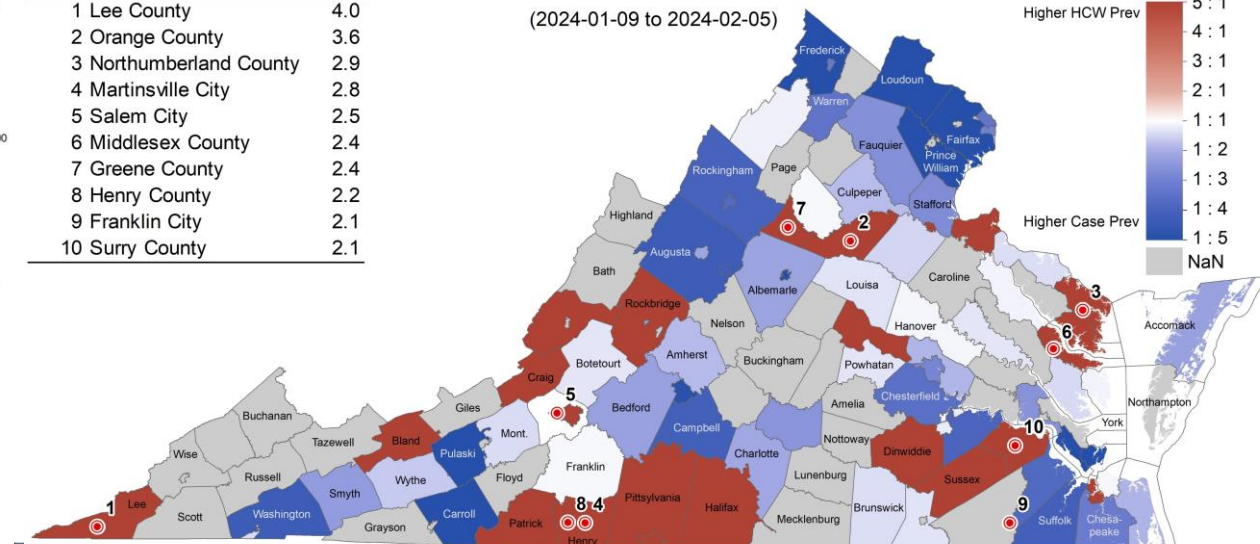
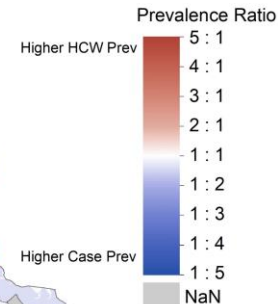
HCW Case Rate by County
(2024-01-09 to 2024-02-05)



Note: Scale differs from general public prevalence maps.

Rank	Name	Ratio
1	Lee County	4.0
2	Orange County	3.6
3	Northumberland County	2.9
4	Martinsville City	2.8
5	Salem City	2.5
6	Middlesex County	2.4
7	Greene County	2.4
8	Henry County	2.2
9	Franklin City	2.1
10	Surry County	2.1

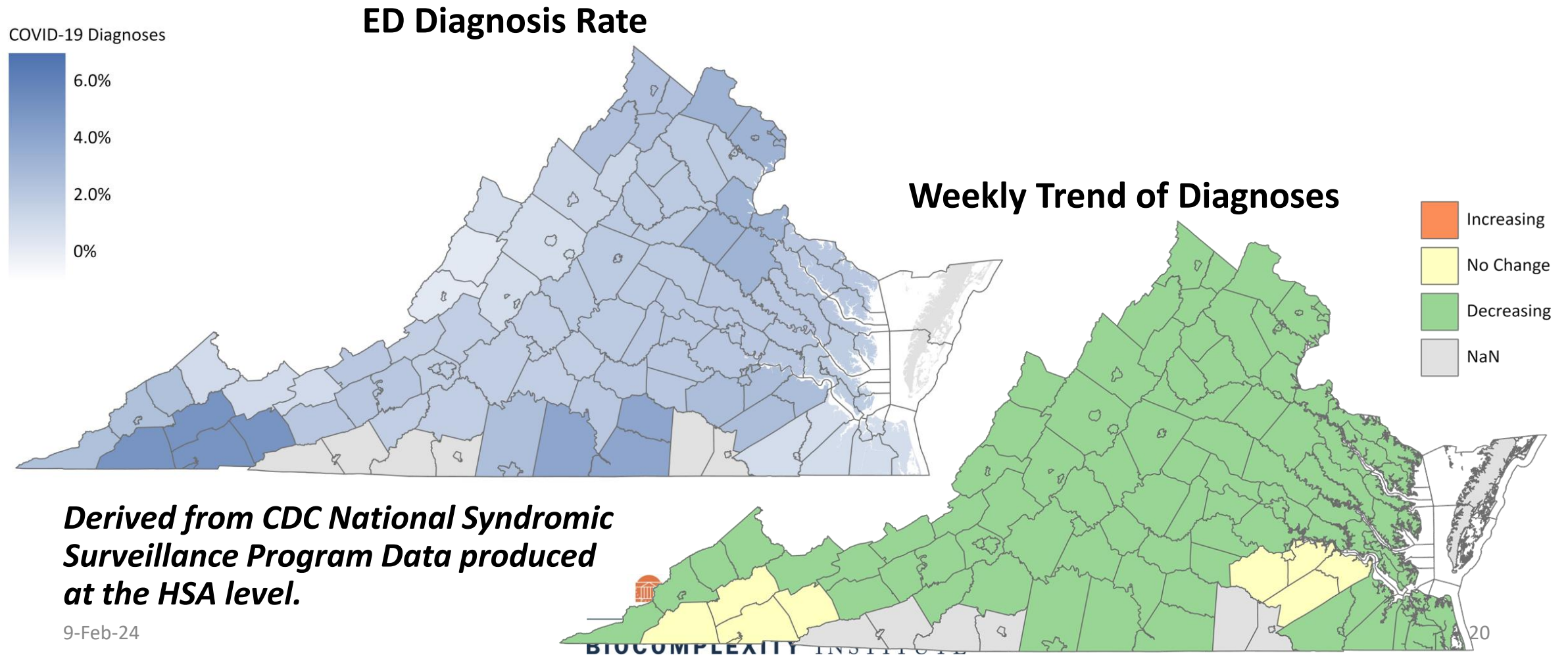
HCW Prevalence / Case Prevalence
(2024-01-09 to 2024-02-05)



Note: This assumes that the ascertainment rate of healthcare workers is double that of the public.

Emergency Department Diagnosis Rate – COVID-19

- COVID-19 diagnoses are currently highest in Far Southwest and the Southside region.
- Far Southwest and Petersburg are the only areas not showing decline this week.

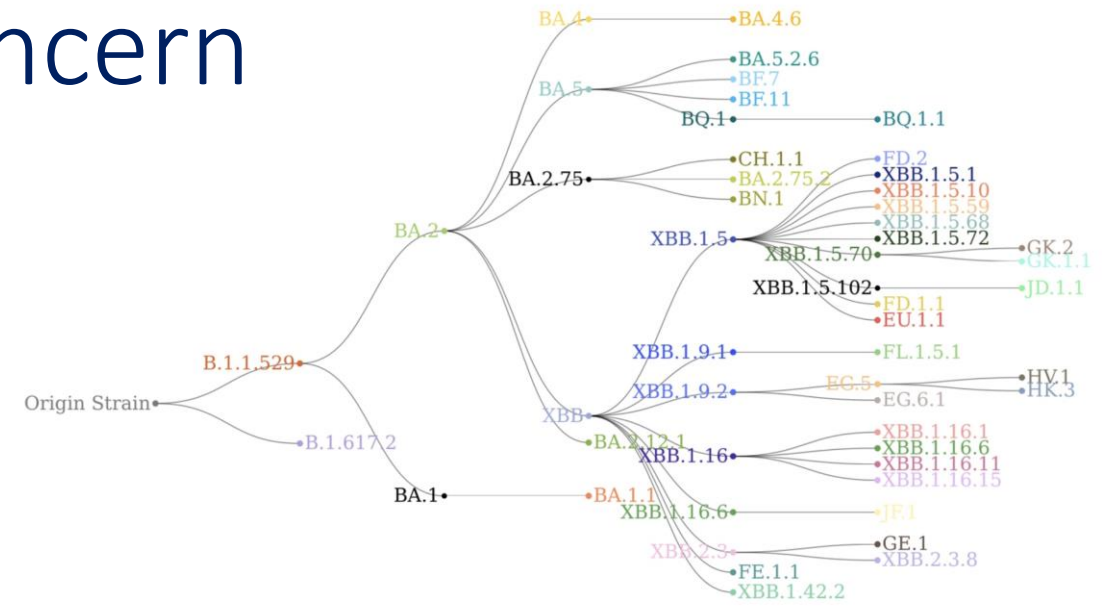


COVID-19 Genomic Update

SARS-CoV2 Variants of Concern

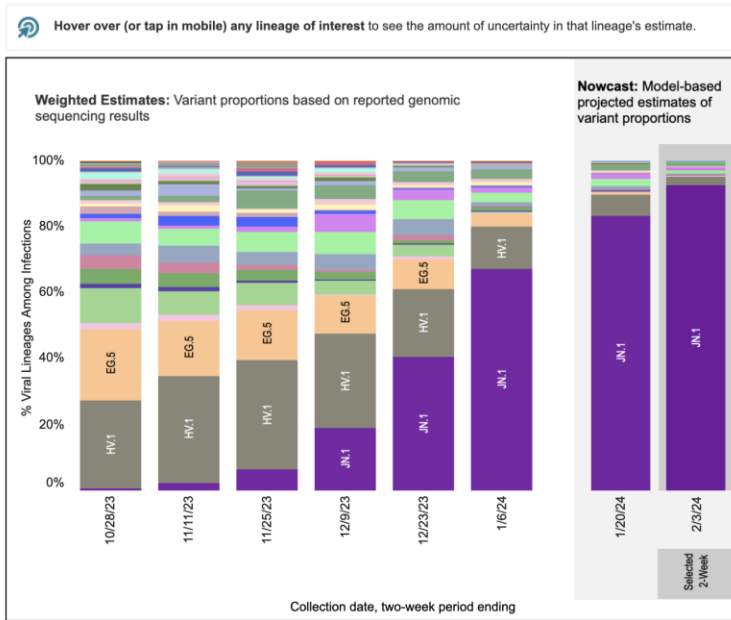
Emerging variants have potential to continue to alter the future trajectories of pandemic and have implications for future control

- Variants have been observed to: increase transmissibility, increase severity (more hospitalizations and/or deaths), and limit immunity provided by prior infection and vaccinations



Weighted Estimates in HHS Region 3 for 2-Week Periods in 10/15/2023 – 2/3/2024

Nowcast Estimates in HHS Region 3 for 1/21/2024 – 2/3/2024



Region 3 - Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia

WHO label	Lineage #	%Total	95%PI
Omicron	JN.1	92.6%	91.1-93.9%
	HV.1	2.6%	2.1-3.2%
	JG.3	1.1%	0.8-1.6%
	JD.1.1	1.1%	0.8-1.3%
	BA.2.86	1.0%	0.6-1.6%
	HK.3	0.4%	0.3-0.6%
	EG.5	0.3%	0.2-0.4%
	GE.1	0.2%	0.0-0.5%
	BA.2	0.1%	0.0-0.5%
	FL.1.5.1	0.1%	0.1-0.1%
	EG.5.1.8	0.1%	0.0-0.1%
	JF.1	0.1%	0.1-0.1%
	XBB.1.9.1	0.0%	0.0-0.1%
	XBB	0.0%	0.0-0.1%
	XBB.1.5.70	0.0%	0.0-0.1%
	XBB.1.16.6	0.0%	0.0-0.1%
	XBB.1.16.11	0.0%	0.0-0.0%
	GK.1.1	0.0%	0.0-0.0%
	XBB.1.16.15	0.0%	0.0-0.0%
	XBB.2.3	0.0%	0.0-0.0%
	HF.1	0.0%	0.0-0.0%
	GK.2	0.0%	0.0-0.0%
	XBB.1.16	0.0%	0.0-0.0%
	XBB.1.5	0.0%	0.0-0.0%
	CH.1.1	0.0%	0.0-0.0%
	EG.6.1	0.0%	0.0-0.0%
	XBB.1.9.2	0.0%	0.0-0.0%
	XBB.1.16.1	0.0%	0.0-0.0%
	XBB.1.16.17	0.0%	0.0-0.0%
	XBB.1.42.2	0.0%	0.0-0.0%
	XBB.1.5.68	0.0%	0.0-0.0%
	XBB.1.5.72	0.0%	0.0-0.0%
Other	Other*	0.1%	0.1-0.2%

Omicron Updates*

- JN.1 further saturates to 92.6% from 84.3%
- Lineage HV.1 (XBB.1.9*) down to 2.6% from 6.1%
- Other BA.2.86, JD.1.1, JG.3 are only other variants above 1%

*percentages are CDC NowCast Estimates

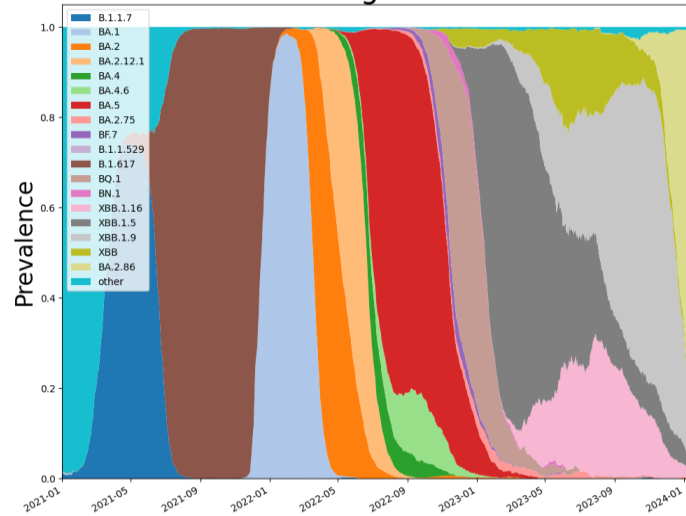
* Enumerated lineages are US VOC and lineages circulating above 1% nationally in at least one 2-week period. "Other" represents the aggregation of lineages which are circulating <1% nationally during all 2-week periods displayed.
 # While all lineages are tracked by CDC, those named lineages not enumerated in this graphic are aggregated with their parent lineages, based on Pango lineage definitions, described in more detail here: <https://www.pango.network/the-pango-nomenclature-system/statements-of-nomenclature-rules/>.

SARS-CoV2 Omicron Sub-Variants

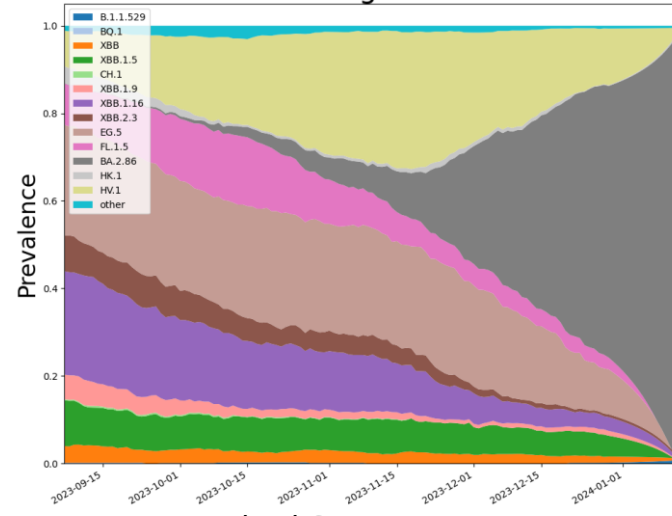
As detected in whole Genomes in public repositories

VoC Polynomial Fit Projections

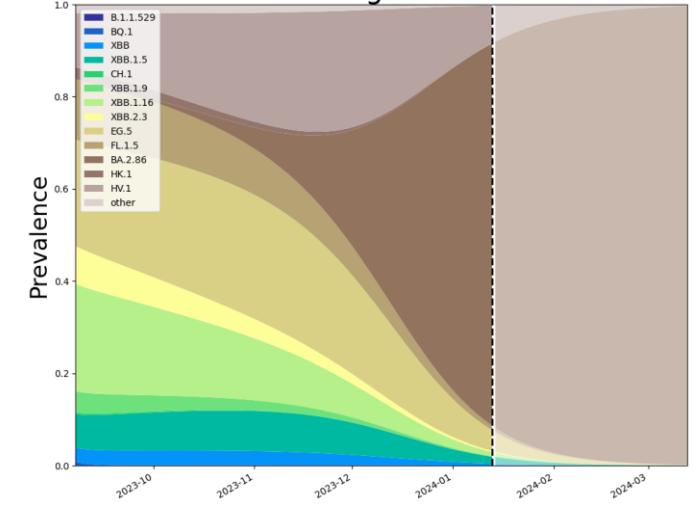
Virginia



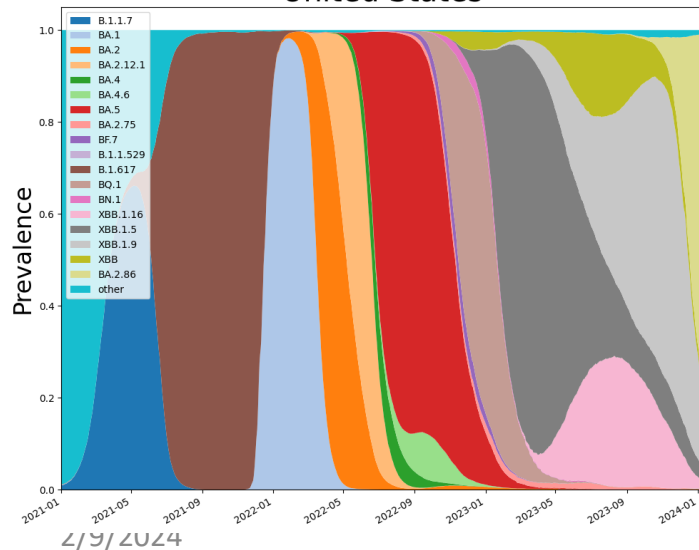
Virginia



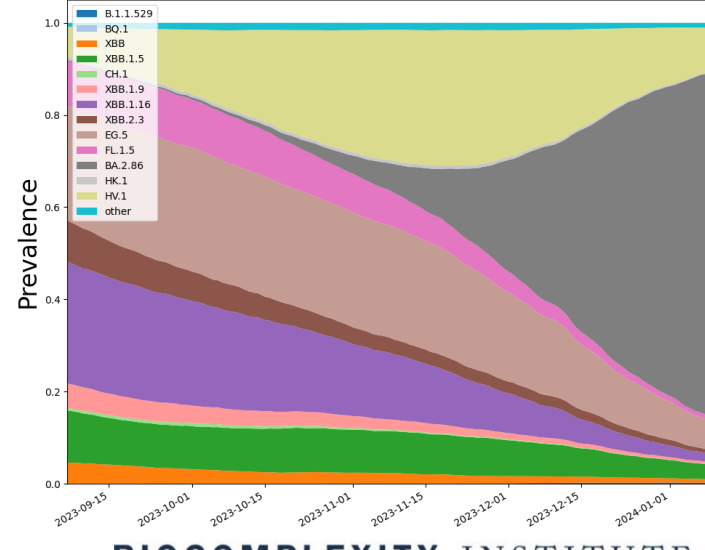
Virginia



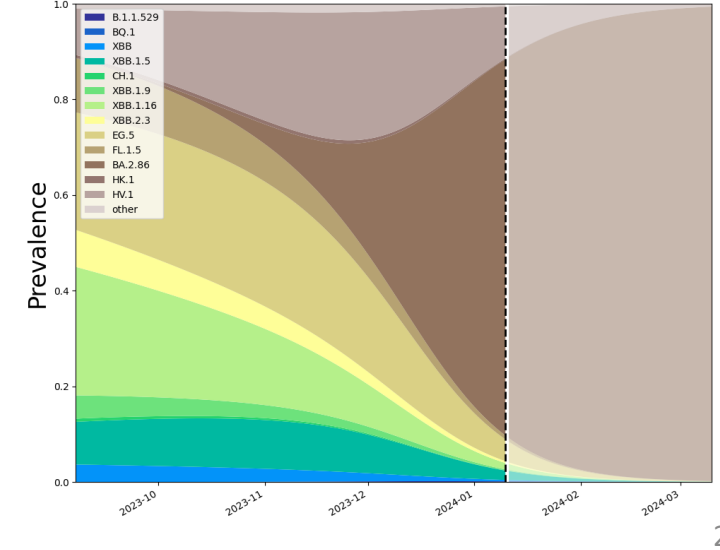
United States



United States



United States



Note:
Everything
from dotted
line forward is
a projection.

1/9/2024

SARS-CoV2 Omicron Sub-Variants

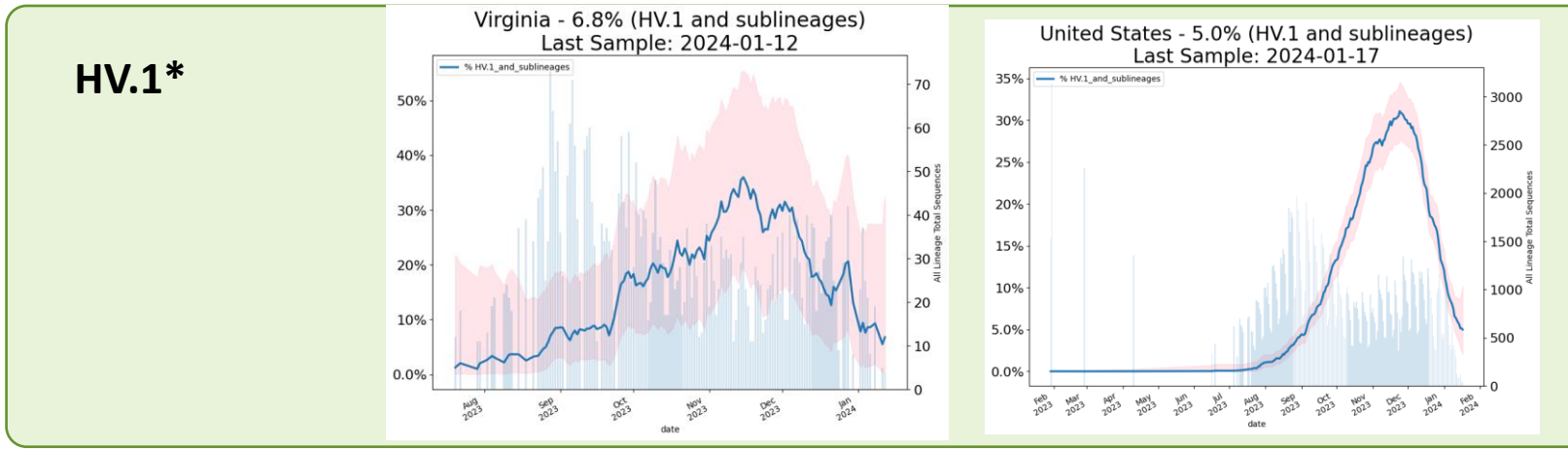
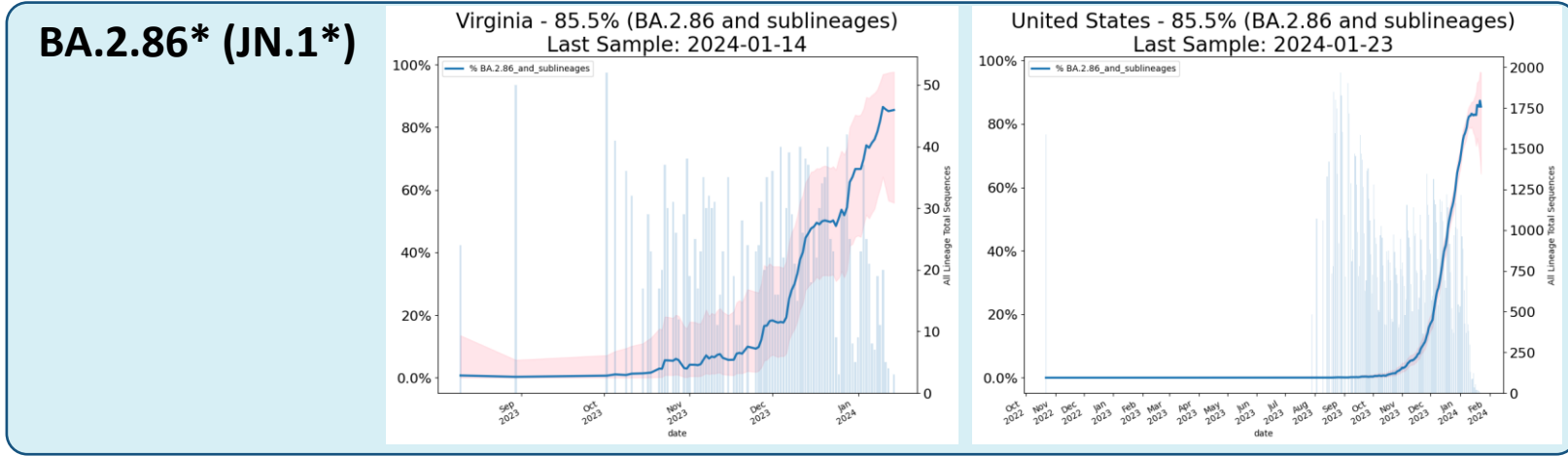
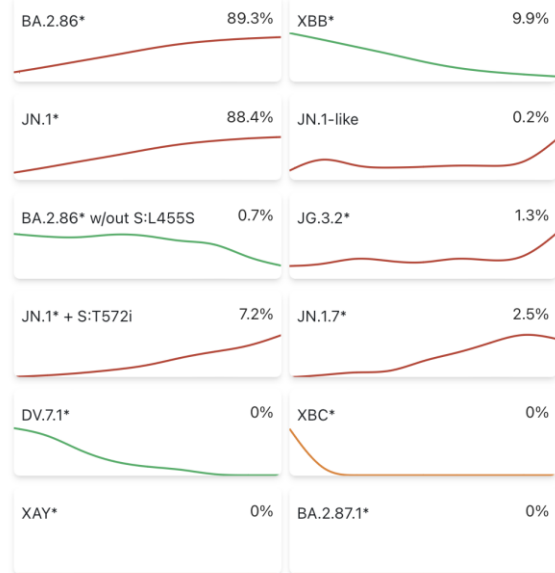
COV-spectrum

“Editor’s choice”
Variants to watch

Known variants

Which variant would you like to explore?

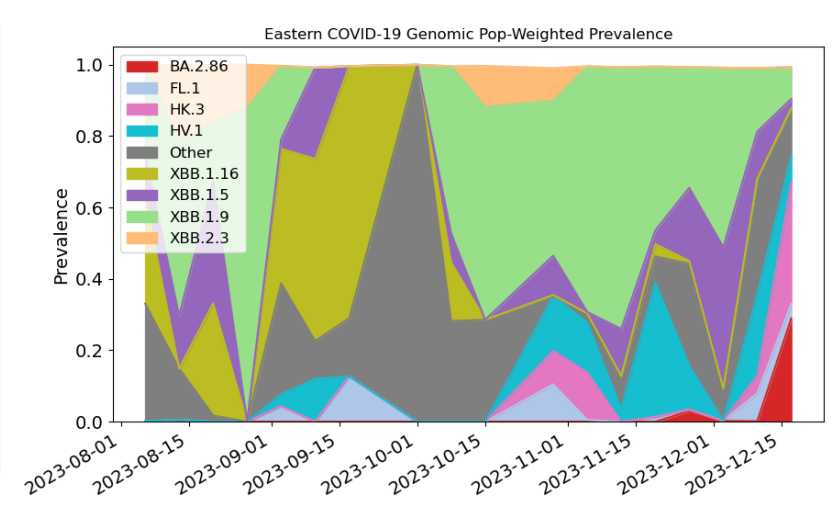
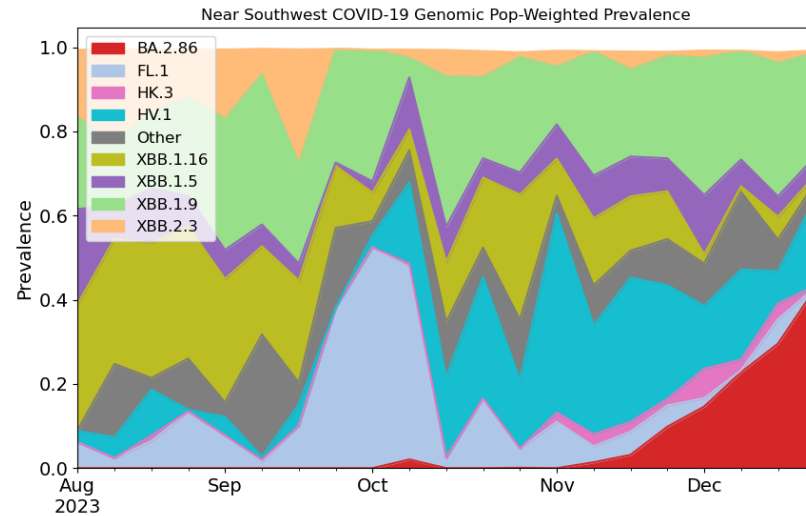
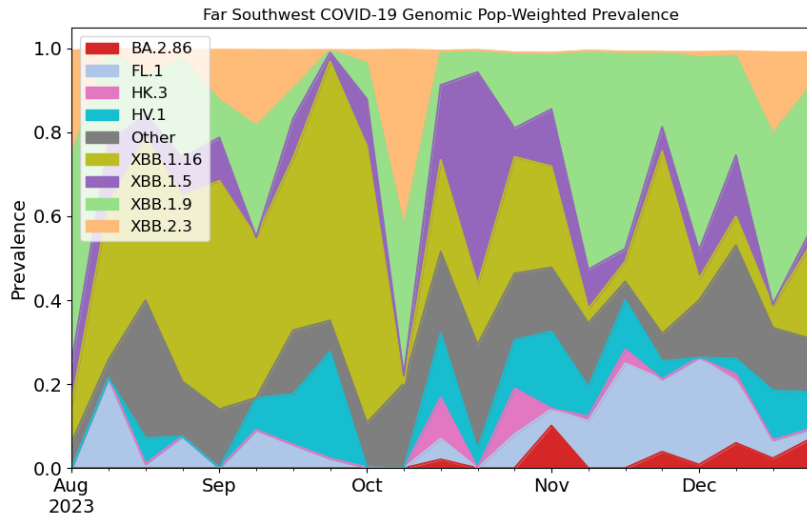
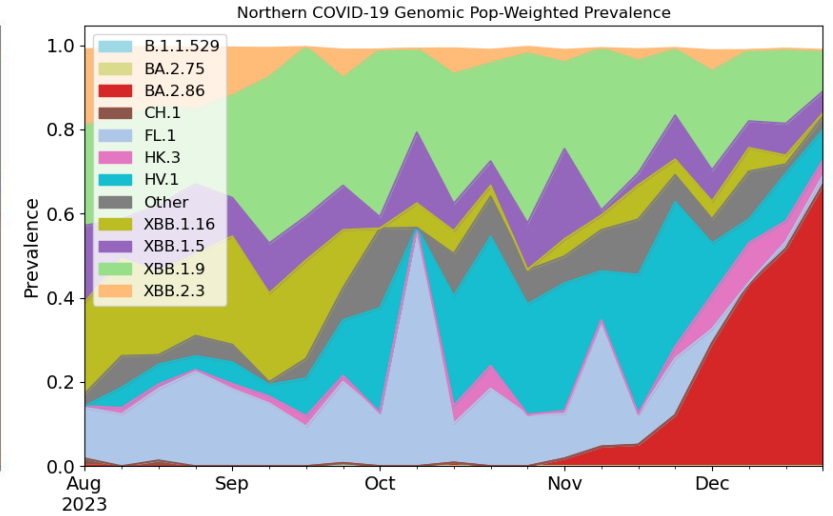
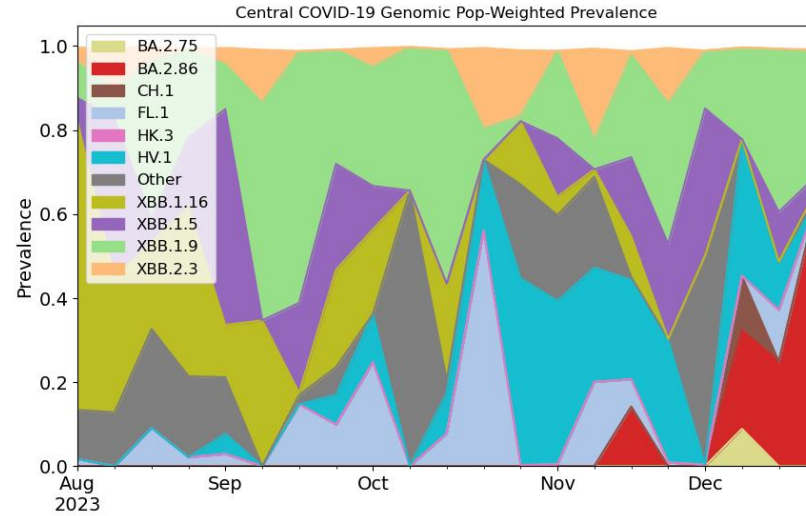
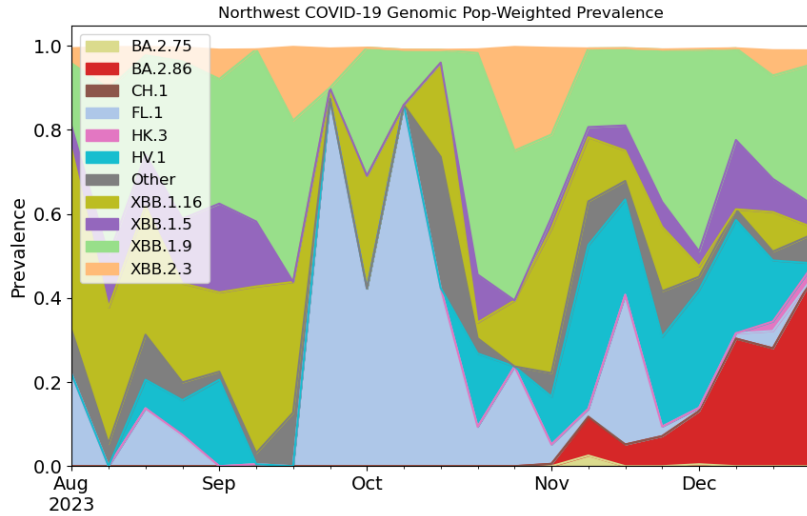
Editor's choice ▼



covSPECTRUM

Enabled by data from GISAID

Virginia Regional Population-Weighted Wastewater Variant Status

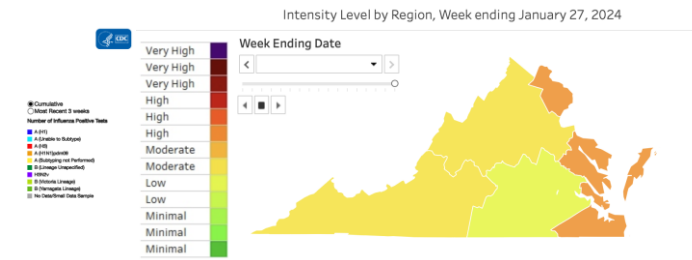
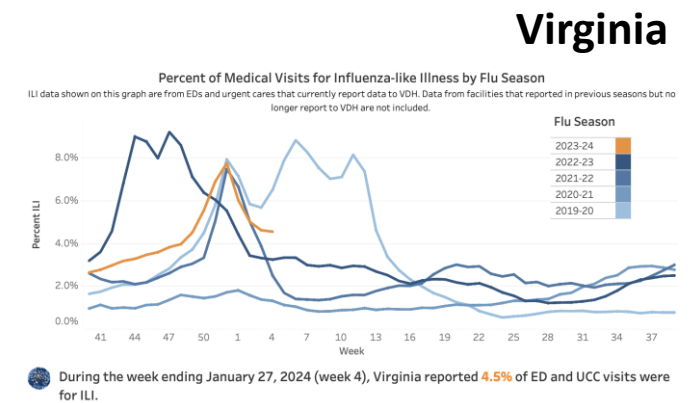
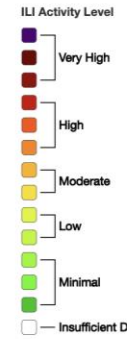
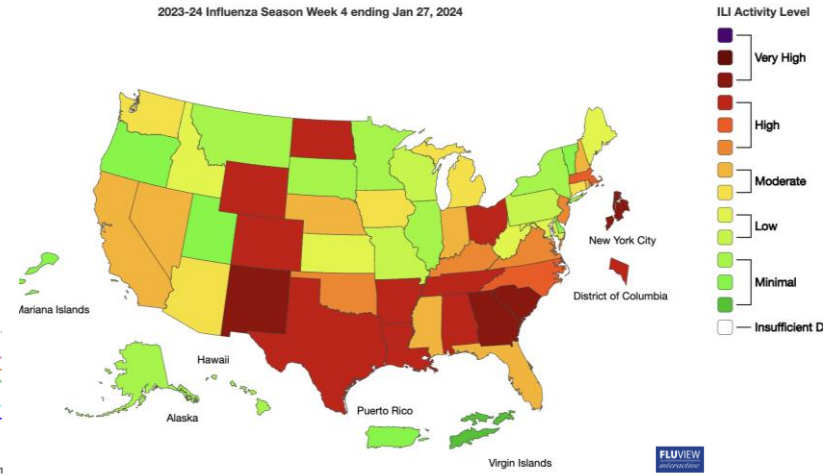
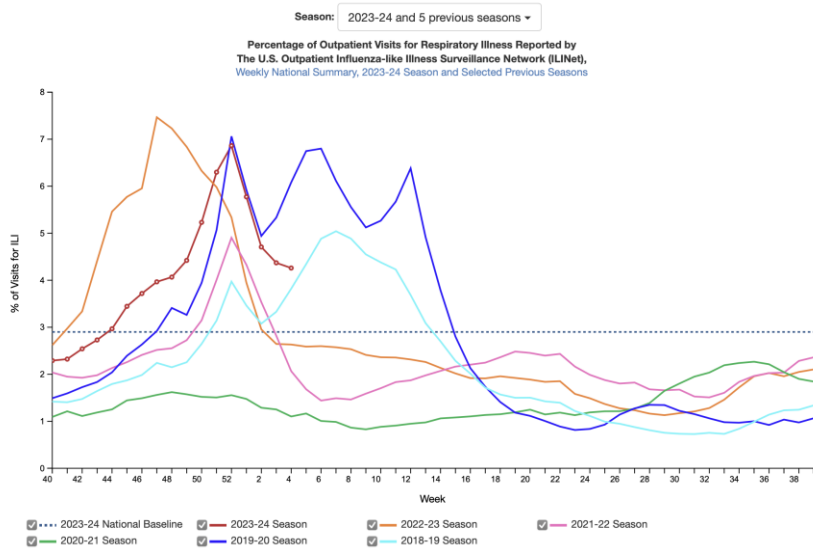
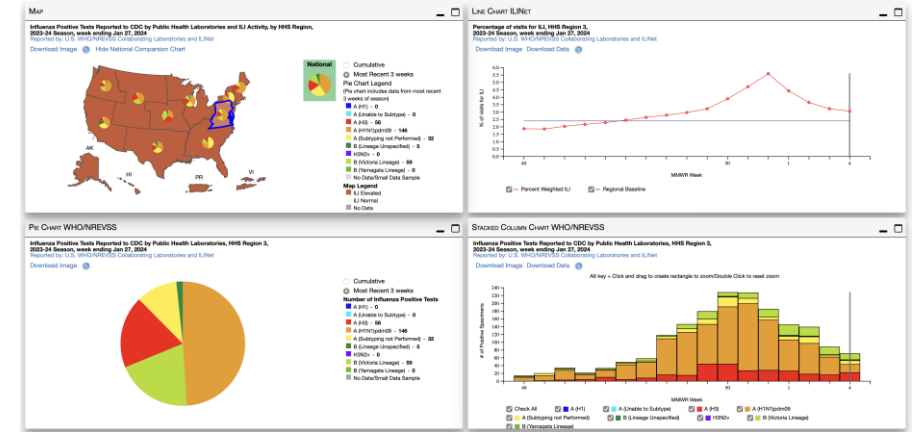


Influenza Update

Current Influenza Situation – ILI Activity

All regions remain above threshold and all are declining

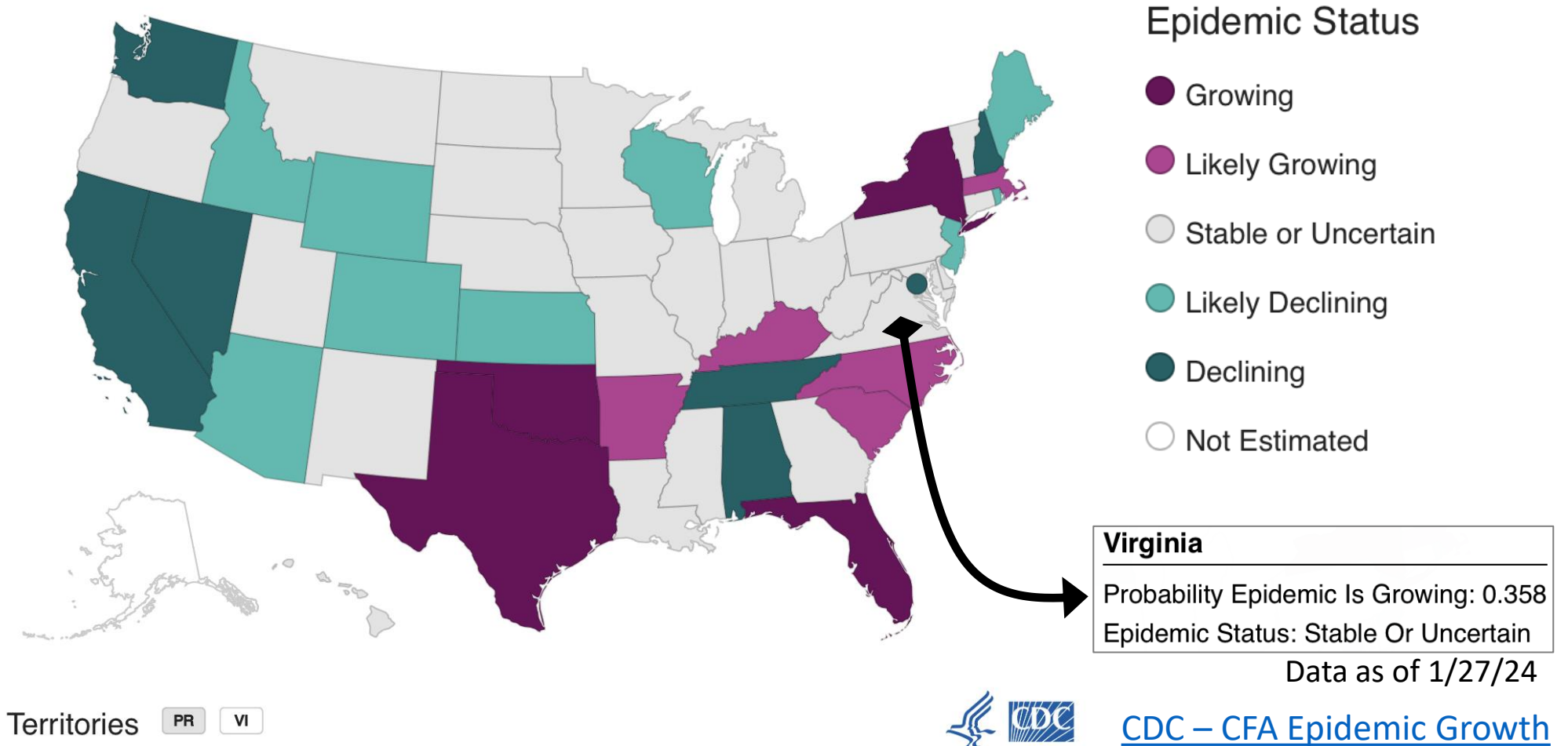
- Virginia is now in a "High" level of Influenza activity
- National ILI activity has peaked and been in decline for 3 weeks.



Virginia

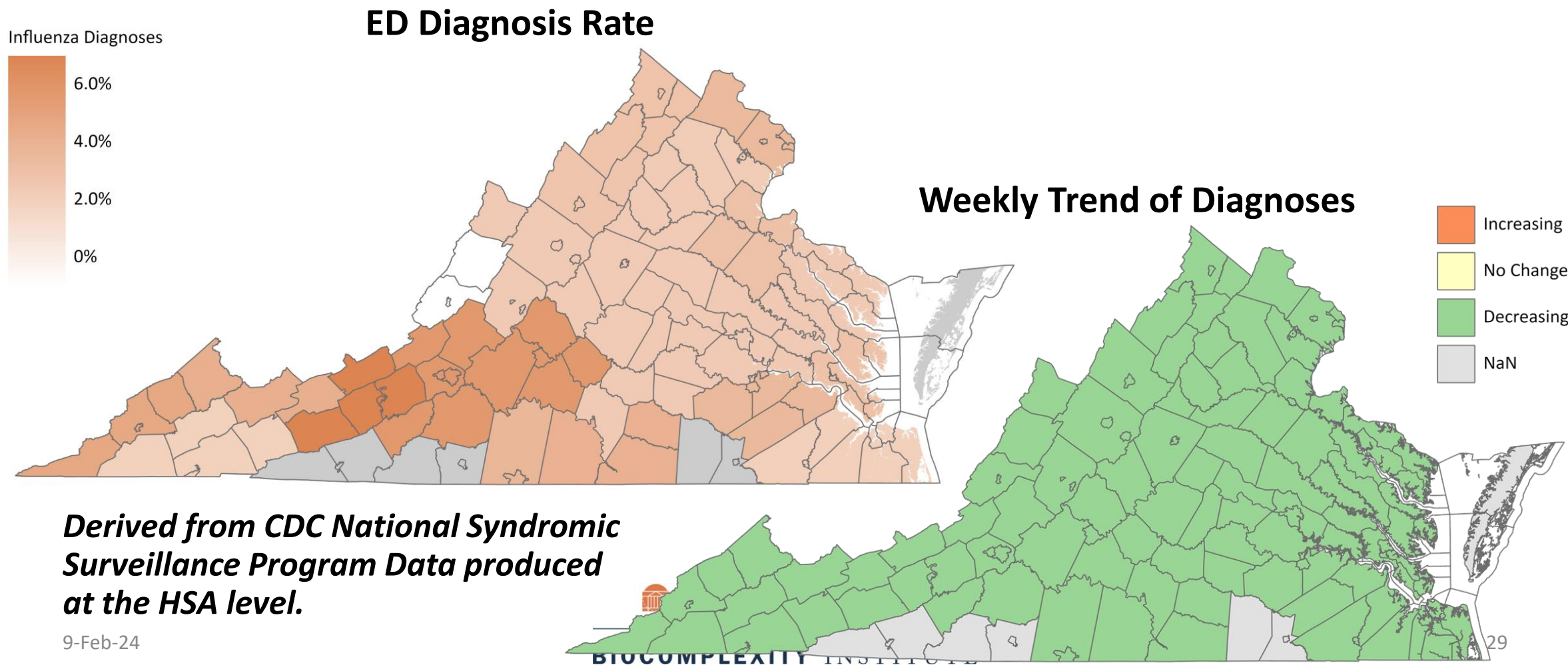
During the week ending January 27, 2024 (week 4), Virginia reported 4.5% of ED and UCC visits were for ILI.

Influenza Hospitalizations – Epidemic Growth



Emergency Department Diagnosis Rate – Influenza

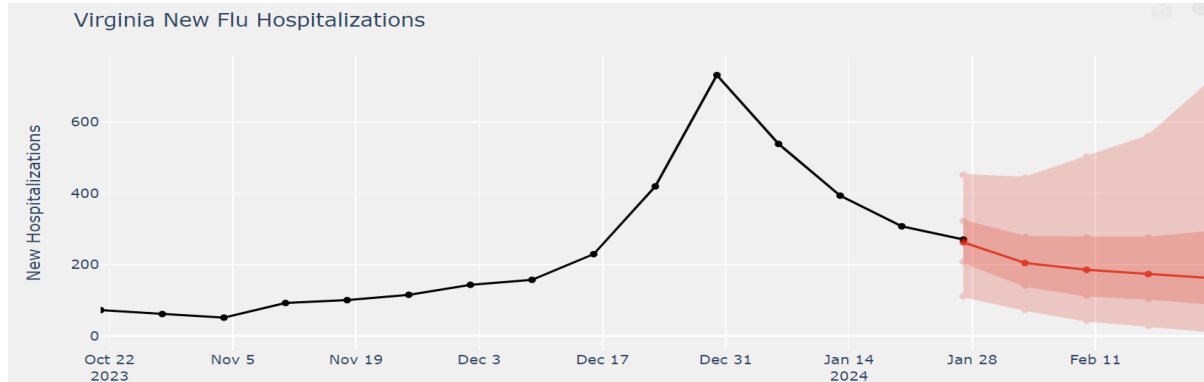
- Flu diagnoses are highest in the New River Valley, and between Roanoke and Lynchburg.
- All counties in the Commonwealth report a decrease in flu diagnoses from last week.



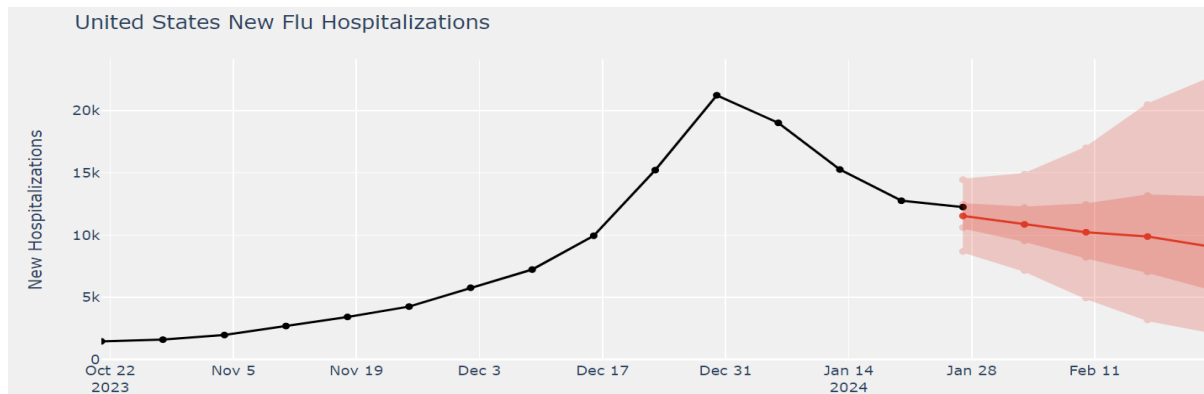
Influenza Forecasts – Hospitalization Admissions

Forecast from Feb 3rd

Virginia

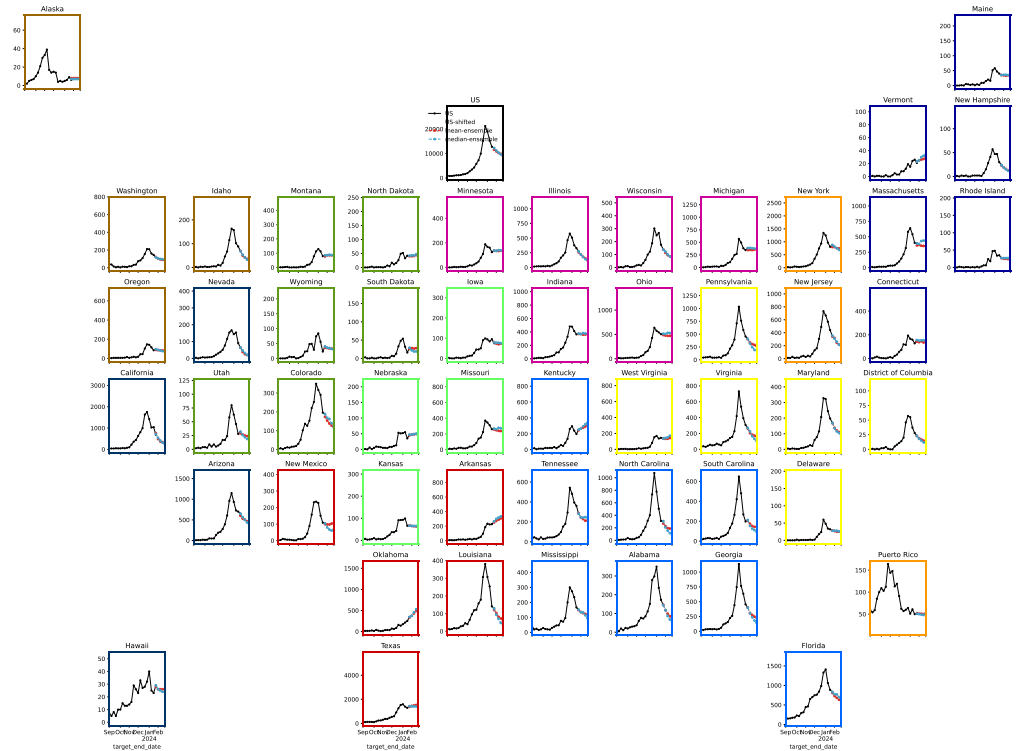


United States



UVA forecast model only
Hospital Admissions for Influenza
and Forecast for next 4 weeks

<http://flux-forecasting.pods.uvarc.io>



Current Influenza Hospitalization Forecast

Statistical models for submitting to [CDC Influenza Forecasting Hub](https://www.cdc.gov/flu/forecasting/)

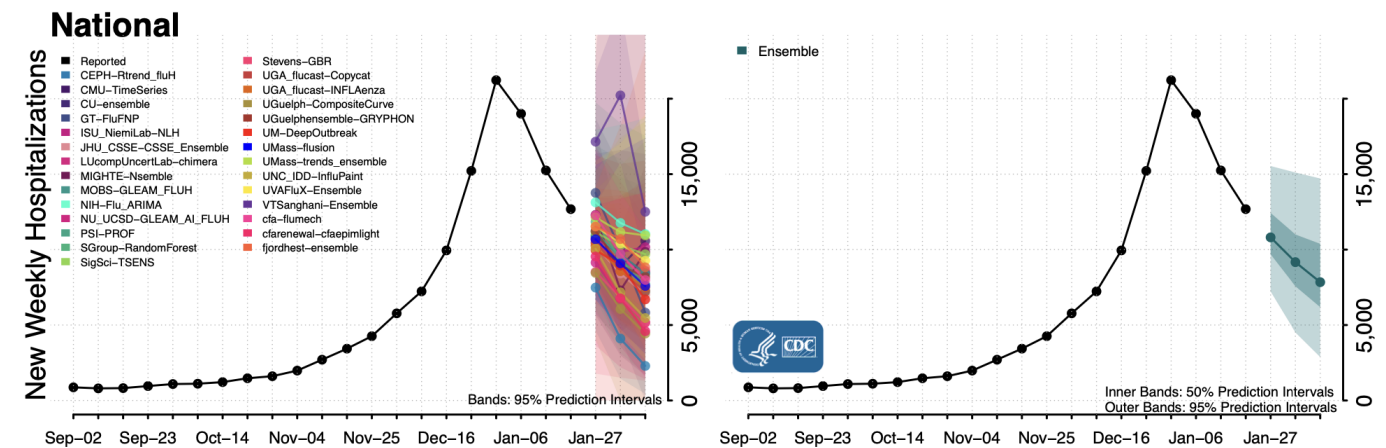
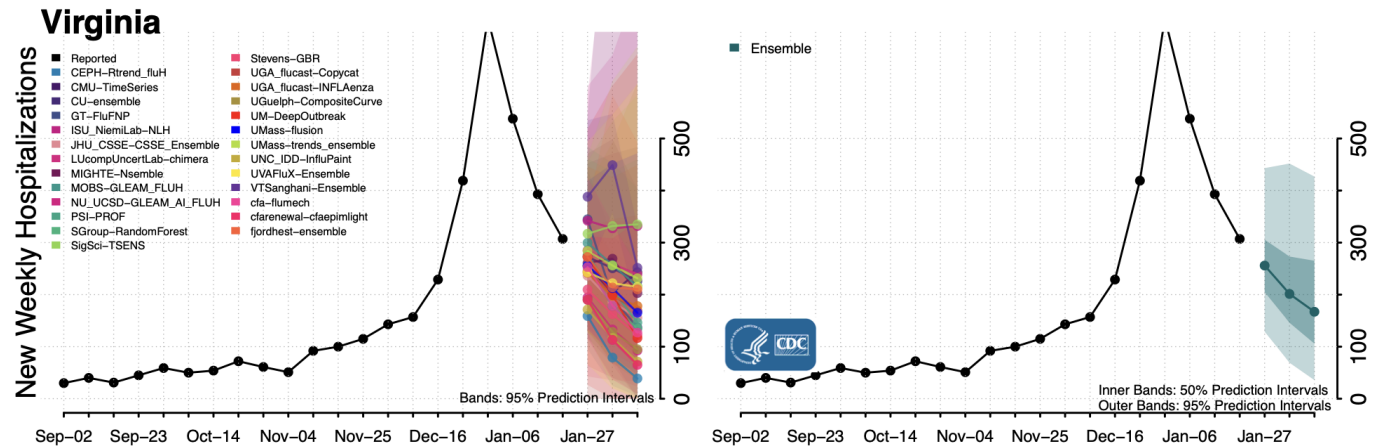
- Uses a variety of statistical and ML approaches to forecast weekly hospital admissions for the next 4 weeks for all states in the US

Hospital Admissions for Influenza and Forecast for next 4 weeks (CDC Influenza Ensemble)

From February 5th

CDC Flu Activity Surveillance

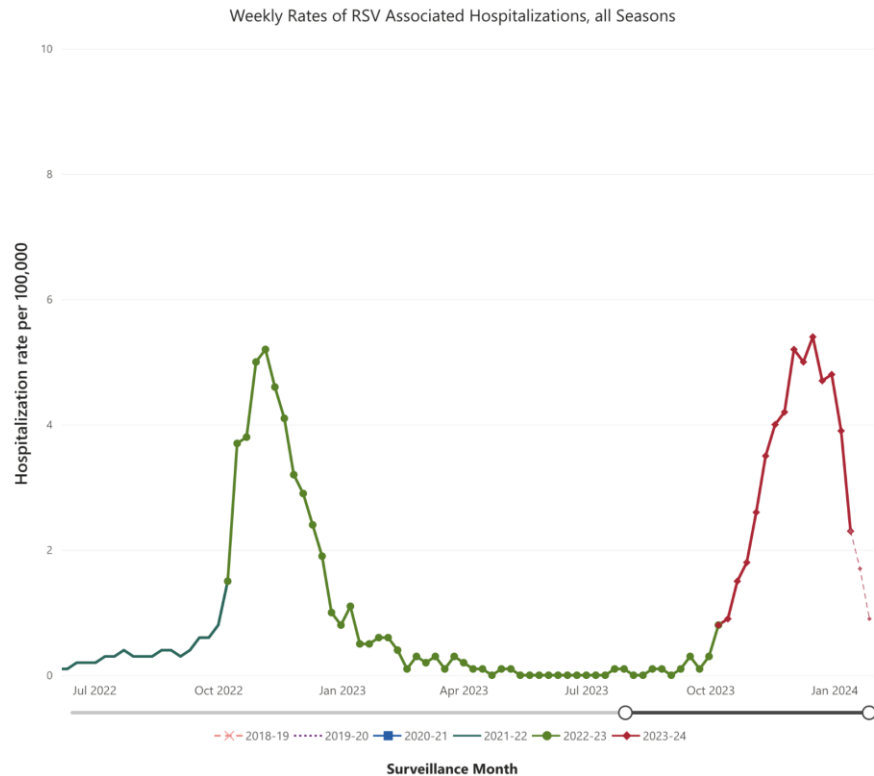
<https://www.cdc.gov/flu/weekly/fluactivitysurv.htm>



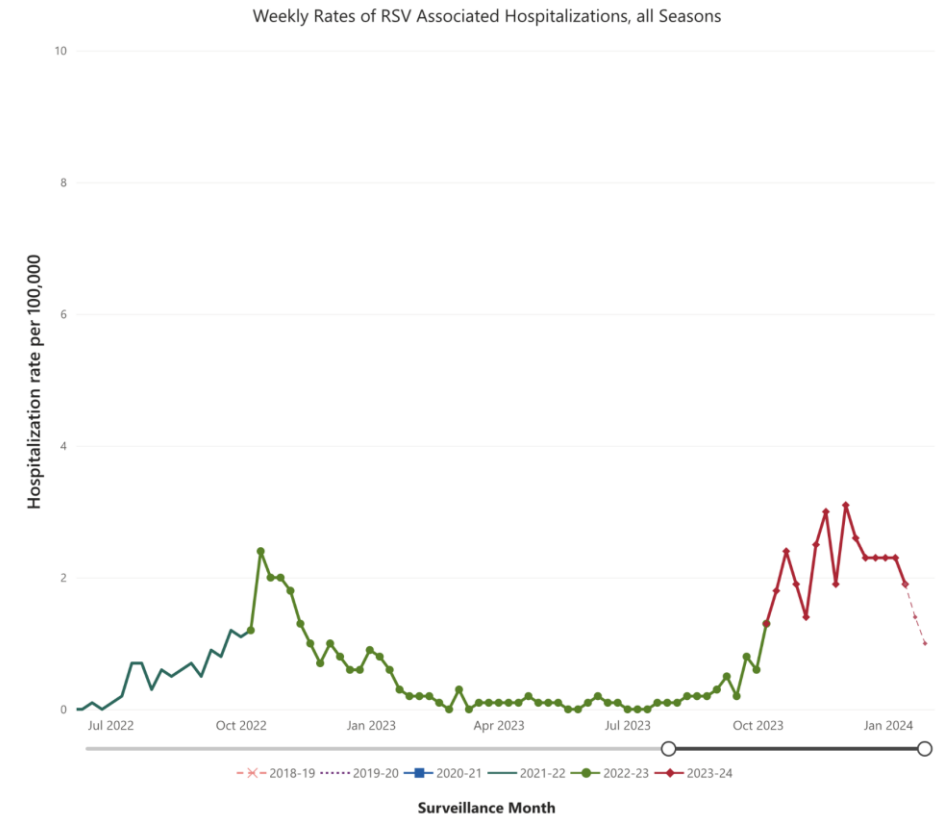
RSV Update

Current RSV Situation – Hospitalization Rates (RSV-Net)

Maryland (RSV-Net)



Tennessee (RSV-Net)



Surveillance data as of:

1/13 (last solid data)

1/27 (last recent but likely to be updated)

2/9/2024



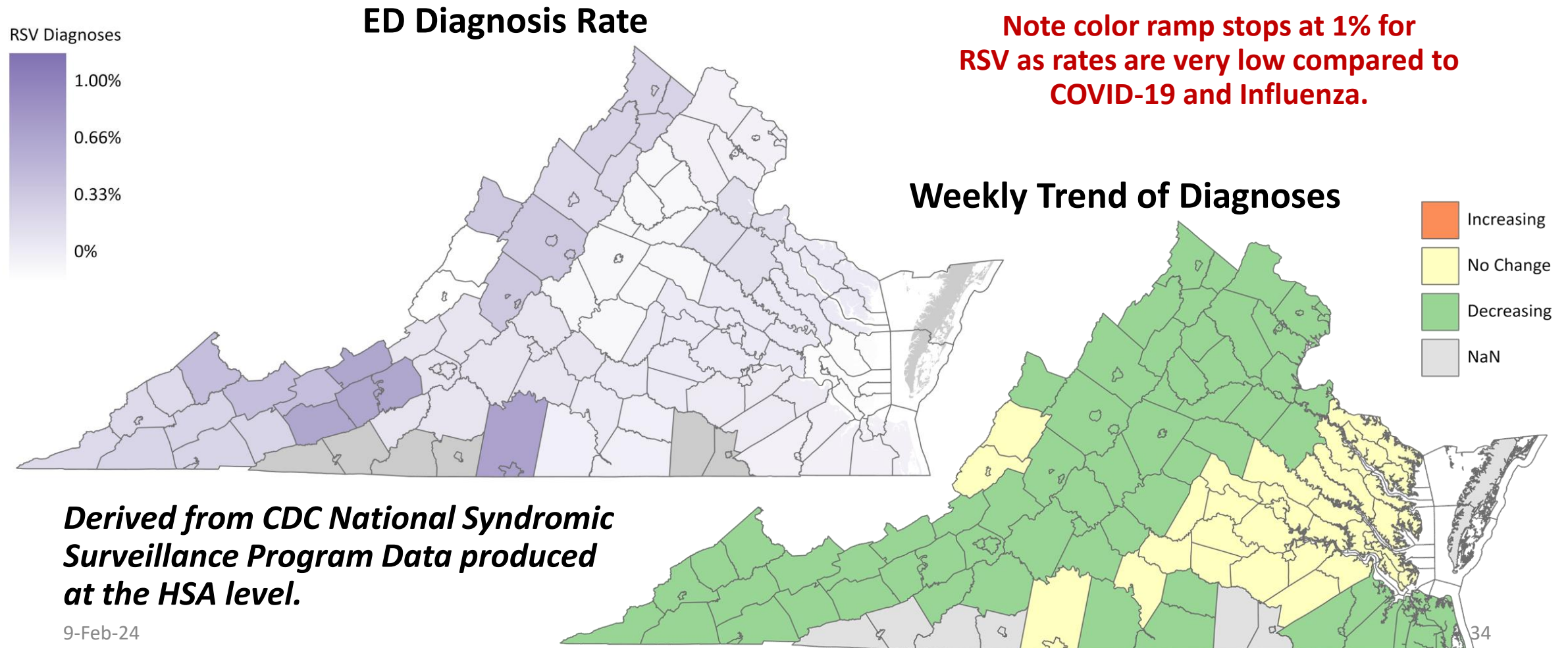
BIOCOMPLEXITY INSTITUTE



[RSV-Net Dashboard](#)

Emergency Department Diagnosis Rate – RSV

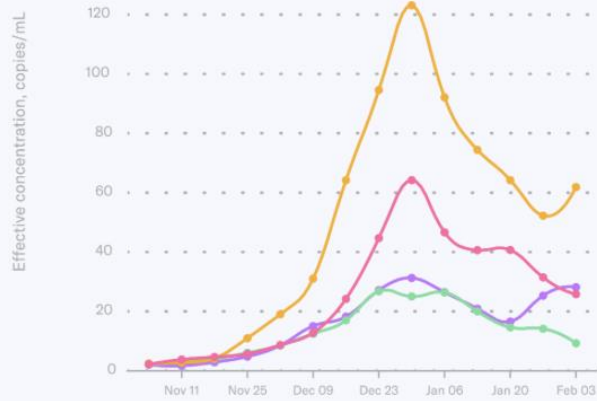
- RSV diagnoses rates are highest in the New River Valley and Pittsylvania-Danville.
- Overall rates are so **low** that many counties report no change from last week.



Respiratory Illness Combined Update

Combined Respiratory Illness Viruses - Wastewater

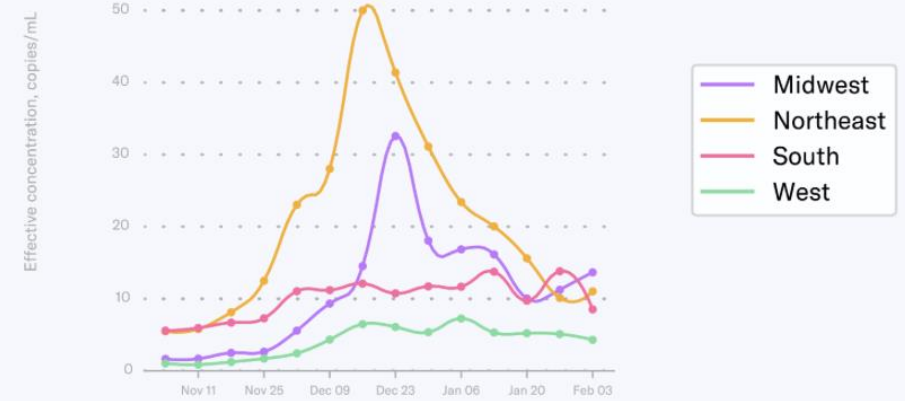
Regional Flu and RSV Wastewater Concentrations



Influenza A



Influenza B



RSV



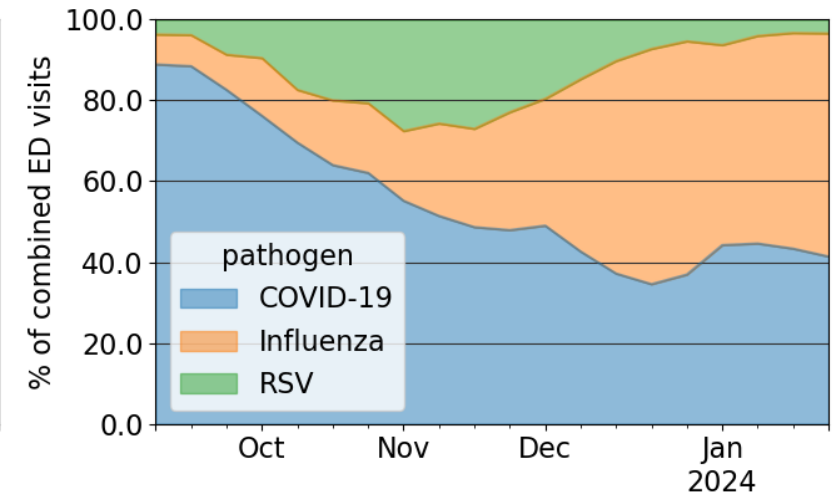
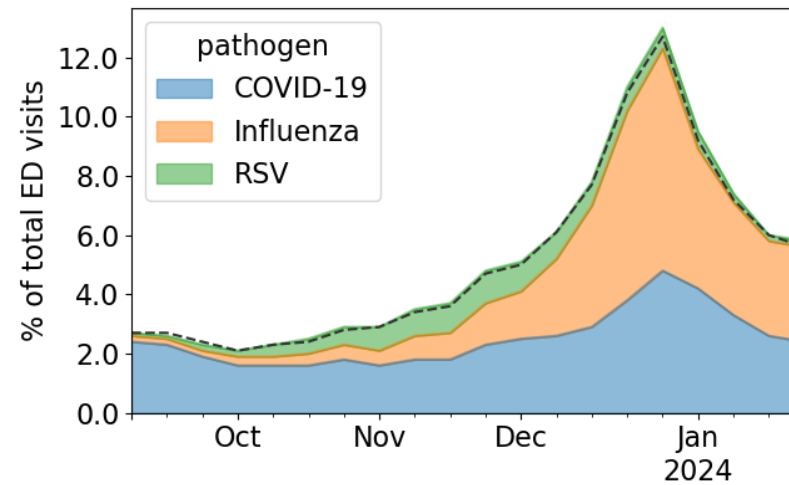
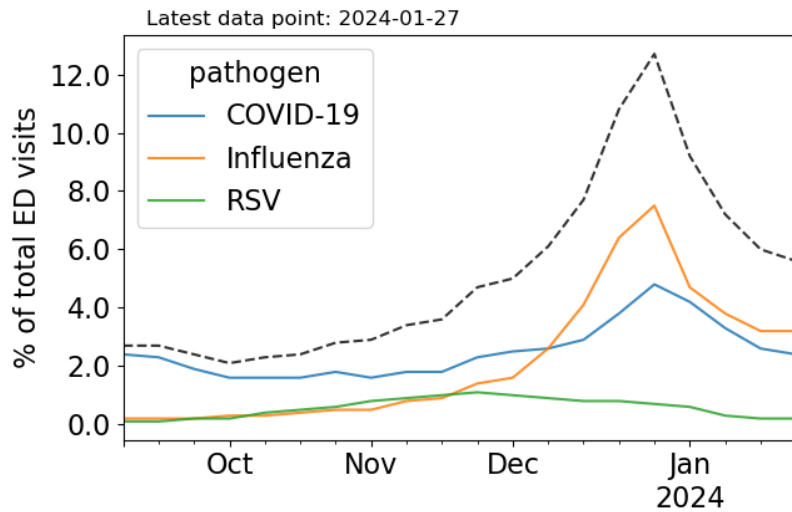
Biobot Analytics

<https://biobot.io/data/>



Combined Respiratory Illness Viruses – NSSP VA ED Visit

Virginia - COVID-19, Influenza, and RSV ED visits - Source: NSSP



Data as of January 27th, 2024

Key Takeaways

COVID-19 indicators show a recent peak and continued declines

- Hospitalization and Diagnosed COVID remain in slow decline
 - Hospitalizations peaked ~20% lower than last year, and continue to decline
- Wastewater continues to show high viral loads (currently lag other indicators)
- Together this suggest continued declines or plateaued activity.

Influenza is declining in VA and across the US

RSV hospitalizations have started to decline while ED visits continue declines

Questions?

Biocomplexity COVID-19 Response Team

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