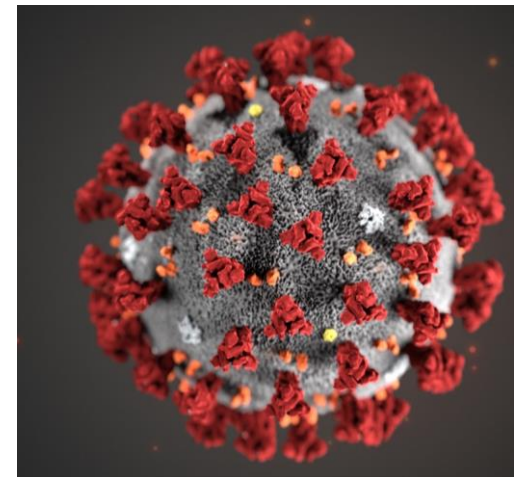




Emergence of SARS-CoV-2 and the Laboratory Response to the COVID-19 Pandemic

Al Bateman, PhD, MPH, D(ABMM)
Assistant Director, Communicable Diseases
Wisconsin State Laboratory of Hygiene
Allen.Bateman@slh.wisc.edu





Outline

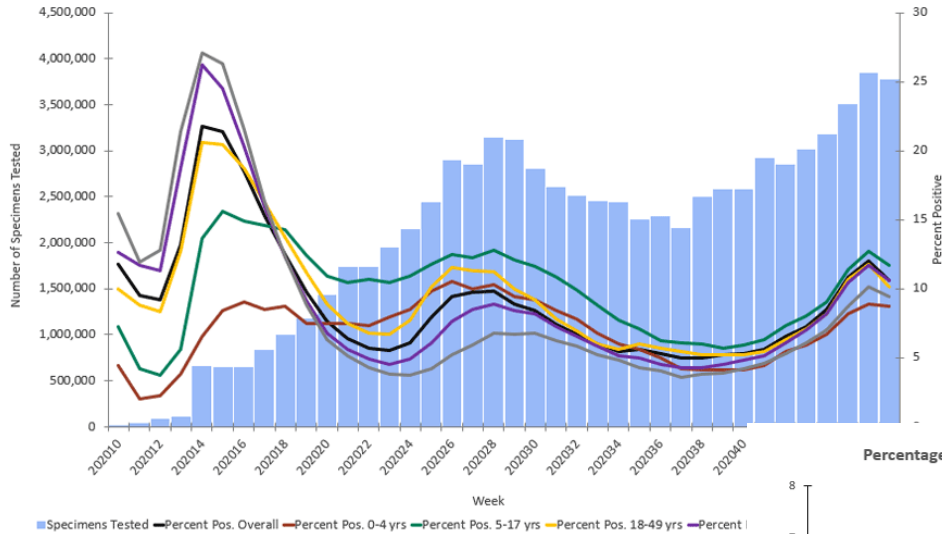
- Useful data dashboards and other resources
- Early days of the pandemic
 - Lab methods used to discover SARS-CoV-2
- Building and maintaining molecular diagnostic capacity
- Serology testing and sero-surveys
- Antigen tests



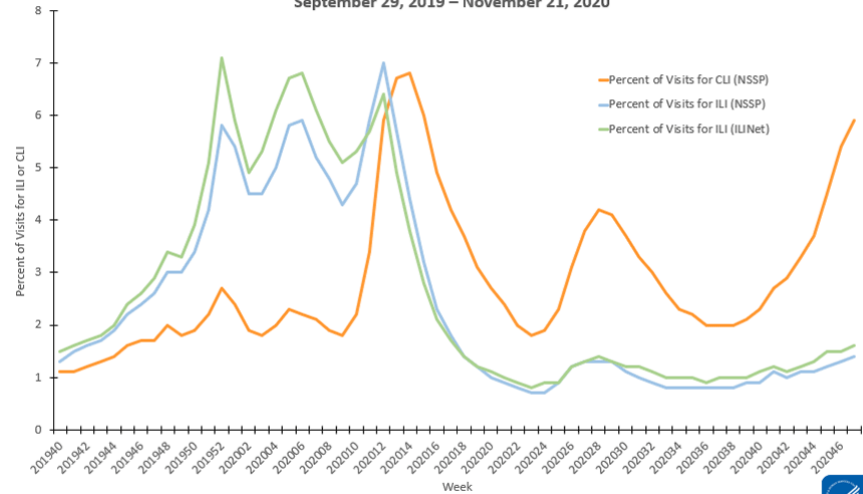


COVIDView

Number of Specimens Tested and Percent Positive for SARS- CoV-2: Combined Laboratories Reporting to CDC (Public Health Laboratories, Subset of Commercial and Clinical Laboratories) March 1, 2020 – November 21, 2020



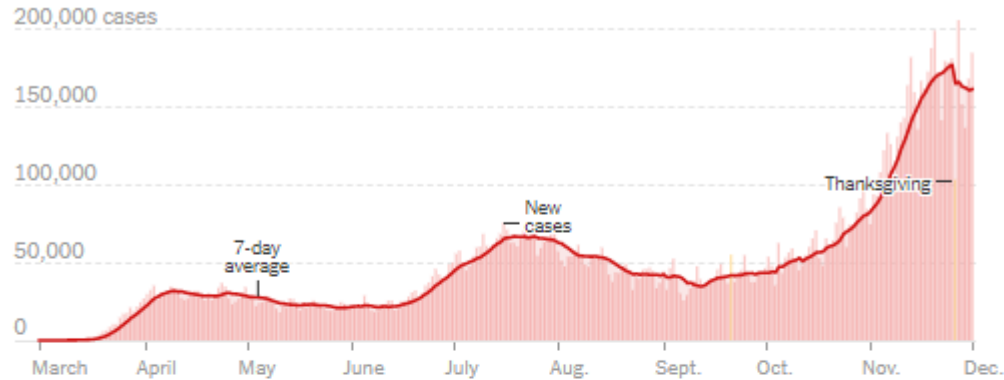
Percentage of Outpatient and Emergency Department Visits for ILI and CLI: ILINet and NSSP September 29, 2019 – November 21, 2020



NY Times website



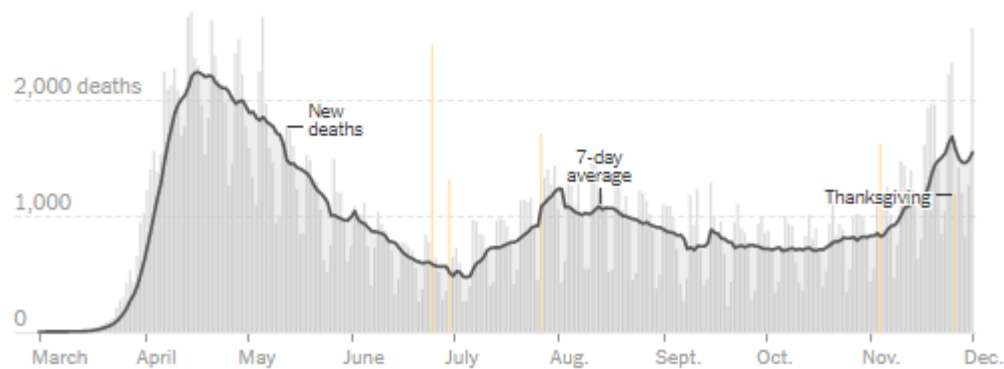
New reported cases by day in the United States



These are days with a data reporting anomaly. Read more [here](#).

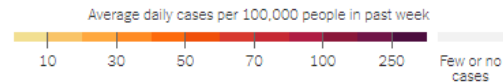
Note: The seven-day average is the average of a day and the previous six days of data.

New reported deaths by day in the United States

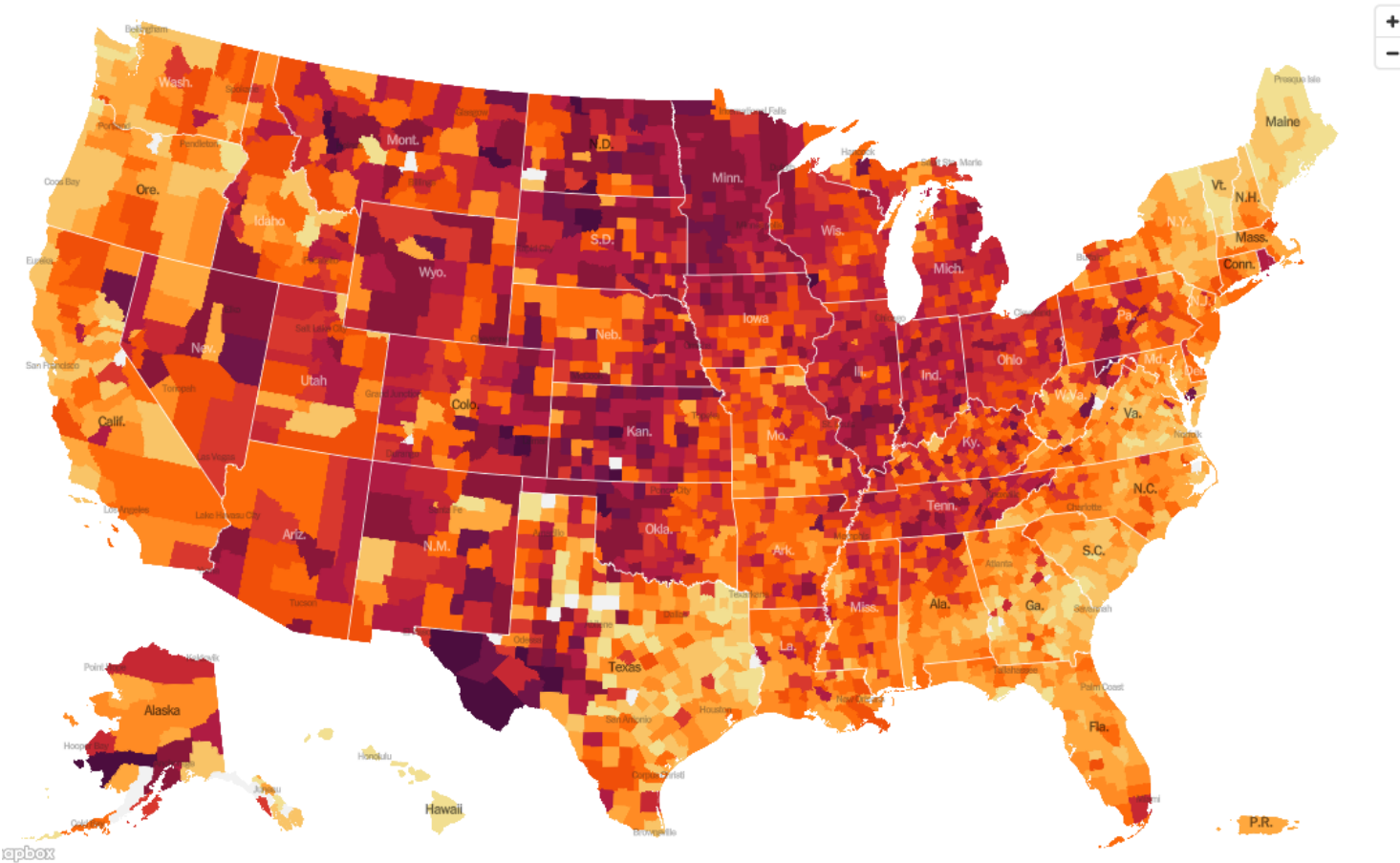


These are days with a data reporting anomaly. Read more [here](#).

NY Times website



Double-click to zoom into the map.



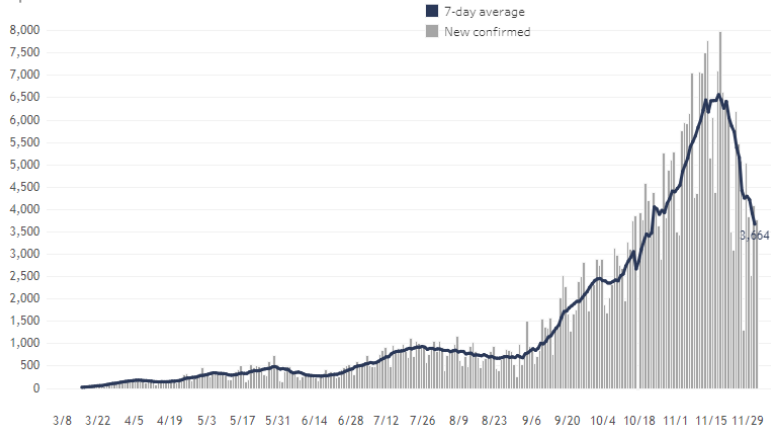
Source: State and local health agencies. Population and demographic data from Census Bureau.



WI DHS

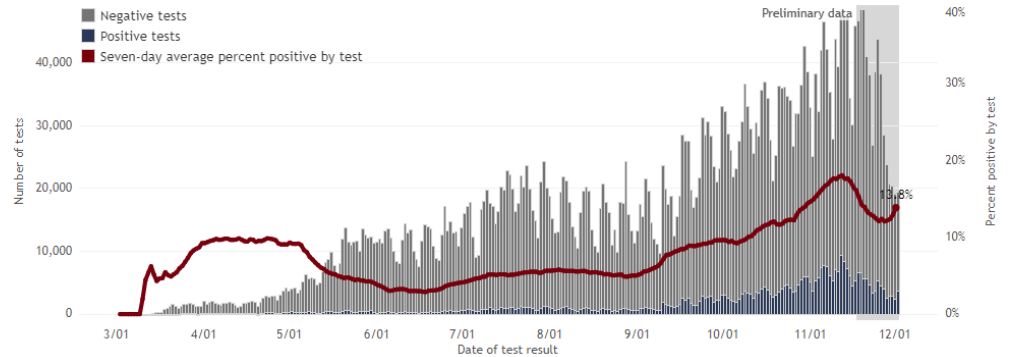
New confirmed COVID-19 cases by date confirmed, and 7-day average

Updated: 12/2/2020



7-day percent positive by test, total tests by day

Updated: 12/2/2020

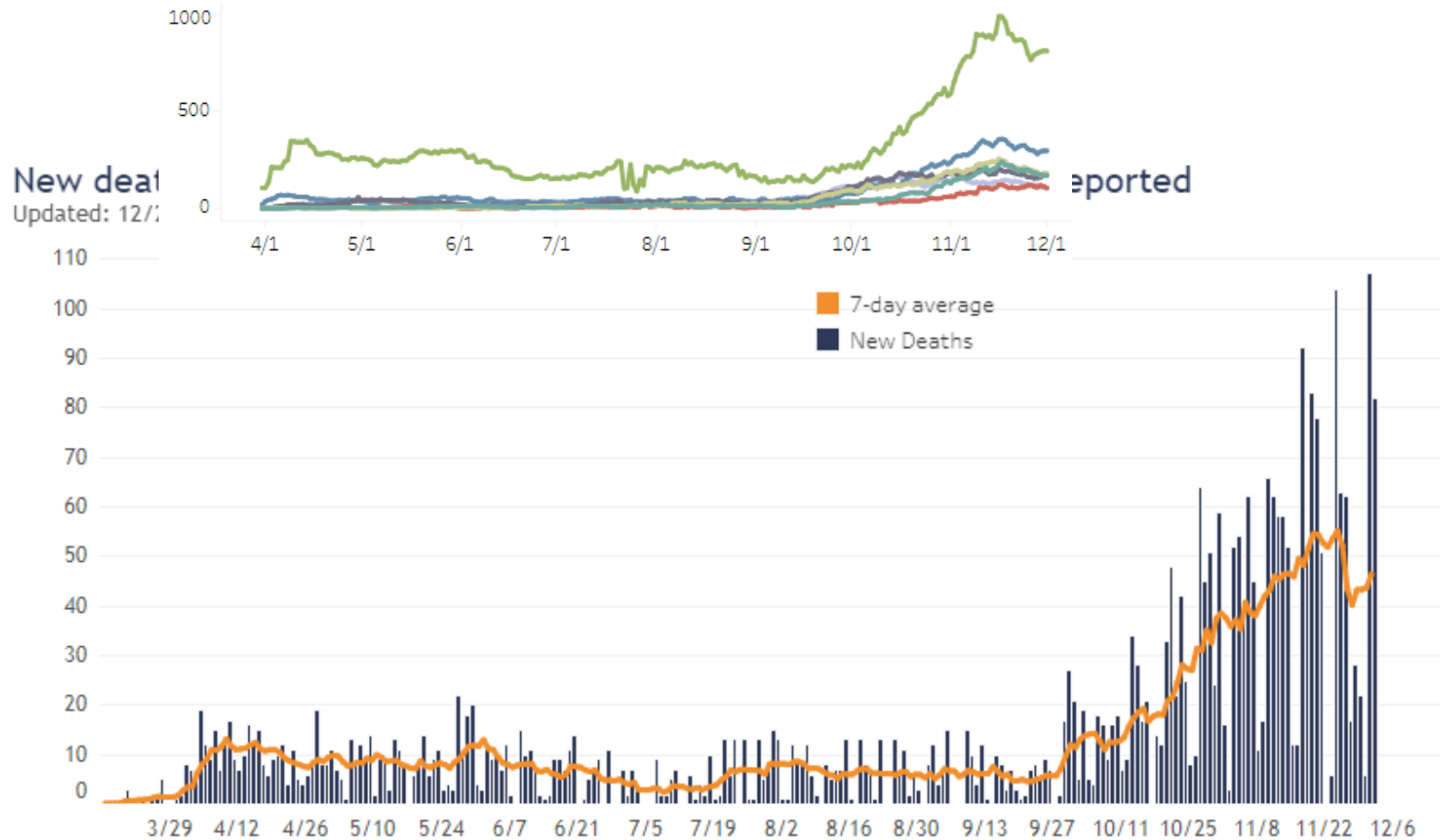


<https://www.dhs.wisconsin.gov/covid-19/data.htm>



WI DHS

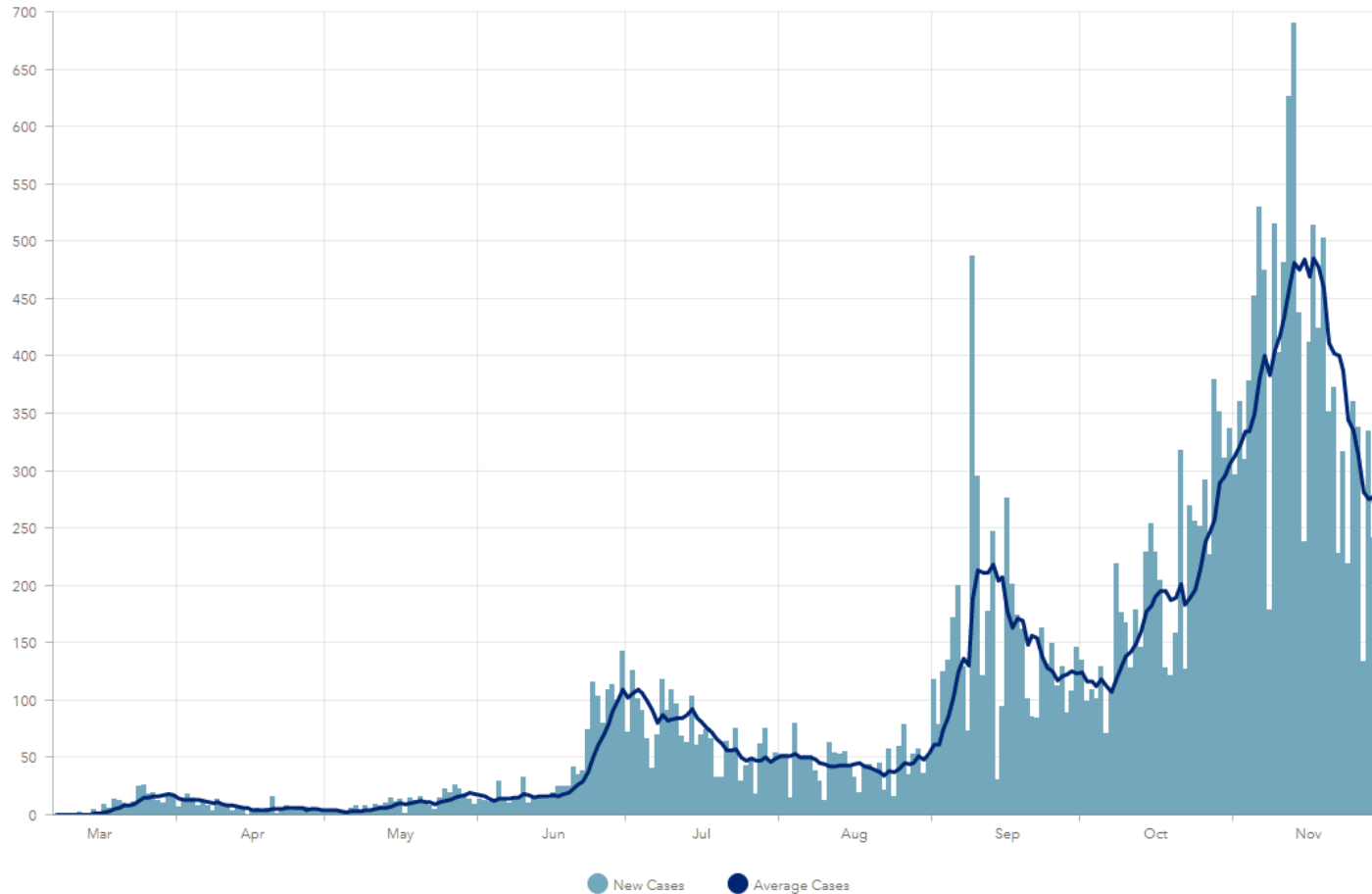
COVID-19 Patients Hospitalized by Region



Public Health Madison Dane Co.



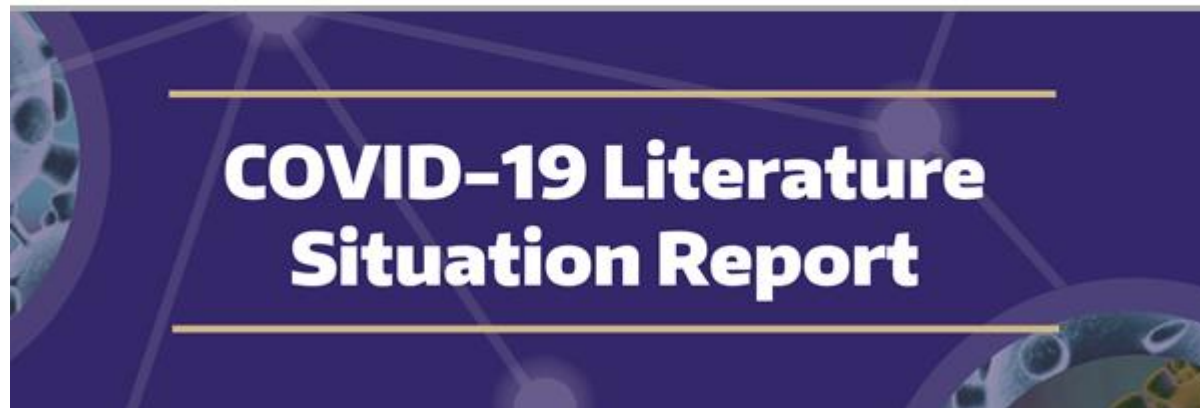
New Cases and 7 Day Average of New Cases by Date of Test Result



<https://publichealthmdc.com/coronavirus/data>



Univ. of Wash. lit review



<https://globalhealth.washington.edu/subscribe>



Ct Values

Ct Values: What They Are and How They Can be Used

Version 1 • November 9, 2020



www.aphl.org

<https://www.aphl.org/programs/preparedness/Crisis-Management/Documents/APHL-COVID19-Ct-Values.pdf>



Centers for Disease Control and Prevention

CDC 24/7: Saving Lives, Protecting People™

LABORATORIES

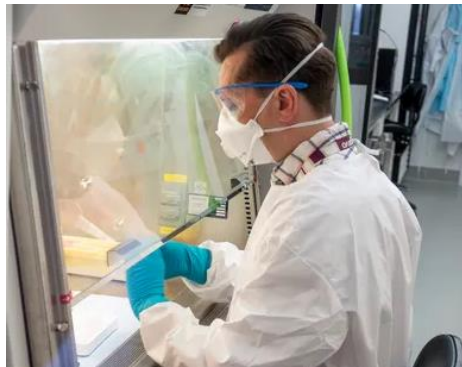
Frequently Asked Questions about Coronavirus (COVID-19) for Laboratories

<https://www.cdc.gov/coronavirus/2019-ncov/lab/faqs.html>



Outline

- Useful data dashboards and other resources
- **Early days of the pandemic**
 - **Lab methods used to discover SARS-CoV-2**
- Building and maintaining molecular diagnostic capacity
- Serology testing and sero-surveys
- Antigen tests





Early Days of the Pandemic: Case study

- 71 yr old male
- Visits clinic with fever and cough
 - Clinician suspects influenza, but test is negative
 - Patient leaves to home care
- 2 days later presents to Emergency Department
 - Still has fever and cough, now difficulty breathing
 - Abnormal chest x-ray
 - Admitted to the hospital
 - All infectious disease tests are negative
 - Infectious Disease physician consulted



Case, continued

- ID doc has seen 3 other similar patients recently
 - All over 70, with underlying conditions
 - Present with pneumonia, but all tests negative
- What does the ID doc do?
 - Consult colleagues
 - Contact public health
 - pneumonia of unknown etiology



Published Date: 2019-12-30 23:59:00

Subject: PRO/AH/EDR> Undiagnosed pneumonia - China (HU): RFI

Patients with unknown cause of pneumonia in Wuhan have been isolated from multiple hospitals

Whether or not it is SARS has not yet been clarified, and citizens need not panic.

On [31 Dec 2019], various hospitals in Wuhan held an emergency symposium on the topic of the treatment of patients with pneumonia of unknown cause in some medical institutions.



Public health's response

- Public health epidemiologists interview patients to find risk factors
 - Seafood/live animal market a common exposure
- Laboratorians work to figure out etiology
 - One approach; cell culture to grow viruses



Cell culture/Virus culture

- Cell lines grown in plastic flasks
- Cells fed with media on top of them
- Add specimen to cells, wait for CPE
 - Virus growth kills cells, and dead vs. live cells can be seen in microscope
- Try many different cell types
 - Certain viruses only grow in certain cell types
- Virus culture used to be a common diagnostic method for viruses; now it's primarily used for research (and finding novel viruses)



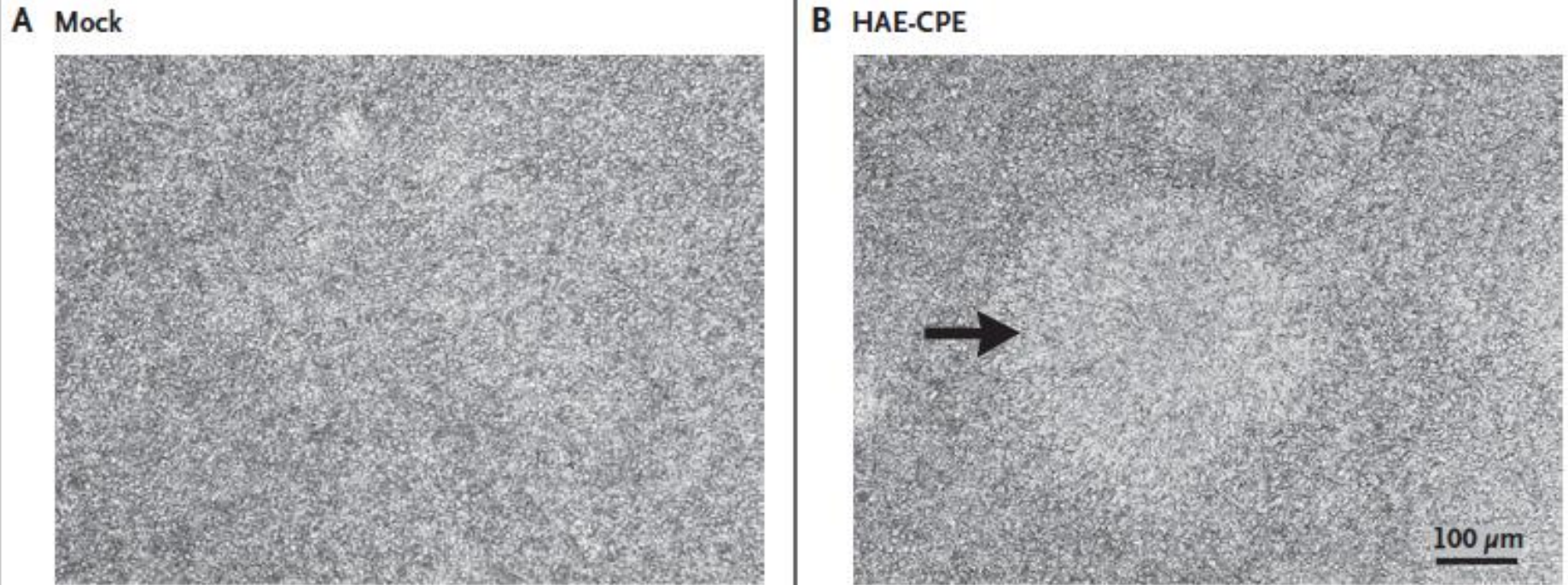


Figure 2. Cytopathic Effects in Human Airway Epithelial Cell Cultures after Inoculation with 2019-nCoV.

- Air-liquid interface cell cultures
- One virus particle first, and CPE spread outward with virus spread



What next?

- Something is causing cell death: how to figure out what it is?
- Most diagnostic tests are very specific, and only look for a single pathogen
- Unbiased pathogen detection:
 - Next-generation sequencing



Published Date: 2020-01-05 18:15:37

Subject: PRO/AH/EDR> Undiagnosed pneumonia - China (HU) (03): updates, SARS, MERS ruled out, WHO, RFI



Published Date: 2020-01-08 23:19:25

Subject: PRO/AH/EDR> Undiagnosed pneumonia - China (HU) (07): official confirmation of novel coronavirus

Archive Number: 20200108.6878869



How did they know it was a new coronavirus?



ProMED
INTERNATIONAL SOCIETY
FOR INFECTIOUS DISEASES

Published Date: 2020-01-11 12:25:54

Subject: PRO/AH/EDR> Undiagnosed pneumonia - China (HU) (10): genome available, Hong Kong surveill.

- Next-generation sequencing
 - Massively parallel sequencing



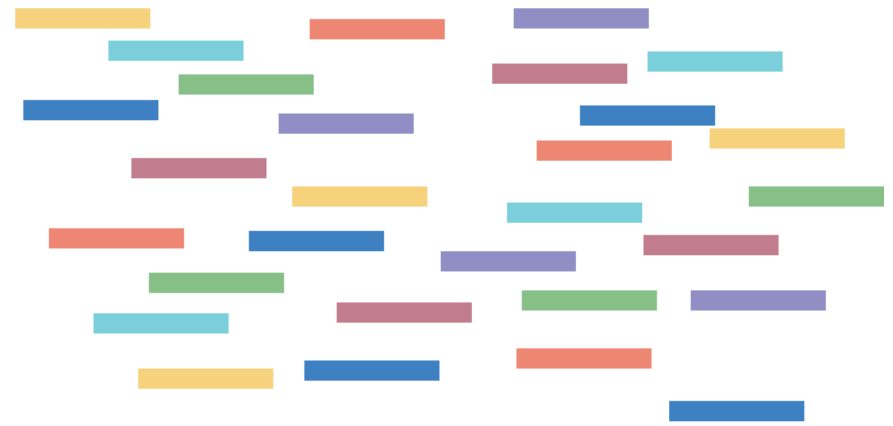
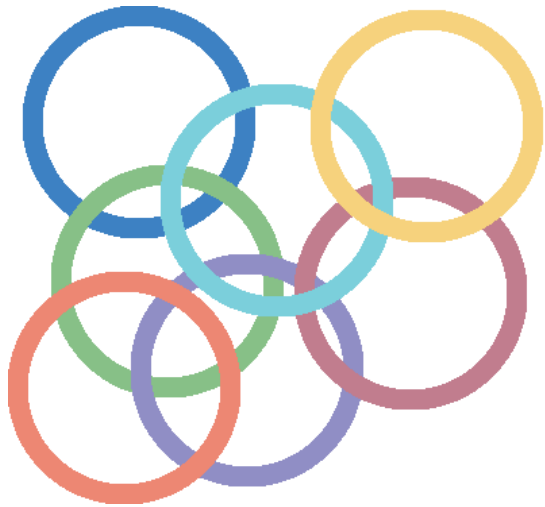


Subsets of Next-generation sequencing

- Whole Genome Sequencing (WGS) from a bacterial isolate
- Targeted amplicon
 - one gene or region of interest
- Metagenomics
 - sequence everything that's in a sample



Metagenomics



Reads

Bacterial genomes,
Human DNA,
Human RNA,
Virus DNA/RNA

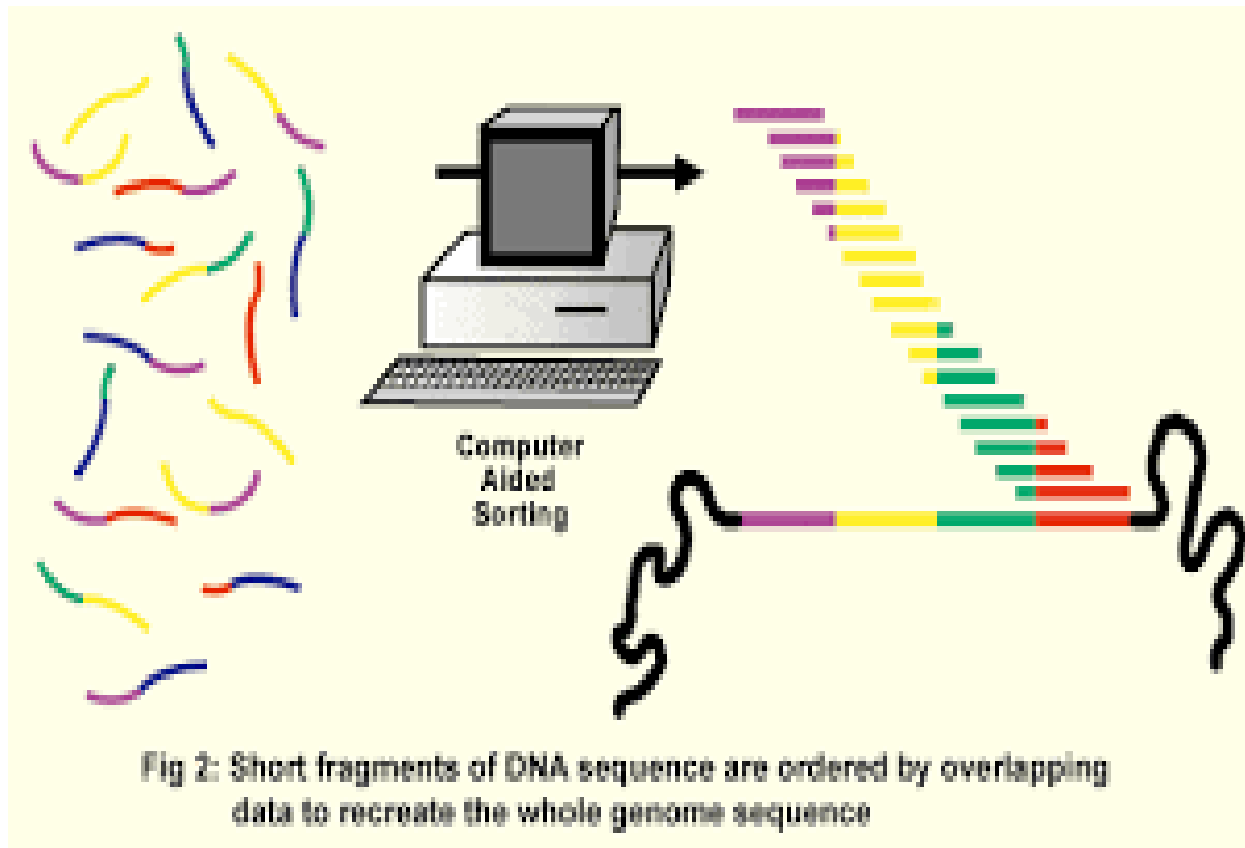


Metagenomics

- Millions of reads per specimen
- For each read, use huge databases to determine:
 - Is it a human sequence?
 - If Y, discard
 - Is it a known bacterial/viral/plant/other sequence?
 - If Y, discard
 - What else is left?
 - Reads that don't match any known sequences
 - Reads that match sequences only ok
 - Not exact matches, but close to other coronaviruses
 - From these reads, can we reconstruct the genome?



Sequence Assembly



- Overlapping data to reconstruct the entire viral genome (>29,000bp)!

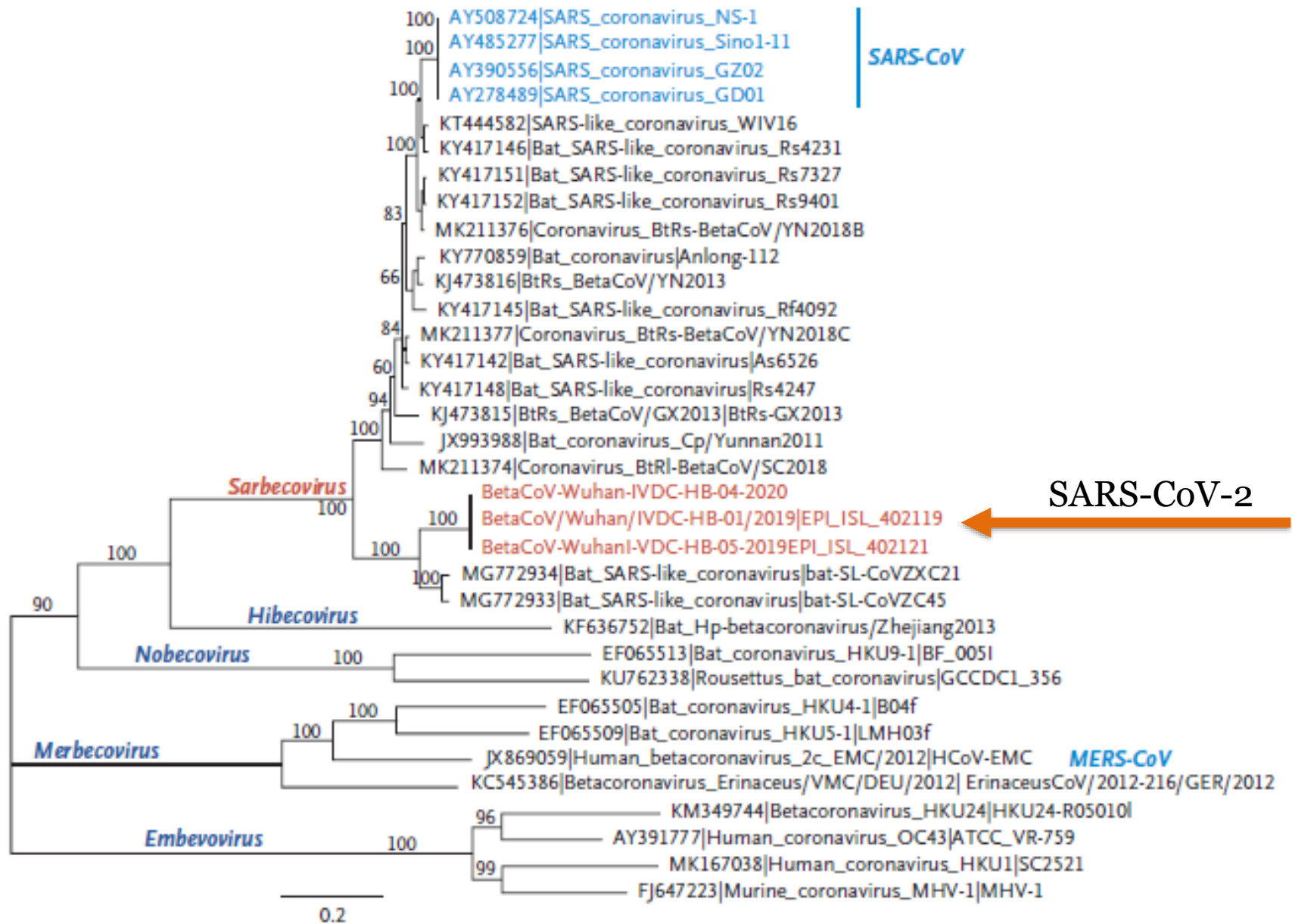


Figure 4. Phylogenetic Analysis of 2019-nCoV and Other Betacoronavirus Genomes in the Orthocoronavirinae Subfamily.



Why is the genome so powerful?

- Compare to other CoV to guess where it originated (bats?)
- Compare multiple SARS-CoV-2 sequences (NextStrain)
- The first step to develop diagnostics
 - Too expensive and slow to do next-generation sequencing on everything
 - Compare to other CoV to look for unique sections in SARS-CoV-2
 - Develop real-time PCR for diagnosis



Real-time PCR

- Diagnostic workhorse
 - Virology, bacteriology, TB, etc, etc, etc
- Two main steps
 - Nucleic acid (DNA, RNA) extraction
 - Nucleic acid amplification
- Sensitive, specific, and fast



Case 1: December 15, 2019

- 71 yr old male
- Visits clinic with fever and cough
 - Clinician suspects influenza, but test is negative
 - While SARS-CoV-2 is being discovered in the lab (weeks for discovery and characterization), patient transmits virus to many others



Case 2: January 25, 2020

- 71 yr old male
- Visits clinic with fever and cough
 - Clinician suspects influenza, but test is negative
 - Clinician also suspects novel coronavirus
 - Immediately isolates patient (in hospital room or at home)
 - Sends specimen to lab
 - Real-time PCR test is positive the next day
 - Few to no exposure to other people = stops transmission



Outline

- Useful data dashboards and other resources
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Steps in laboratory testing for emerging pathogens

	<u>Approx. daily capacity</u> <u>(nationwide)</u>
▪ CDC develops a test	350
▪ CDC rolls out the test to public health labs	
▪ WSLH	15,000
▪ Milwaukee City Lab	
▪ Large clinical labs bring on testing	>300,000
▪ Wisconsin labs	
▪ National reference labs	
▪ Commercial manufacturers get approved tests	>500,000
▪ Small and medium-sized labs can test	



Overview of SARS-CoV-2 PCR at WSLH

- Officially started testing on March 2nd
- All-of-division response to meet the exploding demand
- Issues with supply chain threatened to shut down testing
- Strategy for testing diversification (validated 6 different extraction platforms in two weeks) allowed us to source multiple supply lines. Luckily, we never went down.
- Tested over 75,000 specimens at WSLH to date
- Continuing other mission critical work, new hires



Testing Advancements at WSLH: RNA extraction

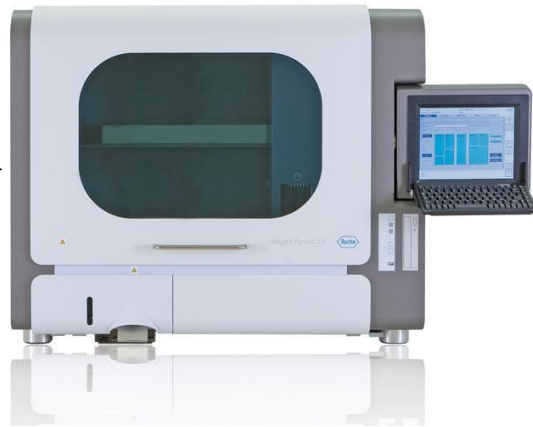
EZ1 - 14
samples



Spin column –
low volume



Magna Pure LC -
24 samples



eMAG - 48
samples



QIAcube HT - 96 samples



KingFisher Flex - 96 samples





Testing Advancements at WSLH: PCR

CDC 2019-nCoV
- 29 samples/plate



ThermoFisher TaqPath
- 94 samples/plate

+

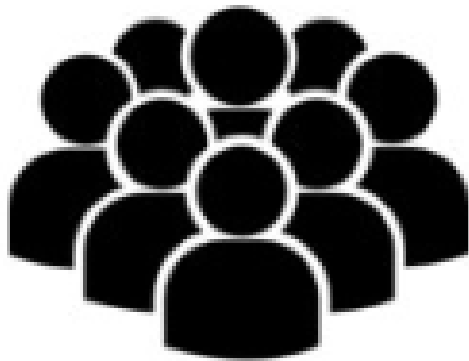
CDC FluSC2 multiplex
- 94 samples/plate





Current Testing

KingFisher Flex + ABI 7500 Fast Dx



Hologic Panther-
300-500/day





Building Capacity Statewide – Wisconsin Clinical Laboratory Network

Thanks for all that you have done!!

How WSLH has assisted:

- >100 Validation Panels
- ~20 Webinars
- >30 Lab Messages
- Maintained listserv
- Technical Consultants

Leveraged and strengthened the WCLN through
SARS-CoV-2 pandemic response

The screenshot shows the website for the Wisconsin State Laboratory of Hygiene (WSLH), part of the University of Wisconsin-Madison. The header includes the WSLH logo and navigation tabs for various services: ABOUT WSLH, WSLH SERVICES, LAB NETWORKS & SURVEILLANCE, RESEARCH SUPPORT CENTER, NEWS & PUBLICATIONS, and PAY YOUR BILL. Below the header is a secondary navigation bar with categories: CLINICAL TESTING, WATER & OTHER ENVIRONMENTAL TESTING, OCCUPATIONAL HEALTH & SAFETY SERVICES, FORENSIC TOXICOLOGY, and PROFICIENCY TESTING. The main content area is titled "COVID-19 (Coronavirus Disease 2019)" and includes a note that information was updated on 06/09/2020 at 6:00 PM. A "A note to patients" section states that results are provided through healthcare providers. A "Recent Updates" section lists several updates, including SEOC Distribution Center details, WCLN Webinars, and lab capacity information. A link to "See more information below" is provided at the bottom.



Statewide Estimated Daily Test Capacity

Last Updated: 12/2/2020 11:45:19 AM
Updated once daily

Current Daily Testing Capacity

59,625

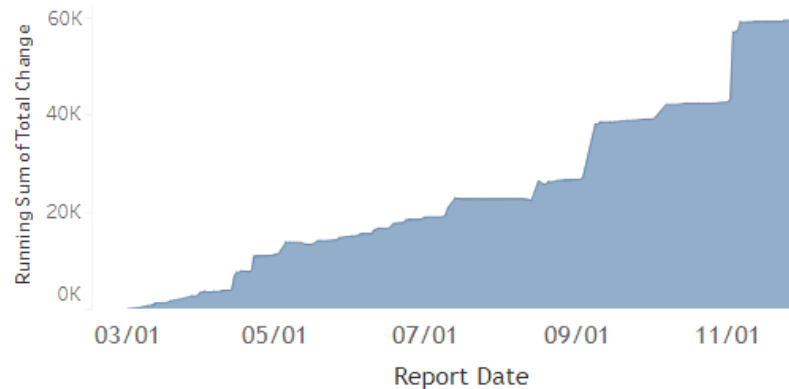
Labs Currently Performing Testing

133

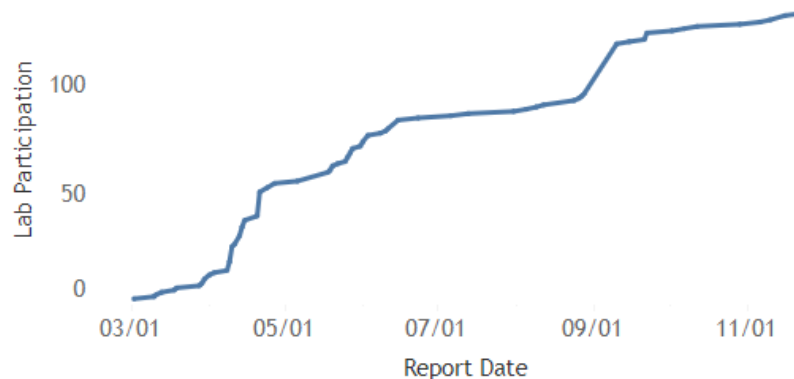
Labs Planning to Test

17

Wisconsin's Lab Testing Capacity Over Time

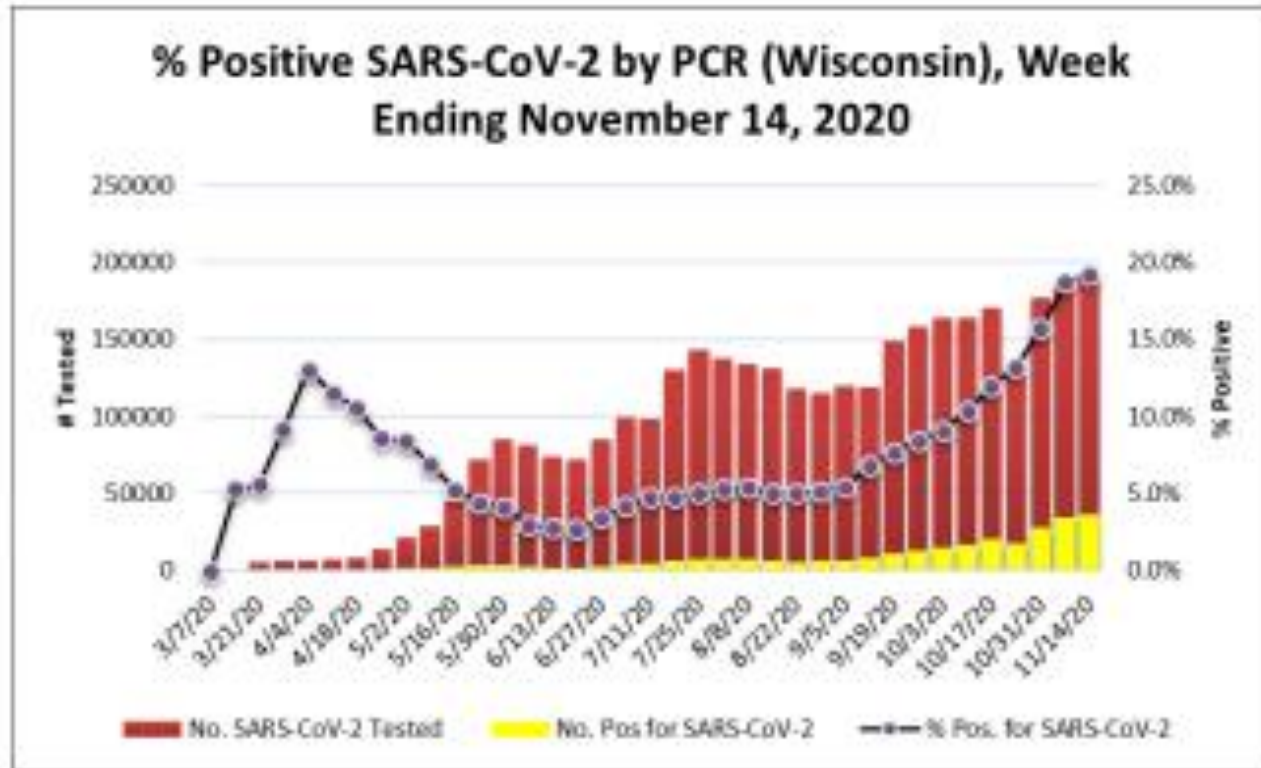


COVID-19 Lab Participation Rate Over Time





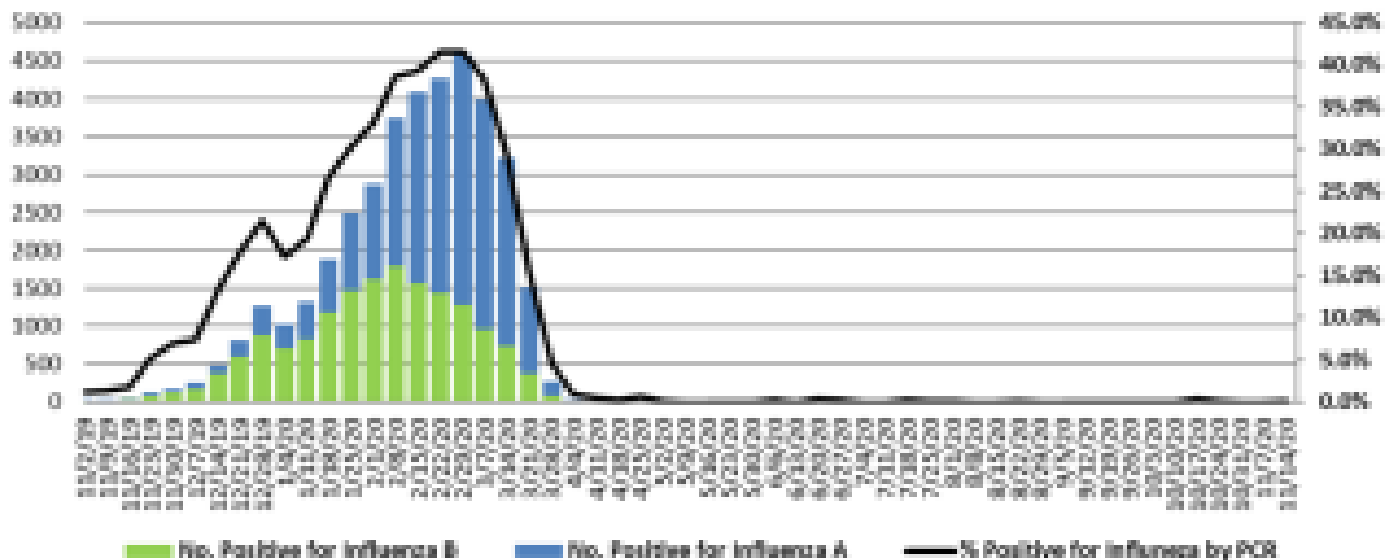
Testing Increase in Wisconsin





Influenza virtually absent

**% Positive for Influenza by PCR (Wisconsin), Week Ending
November 14, 2020**





Week Ending November 14, 2020*

Resp. Pathogen PCR	# Tested	% Positive
SARS-CoV-2	189,764	19.2 ↑
Rhinovirus/ Enterovirus	846	6.0 ↓
Influenza	6,823	<1
RSV	1,073	0
Human metapneumovirus	910	0
Adenovirus	40	0
Parainfluenza	902	0
Seasonal coronaviruses	40	0
<i>B. pertussis</i>	226	<1



Maintaining PCR Capacity

- Continuous supply chain and logistics issues
 - Swabs
 - Transport media
 - Extraction reagents
 - N95s
 - Gloves
 - Plastic pipet tips



- Exchanges with clinical labs to keep all labs running



Outline

- Useful data dashboards and other resources
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- **Serology testing and sero-surveys**
- Antigen tests





Serology at WSLH – SARS-CoV-2 IgG

NOW
ve 90%

Post Crescent.

[Sports](#) [Packers](#) [Business](#) [Life](#) [Nation / World](#) [Obituaries](#) [E-Edition](#) [Legals](#)

NEWS

Here's how Wisconsin's coronavirus antibody study will work, and what we might learn from it

Madeline Heim USA TODAY NETWORK-Wisconsin

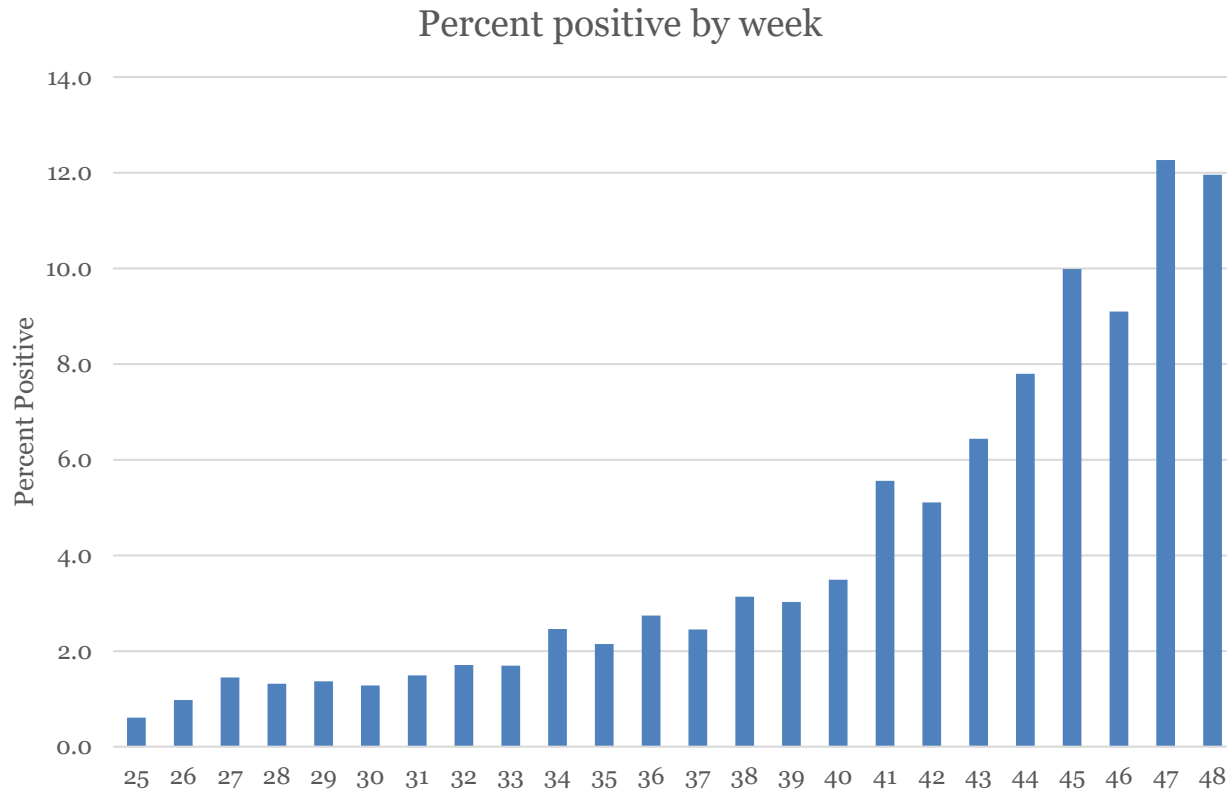
Published 10:31 a.m. CT Jun. 19, 2020





Red Cross Serology Data

American Red Cross donations from healthy donors that screened reactive for antibodies to SARS-CoV-2 by Ortho total immunoglobulin test





Serology at WSLH – SARS-CoV-2 IgG

Strategies

- ~1000 samples/quarter with SHOW
- Inform specific outbreaks
- Collaborate with CDC/DHS/UW
 - UW-Madison and UW-Oshkosh studies



Abbott Architect

Morbidity and Mortality Weekly Report (*MMWR*)

CDC



COVID-19 Outbreak at an Overnight Summer School Retreat — Wisconsin, July–August 2020

Weekly / October 30, 2020 / 69(43);1600–1604

Ian W. Pray, PhD^{1,2}; Suzanne N. Gibbons-Burgener, DVM, PhD¹; Avi Z. Rosenberg, MD, PhD³; Devlin Cole, MD^{1,4}; Shmuel Borenstein⁵; Allen Bateman, PhD⁶; Eric Pevzner, PhD⁷; Ryan P. Westergaard, MD, PhD^{1,4} ([View author affiliations](#))

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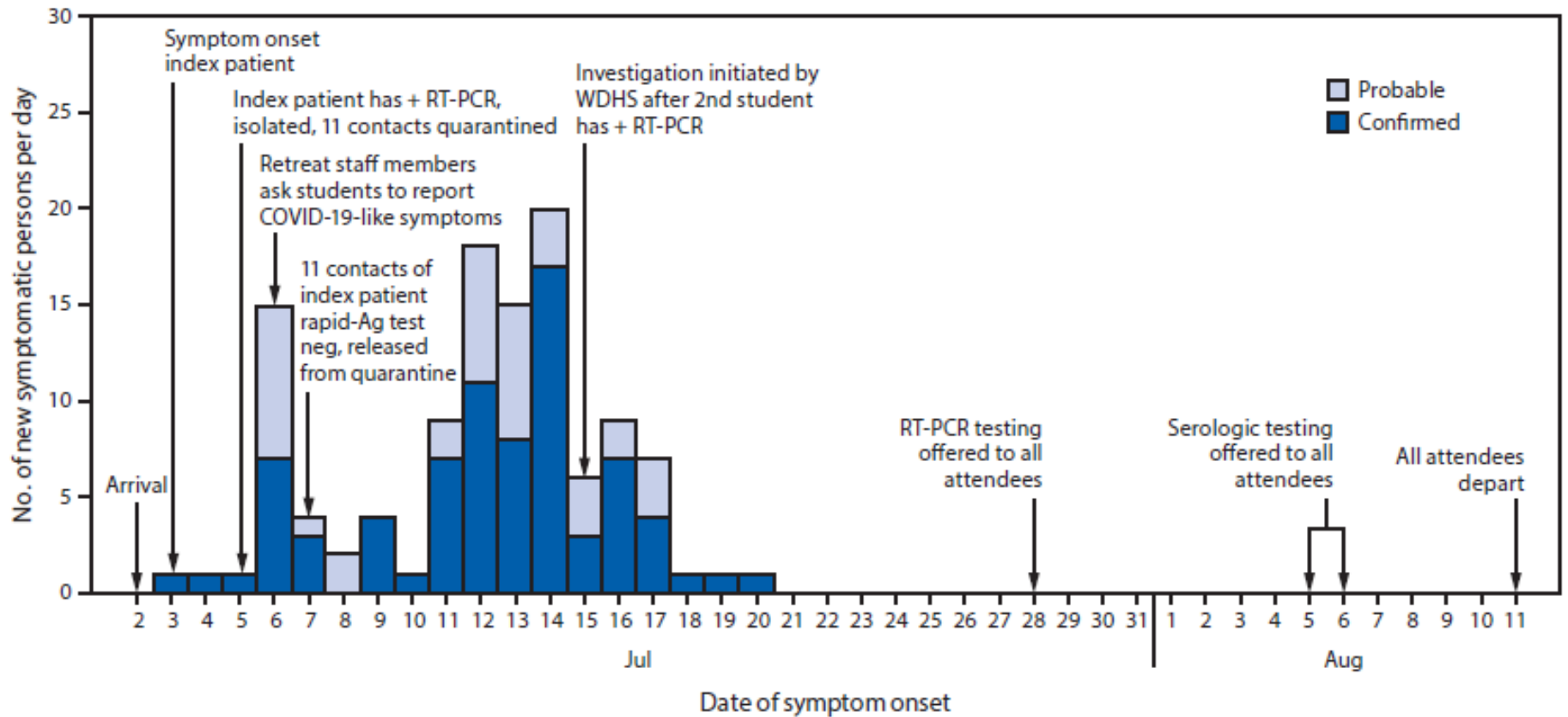
Ian W. Pray, PhD^{1,2}; Suzanne N. Gibbons-Burgener, DVM, PhD¹; Avi Z. Rosenberg, MD, PhD³; Devlin Cole, MD^{1,4}; Shmuel Borenstein⁵; Allen Bateman, PhD⁶; Eric Pevzner, PhD⁷; Ryan P. Westergaard, MD, PhD^{1,4} ([View author affiliations](#))



- July-August, 152 high school boys/counselors/staff from 21 states had a staff retreat in Wisconsin
- Prior to arrival, all attendees had either:
 - Positive serologic test OR
 - Negative PCR within 7 days
- After arrival, no physical distancing or masking
- Many students symptomatic 2 weeks after arrival; two PCR positive for SARS-CoV-2
- PCR testing of everyone: 78 (51%) PCR positive
- In addition, 38 (25%) met clinical criteria for COVID-19.
- End of retreat, IgG conducted at WSLH: 118 (78%) IgG positive



FIGURE. Dates of symptom onset of confirmed (n = 78) and probable (n = 38) COVID-19 cases at an overnight summer school retreat — Wisconsin, July 2–August 11, 2020



COVID-19 Outbreak at an Overnight Summer School Retreat — Wisconsin, July–August 2020

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- WGS showed highly related virus strains
- Large outbreak likely from a single student; emphasizes mitigation measures need to be maintained throughout retreats/camps
- 24 (16%) attendees provided documentation of a positive serology results before the retreat. All 24 received negative RT-PCR results. Six (25%) experienced mild symptoms at the retreat but were not classified as having confirmed or probable COVID-19.
- Excluding the 24 attendees with previous positive serologic results, the COVID-19 attack rate on the remaining susceptible population was 91% (116 of 128).



Real-world data of prior infection/antibodies being protective

1. Summer retreat outbreak
2. Longitudinal study at UW

3.

The image shows the cover of an article in the Journal of Clinical Microbiology, Volume 58, Issue 10, October 2020. The title is "Neutralizing Antibodies Correlate with Protection from SARS-CoV-2 in Humans during a Fishery Vessel Outbreak with a High Attack Rate". The authors listed are Amin Addetia, Katharine H. D. Crawford, Adam Dingens, Haiying Zhu, Pavitra Roychoudhury, Meei-Li Huang, Keith R. Jerome, Jesse D. Bloom, and Alexander L. Greninger. The cover also features the American Society for Microbiology logo, the journal title, and a "Check for updates" button.

- Fishing vessel outbreak with 85% attack rate (104/122)
- Only 3 had prior neutralizing antibodies; none tested positive or had any symptoms
- Presence of neutralizing antibodies from prior infection was associated with protection against reinfection



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Antigen tests

- Diagnostic, to identify acute infection
- Identify the virus
- Targets a virus protein
- Sample-to-answer tests
- Rapid (~15 min)
- Less sensitive than PCR





Antigen tests in the news

FOR IMMEDIATE RELEASE

July 14, 2020

Contact: HHS Press Office

202-205-0143

ashmedia@hhs.gov

Trump Administration Announces Initiative for More and Faster COVID-19 Testing in Nursing Homes

- Rapid point-of-care diagnostic test instruments and tests will be distributed to nursing homes in COVID-19 hotspot geographic areas with the United States.
- Scale-up to most (almost all?) nursing homes in the country
- A one-time procurement of devices and tests targeted to facilitate on-site testing among nursing home residents, staff, and visitors.

<https://www.hhs.gov/about/news/2020/07/14/trump-administration-announces-initiative-more-faster-covid-19-testing-nursing-homes.html>



Antigen tests in the news

 **Governor Phil Scott** ✓
@GovPhilScott

As [@healthvermont](#) Commissioner Mark Levine, M.D., reported today — in response to the reports of 65 positive antigen tests from a private facility in Manchester — 1,613 people were tested through various sites in the area last week by the state. All but 5 were negative. 1/3

7:10 PM · Jul 21, 2020 · [Twitter for iPhone](#)


4 Retweets and comments 22 Likes



 **Governor Phil Scott** ✓ @GovPhilScott · Jul 21
Replying to [@GovPhilScott](#)
A PCR test, which is recommended to confirm the antigen result, has been conducted for 52 of the 65 individuals so far.

Of those 52 people, 48 tested negative. Four people tested positive and are considered confirmed COVID-19 cases. 2/3

3 11

 **Governor Phil Scott** ✓ @GovPhilScott · Jul 21
The Health Department is working with the Centers for Disease Control and Prevention about the tests and our investigation to help determine why there were so many false-positives at this non-Health Department facility, which used antigen tests. 3/3

Ohio Gov. Mike DeWine tests negative for coronavirus after earlier testing positive

DeWine announced late Thursday that he tested negative for the coronavirus after sharing earlier in the day that he had tested positive.

The governor's initial screening in Cleveland, ahead of his planned meeting with President Trump, was an antigen test. The test he took later in the day was done via the polymerase chain reaction method, which is used more commonly than the screening required before having contact with Trump.



Antigen tests in the news



Technical Bulletin



Date: October 2, 2020
Topic: Discontinue the Use of Antigen Testing in Skilled Nursing Facilities Until Further Notice
Contact: Melissa Peek-Bullock, State Epidemiologist, Office of Public Health Investigations and Epidemiology
To: Health Care Providers and Long-Term Care Facilities



Potential for False Positive Results with Antigen Tests for Rapid Detection of SARS-CoV-2 - Letter to Clinical Laboratory Staff and Health Care Providers



**Urgent need to evaluate SARS-
CoV-2 antigen tests!**



Sofia vs. Hologic TMA

JCM Accepted Manuscript Posted Online 25 November 2020

J Clin Microbiol doi:10.1128/JCM.02727-20

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- 1 TITLE: Comparison of Quidel Sofia SARS FIA Test to Hologic Aptima SARS-CoV-2 TMA Test
- 2 for Diagnosis of COVID-19 in Symptomatic Outpatients
- 3
- 4 RUNNING TITLE: Sofia FIA vs. Aptima TMA for Diagnosis of COVID-19
- 5
- 6 AUTHORS: Eric T. Beck^{1,2,*}, Wendy Paar^{1,2,3}, Lara Fojut^{2,4}, Jordan Serwe^{2,3}, and Renee R.
- 7 Jahnke^{2,4}



Sofia vs. Hologic TMA

- 347 symptomatic outpatients
- Nasal swab for Sofia, NP for TMA
- Sensitivity:
 - Symptomatic ≤ 5 d from symptom onset: 82%
 - Symptomatic > 5 d from symptom onset: 55%
- Specificity: $> 99\%$ (one false positive)



Sofia vs. PCR, CDC/DHS/UW

Acknowledgement: Ian Pray, EIS officer with CDC/DHS

Disclaimer: these are preliminary findings/recommendations and CDC will be using this and other studies to finalize guidance on Ag testing soon.

FDA Emergency Use Authorization:

- **Symptomatic patients**, within 5-7 days of onset
- Sofia accuracy: 97% sensitive; 100% specific

Current widespread use for **asymptomatic screening**

- College campuses
- Nursing homes
- Correctional facilities
- Community testing sites

Asymptomatic screening considered **“Off-label”** by FDA





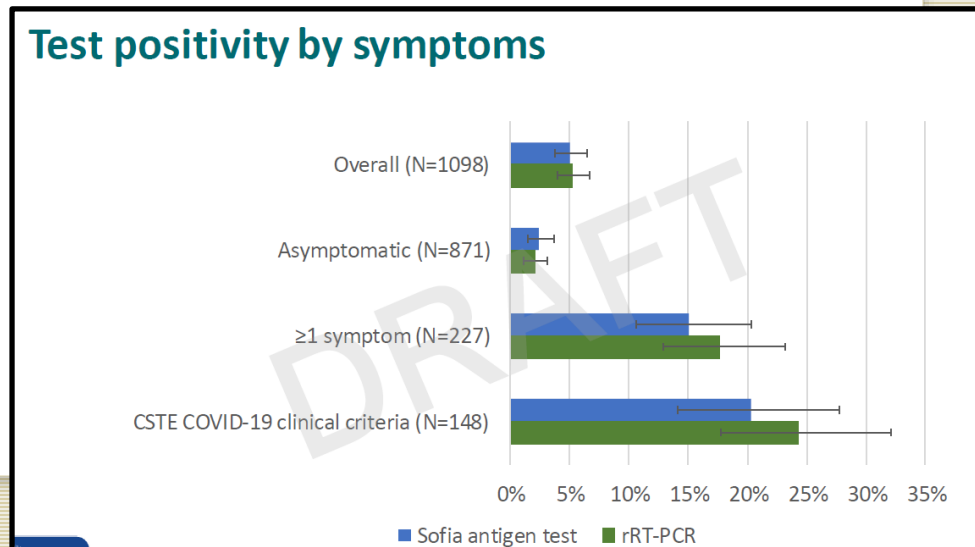
Sofia vs. PCR, CDC/DHS/UW

Objective: Evaluate the diagnostic performance of the Sofia SARS Antigen Fluorescent Immunoassay (FIA) compared to real time RT-PCR and viral culture in asymptomatic and symptomatic persons on two university campuses

Methods:

UW-Oshkosh and UW-Madison

- September 28-October 9
- Nested in existing university testing protocols
 - Weekly surveillance testing
 - Quarantine testing
- Symptom questionnaire
- Paired nasal swabs (Sofia and PCR)





Sofia vs. PCR, CDC/DHS/UW

Sensitivity, specificity, PPV, and NPV of Sofia SARS Antigen FIA compared to RT-PCR

Symptomatic (≥ 1 symptom)			
Antigen	RT-PCR		
	Positive	Negative	Total
Positive	32	2	34
Negative	8	185	193
Total	40	187	227

Asymptomatic			
Antigen	RT-PCR		
	Positive	Negative	Total
Positive	7	14	21
Negative	10	840	850
Total	17	854	871

- **Sensitivity: 80.0%** (95% CI 64.4%-90.9%)
- **Specificity: 98.9%** (95% CI 96.2%-99.9%)
- **PPV: 94.1%** (95% CI 80.3%-99.3%)
- **NPV: 95.9%** (95% CI 92.0%-98.2%)

- **Sensitivity: 41.2%** (95% CI 18.4%-67.1%)
- **Specificity: 98.4%** (95% CI 97.3%-99.1%)
- **PPV: 33.3%** (95% CI 14.6%-57.0%)
- **NPV: 98.4%** (95% CI 97.8%-99.4%)



Sofia vs. PCR, CDC/DHS/UW

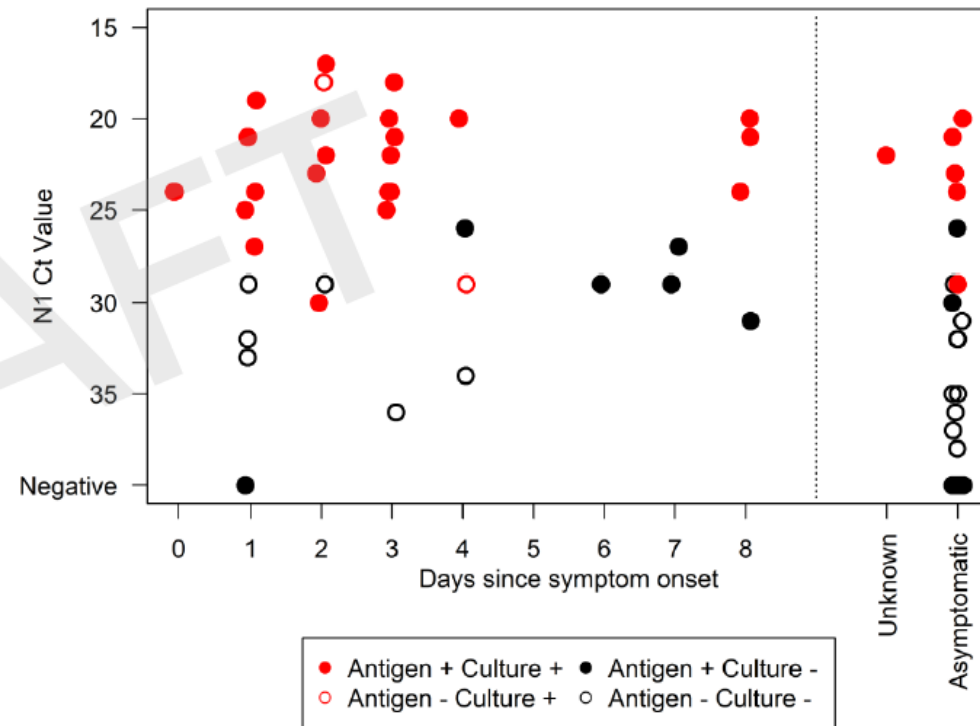
Viral culture and Ct values (n = 73)

False Negative Results (antigen - / PCR +)

- Higher Ct values (mean 32.2 vs. 23.5)
- Less likely to be cultured
 - 2 (11%) out of 18 culture positive

False Positive Results (antigen + / PCR -)

- 0 of 16 were culture positive
- No definitive cause identified



Sofia vs. PCR, CDC/DHS/UW



Summary of findings

- Sofia antigen test had **lower sensitivity** (80.0%) and **lower specificity** (98.9%) than reported in EUA data (96.7%; 100%) in symptomatic individuals
- For asymptomatic screening, sensitivity was **41.2%** (7/17) and positive predictive value was **33.3%** (7/21)
- Virus recovery was possible from **2 of 18 false negative** antigen results
- **Confirmatory molecular testing** should be prioritized for:
 - **Negative antigen results in symptomatic persons** when COVID-19 is suspected
 - **Positive antigen results in asymptomatic persons** where pre-test probability is low



BinaxNOW evaluation: another state PHL

- Paired BinaxNOW (nasal swab) vs CDC nCoV PCR (NP swab)
- Sensitivity
 - Symptomatic (within 7 days symptom onset): 81%
 - Symptomatic (many beyond 7 days symptom onset): 44%
 - Asymptomatic: 17%
- Specificity
 - 100%



BD Veritor vs. PCR

JCM Accepted Manuscript Posted Online 6 October 2020

J. Clin. Microbiol. doi:10.1128/JCM.02338-20

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Veritor SARS-CoV-2 POC test

Young et al., 2020

- 1 **Clinical evaluation of BD Veritor SARS-CoV-2 point-of-care test performance compared to**
- 2 **PCR-based testing and versus the Sofia 2 SARS Antigen point-of-care test.**
- 3

- Paired Veritor (nasal swab) vs Lyra real-time PCR (NP or OP swab)
- Individuals ≤ 7 days from symptom onset
- Veritor sensitivity:
 - 76%-88%, depending on how many days since symptom onset
- Specificity: >99%



Antigen test data thus far

- In symptomatic people within 5-7 days of symptom onset:
 - 80% sensitive, 98-99% specific
- In asymptomatic people:
 - Much lower sensitivity compared to PCR
 - Higher proportion of false positives
 - low prevalence population



Recent reasons for hope



PFIZER AND BIONTECH ANNOUNCE VACCINE CANDIDATE AGAINST COVID-19 ACHIEVED SUCCESS IN FIRST INTERIM ANALYSIS FROM PHASE 3 STUDY

Monday, November 09, 2020 - 06:45am



Moderna Announces Primary Efficacy Analysis in Phase 3 COVE Study for Its COVID-19 Vaccine Candidate and Filing Today with U.S. FDA for Emergency Use Authorization

November 30, 2020 at 6:59 AM EST

 PDF Version



Whole genome sequencing teaser

“What We’ve Learned About COVID-19 Through Genomics”

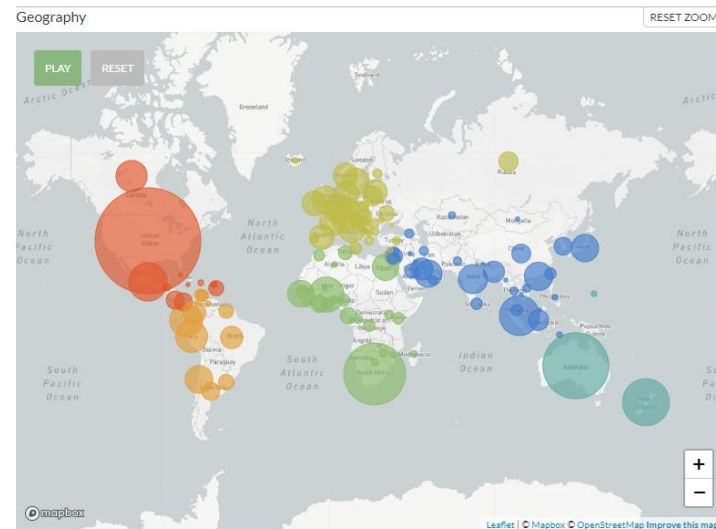
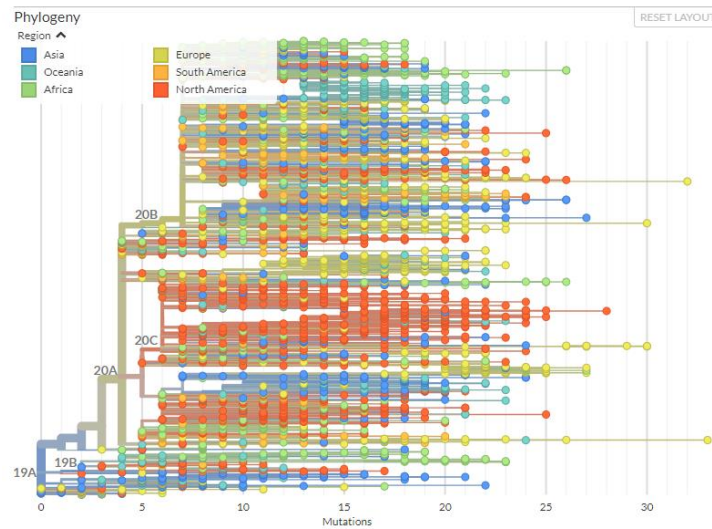
Kelsey Florek, PhD MPH

December 10, noon-1pm

Genomic epidemiology of novel coronavirus - Global subsampling

Maintained by the Nextstrain team. Enabled by data from [GISAID](#)

Showing 3427 of 3427 genomes sampled between Dec 2019 and Nov 2020.





Questions?

