EMS Focus

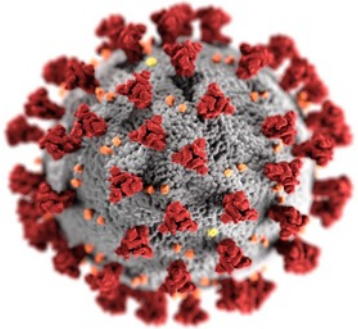
A Collaborative Federal Webinar Series

ems.gov

EMS and COVID-19 Testing

Today

- The Current Science of COVID-19 Testing
- When to Test EMS Clinicians and Other First Responders and How to Operationalize the Results
- The Role of EMS in Expanding Communities' Testing Capabilities
- Questions



Today's Speakers

- S. Michele Owen, PhD
  - Associate Director, National Center for HIV/AIDS, Viral Hepatitis, STD and TB Prevention, CDC
  - Co-Lead, COVID-19 Laboratory Task Force, CDC
- Jonathan Jui, MD, MPH, FACEP
  - EMS Medical Director, Multnomah County, Oregon
  - Professor of Emergency Medicine, Oregon Health & Science University
- Michael Sayre, MD
  - Medical Director, Seattle Fire Department and Seattle Medic One
  - Professor of Emergency Medicine, University of Washington

SARS-CoV-2 Testing

S. Michele Owen, PhD

Viral Tests

Many commercially available diagnostic tests are on the market

- Most are nucleic acid tests*
- Mix of lab-analyzed and point-of-care tests

CDC EUA nucleic acid test- laboratory test

- Several types of specimens from the nasal cavity
- Observed self-collection of nasal swabs are PPE sparing

Proper specimen collection is key to getting an accurate result

Specimen collection on CDC's coronavirus website:

https://www.cdc.gov/coronavirus/2019-ncov/lab/guidelines-clinical-specimens.html

Antigen Test: First EUA granted May 8th

- Rapid test format
- High specificity so positive results are highly accurate
- Sensitivity lower compared to NAT so greater chance of false negatives

* fda.gov/medical-devices/emergency-situations-medical-devices/emergency-use-authorizations

Serology

- There are currently 12 serology tests with EUA
- Serology tests indicate prior infection
- Tests can detect total Ig or IgG, IgM or IgA or combinations
- We do not currently know if having antibodies means that an individual is immune
- Multiple studies ongoing to learn more about immunity and duration of antibody response
- Should not be used to diagnose active infection
- Useful for determining population prevalence
- Valuable in investigating transmission dynamics to inform prevention strategies

General Testing Considerations

Sensitivity and specificity are characteristics of the test

Predictive value of a test is related to prevalence of the disease in a population.

- Positive predictive value is the probability that subjects with a positive test truly have (had) the disease.
- Negative predictive value is the probability that subjects with a negative screening test truly don't have (had) the disease

Predictive Value Examples

Assume 20% Disease Prevalence and a Test with 95% Sensitivity and 95% Specificity

		Disease		
		Present	Absent	Total
Test Result	Positive	TP 190,000	FP 40,000	230,000
	Negative	FN 10,000	TN 760,000	770,000
	Total	200,000	800,000	1,000,000

Positive Predictive Value (PPV) = 82.6%

Negative Predictive Value (NPV) = 98.7%

Test result: TP: true positive; FP: False Positive; TN: true negative; FN: false negative
PPV= (TP/TP +FP) NPV= (TN/TN+FN)

Predictive Value Examples

Assume 5% Disease Prevalence and a Test with 95% Sensitivity and 95% Specificity

		Disease		
		Present	Absent	Total
Test Result	Positive	TP 95,000	FP 95,000	190,000
	Negative	FN 5,000	TN 1,805,000	1,810,000
	Total	100,000	1,900,000	2,000,000

Positive Predictive Value (PPV) = 50%

Negative Predictive Value (NPV) = 99%

Test result: TP: true positive; FP: False Positive; TN: true negative; FN: false negative
PPV= (TP/TP +FP) NPV= (TN/TN+FN)

SARS-CoV-2 Testing is Evolving to Increase Scale

Additional specimens

- Nasal swabs and saliva
- At home collection of nasal swabs

Additional nucleic acid extraction and amplification technology

Multiplex platforms that test for other pathogens

- CDC is developing a multiplex assay that can be used to test for Influenza A, B and SARS-CoV-2

Serology testing is increasing and being refined

- Commercial laboratories
- High-throughput tests
- Potential for two test algorithms to improve overall results

Current Testing Priorities

Developed by the White House Coronavirus Task Force with input from the NRCC, HHS, and CDC

- Last updated April 27th to reflect the current state of the pandemic

High priority

- Hospitalized patients with symptoms
- Healthcare facility workers with symptoms
- Workers in congregate living settings
- First responders with symptoms
- Residents in long-term care facilities with symptoms
- Other congregate living settings where there are symptoms

https://www.cdc.gov/coronavirus/2019-nCoV/hcp/clinical-criteria.html

Current Testing Priorities

Priority

- Persons with symptoms: fever, cough, shortness of breath, chills, muscle pain, new loss of taste or smell, vomiting or diarrhea, and/or sore throat

- Individuals who are prioritized by health departments or clinicians, including, but not limited to:
  - Sentinel surveillance
  - Screening of other asymptomatic individuals according to state and local plans

https://www.cdc.gov/coronavirus/2019-nCoV/hcp/clinical-criteria.html

https://wwwn.cdc.gov/dcs/ContactUs/Form

800-CDC-INFO

Diagnostic and Antibody Testing

Jonathan Jui, MD

Conflict of Interest Statement

Nothing to Declare

Opinions are my own, not my agency's

Interpreting Diagnostic Tests For SARS-CoV-2

Sethuraman et al.
JAMA
May 6, 2020

What is Currently the Best Method of Screening Providers for SARS-CoV-2?

Answer:

Best method is still PCR screening for viral RNA

SARS-CoV-2 antigen tests (aka is the virus present)

Looks for the presence of the virus itself

Currently "Gold Standard" for early diagnosis (rt PCR test)

Good :

- When it is positive, it is rarely false positive (so if you have a positive test, you most likely have COVID-19 (aka specificity is high)

Problem:

- Ability to detect is only 70% to 80% depending on the percentage of the population with COVID-19.
- Often requires serial testing to determine if patient has COVID-19

Variation in Viral Detection of SARS-CoV-2

Emerging Microbes & Infections
2020, VOL. 9
https://doi.org/10.1080/22221751.2020.1729071

Molecular and serological investigation of 2019-nCoV infected patients: implication of multiple shedding routes

Wei Zhang[a]*, Rong-Hui Du[b]*, Bei Li[a], Xiao-Shuang Zheng[a], Xing-Lou Yang[a], Ben Hu[a], Yan-Yi Wang[a], Geng-Fu Xiao[a], Bing Yan[a], Zheng-Li Shi[a] and Peng Zhou[a]

[a]CAS Key Laboratory of Special Pathogens, Wuhan Institute of Virology, Center for Biosafety Mega-Science, Chinese Academy of Sciences, Wuhan, People's Republic of China; [b]Wuhan Pulmonary Hospital, Wuhan, People's Republic of China

ABSTRACT

In December 2019, a novel coronavirus (2019-nCoV) caused an outbreak in Wuhan, China, and soon spread to other parts of the world. It was believed that 2019-nCoV was transmitted through respiratory tract and then induced pneumonia, thus molecular diagnosis based on oral swabs was used for confirmation of this disease. Likewise, patient will be released upon two times of negative detection from oral swabs. However, many coronaviruses can also be transmitted through oral–fecal route by infecting intestines. Whether 2019-nCoV infected patients also carry virus in other organs like intestine need to be tested. We conducted investigation on patients in a local hospital who were infected with this virus. We found the presence of 2019-nCoV in anal swabs and blood as well, and more anal swab positives than oral swab positives in a later stage of infection, suggesting shedding and thereby transmitted through oral–fecal route. We also showed serology test can improve detection positive rate thus should be used in future epidemiology. Our report provides a cautionary warning that 2019-nCoV may be shed through multiple routes.

ARTICLE HISTORY Received 4 February 2020; Revised 6 February 2020; Accepted 7 February 2020

KEYWORDS 2019-nCoV; Wuhan pneumonia; epidemiology; swabs; intestine

Molecular Detection of COVID-19

Table 1. Molecular detection of 2019-nCoV in swabs and blood. Samples were from oral swabs (OS), anal swabs (AS) and blood. Data were shown as qPCR Ct values. Patients in severe condition during investigation were shown.

	OS	AS	Whole blood	Serum	Severe disease
Patient 1	33.5				No
Patient 2			30.3	24.3	Yes
Patient 3	30.3				No
Patient 4			32.1		No
Patient 5		33.1			No
Patient 6			30.6		No
Patient 7	32.7	30.2			No
Patient 8		33.1			No
Patient 9			31.4	34.5	No
Patient 10			30.9	33.0	Yes
Patient 11	27.3				No
Patient 12	34.4				Yes
Patient 13	32.9	33.6			No
Patient 14	32.3				No
Patient 15			31.6		No

SARS-CoV-2 Antigen Tests

SARS-CoV-2 Antigen Tests

Type of Test	Testing for	Examples	Advantages	Disadvantages
Rt PCR	RNA	CDC, Abbott, Quest, Labcorp	Very sensitive and specific, rarely false +	Takes longer to perform, not able to mass testing
Antigen FIA	Nucleocapsid	Sofia2 (Quidel)	Quick, “simple”, “doctor office test”	Less sensitive than PCR test

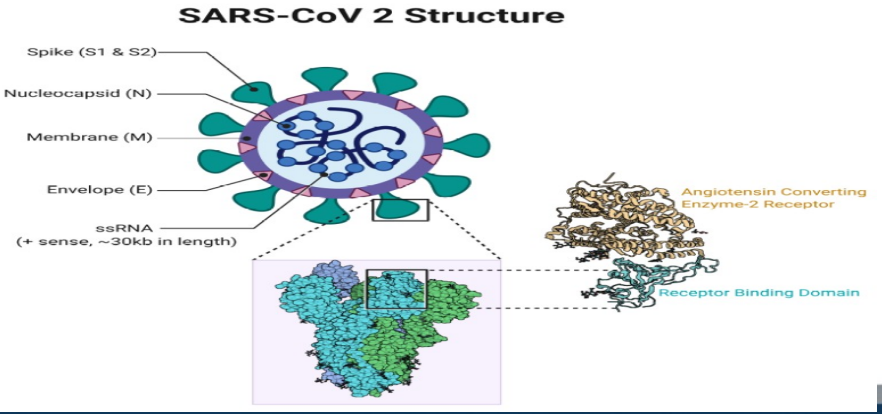
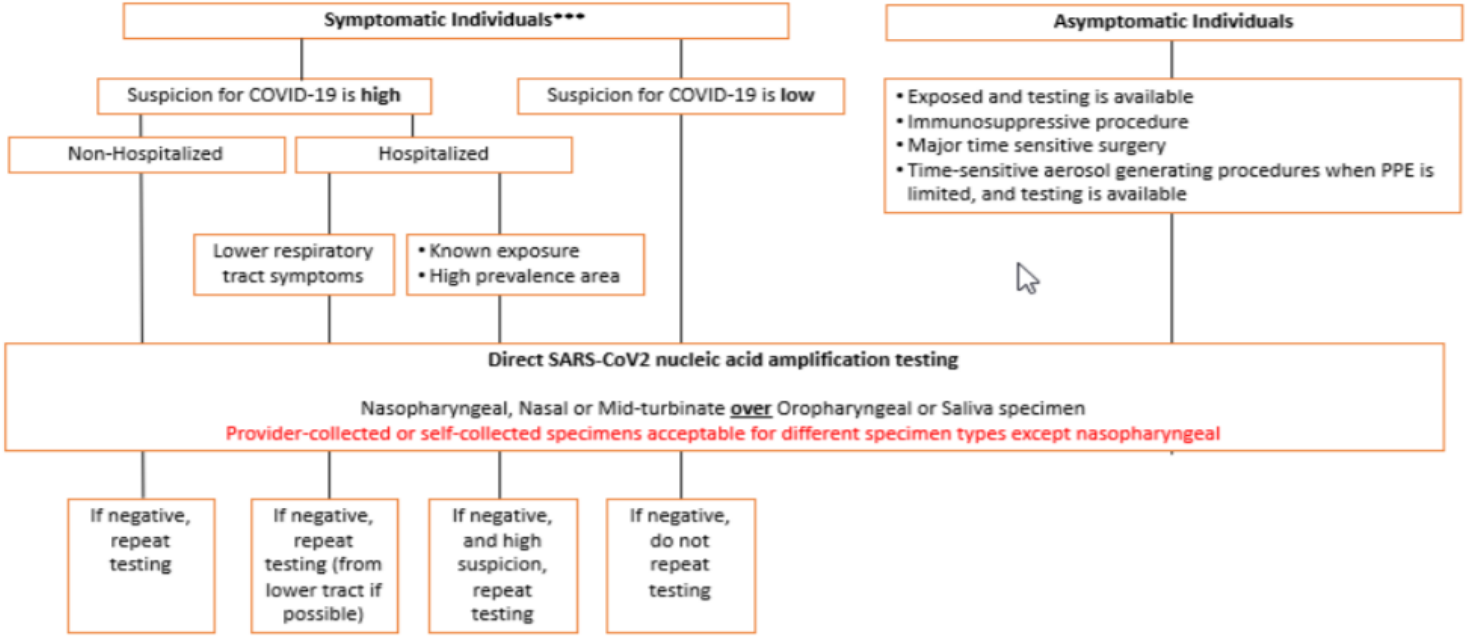


Figure 1. IDSA Algorithm for SARS-CoV-2 Nucleic Acid Testing



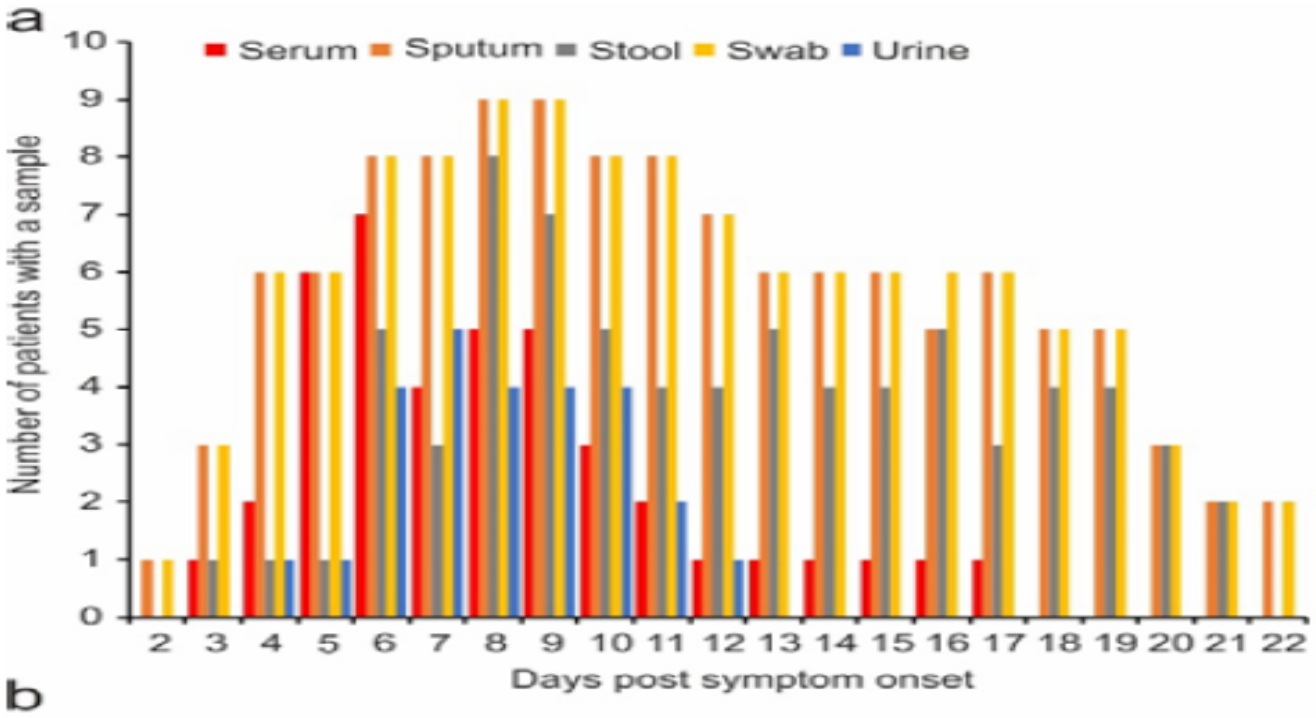
- Testing should be prioritized for symptomatic patients first.
- When resources are adequate, testing for selected asymptomatic individuals can also be considered.

Virological Assessment of Hospitalized Cases

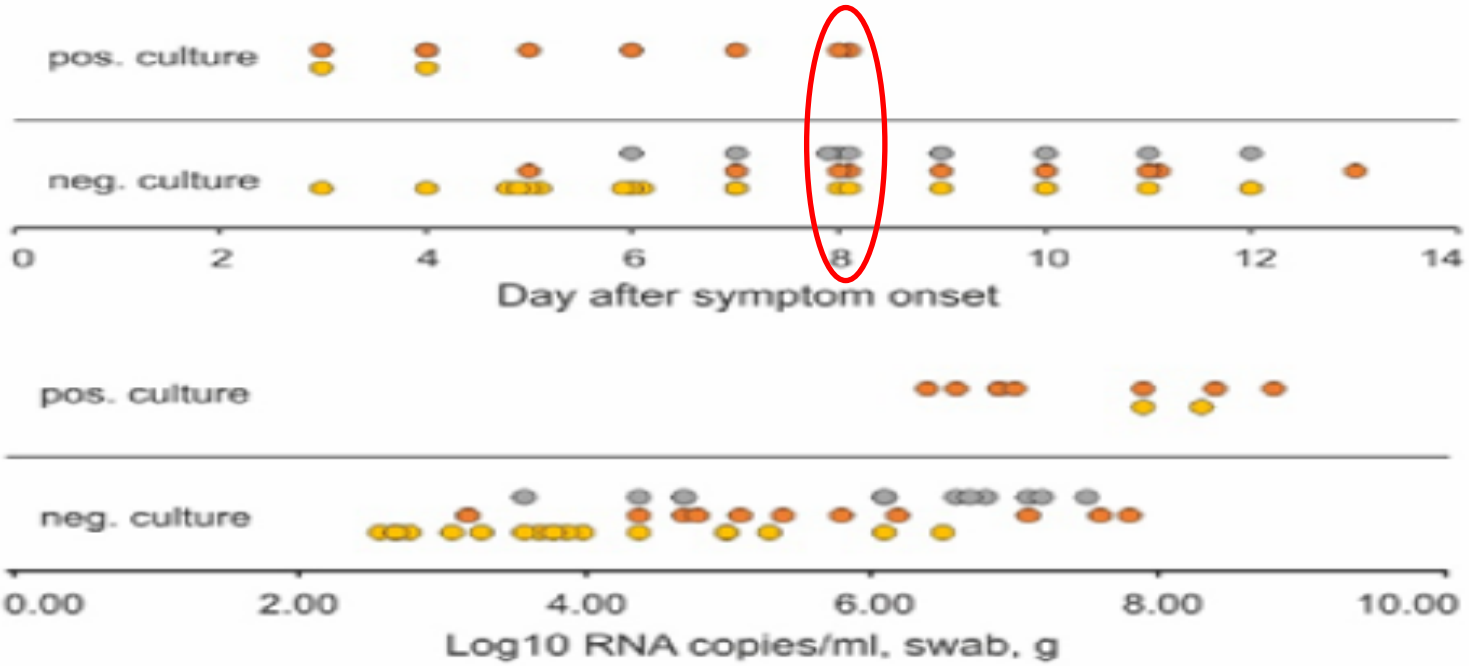
Roman Wölfel*, Victor M. Corman*, Wolfgang Guggemos*, Michael Seilmaier, Sabine Zange, Marcel A. Müller, Daniela Niemeyer, Terence C. Jones Kelly, Patrick Vollmar, Camilla Rothe, Michael Hoelscher, Tobias Bleicker, Sebastian Brünink, Julia Schneider, Rosina Ehmann, Katrin Zwirglmaier, Christian Drosten**, Clemens Wendtner**

*equal contribution

**senior authors with equal contribution


a
Serum
Sputum
Stool
Swab
Urine
Number of patients with a sample
0
1
2
3
4
5
6
7
8
9
10
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Days post symptom onset
b

SARS-CoV-2 PCR Detection vs Positive Culture



Summary

Current strategy for the detection of viral RNA in oral swabs used for 2019-nCoV diagnosis is not perfect.

The virus may be present in anal swabs or blood of patients when oral swabs detection is negative.

COVID-19 Antibodies: The Controversy

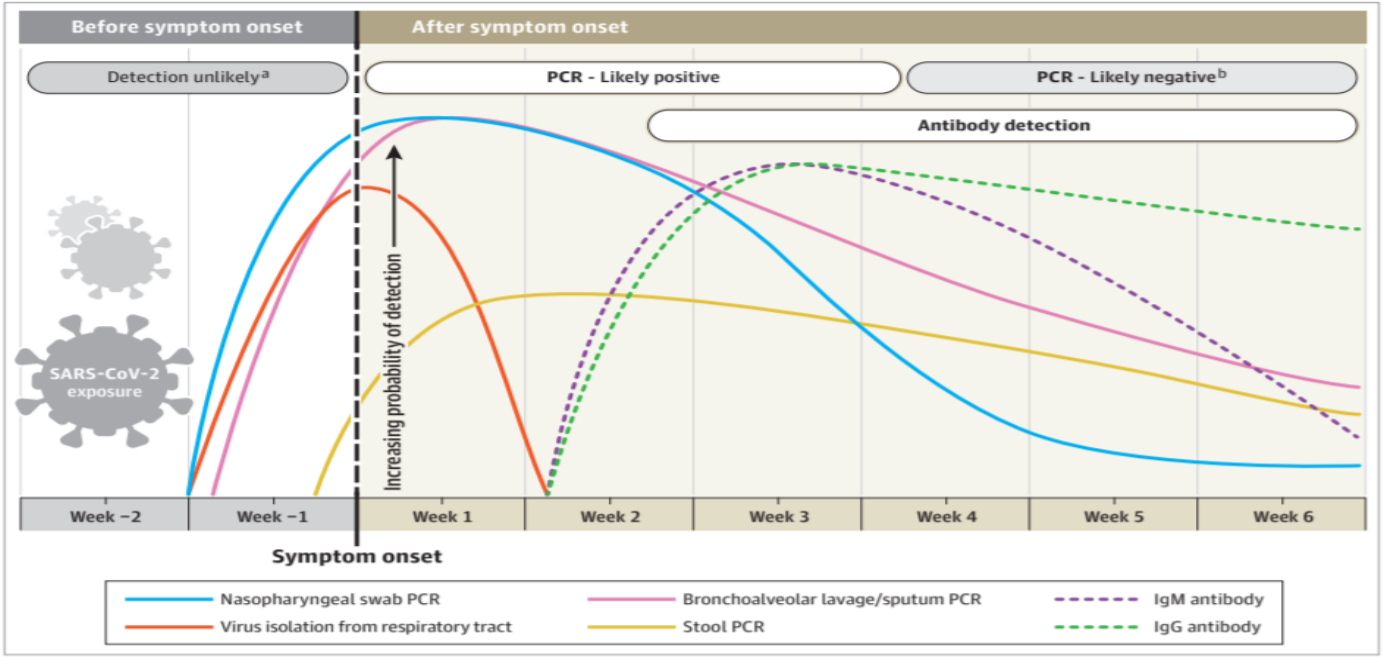
Can I use antibody tests to see who is immune and can go back to work?

Answer:
Not at this time (maybe in the future)

Antibody tests

- Not useful for early diagnosis
- Detection of **exposure to virus** (near future)
  - Recent **IgM**
  - Past **IgG**
- Detection of **immunity** (eventually)

Figure. Estimated Variation Over Time in Diagnostic Tests for Detection of SARS-CoV-2 Infection Relative to Symptom Onset



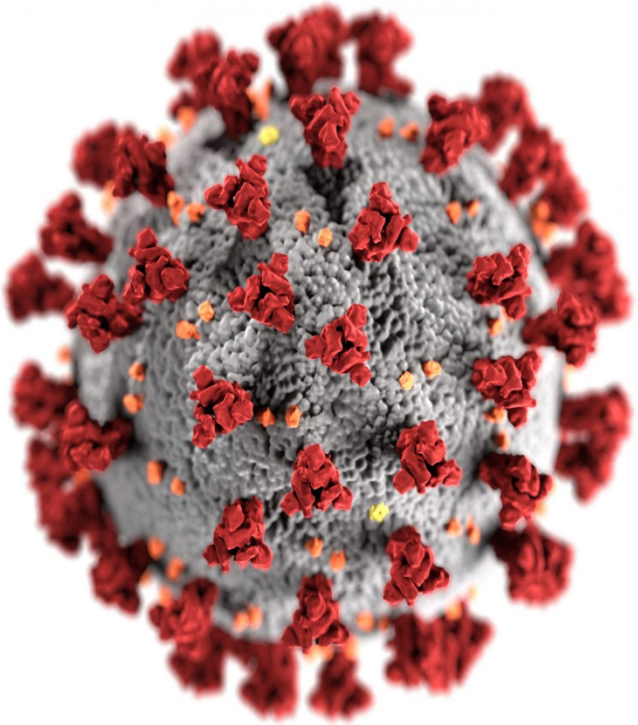
Estimated time intervals and rates of viral detection are based on data from several published reports. Because of variability in values among studies, estimated time intervals should be considered approximations and the probability of detection of SARS-CoV-2 infection is presented qualitatively. SARS-CoV-2 indicates severe acute respiratory syndrome coronavirus 2; PCR, polymerase chain reaction.

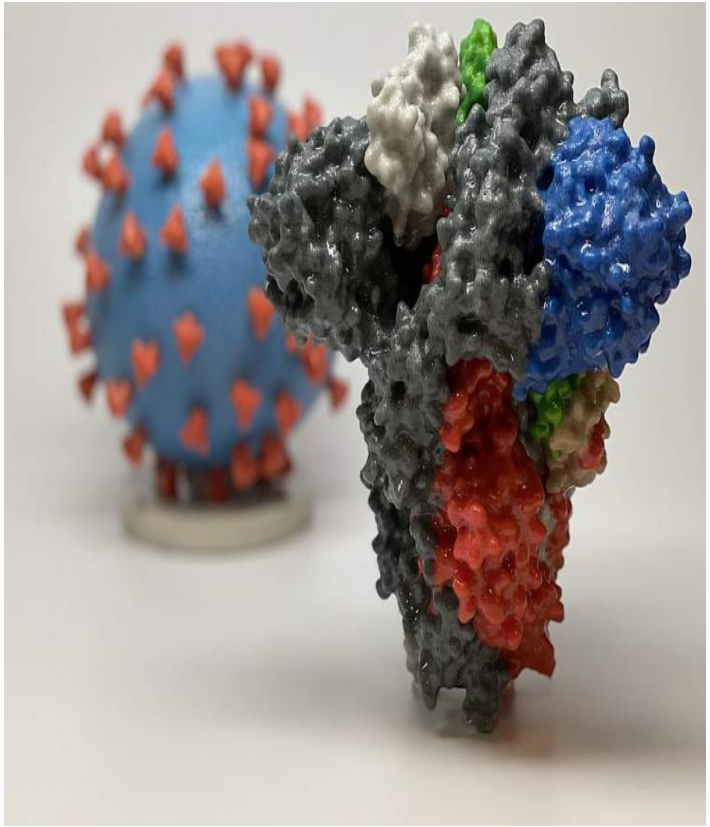
[a] Detection only occurs if patients are followed up proactively from the time of exposure.

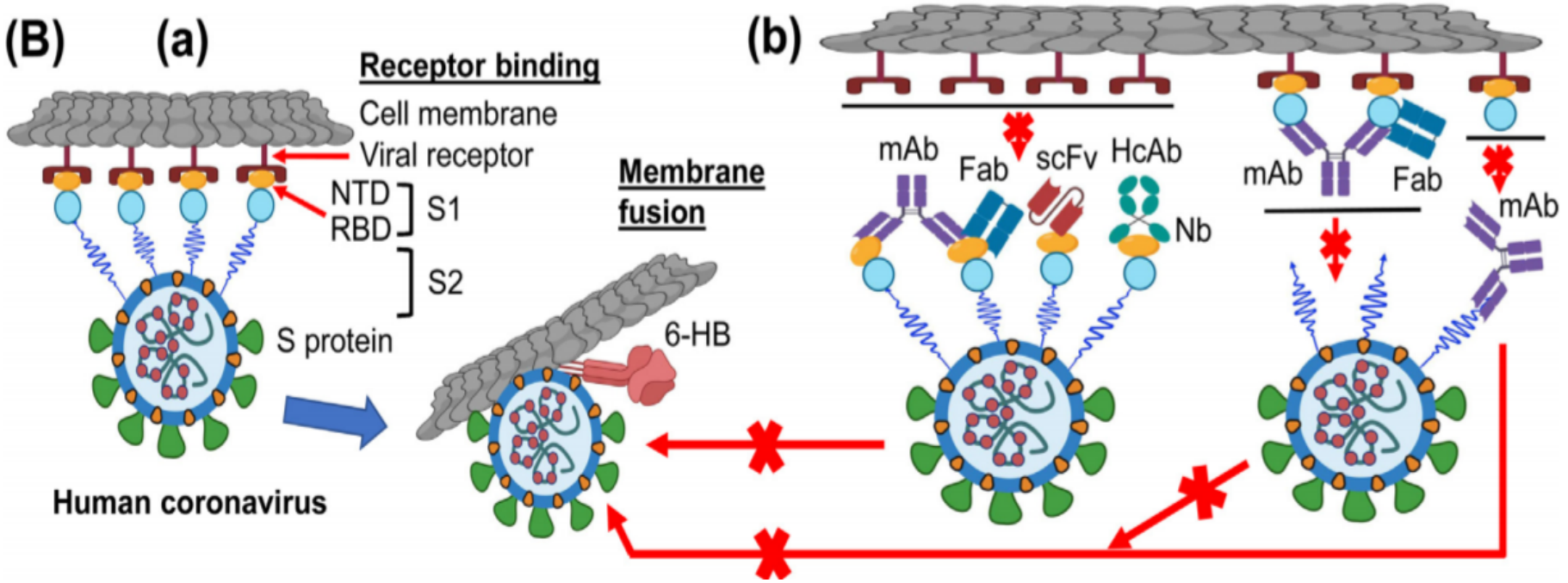
[b] More likely to register a negative than a positive result by PCR of a nasopharyngeal swab.

Neutralizing Antibodies Against SARS-Cov-2 and Other Coronaviruses

Jiang et al
Trends in Immunology 1669 2020






(B)
(a)
Receptor binding
Cell membrane
Viral receptor
NTD
RBD
S1
S2
S protein
Human coronavirus
Membrane fusion
6-HB
(b)
mAb
Fab
scFv
HcAb
Nb
mAb
Fab
mAb

MERS and SARS
Antibody Duration

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ISSN: 1080-6059

EID Journal > Volume 23 > Number 7—July 2017 > Main Article

Volume 23, Number 7—July 2017

Research

MERS-CoV Antibody Responses 1 Year after Symptom Onset, South Korea, 2015

Pyoeng Gyun Choe[1], R.A.P.M. Perera[1], Wan Beom Park, Kyoung-Ho Song, Ji Hwan Bang, Eu Suk Kim, Hong Bin Kim, Long Wei Ronald Ko, Sang Won Park, Nam-Joong Kim, Eric H.Y. Lau, Leo L.M. Poon, and Myoung-don Oh

Author affiliations: Seoul National University College of Medicine, Seoul, South Korea (P.G. Choe, W.B. Park, K.-H. Song, J.H. Bang, E.S. Kim, H.B. Kim, S.W. Park, N.-J. Kim, M.-D. Oh); University of Hong Kong School of Public Health, Hong Kong, China (R.A.P.M. Perera, L.W.R. Ko, E.H.Y. Lau, L.L.M. Poon, M. Peiris)

Cite This Article

On This Page

Figure

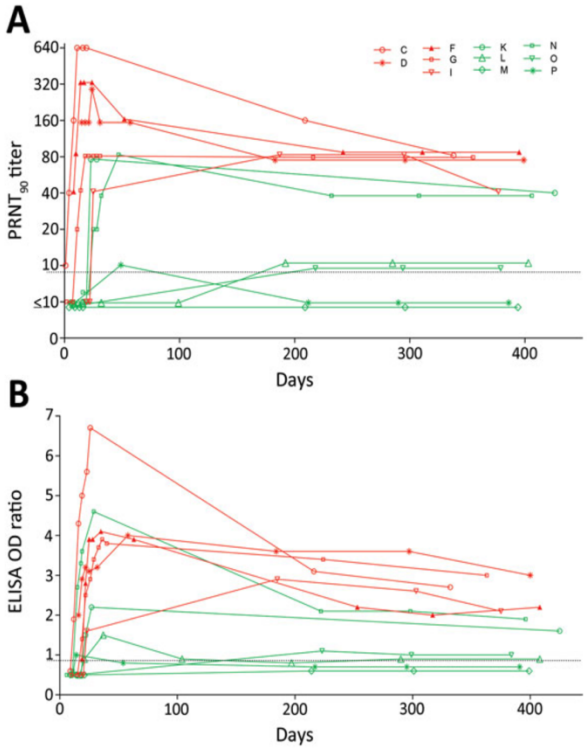


Figure. Middle East respiratory syndrome (MERS) coronavirus antibody titers in serially collected serum samples from 11 patients with reverse transcription PCR–confirmed symptomatic MERS, South Korea, 2015. $PRNT_{90}$ titers (A) and MERS spike protein (S1) ELISA OD ratios (B) were determined at multiple time points 0 to >400 days after disease onset. The limit of detection was 10 for the PRNT, and the cutoff between negative and borderline samples for the S1 ELISA was an OD ratio of 0.8. Letters in key indicate patients; red indicates those with severe disease, and green indicates those with nonsevere disease. OD, optical density; $PRNT_{90}$, ≥90% plaque-reduction neutralization test.

IDSA
Infectious Diseases Society of America

IDSA COVID-19 Antibody Testing Primer

Updated: April 22, 2020

As serological testing for SARS-CoV-2 advances, there are multiple issues that need to be addressed, from test quality to interpretation. Unlike molecular tests for COVID-19 (e.g., PCR), antibody tests may be better suited for public health surveillance and vaccine development than for diagnosis. The current antibody testing landscape is varied and clinically unverified, and these tests should not be used as the sole test for diagnostic decisions. Further, until more evidence about protective immunity is available, serology results should not be used to make staffing decisions or decisions regarding the need for personal protective equipment.

The sections below outline the current state of antibody testing for SARS-CoV-2, along with research questions and additional testing and policy considerations. This information will be updated regularly as new research, tests, and increased public health capacity become available.

Background on Antibody Testing for SARS-CoV-2 Infection

The antibody response in infected patients remains largely unknown, and the clinical values of antibody testing have not been fully demonstrated. Seroprevalence data will be important in understanding the scale of the pandemic and future vaccine utility.

- Potential utility of serology in SARS-CoV-2:
  - **Detection of PCR-negative cases**, especially for patients who present late with a very low viral load below the detection limit of RT-PCR assays, or when lower respiratory tract sampling is not possible;
  - **Identification of convalescent plasma donors**;
  - **Epidemiologic studies** of disease prevalence in the community;
  - **Verification of vaccine** response once antibody correlate(s) of protection identified.

- Potential drawbacks if serological assays are not well-validated:
  - **False negative risks** if performed early in disease course, especially in mild disease;
  - **False positive risks**, particularly with tests for Immunoglobulin M (IgM) and potential cross-reactivity with common cold coronaviruses (e.g. HKU1, NL63, OC43, 229E).

Seattle and King County EMS COVID-19 EMS Response

Michael Sayre, MD

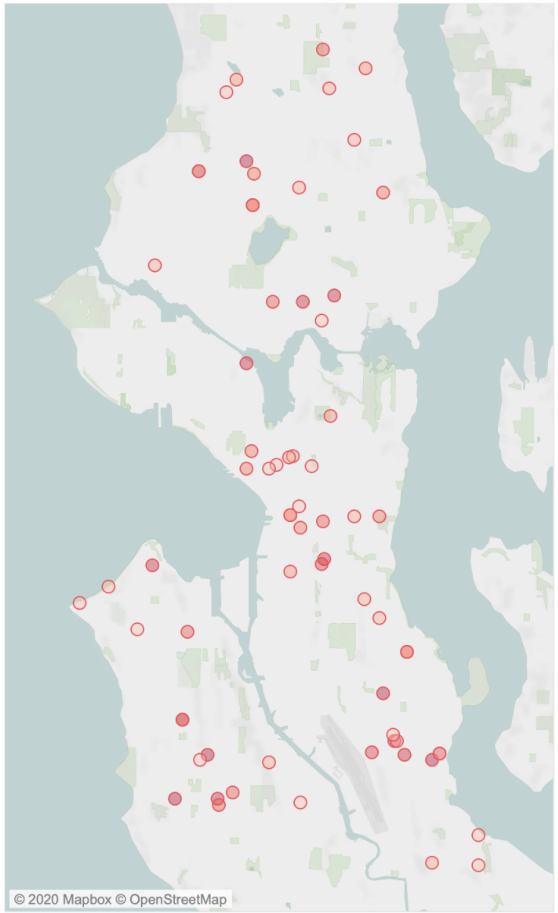
Seattle EMS COVID Like Illness Syndromic Surveillance

Limited to cases in the past 14 days. Includes all EMS incidents with a primary or secondary impression of common cold, fever, SARS, COVID-19, infectious disease, or pneumonia. Cases with the word "coronavirus" or "covid" in the chief complaint are also included.

Days Ago
1 14

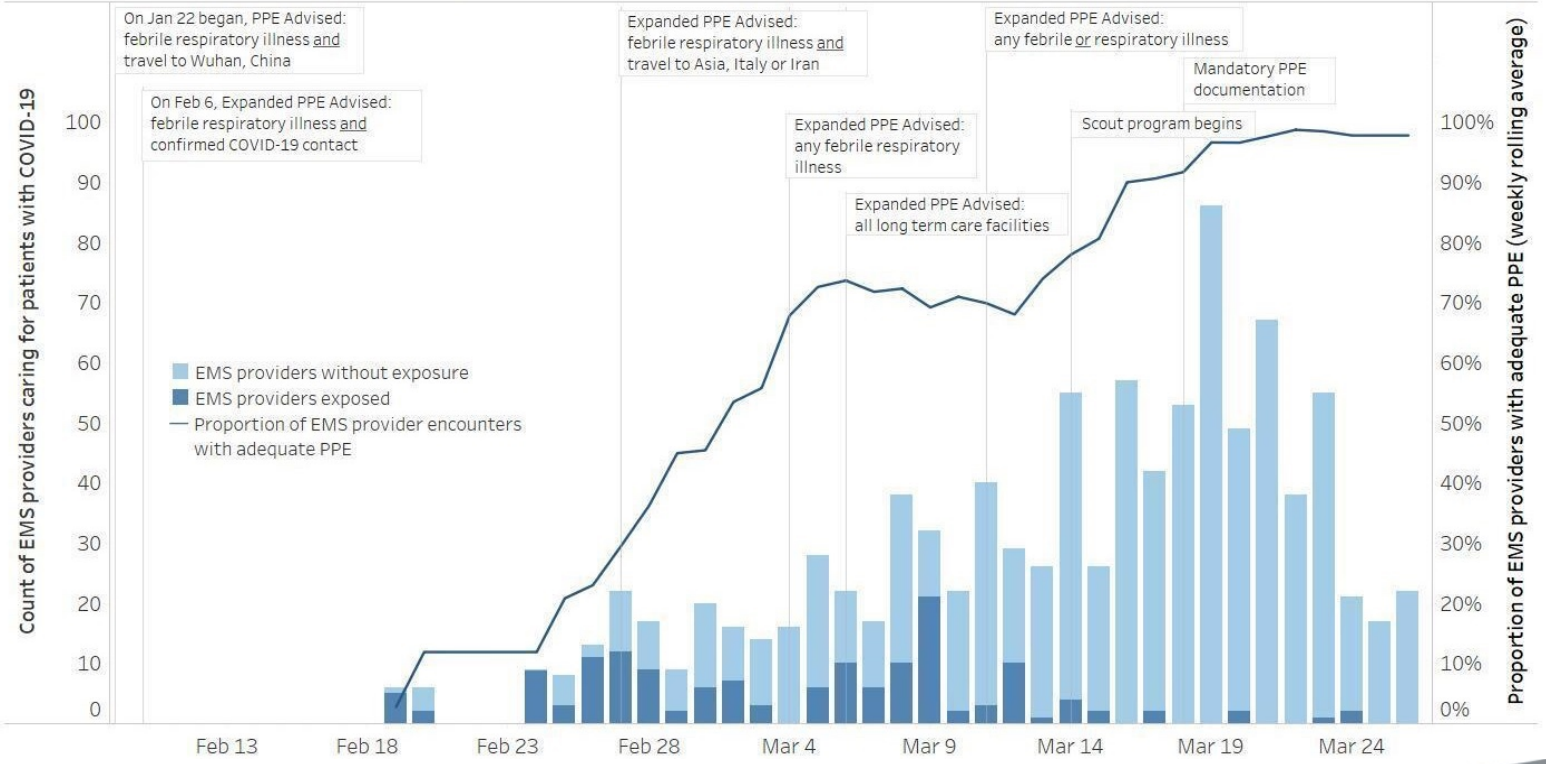
70 patients from Apr 27 through May 10, 2020.

Daily average previous 14 days




SEATTLE FIRE DEPT.
A10
33086
MEDIC ONE
E450
SEATTLE FIRE DEPT.
A5

Occupational Exposures and PPE use among EMS Providers caring for COVID-19 Patients, Seattle & King County through March 26, 2020



First Responder Testing Clinic

First Responder COVID-19 Testing Sites

Seattle/King County EMS

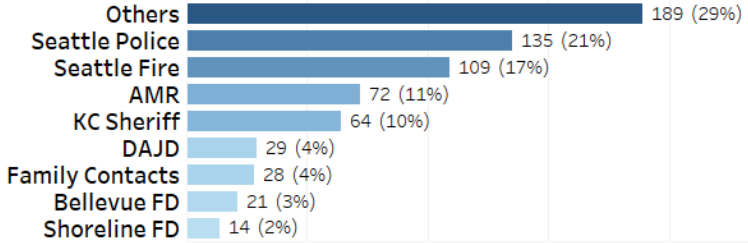
Results through
May 10, 2020

Persons Tested: 658

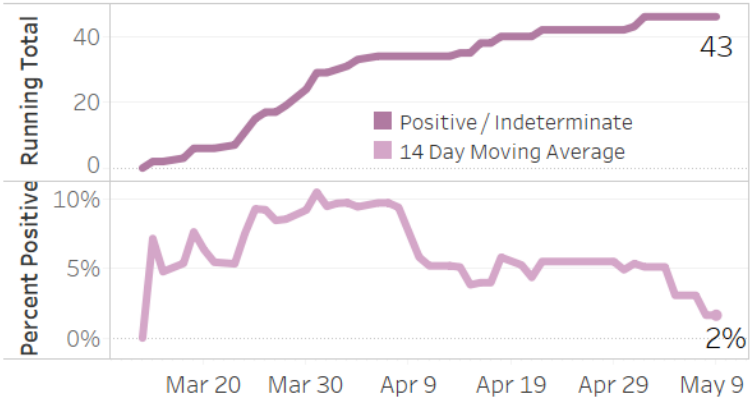
	Seattle	Covington	Shoreline
Tested	488	115	57
Positives	34	5	4
Percent Positive	7%	4%	7%

**Responders tested at multiple sites are counted at each site. However they are only counted once in the grand total.

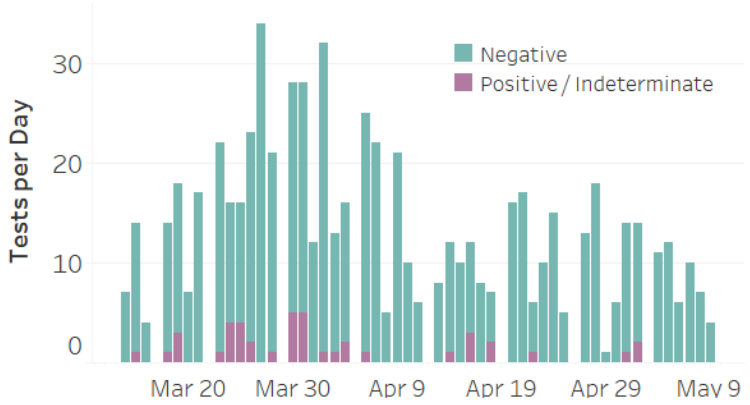
Organization



Testing Over Time

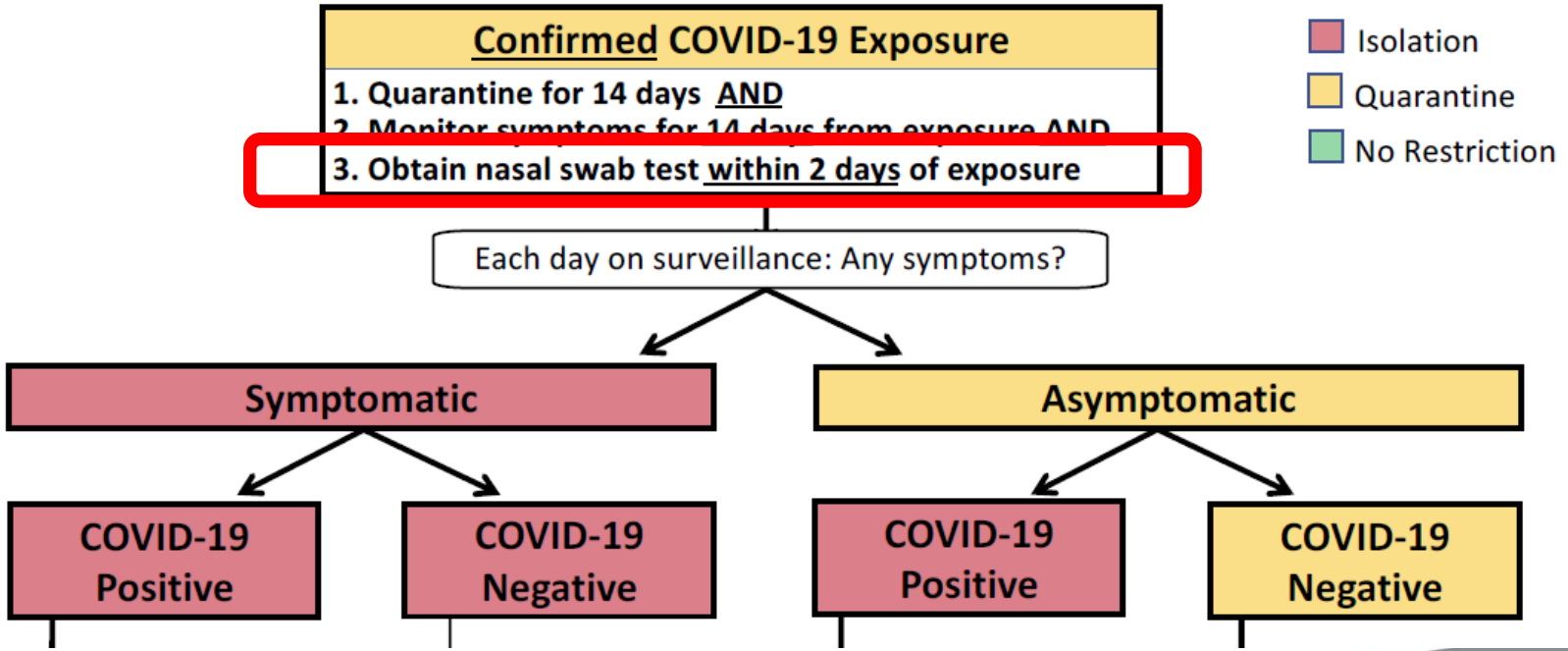


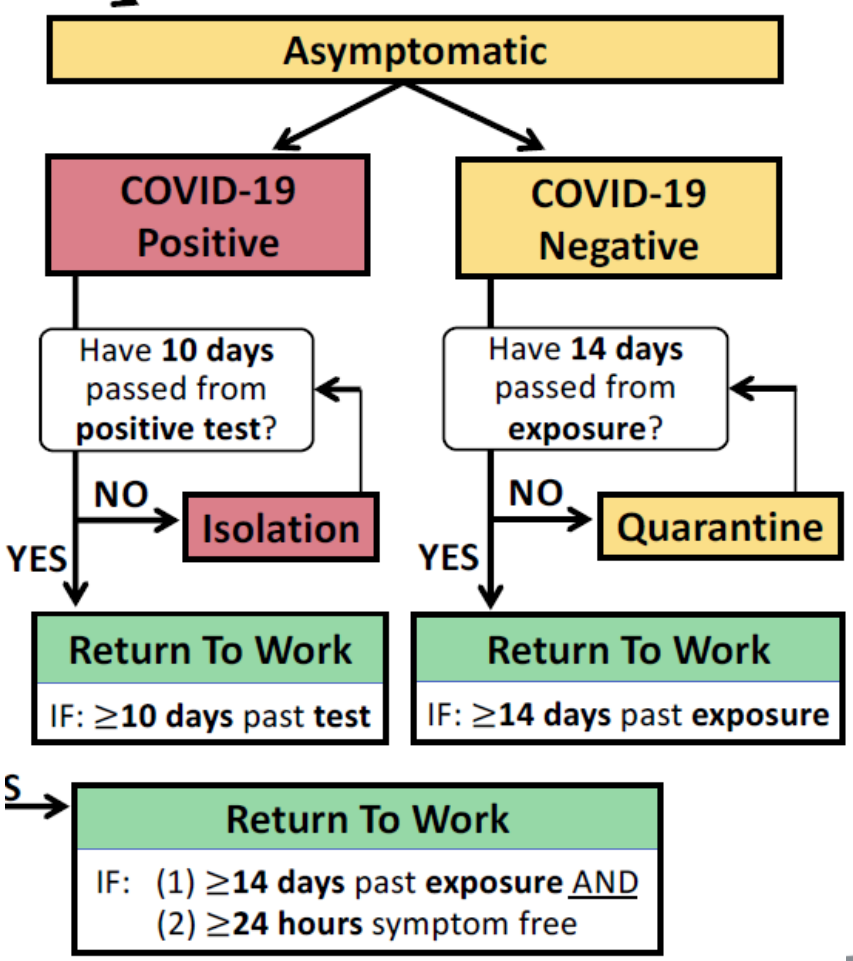
Daily Testing



COVID-19 Exposure Guidelines for Return to Work

Public Health
Seattle & King County




Asymptomatic
COVID-19 Positive
COVID-19 Negative
Have 10 days passed from positive test?
Have 14 days passed from exposure?
NO
Isolation
YES
NO
Quarantine
YES
Return To Work
IF: ≥10 days past test
Return To Work
IF: ≥14 days past exposure
S
Return To Work
IF: (1) ≥14 days past exposure AND
(2) ≥24 hours symptom free

Expanding Testing to Community

- EMS nasal swab testing in nursing homes and congregant setting
- For residents AND staff members

Follow **@ResuscAcademy** on Twitter
Read **www.resuscitationacademy.org/blog**

Public Health
Seattle & King County

HARBORVIEW MEDICAL CENTER
UW Medicine

Questions?

Please submit questions through the webinar platform

For info on COVID-19 and EMS:
ems.gov/projects/coronavirus_covid-19_resources.html

Latest Information from the CDC:
cdc.gov/coronavirus/2019-nCoV/index.html

Dr. Michele Owen • smo2@cdc.gov

Dr. Jonathan Jui • jjui@frontier.com

Dr. Michael Sayre • sayrem@uw.edu

Visit

ems.gov

for more info on COVID-19 and other national EMS initiatives.

Thank You

EMS STRONG

READY TODAY. PREPARING FOR TOMORROW.