



Amedeo Modigliani, *Léopold Zborowski*, c. 1916, MFA Houston

COVID-19

Transmission and Risk to Healthcare Workers

Covid-19 Symposium: From Prevention to Control

Hong Kong Hospital Authority & Centre for Health Protection

December 8, 2020

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Disclosures

- **Grant funding**

- Centers for Disease Control and Prevention
- Massachusetts Department of Public Health
- Agency for Healthcare Research and Quality

- **Royalties**

- UpToDate Inc.
-

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主会场
停车场 (P)



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EXITED

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PLEASE DO NOT
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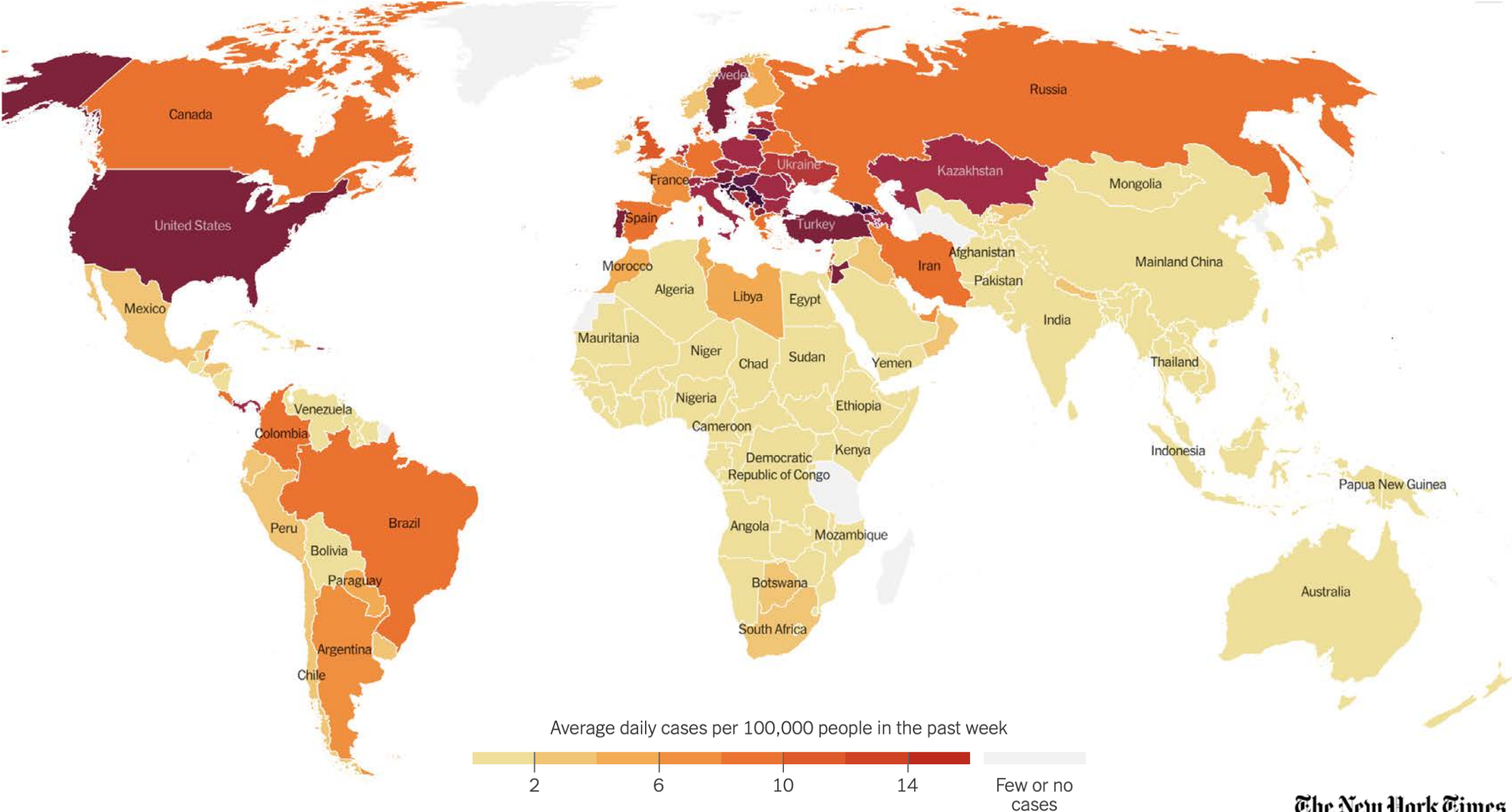
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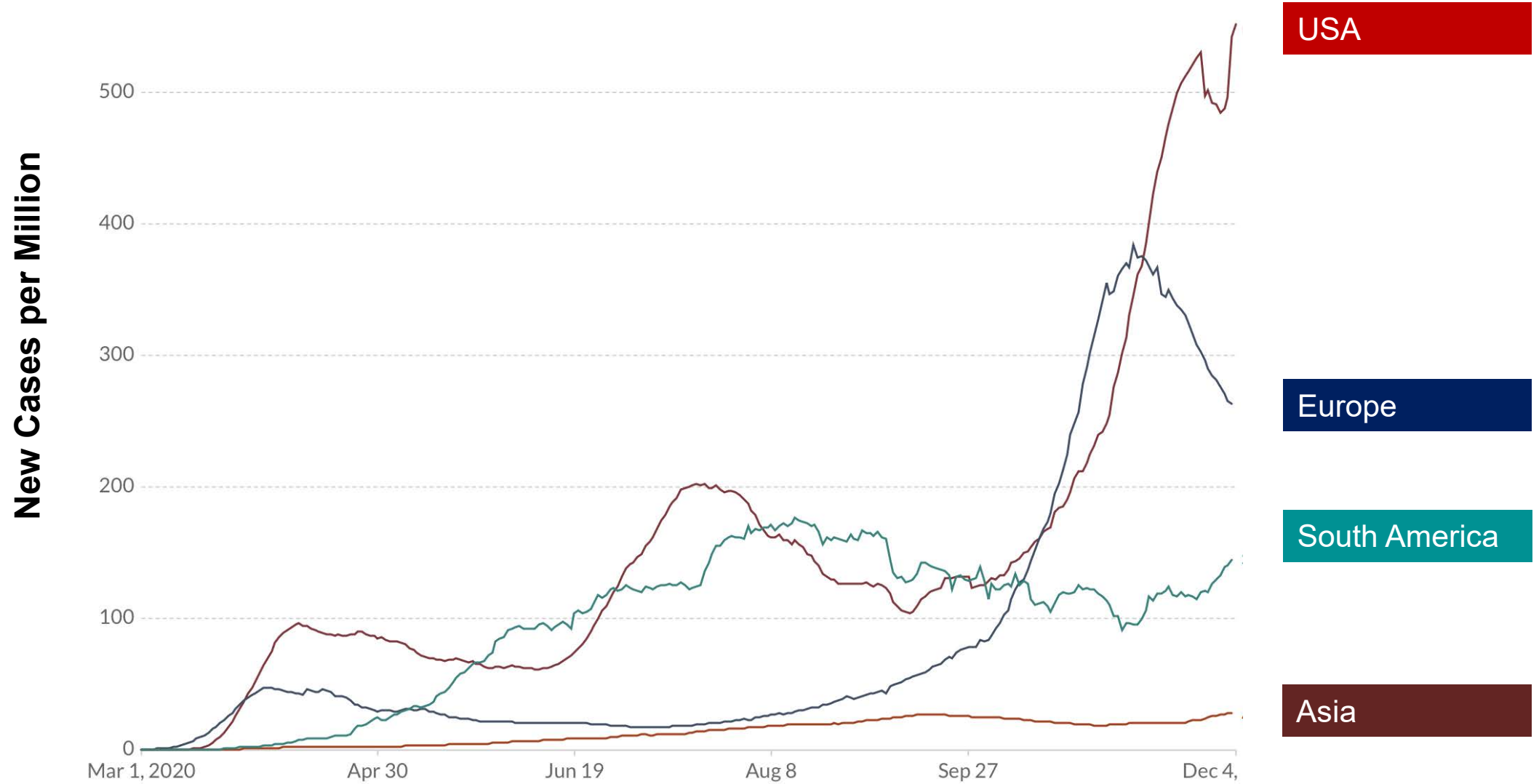
Dance Culture

舞都舞器文化會

Over 68 Million Cases and 1.5 Million Deaths



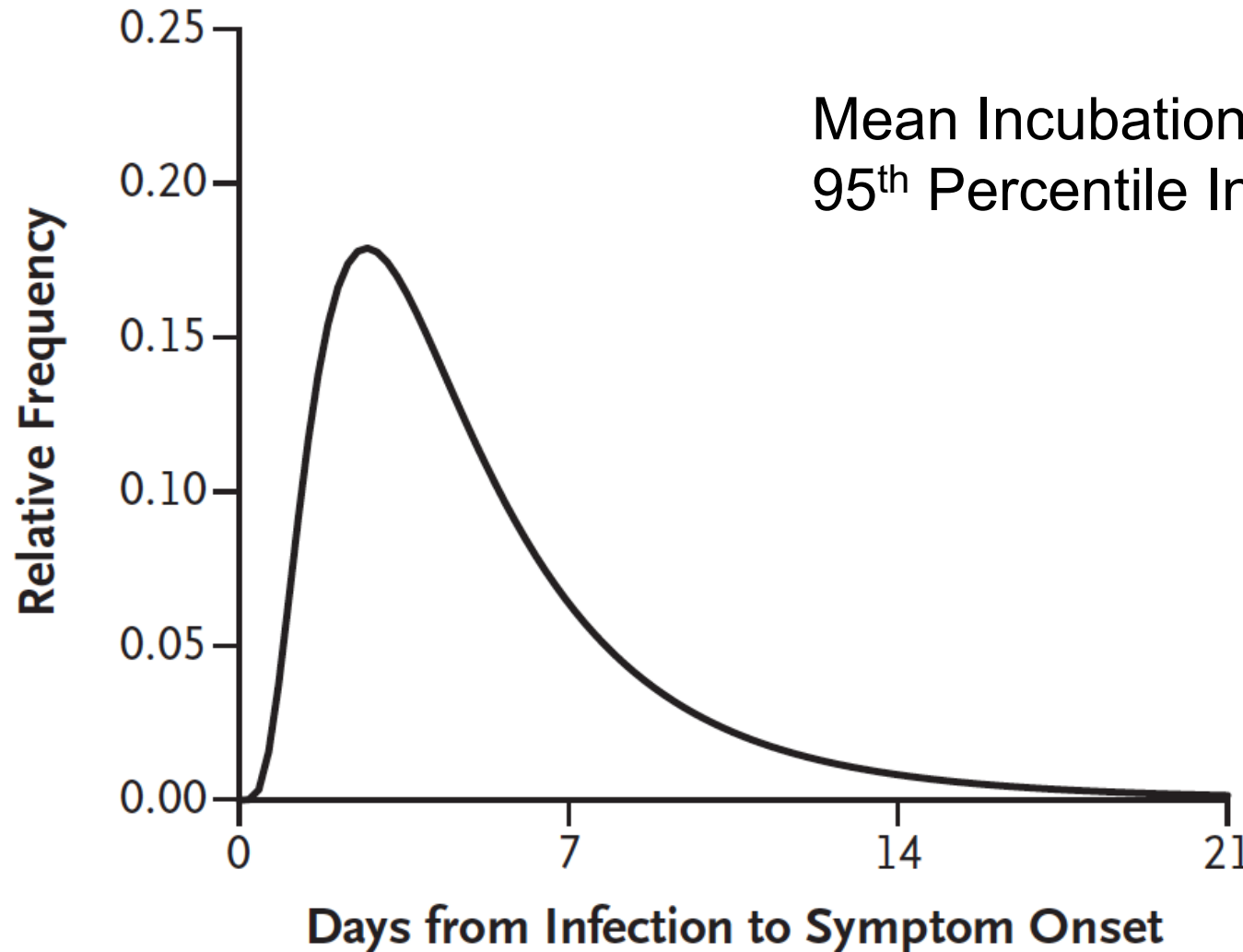
New Cases Per Day



Transmission



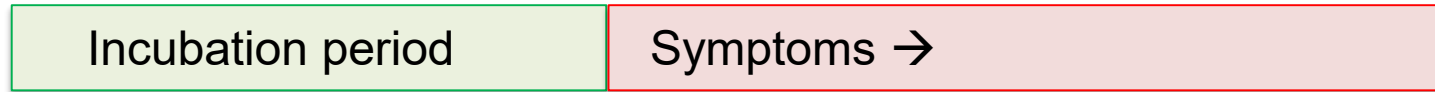
Incubation Period



**How long are people contagious before
they develop symptoms?**

Quantifying the Infectious Period

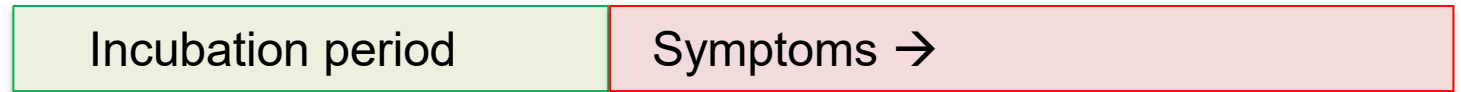
First Patient



Serial
Interval

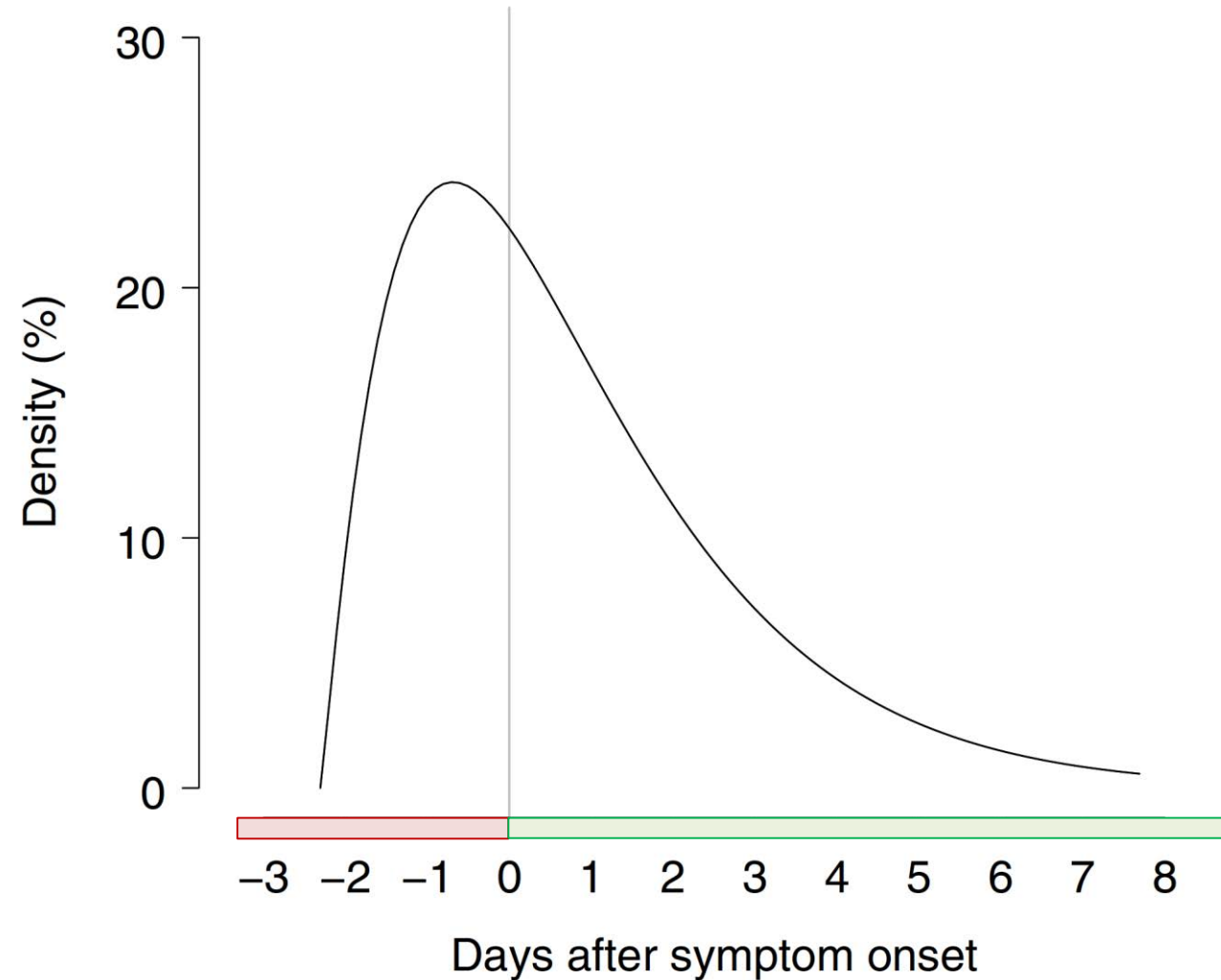
A diagram representing the serial interval. It consists of two vertical tick marks. A horizontal line segment connects the two tick marks, with the text 'Serial Interval' centered above it.

Second Patient

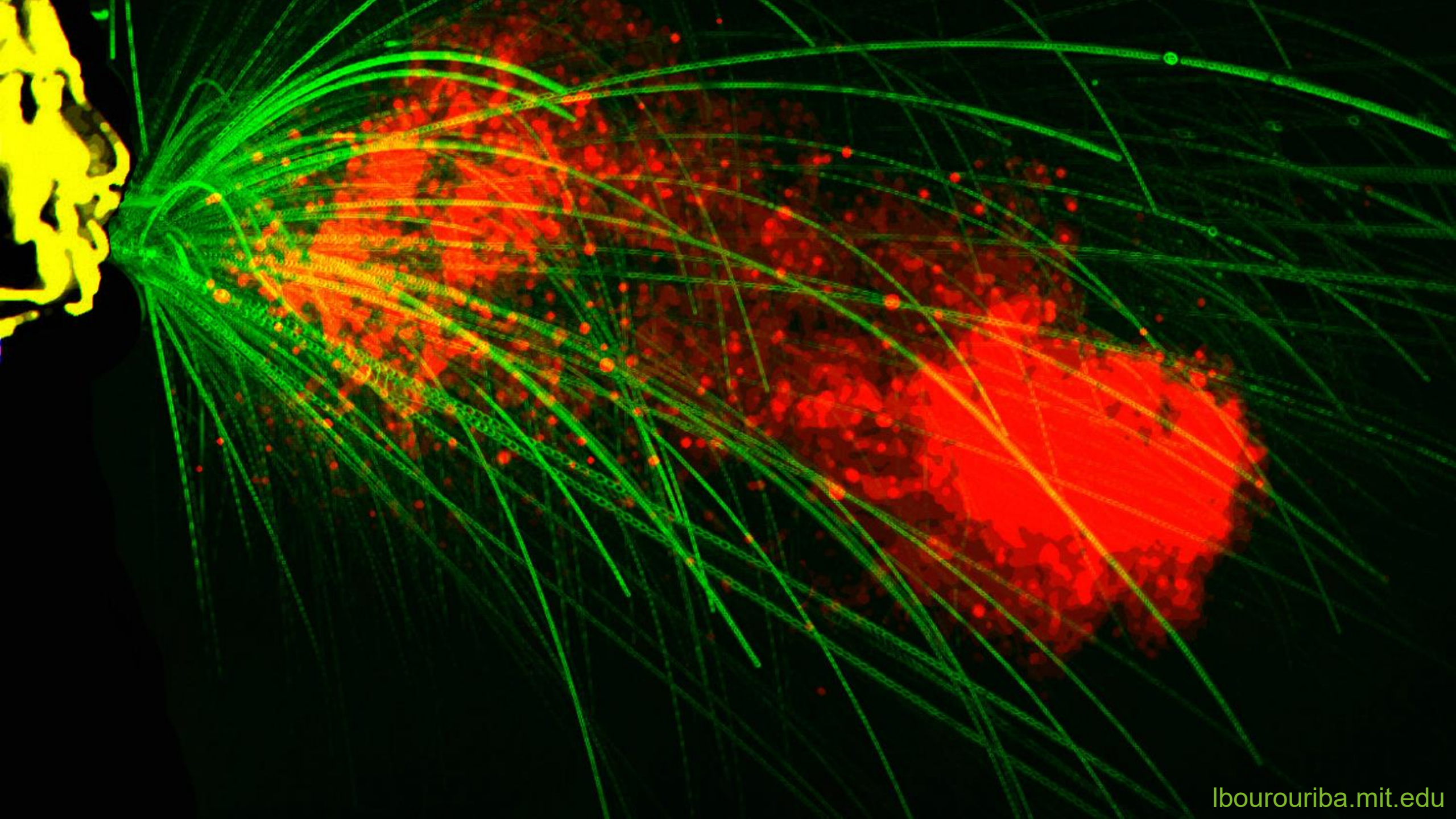


Presymptomatic Transmission

Distribution of Infectivity

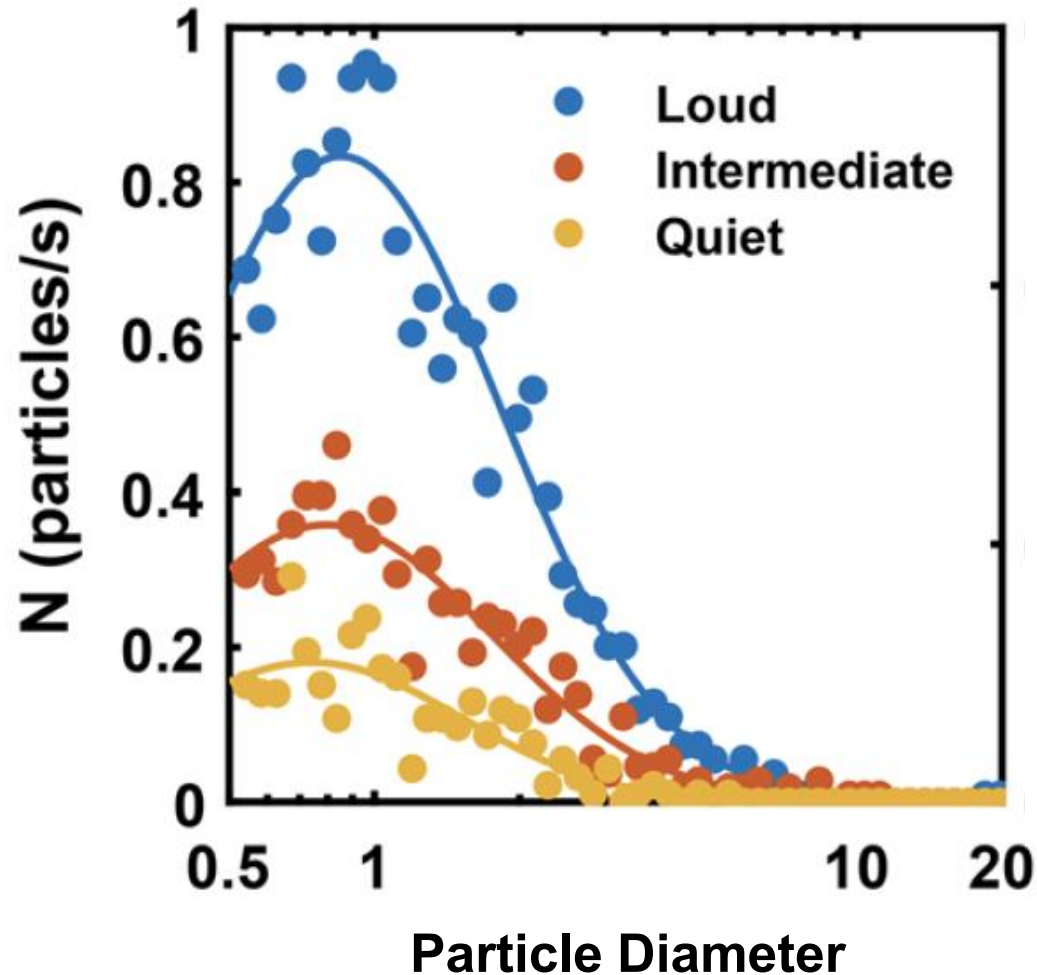


Is Covid spread by droplets or aerosols?



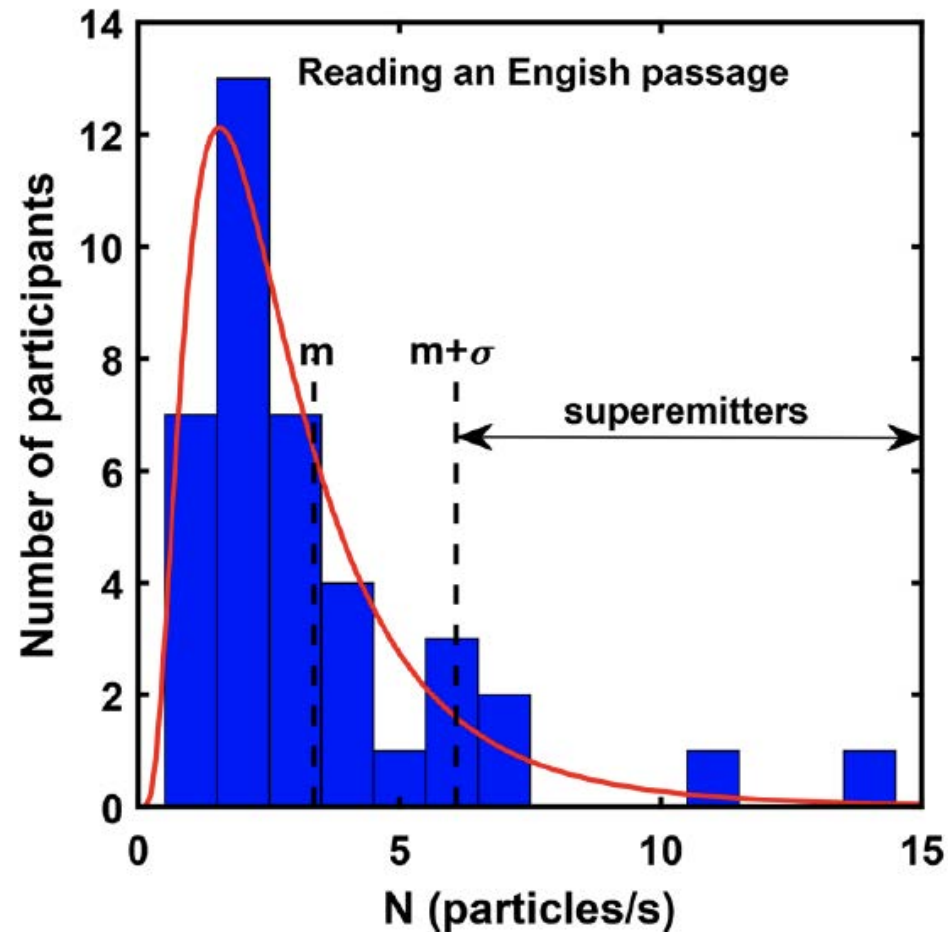
Respiratory Emissions Vary by Volume and by Person

Louder speech → more particles



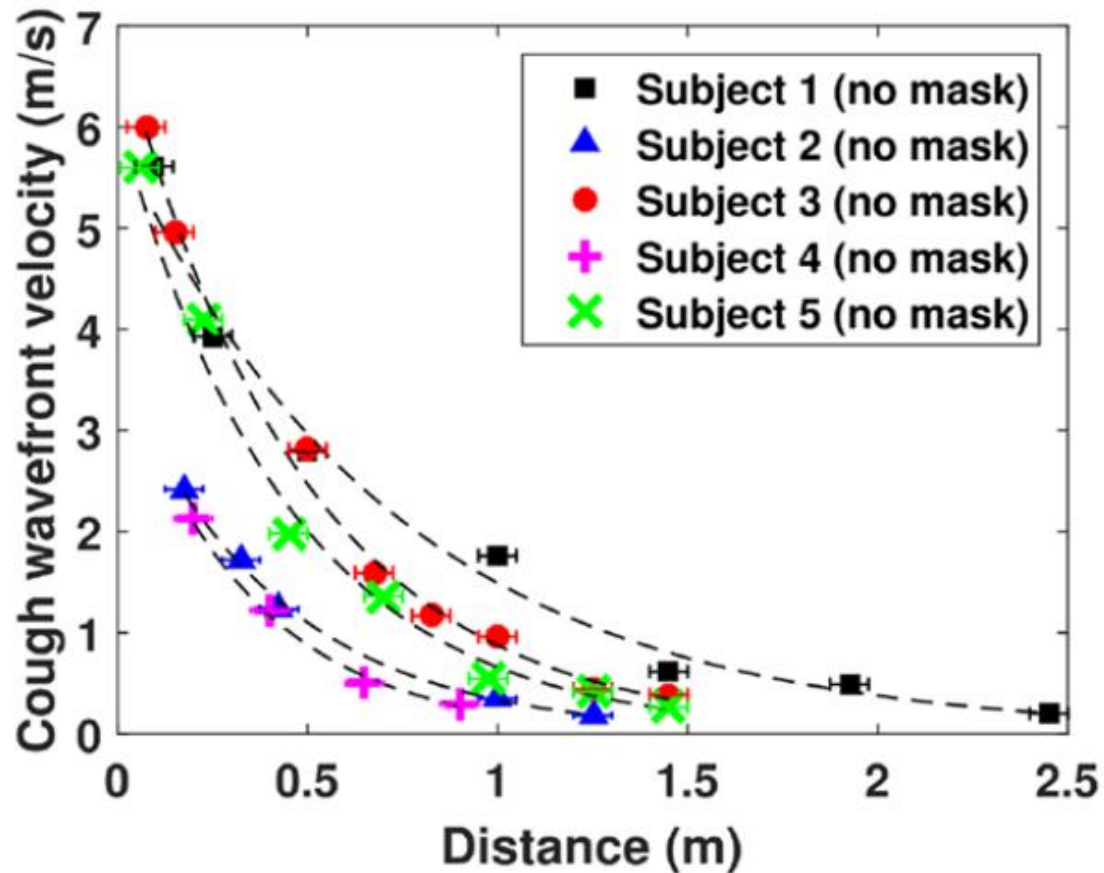
Respiratory Emissions Vary by Volume and by Person

Some people emit much more than others

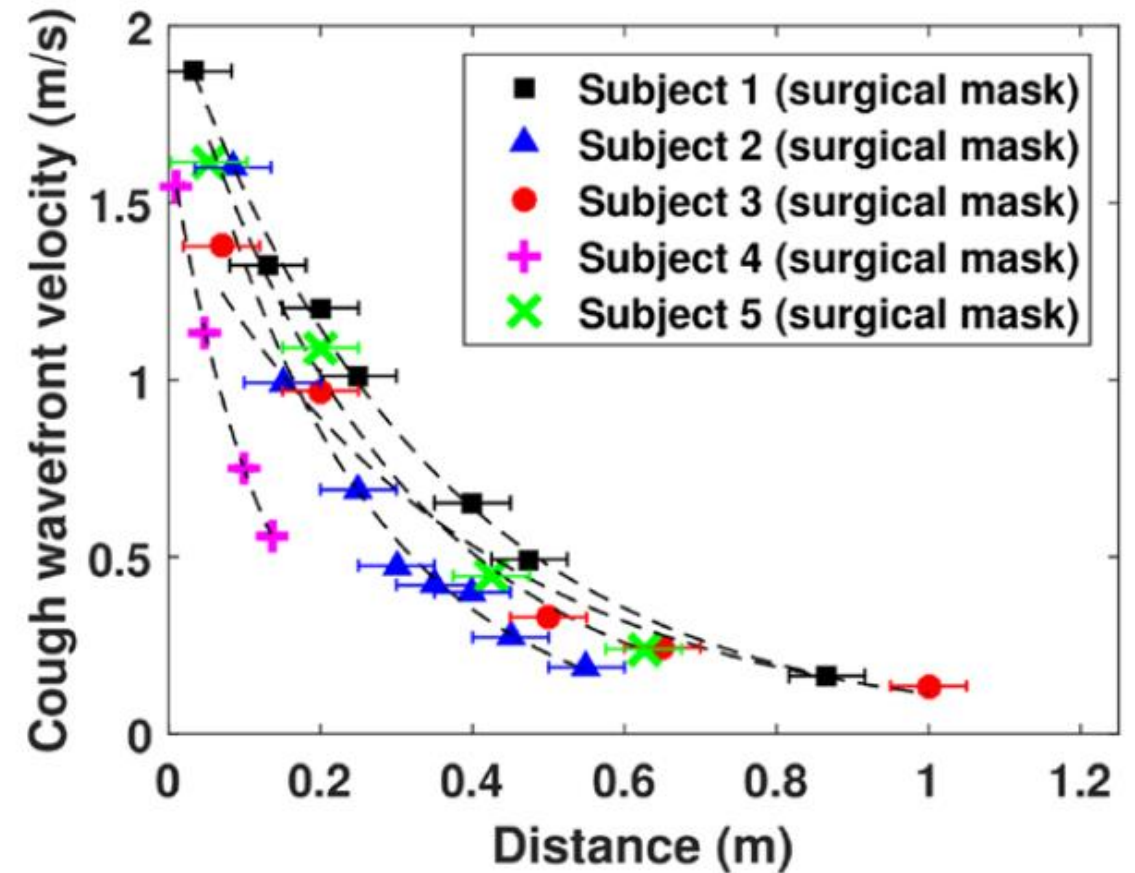


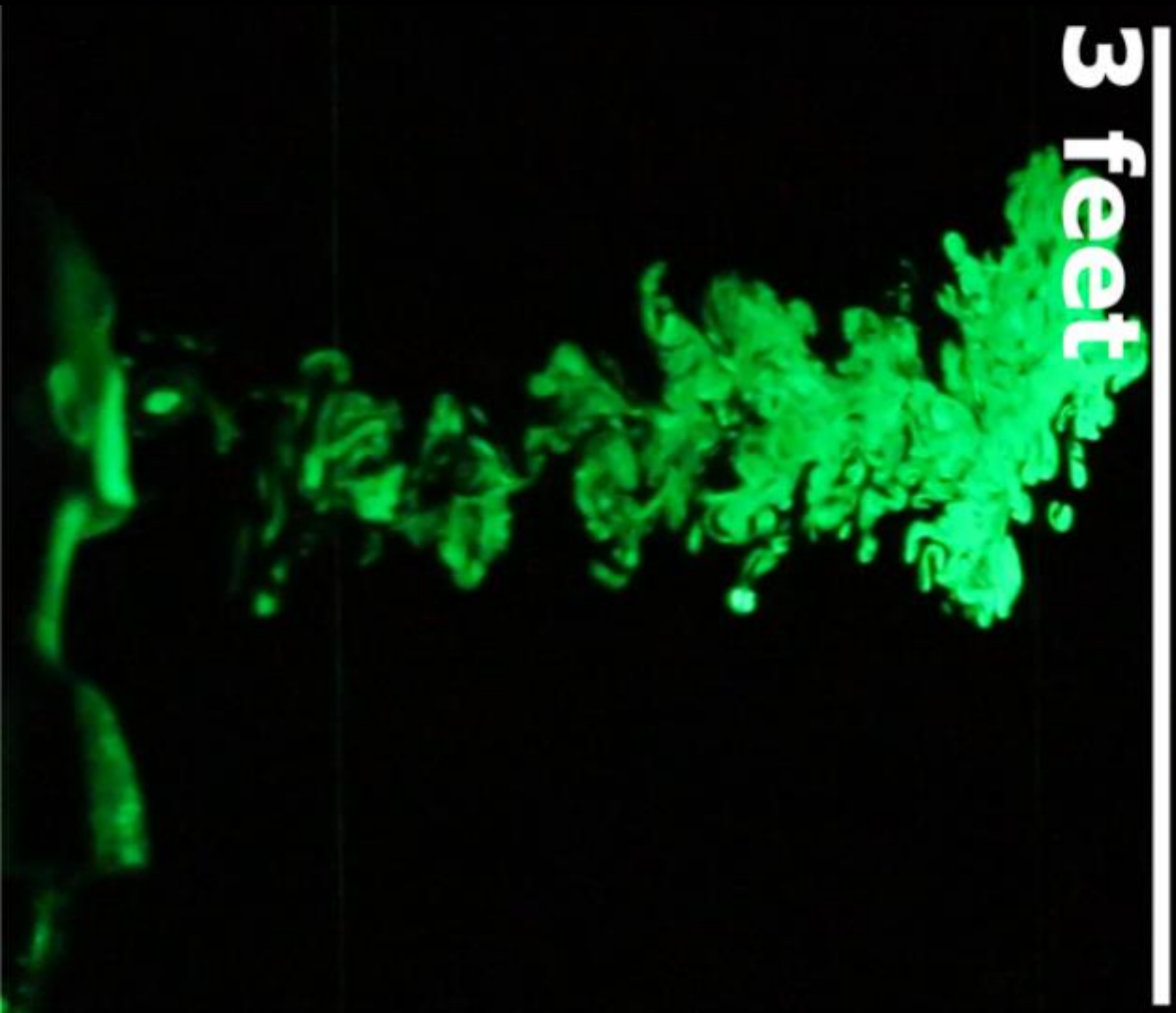
How far does a cough travel?

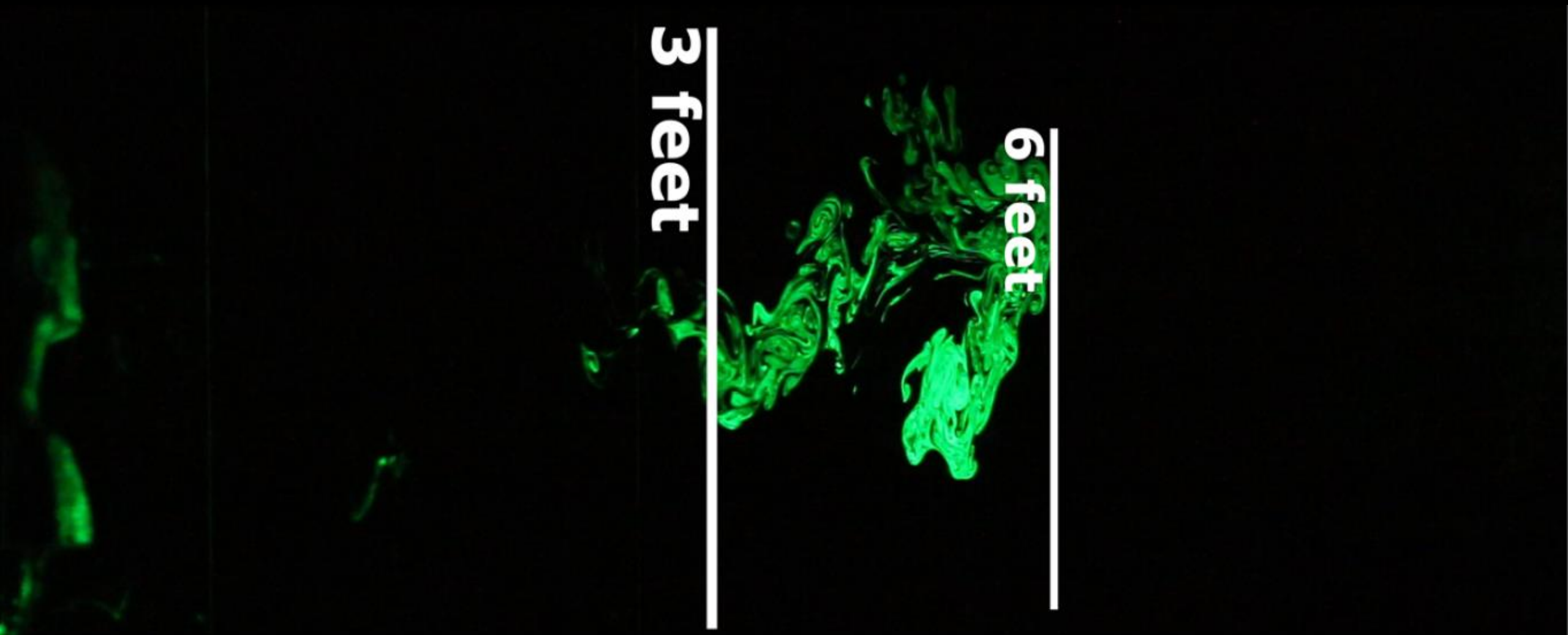
No Mask: Cough travels 1-2 meters

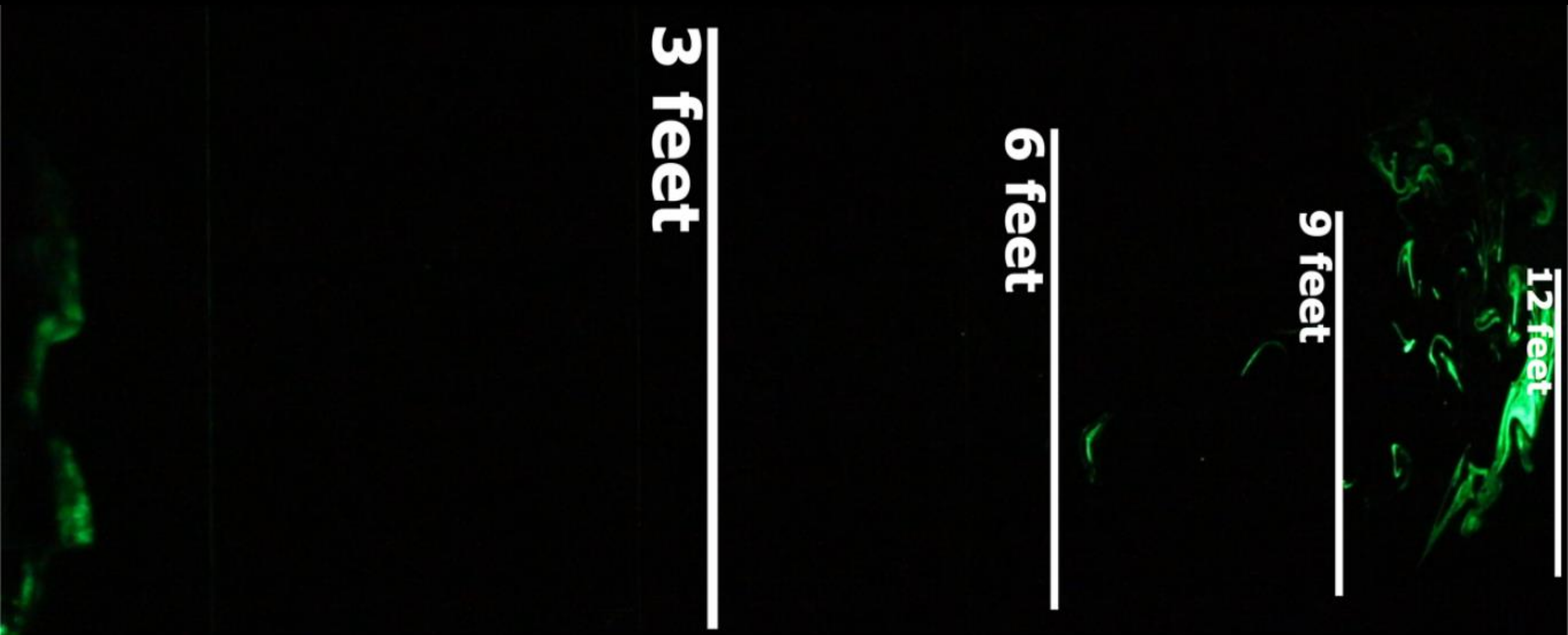


With Mask: Cough travels 0.5-1 meters



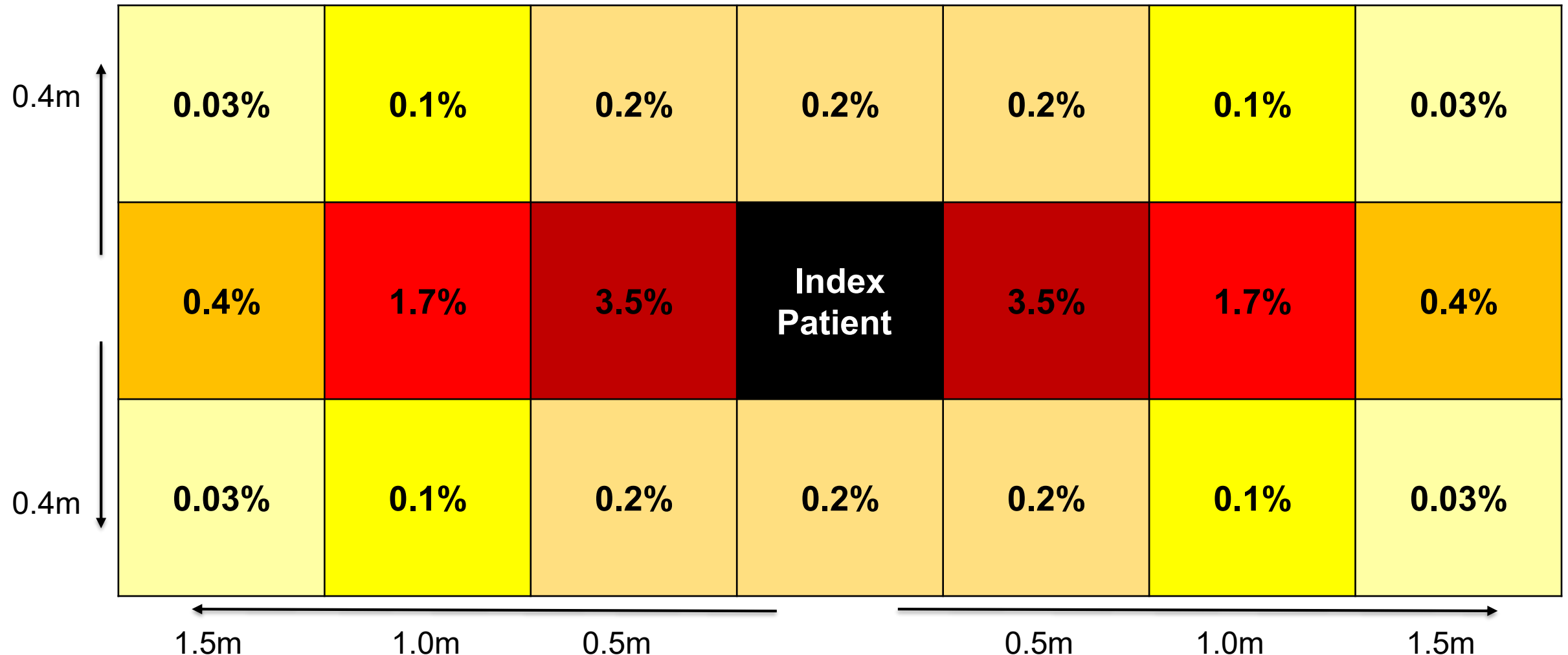






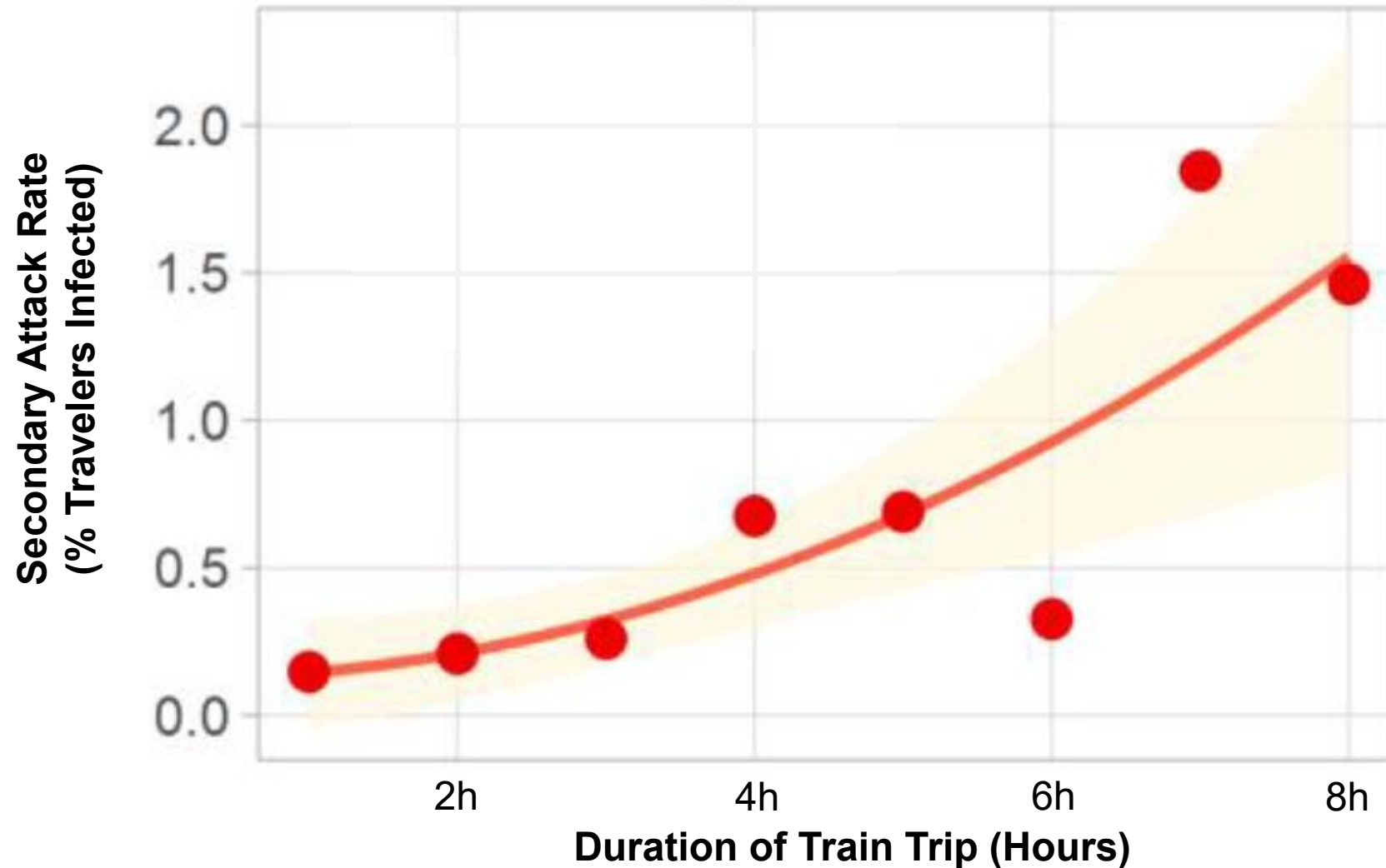
Transmission Risk is Affected by Proximity

Spatial analysis of 2,334 Covid patients and 72,093 close contacts who rode high-speed trains in China



Transmission Risk is Affected by Duration

Temporal analysis of 2,334 Covid patients and 72,093 close contacts who rode high-speed trains in China





Skagit Valley Choir Outbreak

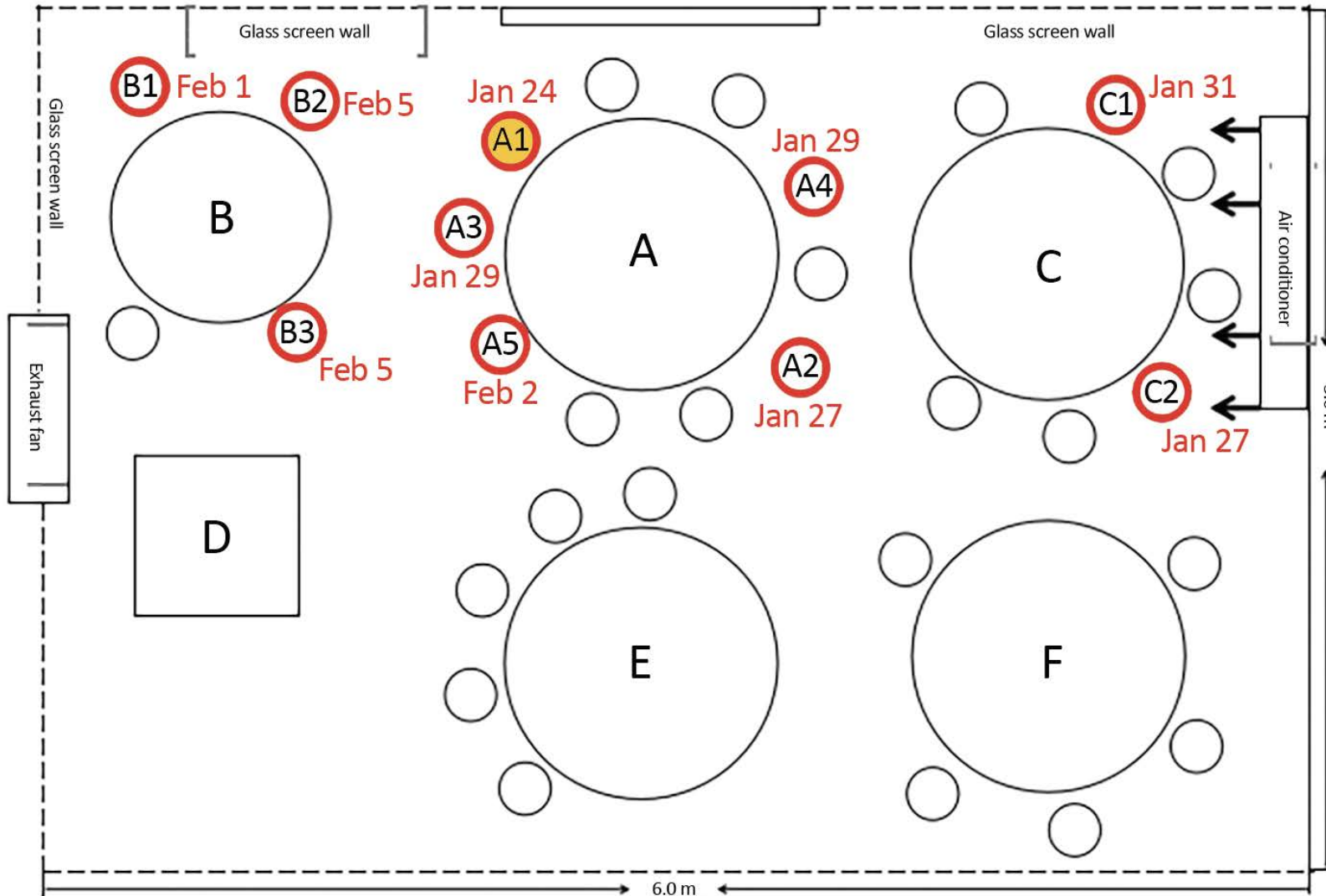


- **61 members of the choir attended practice together March 10**
 - 53 developed Covid-19 (87% attack)
 - 3 hospitalized, 2 died

- **Investigation**

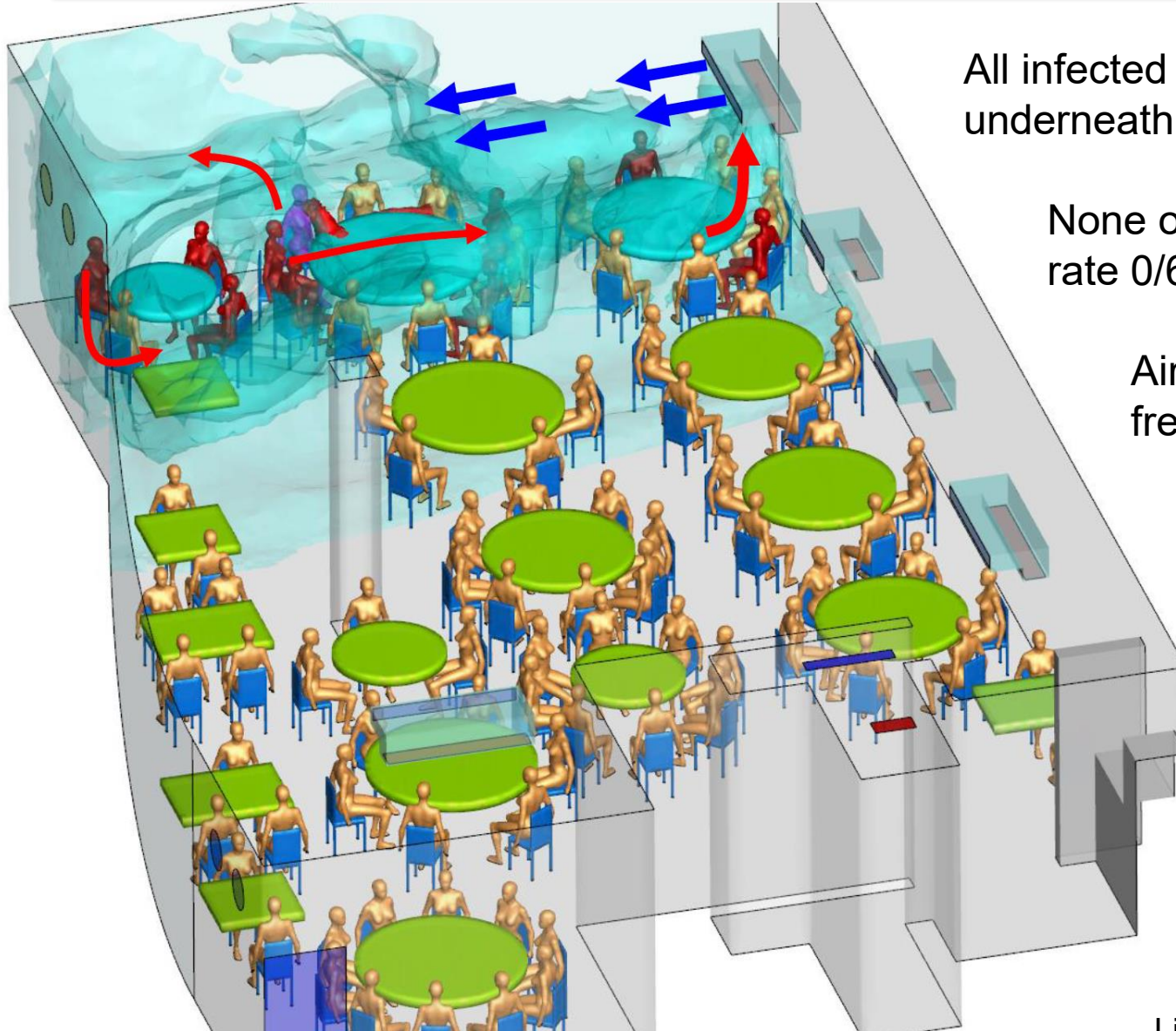
- One member with flu-like symptoms 3 days before practice, later found to be positive for SARS-CoV-2
- 2.5 hour practice; no masking
- Participants sat in chairs 6-10 inches apart
- Cases broadly spread throughout the room, no clustering by seating location
- Air change rate estimated to have been 0.7 changes per hour

Restaurant Cluster Associated with Air Conditioning, Guangzhou, China



- **Well documented cluster in a restaurant in Guangzhou**
- **One pre-symptomatic diner infected 9 other diners (4 at own table, 5 at other tables)**
- **Some of the infected diners up to 4 meters (12 feet) away from the index case**
- **Air conditioner and lack of ventilation potentially contributory**

Air Flow Modeling



All infected diners were in one area of the restaurant underneath an air conditioner (attack rate 9/20, 45%)

None of the 68 diners in other areas were infected (attack rate 0/68). None of the 8 waiters infected.

Air conditioner was recirculating “old” air rather than fresh (exhaust vents were closed)

Tracer gas studies confirmed VERY poor ventilation in the affected area of the restaurant (0.7 air changes/hour; hospital standard is ≥ 6 air changes/hour)

Take home: aerosol transmission possible but under conditions of very poor ventilation.

Cluster of Infections on Poorly Ventilated Bus

- Cluster of 31 infections amongst 300 people who attended an outdoor Buddhist ceremony and lunch in Eastern China. Traced to one pre-symptomatic attendee.
- Two groups traveled to the ceremony by bus. Others travelled via private transport
- 100 mins travel time. 150 mins ceremony time. Ceremony Outdoors.



Bus #1 (indoor exposure)

- Pre-symptomatic patient onboard
- 24/68 people on bus infected

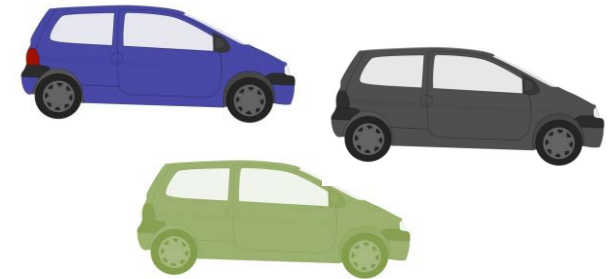
35% infected



Bus #2 (outdoor exposure)

- 0/60 infected despite attending the same ceremony as passengers on Bus #1

0% infected



Private transport

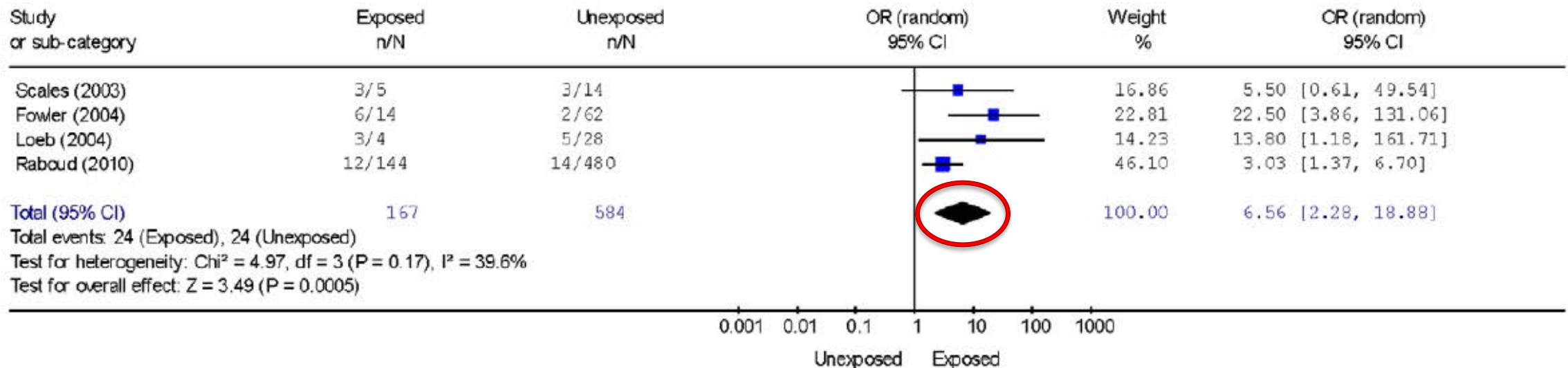
- 7/172 infected.
- All 7 had close contact with the index patient at ceremony

4% infected

What is an aerosol generating procedure?

Tracheal Intubation Associated with Increased Risk of SARS

Risk of SARS-CoV-1 in HCWs Exposed to Tracheal Intubation



Tracheal intubation associated with a 6-fold increase in SARS-CoV-1!

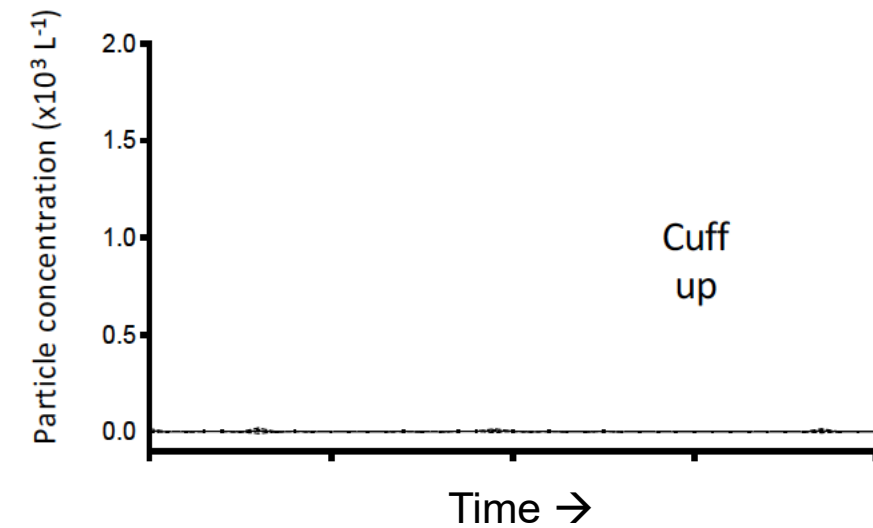
Other procedures that have been associated with increased risk of HCW infections include non-invasive ventilation, manual ventilation before intubation, tracheotomy, cardiac resuscitation.

...but how much aerosols does intubation generate?

Continuous aerosol monitoring using an optical particle sizer in an operating room

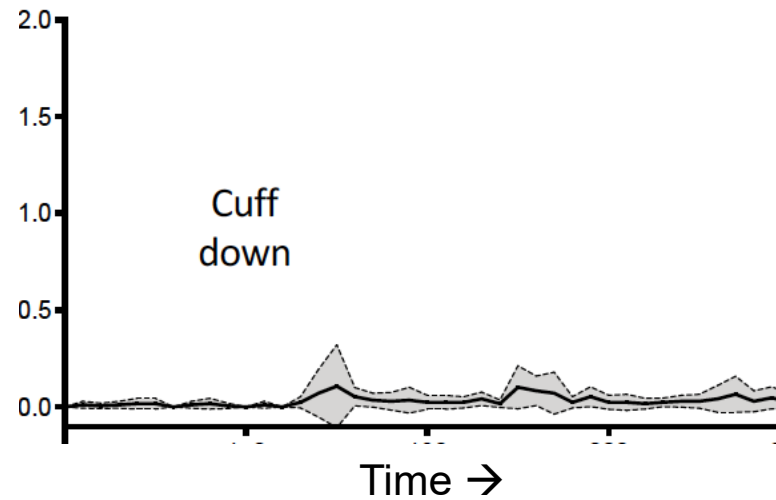
Intubation

Mean 1.4 particles/L, N=14



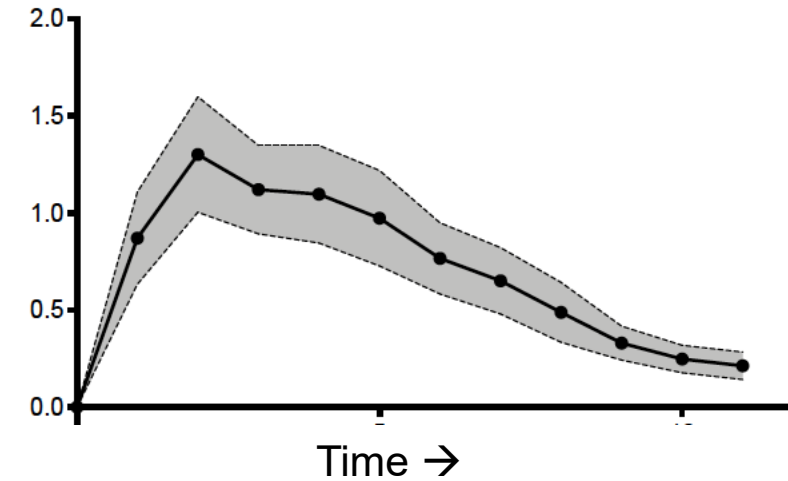
Extubation

Mean 21 particles/L, N=10

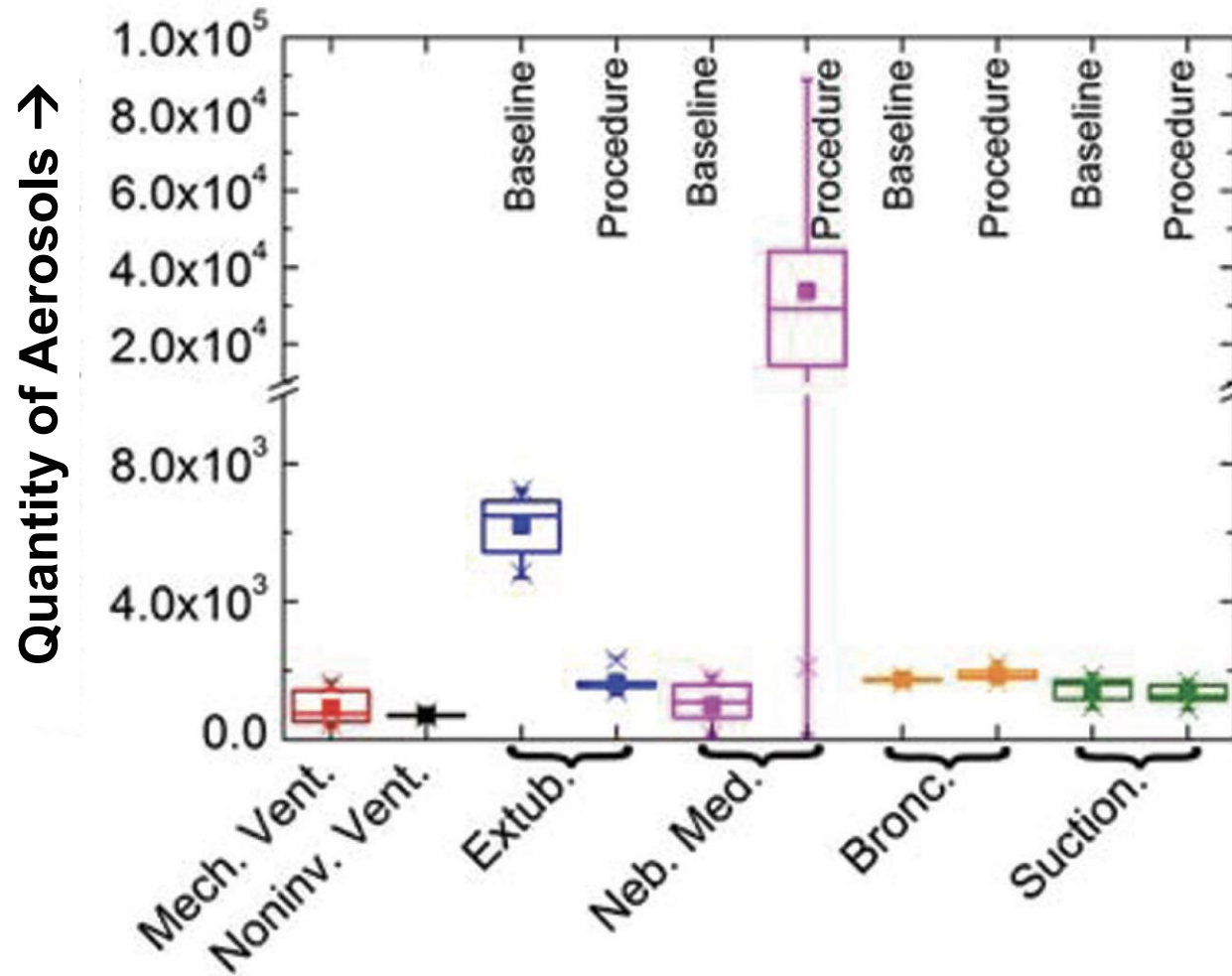


Cough

Mean 732 particles/L, N=38



Most “Aerosol Generating Procedures” Generate Very Few Aerosols



The Intubation Paradox

- **It's not the procedure, it's the patient!**
- **Associations between procedures and healthcare worker infections more likely due to the circumstances surrounding procedures rather than the procedures themselves**
 - Severe illness (high viral loads)
 - Symptoms (tachypnea, heavy breathing, coughing)
 - Profound proximity to the respiratory tract
 - Sustained exposure

How contagious is Covid?

How Contagious Is Covid?

- **Intensive contact tracing, Ningbo City, China**
 - Amongst 2,147 close contacts of 147 cases
 - 6.2% became infected
- **Secondary attack rates**
 - Household members – 18% developed infection
 - Eating together – 7% developed infection
 - Relatives – 5% developed infection
 - Supermarket – 0.6% developed infection

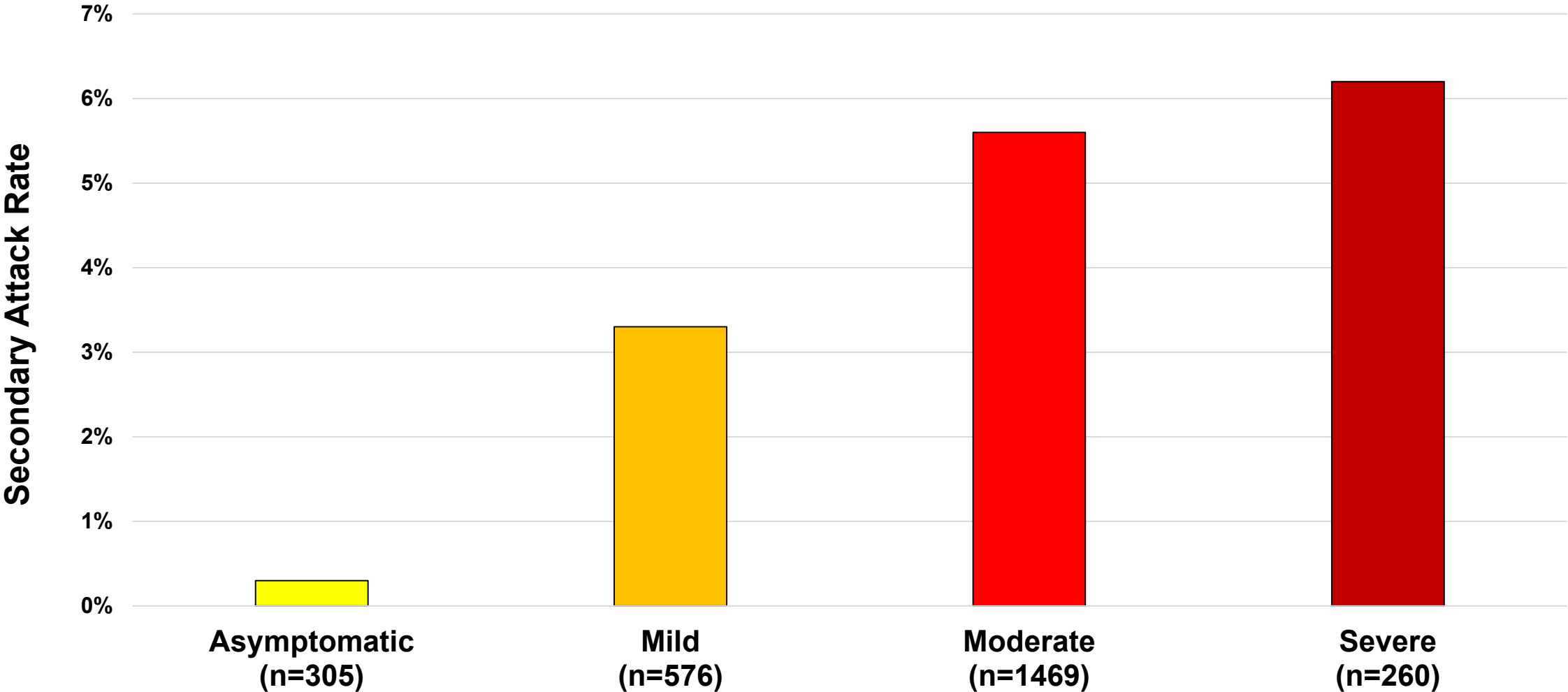
How Contagious is Covid?

Intensive contact tracing, Guangzhou, China

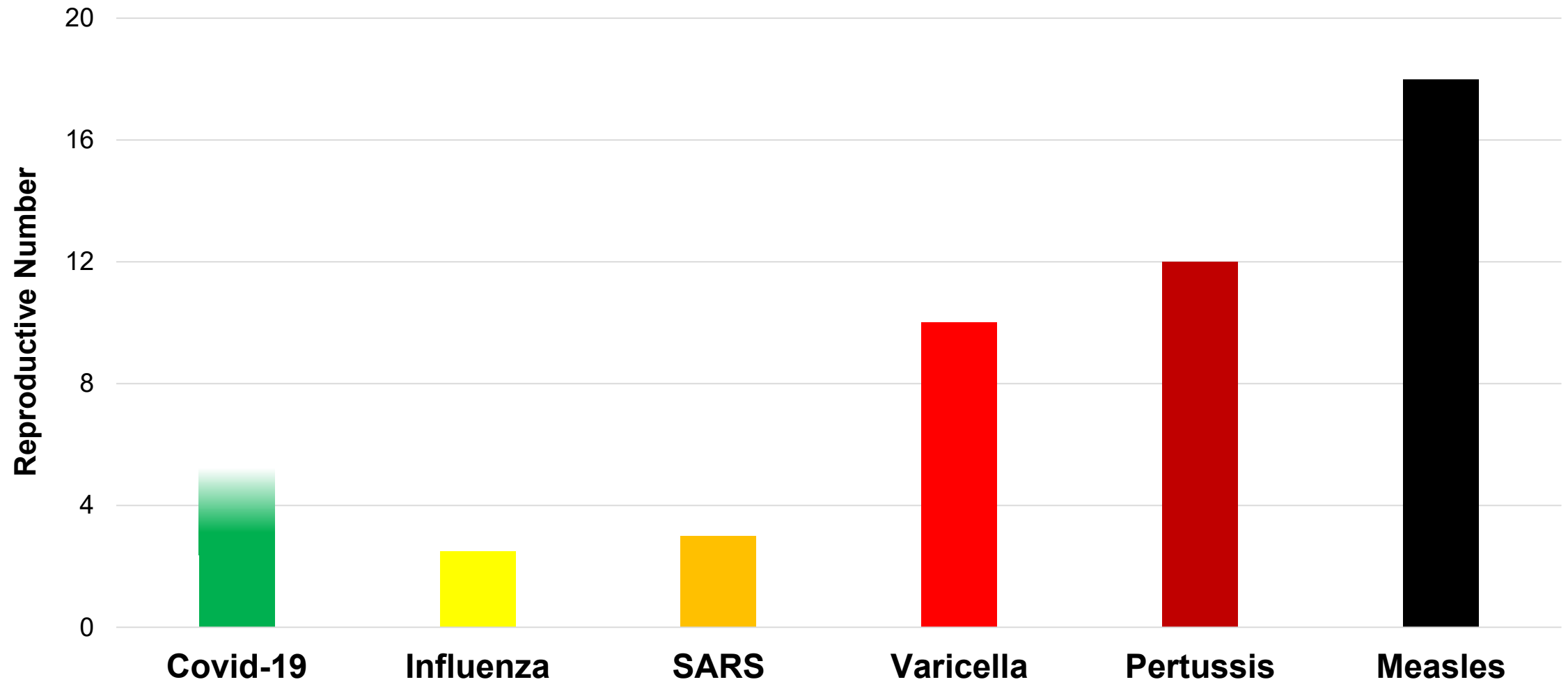
- 3410 close contacts of 391 Covid patients
- Close contacts identified by interview and cell phone tracing
- 127/3410 contacts infected (3.7%)
- **Secondary attack rates varied by setting:**
 - Household (10.3%)
 - Entertainment venues or workplace (1.3%)
 - Health care settings (1.0%)
 - Public transport (0.1%)

Secondary Attack Rates by Severity of Illness

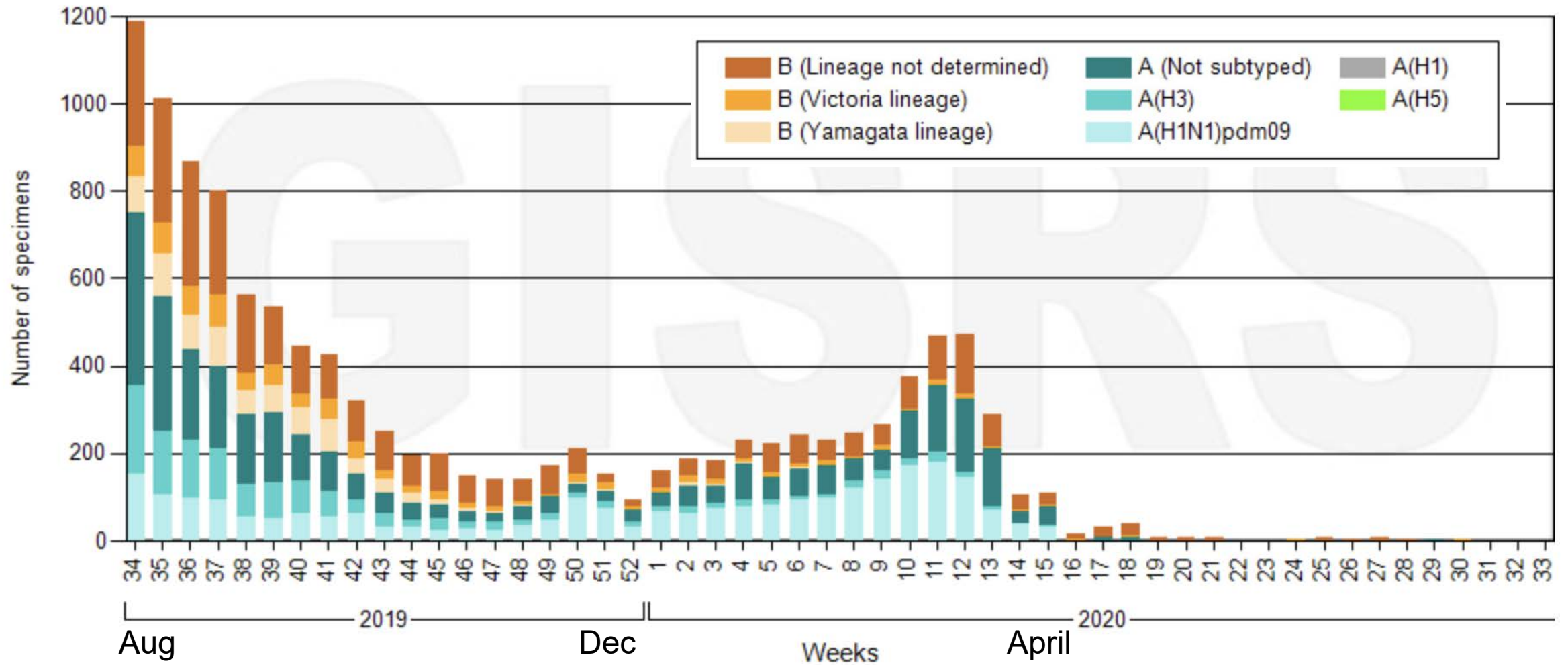
Secondary attack rates amongst 3410 close contacts of 391 Covid patients, Guangzhou, China



Contagiousness (R_0)

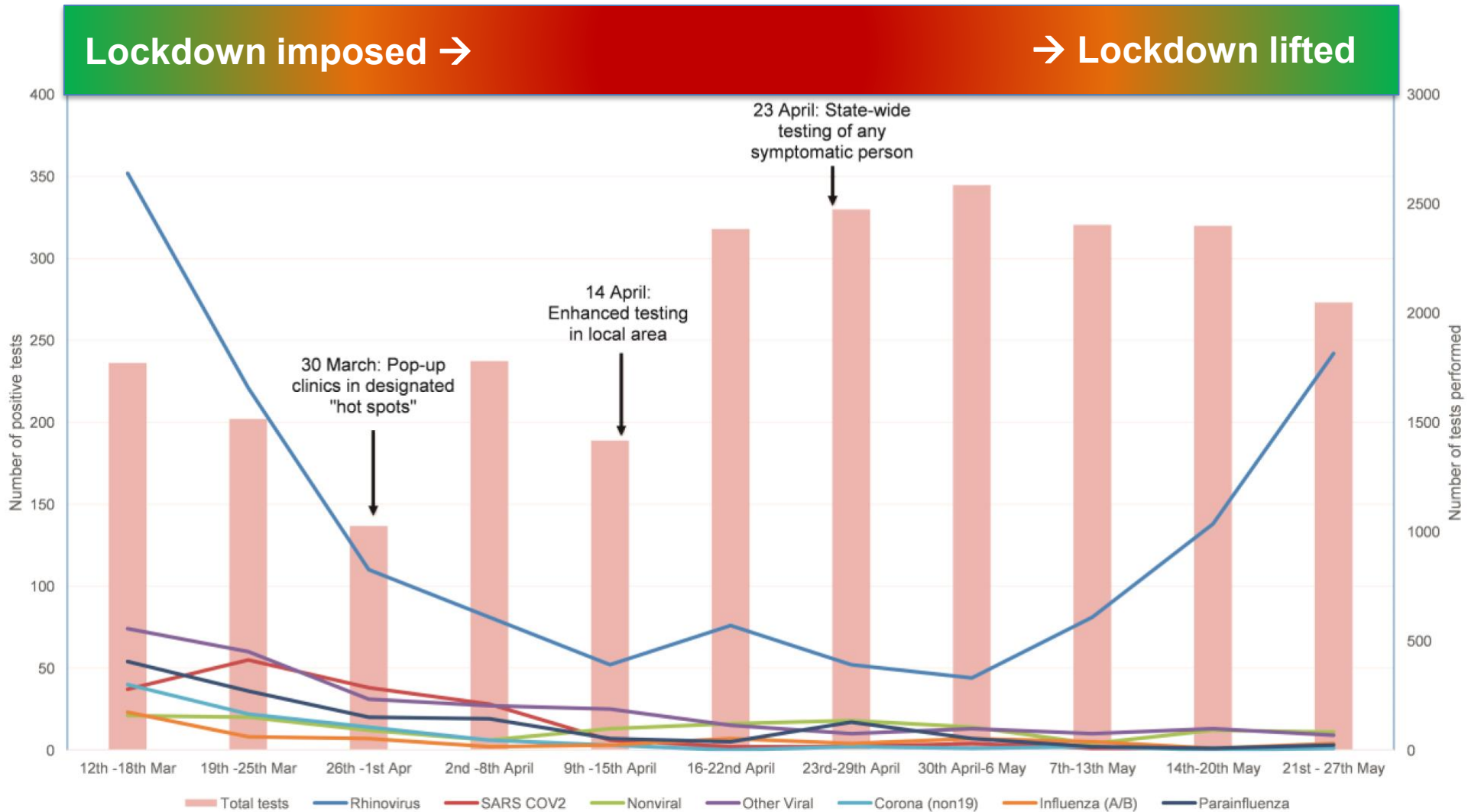


Influenza Cases – Southern Hemisphere



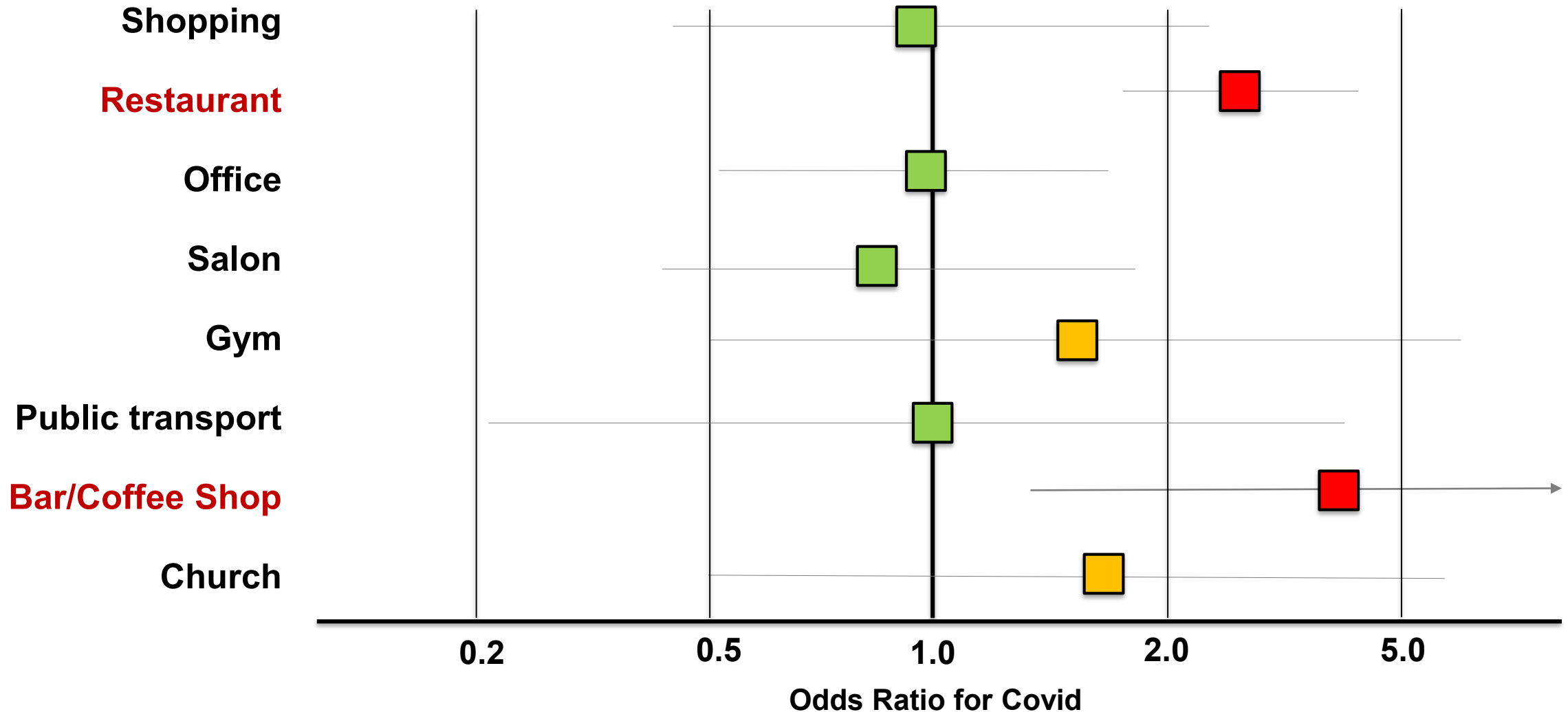
Rhinovirus Conquers All?

Respiratory multiplex testing on symptomatic patients, St. Vincent's Hospital, Australia (N=21,808)



Risk Factors for Covid outside the Home

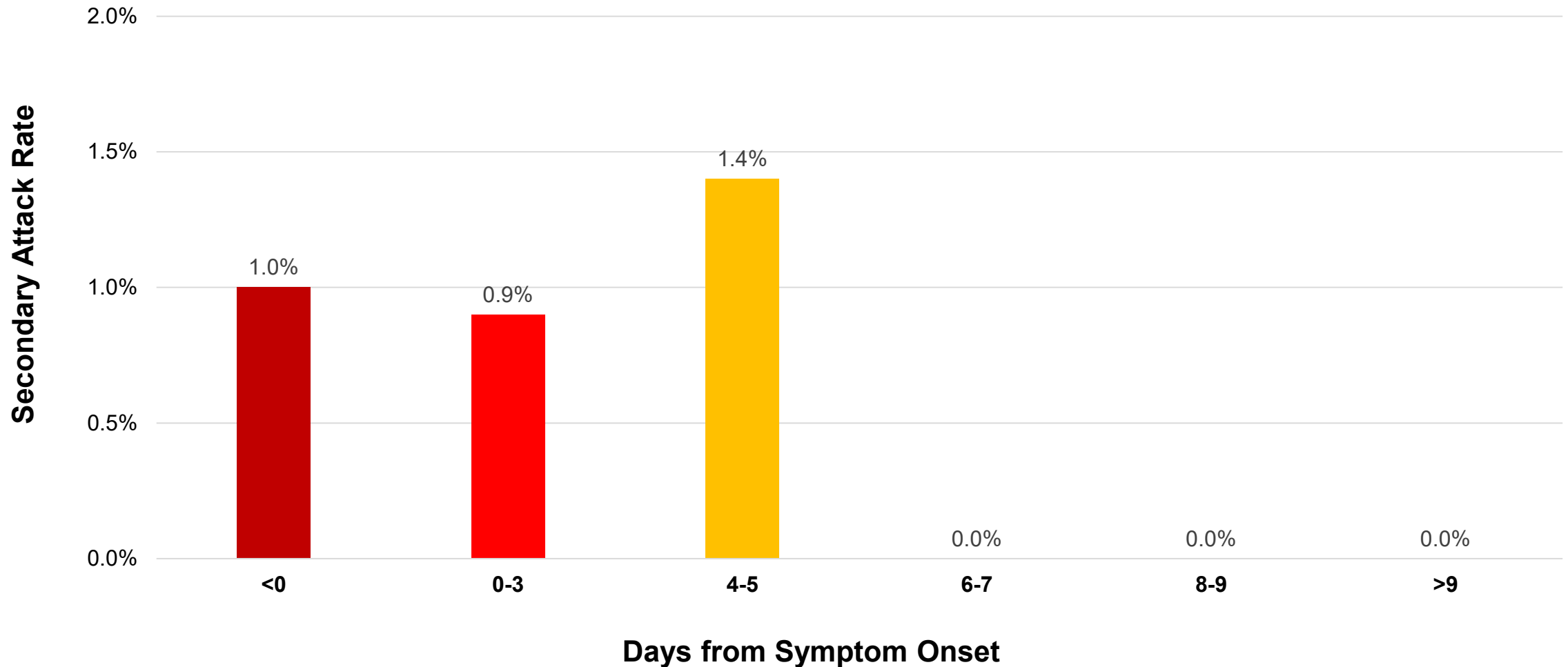
Case-Control study, symptomatic outpatients without known Covid exposures, 10 U.S. states, N=225



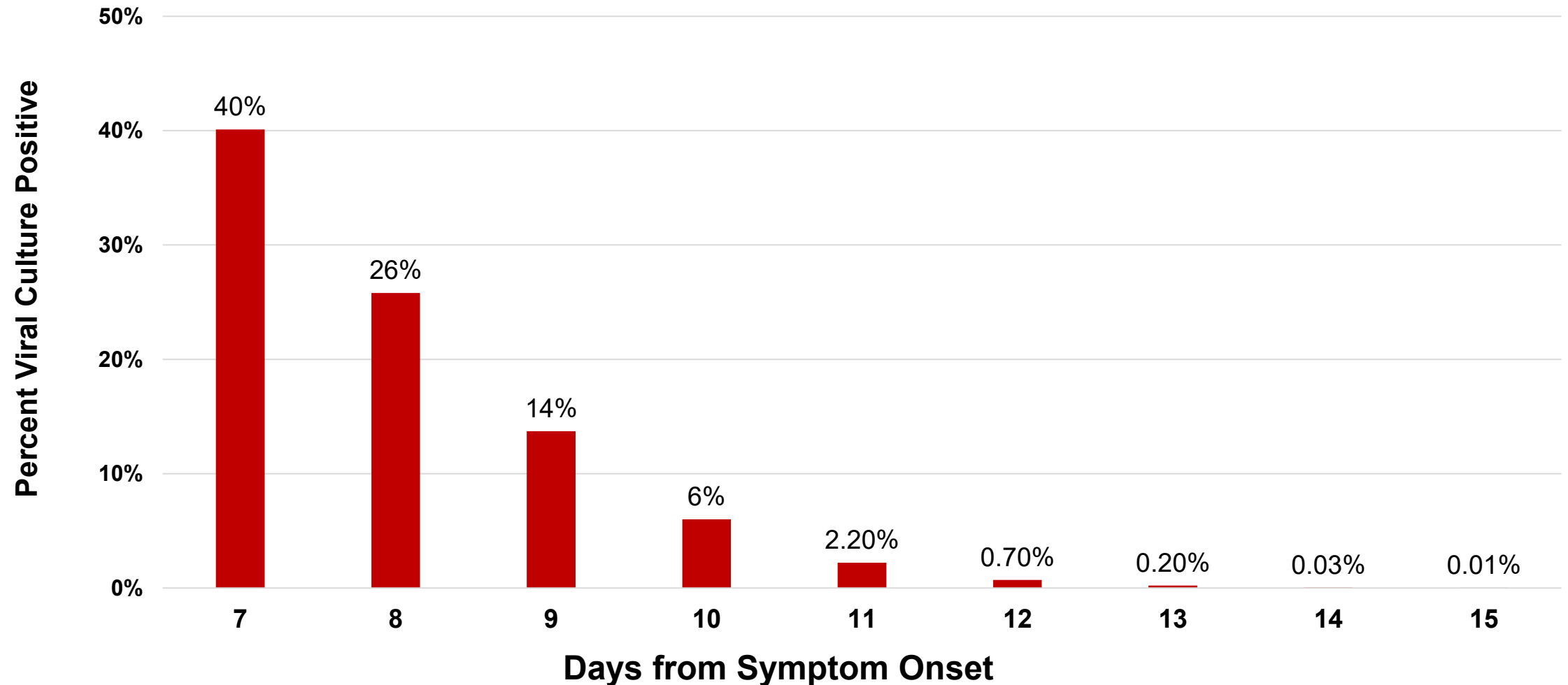
How long are people contagious?

Duration of Infectiousness

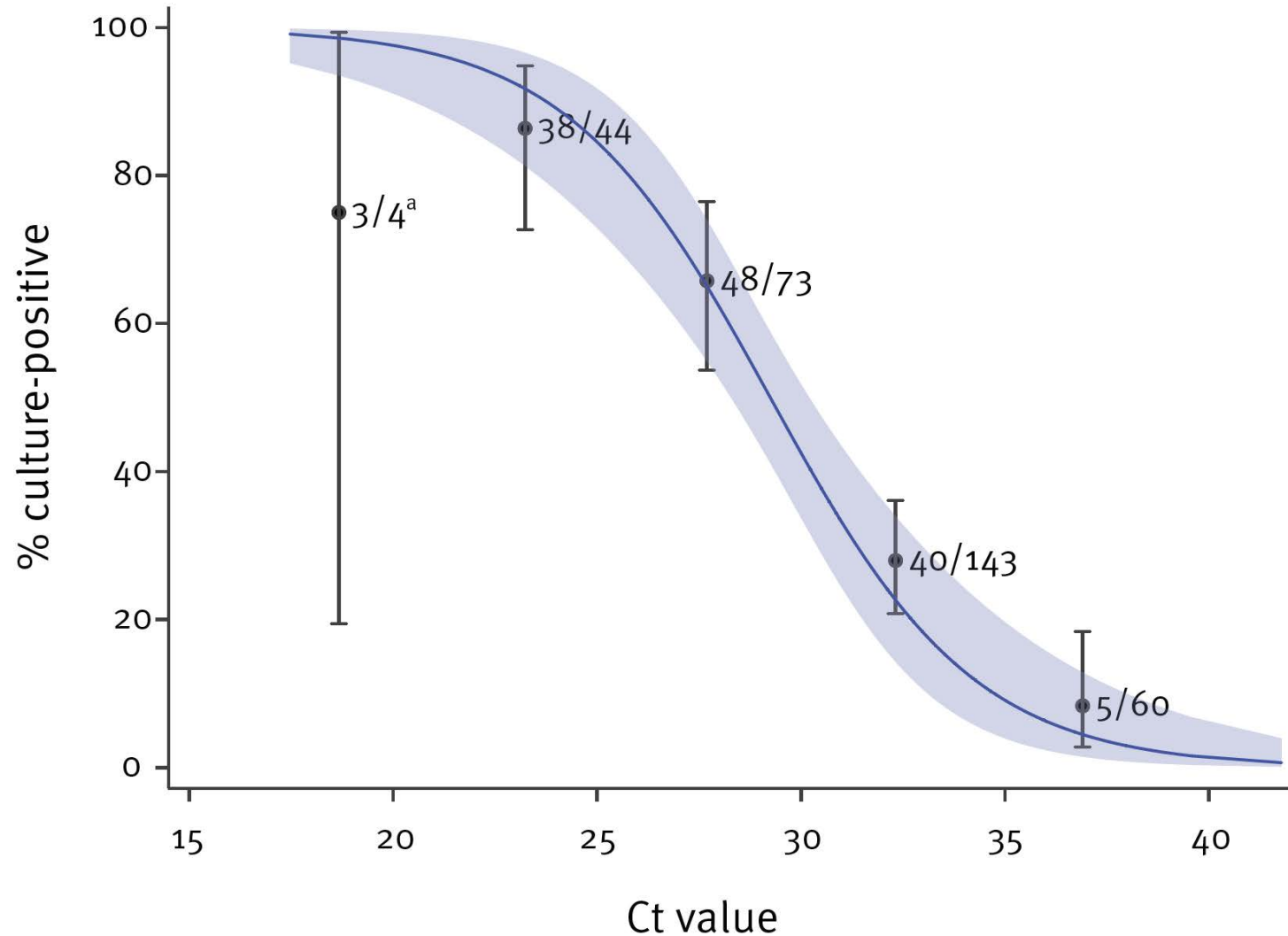
Infection rates amongst 2,761 close contacts of 100 patients with confirmed Covid-19 in Taiwan



Probability of Viral Viability After Symptom Onset



Association between Cycle Threshold and Culture



How reliable is a post-exposure test to rule out Covid transmission?

Household Transmission Rates

- CDC study of 191 household contacts of 101 Covid patients
- Household contacts tested daily following exposure

53%

of household contacts ultimately tested positive

- 53% if index patient age <12
- 38% if index patient age 12-17

75%

of transmissions detected by **day 5**
following the index patient's start of illness

What is the risk to healthcare workers?

UC DAVIS MEDICAL CENTER

**BREAKING
NEWS**

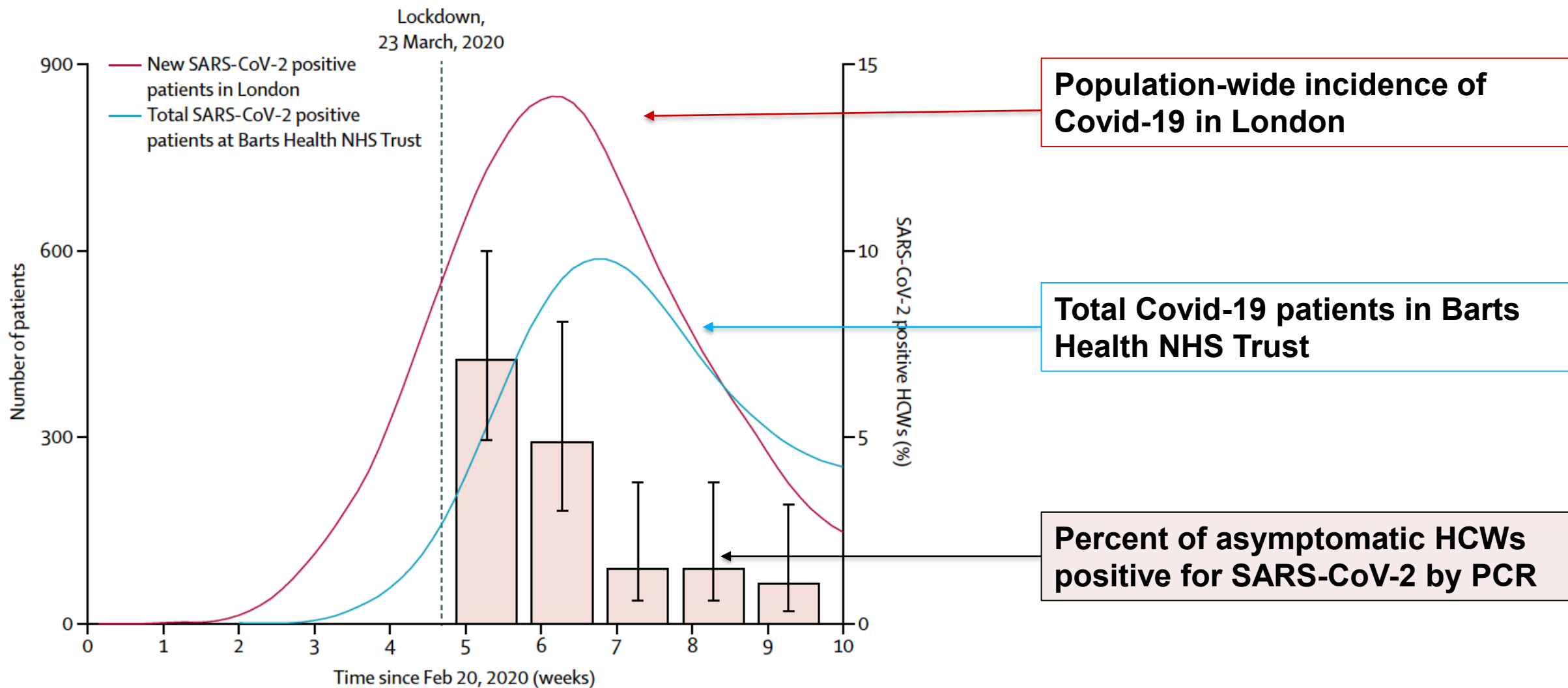
First Coronavirus Case of Unknown
Origin Being Treated at UC Davis



Risk of SARS-CoV-2 Transmission for Healthcare Workers

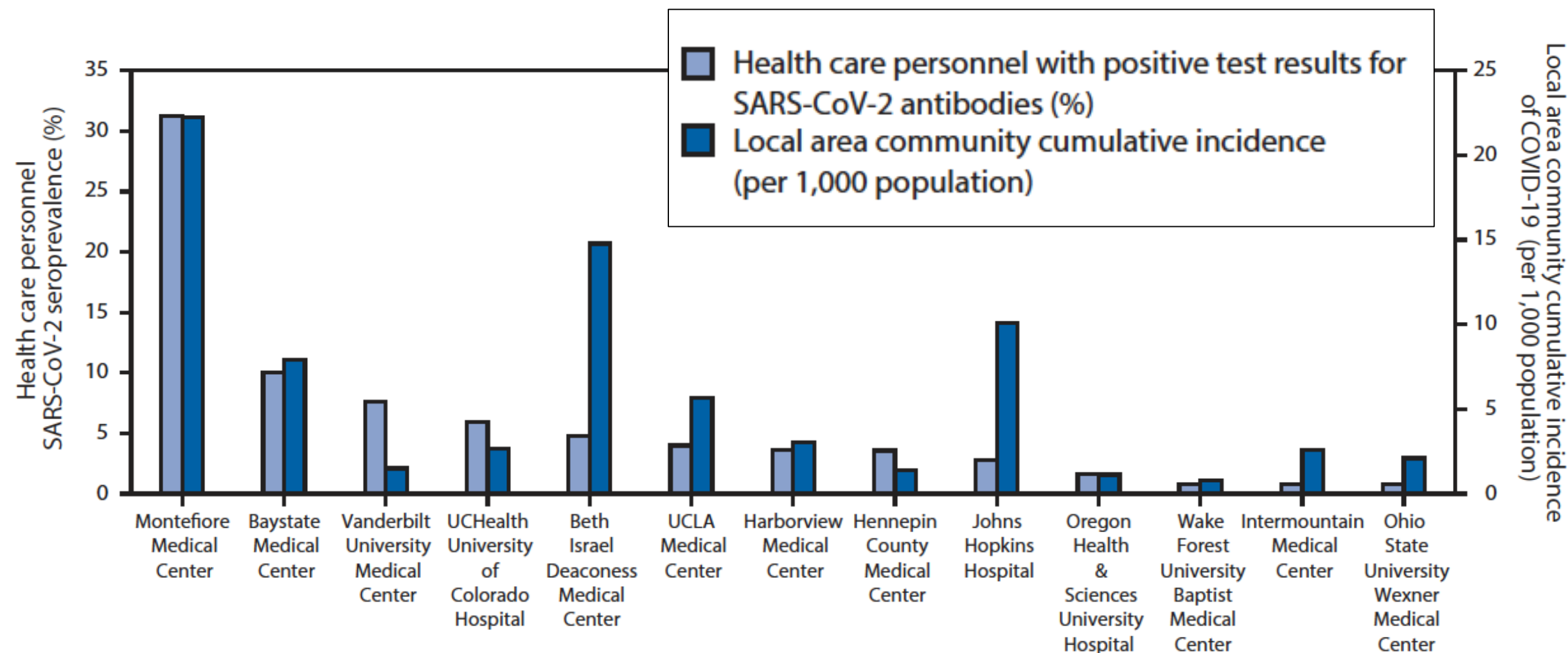
- CDC analysis of the first U.S. case of locally acquired COVID19 (Solano, CA)
 - Patient with unsuspected COVID19
 - 121 providers had contact with the patient, no precautions
 - 3 developed COVID-19 (2.5%)
 - Risk factors:
 - aerosol generating procedures (2 HCWs)
 - prolonged contact (>2 hours, 1 HCW)

Healthcare Worker Infection Rates Parallel Community Rates



Healthcare Worker Infection Rates Parallel Community Rates

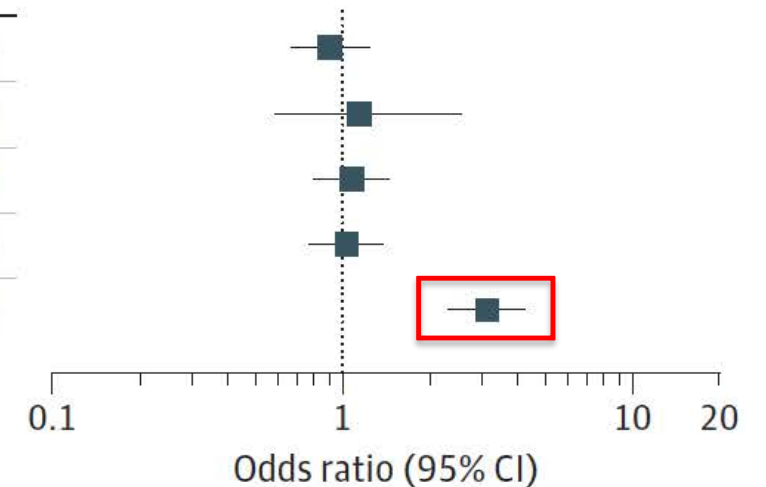
SARS-CoV-2 seroprevalence amongst 3,248 healthcare workers from 13 different hospitals



Risk Factors for Healthcare Worker Infections

Hospital-wide seroprevalence survey, Hospital East-Limburg, Belgium, N=3,056

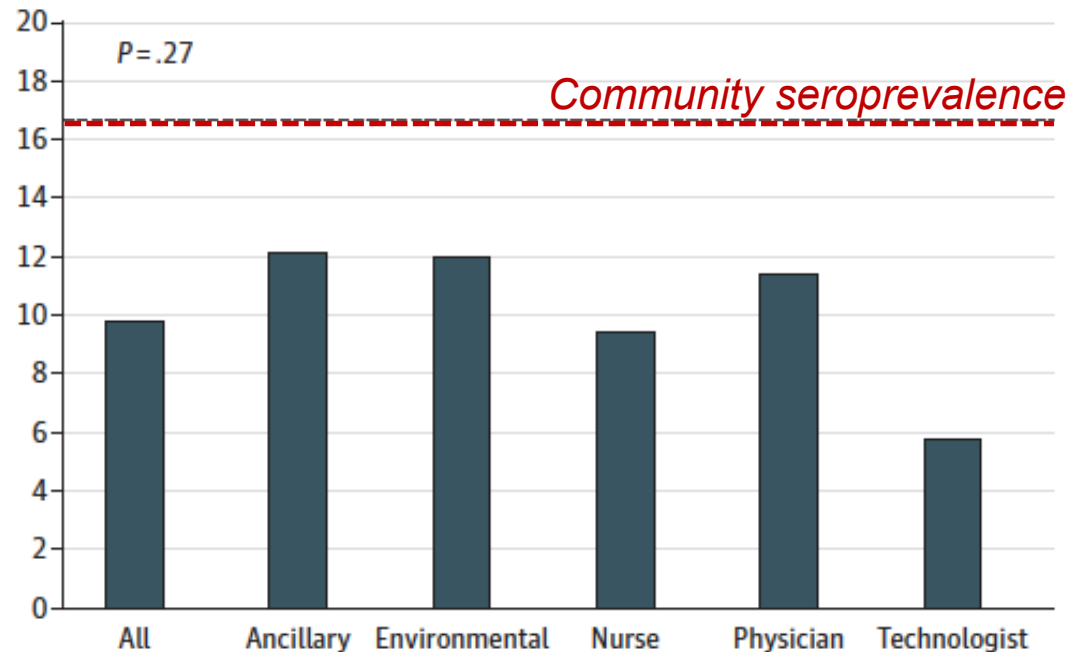
	No. with SARS-CoV-2 antibodies/total (%)		Odds ratio (95% CI)
	Exposure present	Exposure absent	
Patient contact	114/1864 (6.1)	67/1000 (6.7)	0.91 (0.67-1.25)
Worked during lockdown	188/2902 (6.5)	8/142 (5.6)	1.14 (0.59-2.57)
COVID-19+ patient contact	73/1092 (6.7)	120/1921 (6.2)	1.08 (0.80-1.45)
COVID-19+ coworker contact	95/1434 (6.6)	100/1548 (6.5)	1.03 (0.77-1.38)
Suspected COVID-19+ household	81/593 (13.7)	116/2435 (4.8)	3.15 (2.33-4.25)



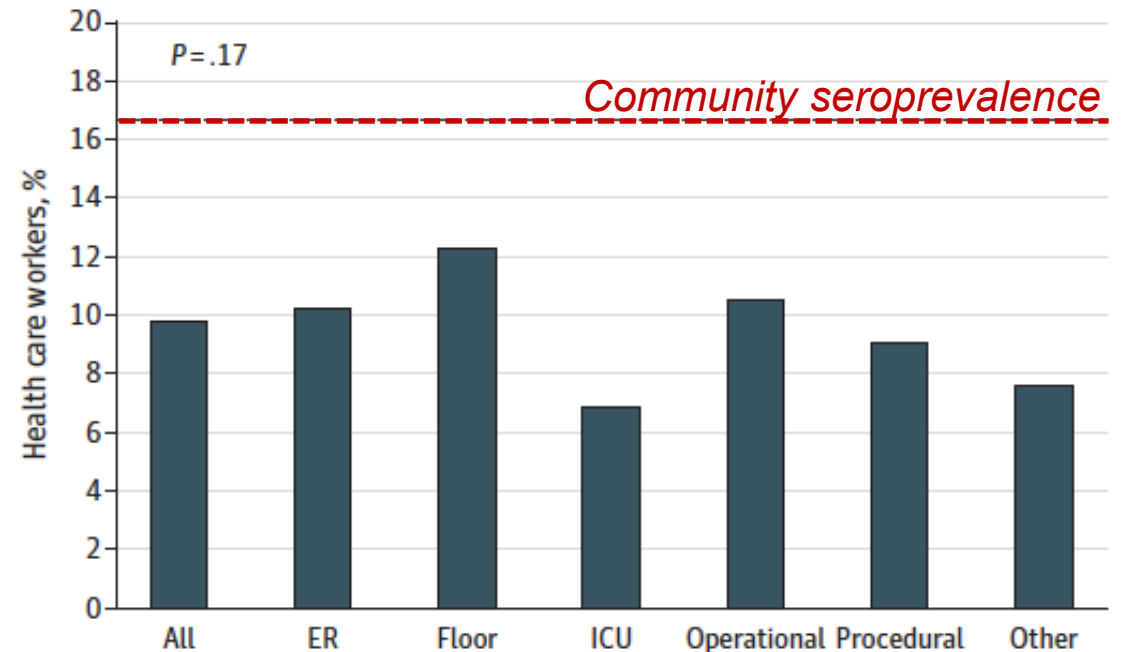
SARS-CoV-2 seroprevalence by Job Type & Setting

Antibody testing amongst 1699 employees of St Francis Hospital, Roslyn, NY

Job Type



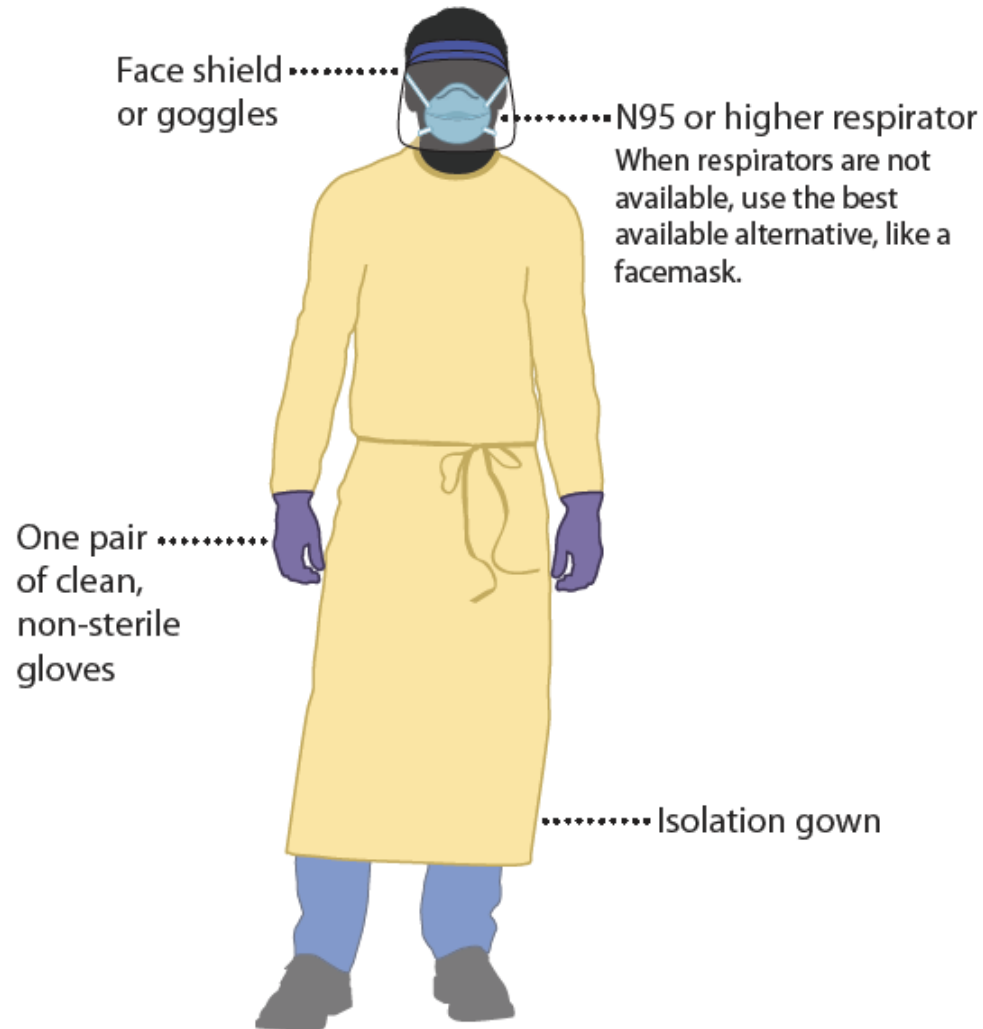
Hospital Department



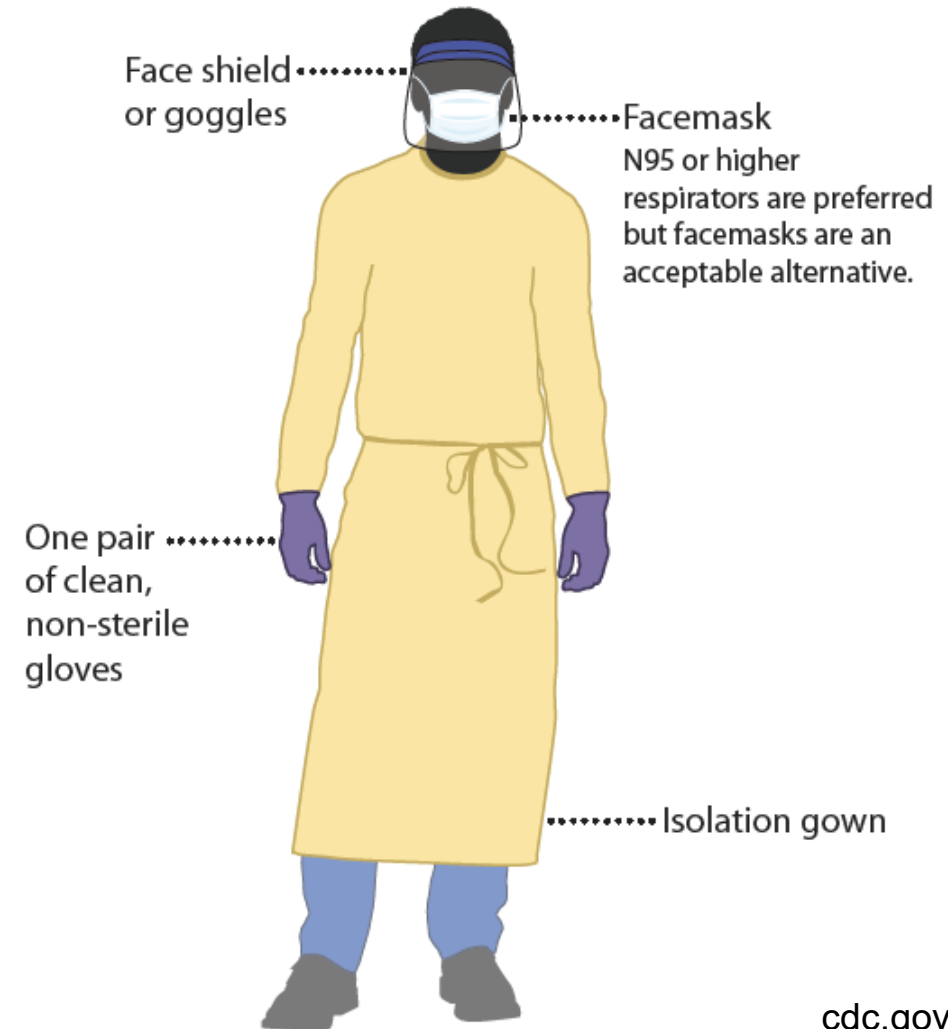


PPE for Patients with Suspected or Confirmed Covid-19

Preferred PPE – Use N95 or Higher Respirator



Acceptable Alternative PPE – Use Facemask



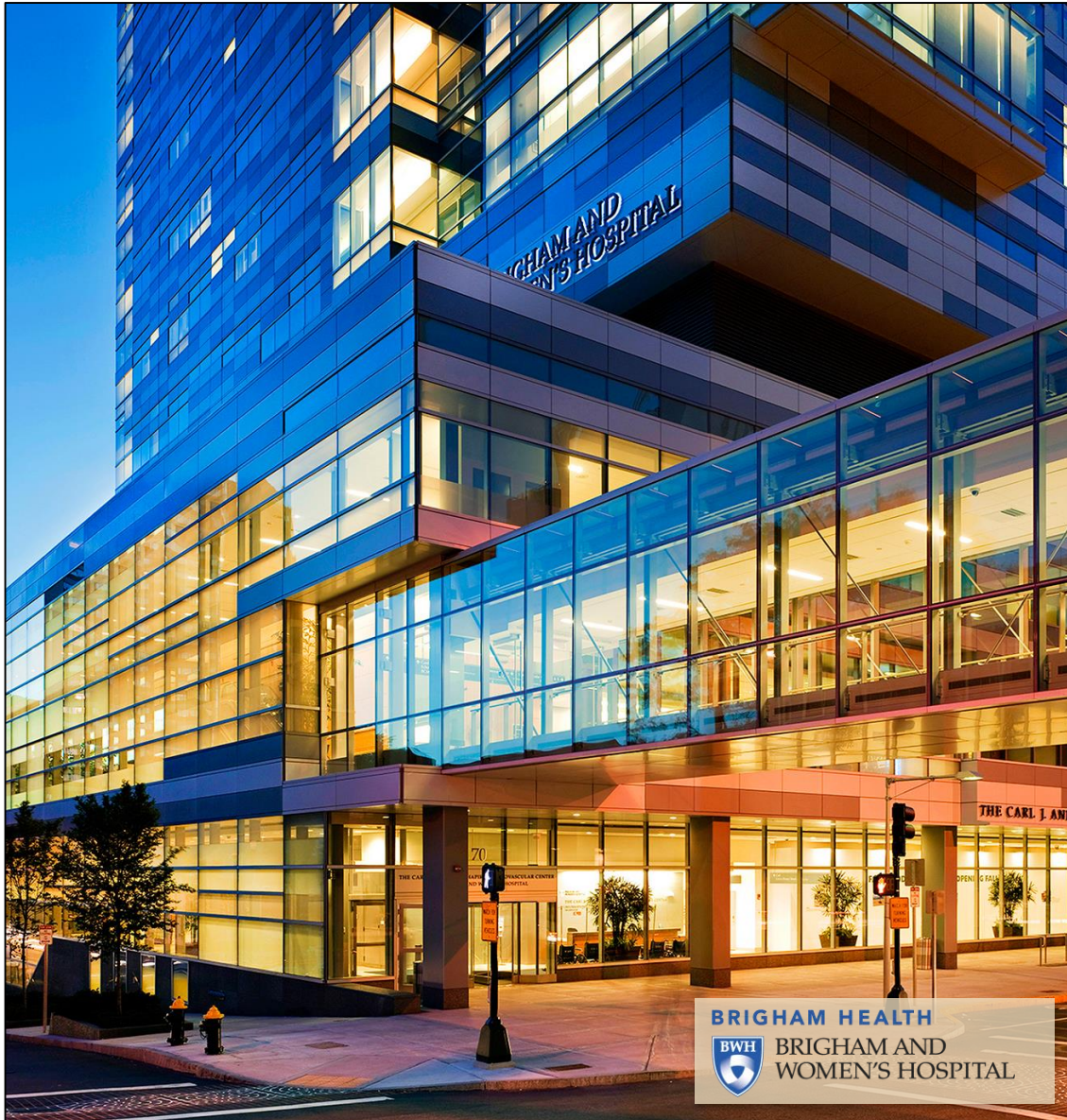
What is the risk to patients?

Nosocomial Transmission Rare



- We identified 226 patients at Brigham & Women's Hospital exposed to healthcare workers who were subsequently diagnosed with Covid
- Followed each patient x 14 days for symptom & tests
- Identified 1 patient infection potentially attributable to their healthcare exposure

Nosocomial Transmission Rare



- From Mar 7- May 30 we admitted almost 700 patients with Covid & 8000 patients without Covid
- We reviewed all patients who tested positive on hospital day ≥ 3
- Only 2 cases of hospital-acquired COVID detected:
 - 1 in March who likely acquired Covid from visiting wife
 - 1 in April who developed Covid shortly after long hospitalization – no clear exposures inside or outside hospital

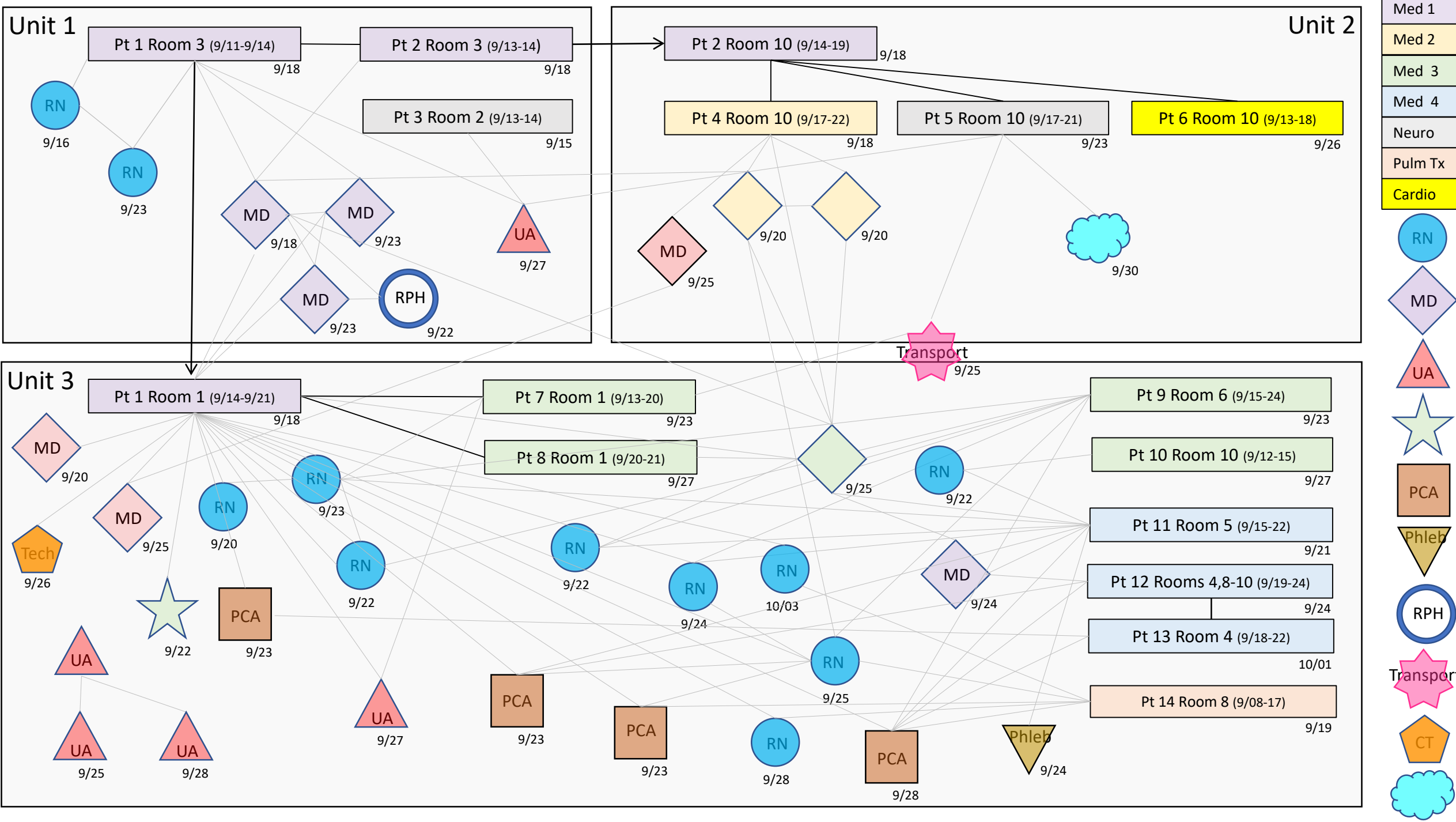
The Boston Globe

Brigham and Women's COVID-19 cluster illustrates challenges in controlling infection

Experts say leadership, vigilance, and culture change are needed, along with more space to gather and eat at safe distances

By [Felice J. Freyer](#) Globe Staff, Updated September 26, 2020, 1:16 p.m.





Our Hospital Cluster

- 14 patients, 38 staff (confirmed by whole genome sequencing)
 - Likely source: patient admitted during incubation period (negative by NP x 2 on admission) but contagious by day 3
 - High rate of transmission amongst patients sharing rooms
 - Factors that may have facilitated transmission: early infections, symptomatic patient, variable use of eye protection by providers, inconsistent masking of patients
-

Mitigation and Lessons Learned

- Pre-emptive precautions for all patients on cluster units & services
 - Serial testing of all patients and staff associated with cluster units (every 3 days)
 - Confirmation of adequate ventilation
 - Messaging about eye protection & masking patients
 - Structural changes to breakrooms/workrooms to decrease density
 - **New measures instituted post-cluster**
 - Retest all patients 3 days after admission
 - Serial testing of all patients getting aerosol generating procedures
-

Protective Measures to Prevent Covid

Case-Control study, asymptomatic contacts of people with confirmed Covid, Thailand, 211 cases & 839 controls

Distance

Direct contact

<1 meter

>1 meter

Duration of Contact

>60mins

15-60mins

<15mins

Handwashing

Never

Sometimes

Often

Type of Mask

None

Cloth mask

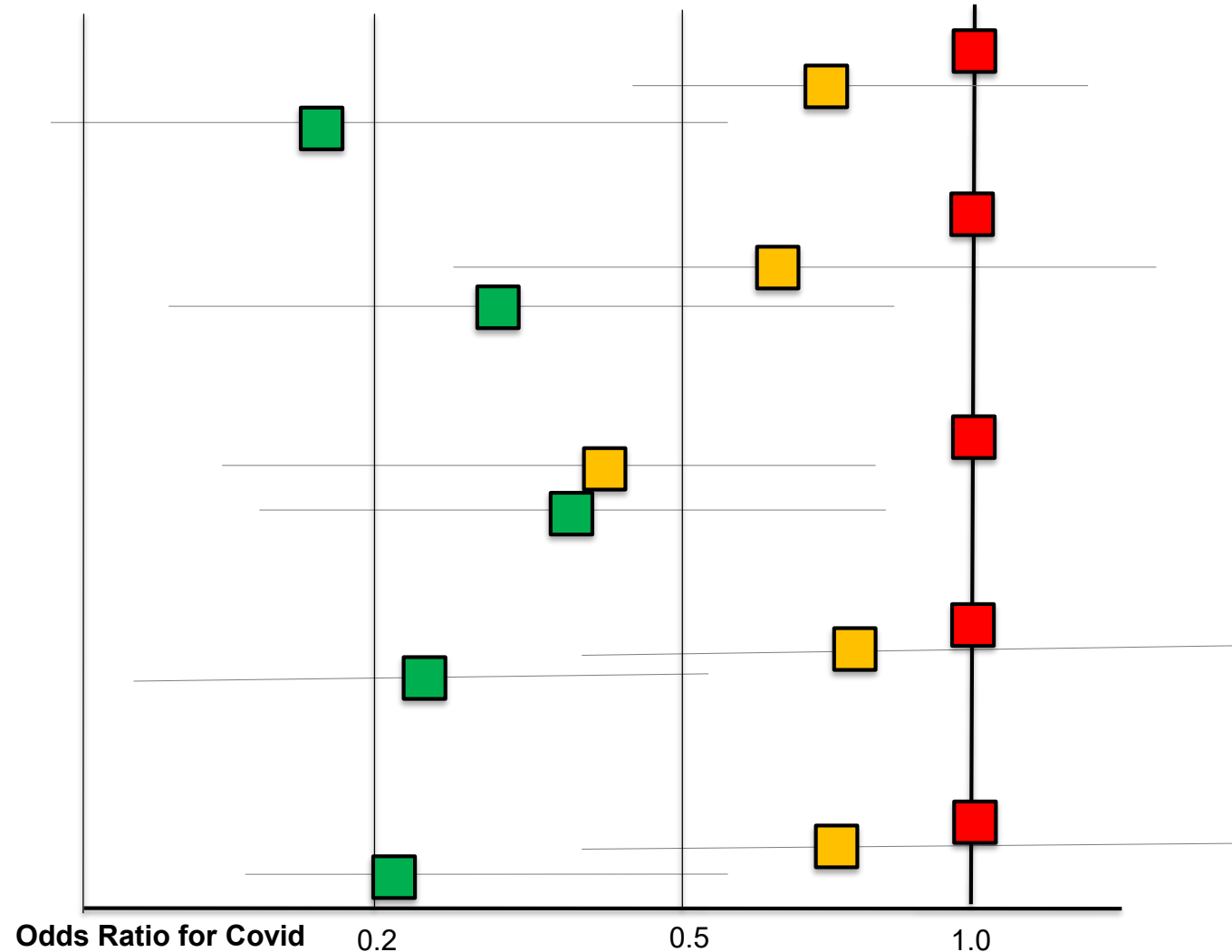
Medical mask

Mask Frequency

Never

Sometimes

Always



Thank You!

For all the lives we touch

Clean hands protect our patients.

Always perform hand hygiene
and help others do the same.



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