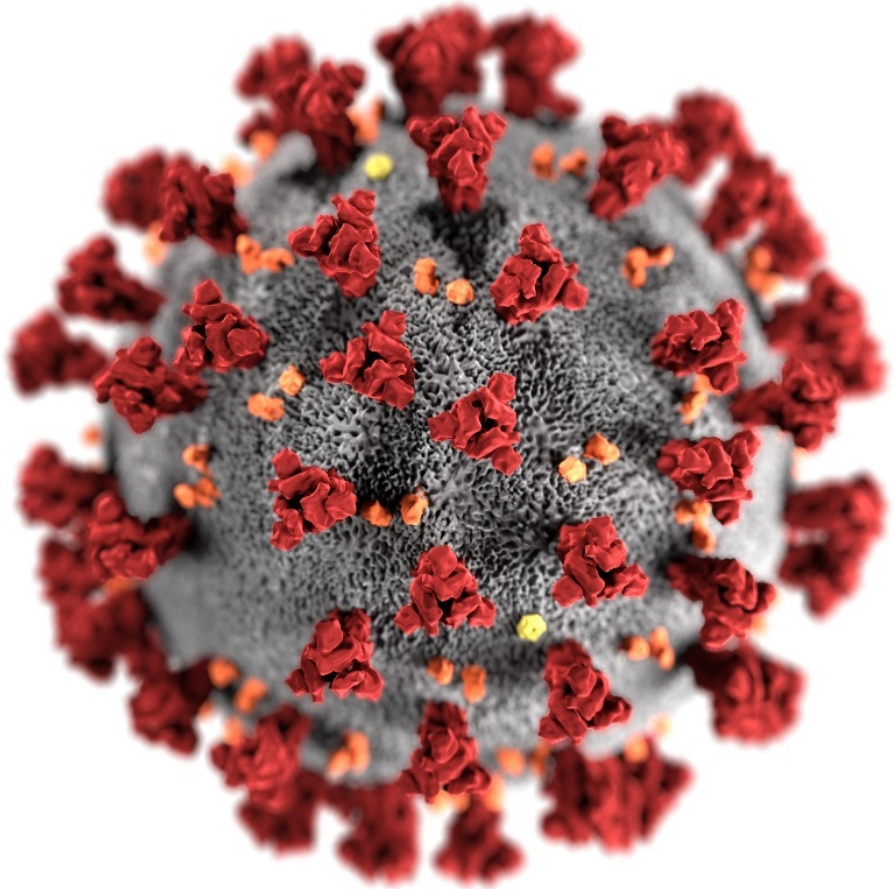
COVID 19
CORONAVIRUS DISEASE

Importance of Understanding The Role of Airborne Transmission in COVID-19



Jay C. Butler, MD
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August 26, 2020

DEPARTMENT OF HEALTH & HUMAN SERVICES USA
CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

Overview

- Discuss airborne transmission of infectious microorganisms from an ID physician's perspective
- Summarize what the epidemiology of COVID-19 tell us about the mode(s) or transmission
- Discuss challenges to understanding transmission of SARS-CoV-2
- Critical unknowns for developing evidence-based policy and practices

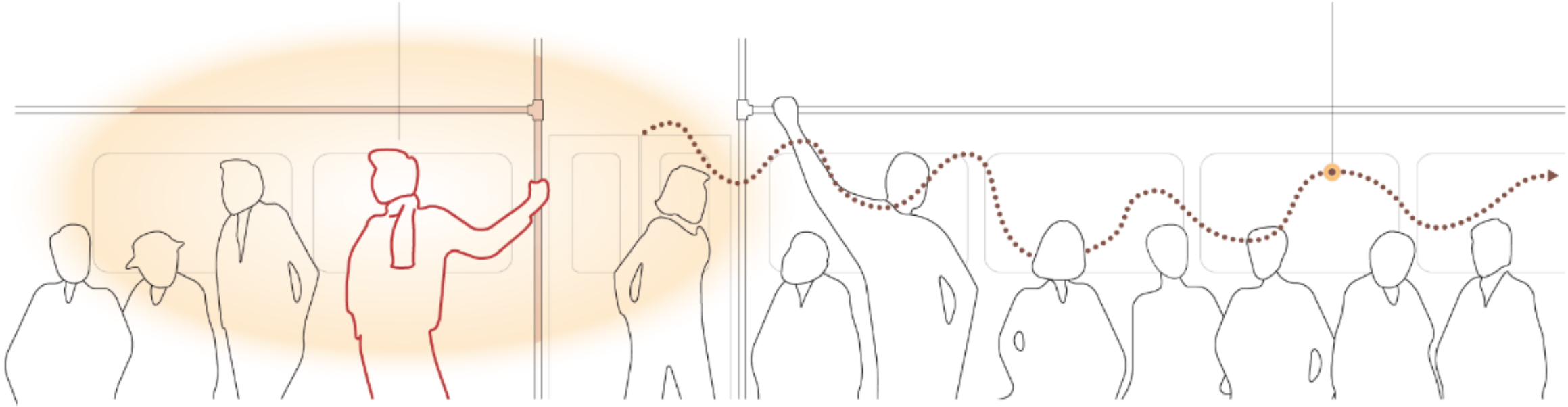
Current View on Transmission of SARS-CoV-2

- Spreads more efficiently than influenza, but not as efficiently as measles.
- Thought to spread mainly person to person:
  - Through respiratory droplets produced when an infected person coughs, sneezes, or talks.
  - These droplets can land in the mouths, noses, or eyes of people who are nearby SARS-CoV2.
- The virus may be spread in other ways.
  - Fomites: touching a surface or object that has the virus on it and then touching the mouth, nose, or possibly their eyes.
  - Airborne spread is plausible.

Droplet Transmission and Airborne Spread

Droplet: infectious particles are projectiles; spread limited by gravity

Airborne: infectious droplets remain airborne minutes to hours, potential spread by air currents (e.g., via HVAC)



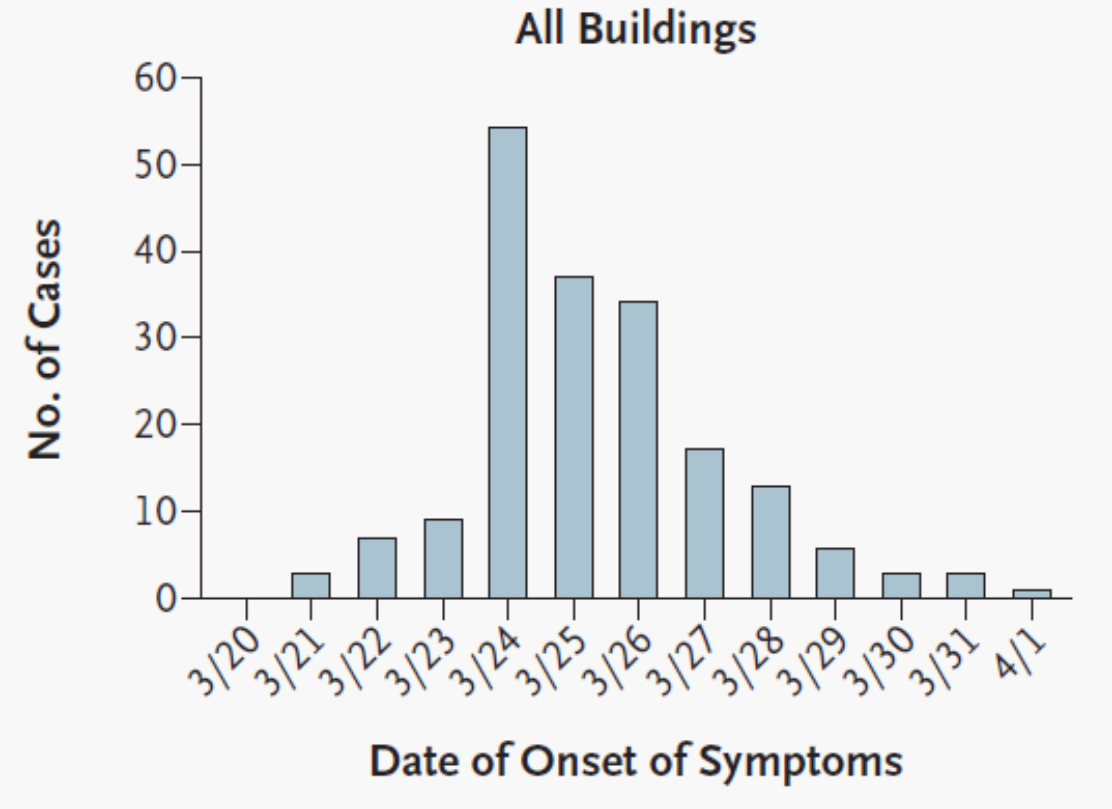
New York Times, January 31, 2020

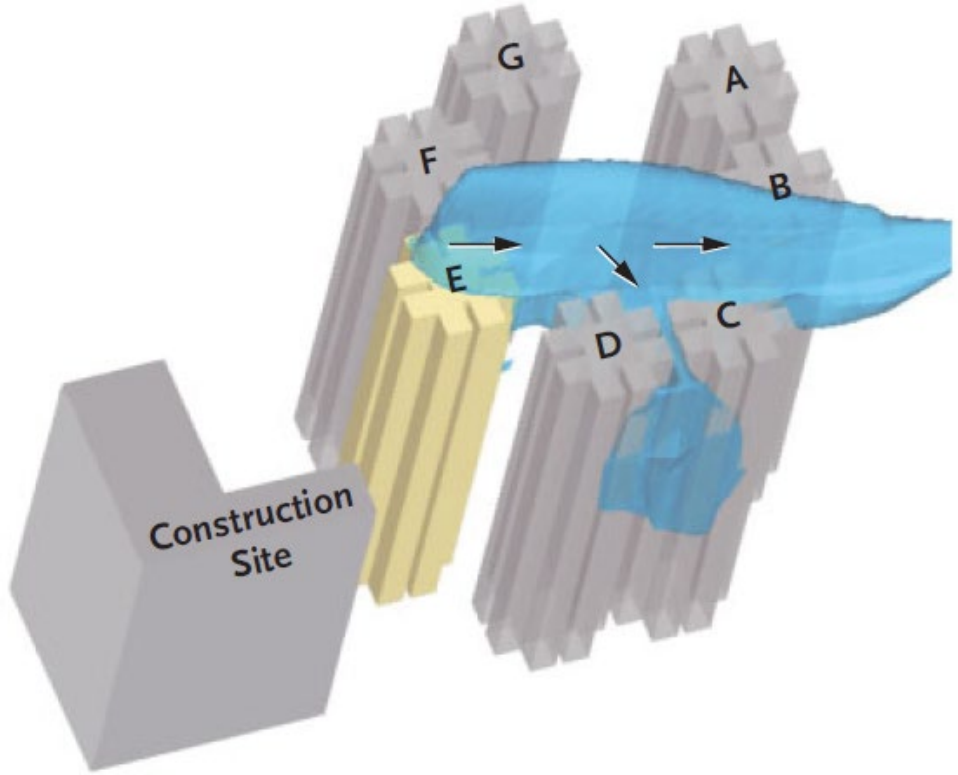
Paradigm for Classification of Airborne Transmission

- Obligate: infection initiated only by aerosol deposition in the distal lung
  - E.g., tuberculosis
- Preferential: multiple routes of transmission but predominantly via aerosols deposited in distal airways; clinical presentation determined by mode of transmission and site of inoculation
  - E.g., smallpox, *Legionella* sp., anthrax
- Opportunistic: transmission most common via non-airborne route, but fine-particle aerosols may transmit infection under favorable conditions
  - E.g., SARS outbreak, Amoy Gardens apartment complex, 2003

Roy CJ, Milton DK. *N Engl J Med* 2004; 350(17):1710-1712

Amoy Gardens: 187 Cases of SARS in a Multi-Building High-Rise Apartment Complex, Hong Kong, 2003





Ignatius TS, et al. *N Engl J Med* 2004; 350(17):1731-1739

Risk of Person-to-Person Infectious Disease Transmission is Complex

- Driven by a number of biological, behavioral, and environmental factors:
  - Exposure to a greater number of infected persons
  - Proximity of a susceptible person to an infectious person
  - Cumulative length of exposure during infectious period
  - Lack of protective measures
  - Environmental factors (e.g., air and airflow characteristics)

Epidemiology of COVID-19

- Outbreaks occur in situations where crowding in common:
  - LTCFs
  - Cruise ships
  - Certain workplace settings: meatpacking plants
  - Correctional facilities
  - Homeless shelters
  - Bars
- Community spread
  - Secondary attack rates greatest among household contacts (10%-40%)

Community and Close Contact Exposures among Symptomatic Adults – 11 U.S. Medical Centers

- Influenza Vaccine Effectiveness in the Critically Ill (IVY) Network sites in 10 states
- Symptomatic adults, first SARS-CoV-2 test at outpatient testing centers during July 1-29, 2020
- Cases (SARS-CoV-2 positive) and controls (SARS-CoV-2 test-negative) in outpatient testing settings
- Participants (n=314): 154 cases and 160 test-negative controls
- Interviewed 14-23 days after test

	Negative (n = 160)	Positive (n = 154)
Reported close contact with a known COVID-19 case		
No	86%	58%
Yes	14%	42%
Relationship to close contact (n = 88)		
Family	22%	51%
Friend	17%	14%
Work colleague	26%	17%
Other	35%	9%
Multiple	0%	9%

Fisher KA, PhD1; Tenforde MW, MD, Feldstein LR. *MMWR* 2020; 69(36);1258–1264

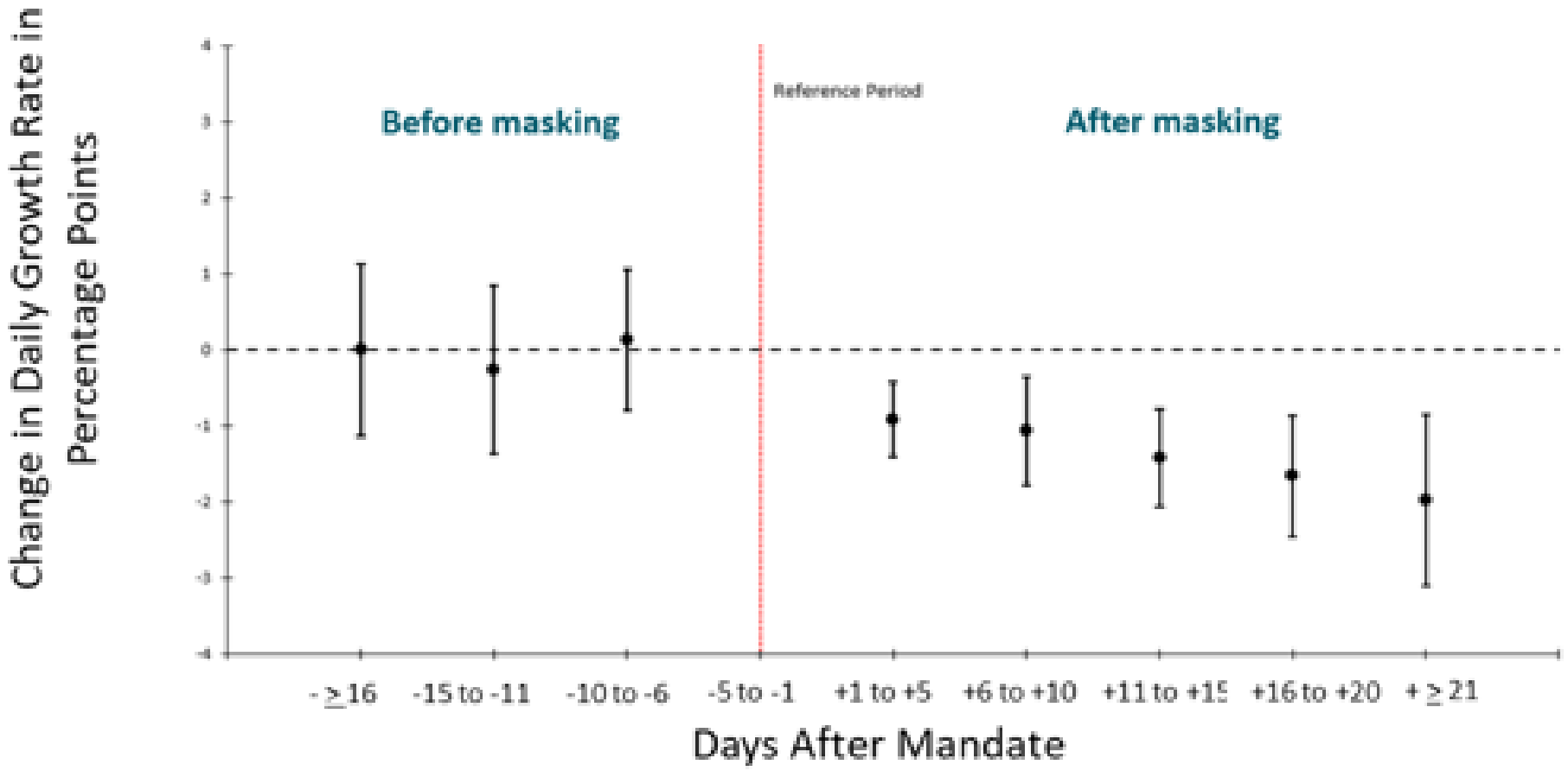
Community and Close Contact Exposures among Symptomatic Adults – 11 U.S. Medical Centers

- Similar community exposures between cases and controls, with the exception of dining at a restaurant
  - 41% of cases and 28% of controls reported dining at a restaurant 14 days prior to illness onset
- High rates of participants reported "Always" wearing a mask 14 days prior to illness onset (74% controls and 71% cases)

	Negative (n = 160)	Positive (n = 154)	p-value
Community exposure 14 days prior to illness onset			
Shopping	88%	86%	0.51
Home, 10 or less	52%	51%	0.83
Restaurant	28%	41%	0.01
Office setting	30%	24%	0.27
Salon	18%	16%	0.63
Home, more than 10	15%	14%	0.73
Gym	6%	8%	0.60
Public transportation	6%	5%	0.68
Bar/coffee shop	5%	8%	0.22
Church/religious gathering	5%	8%	0.32
Restaurant: others following recommendations such as wearing a mask or social distancing (n = 107)			0.03
None/A few	2%	19%	
About half/Most	48%	40%	
Almost all	50%	41%	
Cloth face covering or mask 14 days prior to illness onset			0.86
Never	3%	4%	
Rarely	4%	4%	
Sometimes	4%	7%	
Often	15%	14%	
Always	74%	71%	

Fisher KA, PhD1; Tenforde MW, MD, Feldstein LR. *MMWR* 2020; 69(36);1258–1264

Community Face Mask Use Associated with Slowing of Daily COVID-19 Case Growth Rate, April-May 2020



Lyu W, Wehby GL. *Health Affairs* 2020; 39(8):1419-1425

Potential Determinants of Transmission in COVID-19: A Growing Number of Cs

- Crowds
- Close contact
- Continuous exposure
- Coverings
- Cold (?)
- Closed spaces

Challenges to Understanding Transmission of SARS-CoV-2

- Pre-symptomatic and asymptomatic viral shedding in respiratory secretions
  - Identifying point-source exposures difficult
- Detection of viral RNA in a wide variety of body fluids and environmental specimens by highly sensitive RT-PCR
  - Significance of RNA in aerosols uncertain
- Superspreading events
  - Suggestive but do not prove any specific mode of transmission

Transmission Dynamics of Pathogenic Human *Coronaviridae* (CoV)

	SARS-CoV-1	MERS-CoV	SARS-CoV-2
Incubation period, median (range)	4-6 days (up to 16)	4-6 days (range 2-14)	4-6 days (range 2-14)
Infectious before ill	No	No	Yes

SARS-CoV-2

- Peak infectiousness days before symptom onset (***pre-symptomatic***) and shortly thereafter
- A substantial fraction of infections, **estimated 15-45%, are *asymptomatic***

Lauer 2020 Ann Intern Med; doi:10.7326/M20-0504. Du 2020, Emerg Infect Dis; doi.org/10.3201/eid2606.200357.
Nichiura 2020, Int J Infect Dis; doi.org/10.3201/eid2606.200357. Lipsitch 2003, Science; 300(5627):1966-70.
Park 2018, BMC Public Health; doi.org/10.1186/s12889-018-5484-8

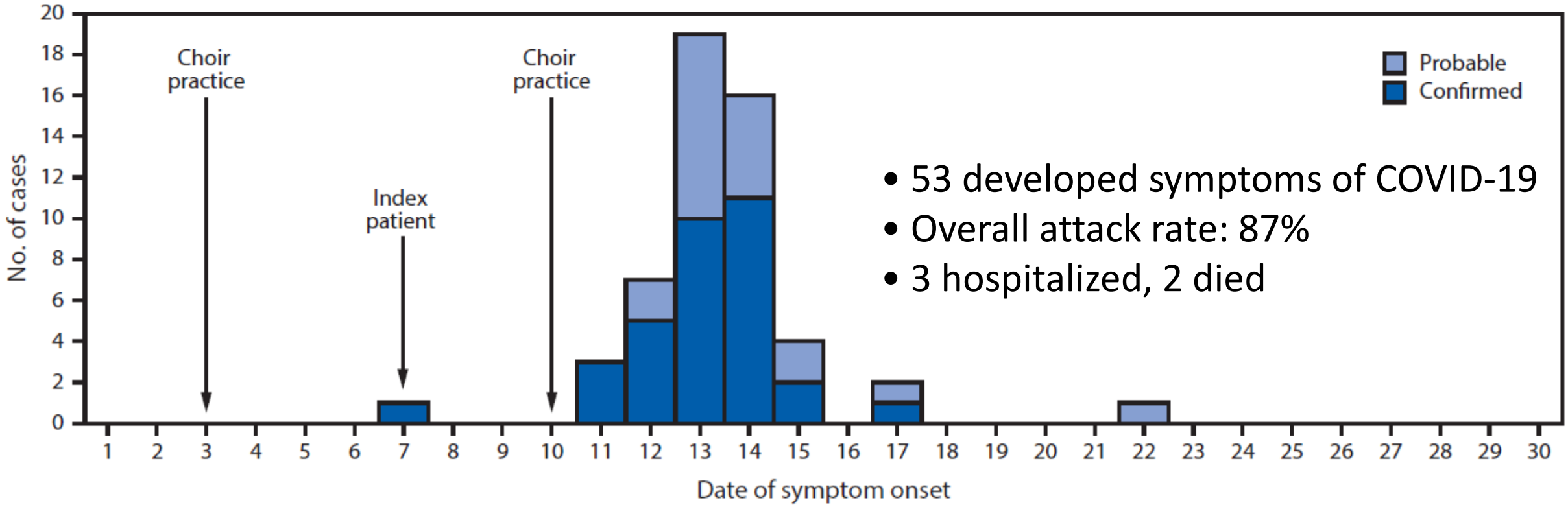
SARS-CoV-2 in Human Samples and Transmission

Sample	Possible mode of transmission	Detected by PCR	Isolated by culture	Observed mode of transmission
Nasopharyngeal swab	**RESPIRATORY**	**Yes**	**Yes**	**Yes**
Oropharyngeal swab		**Yes**	**Yes**	**Yes**
Sputum		**Yes**	**Yes**	**Yes**
Stool	**FECAL**	**Yes**	Yes but likely rare	Not yet reported
Urine	**URINARY**	**No**	Not yet reported	Not yet reported
Blood/serum	**TRANSFUSION**	Not reliably	**No**	Not yet reported
Cervicovaginal fluid	**SEXUAL**	**No**	Not yet reported	Not yet reported
Semen		Yes, but likely rare	Not yet reported	Not yet reported

Zou 2020, N Engl J Med; DOI: 10.1056/NEJMc2001737. Pan 2020, Lancet Infect Dis; https://doi.org/10.1016/S1473-3099(20)30113-4. Zhang 2020; China CDC Weekly: http://weekly.chinacdc.cn/en/article/id/ffa97a96-db2a-4715-9dfb-ef662660e89d. Chen 2020; Lancet: https://doi.org/10.1016/ S0140-6736(20)30360-3. Zhu 2020, Transl Pedtr; http://dx.doi.org/10.21037/tp.2020.02.06. Li 2020, JAMA Network Open; doi:10.1001/jamanetworkopen.2020.8292. Yu 2020, Lancet Infect Dis; doi.org/10.1016/S1473-3099(20)30320-0. Chang 2020, Emerg Infect Dis; in press. Xiao 2020, Emerg Infect Dis; August 26(8). Xiao 2020, Gastroentrol; doi.org/10.1053/j.gastro.2020.02.055

Choir Practice, Skagit County, WA, March 2020

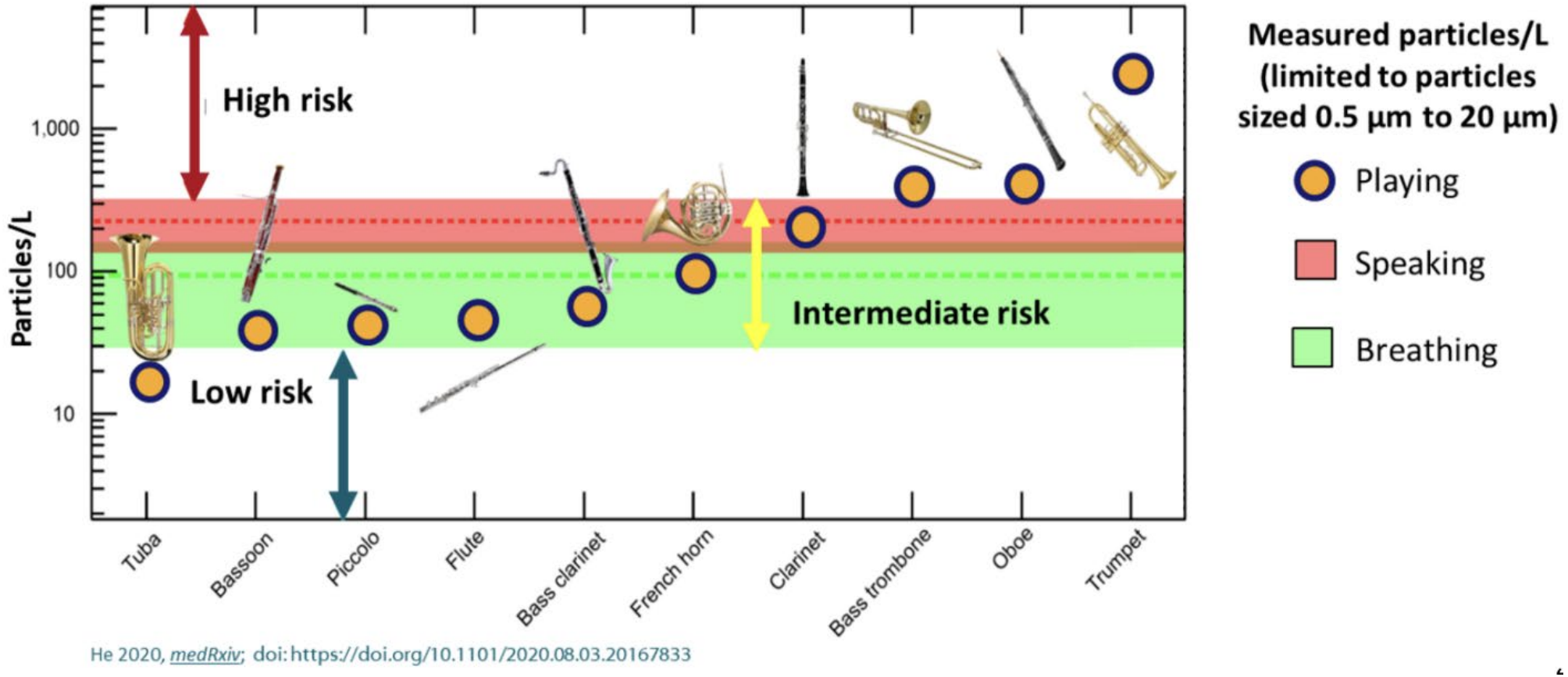
- 61 persons attending a 2.5 hour choir practice on March 10



- 53 developed symptoms of COVID-19
- Overall attack rate: 87%
- 3 hospitalized, 2 died

Hamner L, et al. *MMWR* 2020; 69(19):606-610

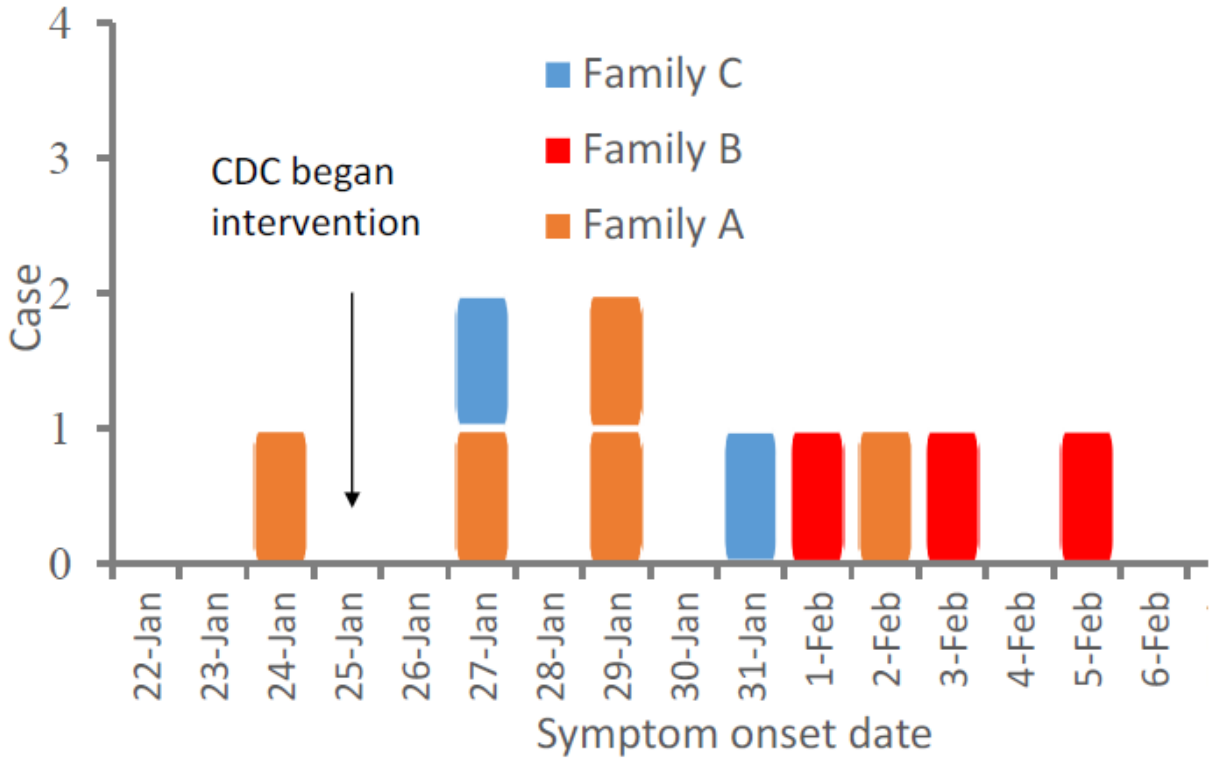
Aerosolized Particles Produced by Wind Instruments



He 2020, *medRxiv*; doi: https://doi.org/10.1101/2020.08.03.20167833

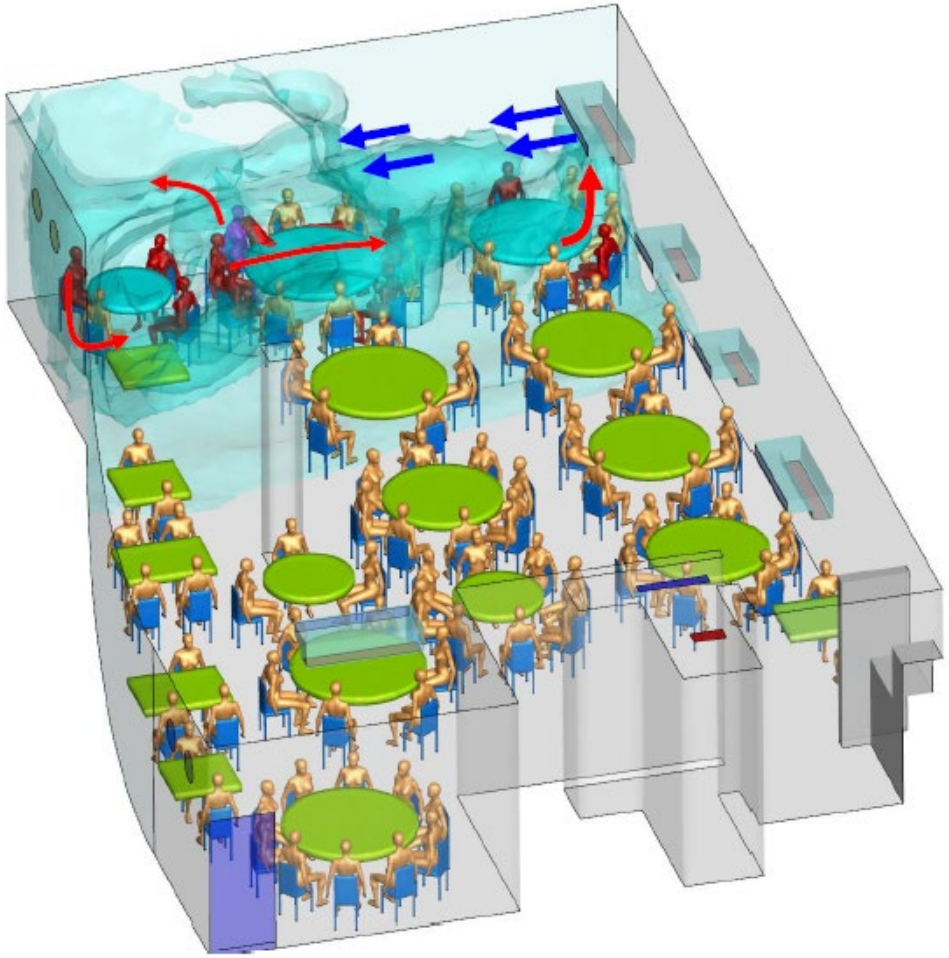
Likely Transmission in Restaurant, Guangzhou, China

- Family A arrived from Wuhan area on Jan 23 and had lunch at Restaurant X on Jan 24
- One Family A member developed symptoms on Jan 24
- 3 members of Family B and 2 members of Family C, seated at adjacent tables subsequently developed confirmed SARS-CoV-2 infection, Jan 27-Feb5, a time when only ~10 cases had been confirmed in Guangzhou



Li Y, et al. *MedRxIV preprint* https://doi.org/10.1101/2020.04.16.20067728

Likely Transmission in Restaurant, Guangzhou, China



- Internal air circulated by fan coil AC units
- Tracer gas tracked in restaurant as a surrogate for exhaled droplets
- Index patient (purple) transmitted 5 others (red) at adjacent tables but not to other patrons or staff in the room
- Authors speculate fine droplets were distributed by air currents from AC unit

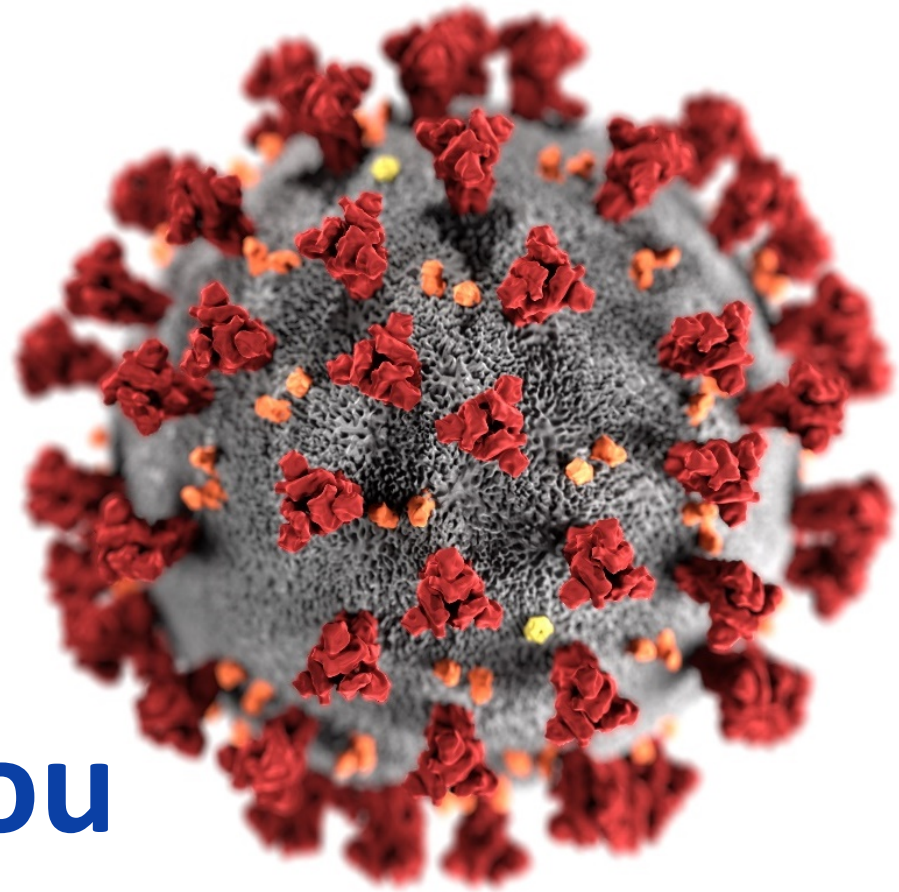
Li Y, et al. *MedRxIV preprint* https://doi.org/10.1101/2020.04.16.20067728

Critical Unknowns

- What is the proportion of SARS-CoV-2 infections acquired by the airborne route?
- What are the conditions that facilitate superspreading events?
- What is the infectious dose for SARS-CoV-2?
- Is disease severity influenced by:
  - Inoculum size?
  - Route of inoculation?
- What role do face masks play in preventing spread?
- What are the appropriate masks for use in the community?

Critical Unknowns (continued)

- In what situations is airborne spread more likely to occur?
  - In the community:
    - What are the characteristics of aerosols created by activities of daily life: sneezing, coughing, singing, shouting, speaking, breathing?
    - What is the effect of temperature and humidity on airborne transmission risk?
  - In healthcare settings
    - What aerosol generating procedures produce the highest risk?
- What are the optimal microbiological methods to assess airborne transmission?



Thank you

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov