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## SARS-CoV-2 Airborne Transmission Controversy

As promised Friday I am devoting this issue to the controversy over airborne transmission of SARS-CoV-2. A few weeks ago, I did review a very thoughtful Viewpoints by colleagues in Boston. (JAMA published online July 13, 2020) Since that time several additional articles have been published (see below). I will “attempt” to give my best “opinion” based on current level of science. Your feedback is welcomed.

Ed

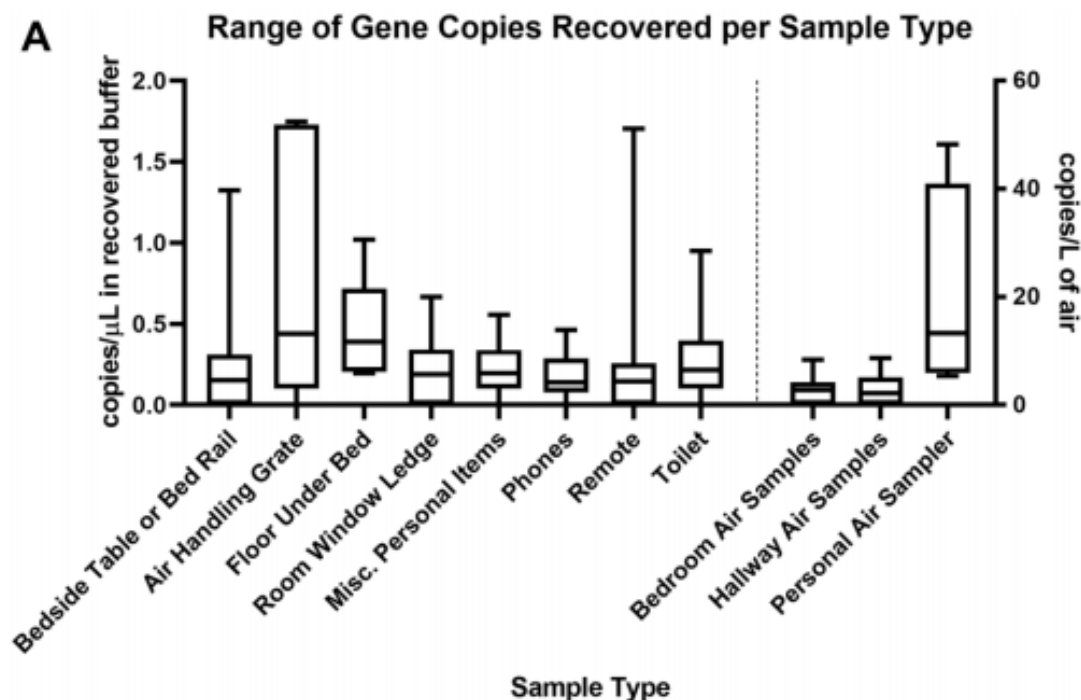
**Conclusion:** Although it has been well-accepted that SARS-CoV-2 can be transmitted through large droplets ( $>5 \mu\text{m}$ ) capable of carrying sufficient viral load produced by coughing, sneezing, singing, and speaking there is substantial debate regarding whether the transmission can be airborne with small droplets over long distances. Investigators have found that coughing can produce a mixture of both droplets and aerosols and these aerosols can travel up to 27 feet and remain suspended in the air for hours. (JAMA 2020; 323:1837-1838) Nevertheless, growing evidence, including the detection of SARS-CoV-2 RNA in collected particles by PCR and the ability of SARS-CoV-2 to be detected for hours in particles, indicates that under certain conditions airborne transmission may be possible. On July 9, the W.H.O. changed its position. They state further studies are needed to determine whether it is possible to detect viable SARS-CoV-2 in air samples from settings where no procedures that generate aerosols are performed and what role aerosols might play in transmission. In addition, the role and extent of airborne transmission outside of health care facilities, and in particular in close settings with poor ventilation, also requires further study. I believe just because aerosols can contain SARS-CoV-2 RNA does not in itself prove that they can cause an infection and that if SARS-CoV-2 were primarily spread by aerosols over a long distance we would see a much higher reproductive number like we see with rubeola and varicella. [reproductive number for SARS-CoV-2 is  $\sim 2.4$  compared to rubeola and varicella 18 and 10 respectively] In addition, transmission of infection will also depend on route of exposure, duration, and size of inoculum. I believe based on current science that long-range transmission by aerosols probably is not the dominant source for transmission, but it may play a greater role in crowded, poorly ventilated spaces. To date studies still support close-range transmission [3-6 feet] by aerosols as the most likely mode of transmission. So, for now my recommendations: social distancing, wear a mask to block droplets and aerosols, avoid crowds, wash your hands, and improve ventilation. Despite the political discussion over masks to preserve “personal freedom” versus a national mandate, I ask you how free are we if we cannot work or play, our children cannot go to school, and we cannot see our grandchildren?

### **Aerosol and surface contamination of SARS-CoV-2 observed in quarantine and isolation care** Nature published online July 24, 2020

In this study published last week, researchers at the University of Nebraska Medical Center found that aerosols collected in the hospital rooms of Covid-19 patients were positive for SARS-CoV-2 by PCR. They did collect both air and surface samples. These results had been shared several months back in the Daily Briefing when posted as a non-peer reviewed paper. In general, percent positive samples in the NQU

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(National Quarantine Unit) were higher on Days 5–7 (72.5%) versus Days 8–9 (64.9%) A subset of samples that were positive for viral RNA by RT-PCR was examined for viral propagation in Vero E6 cells. Several indicators were utilized to determine viral replication including cytopathic effect (CPE), immunofluorescent staining, time course PCR of cell culture supernatant, and electron microscopy. Due to the low concentrations recovered in these samples cultivation of virus was not confirmed in these experiments except in two of the samples. Since they detected viral contamination among many air samples, they believe these results supports the use of airborne isolation precautions when caring for COVID-19 patients.

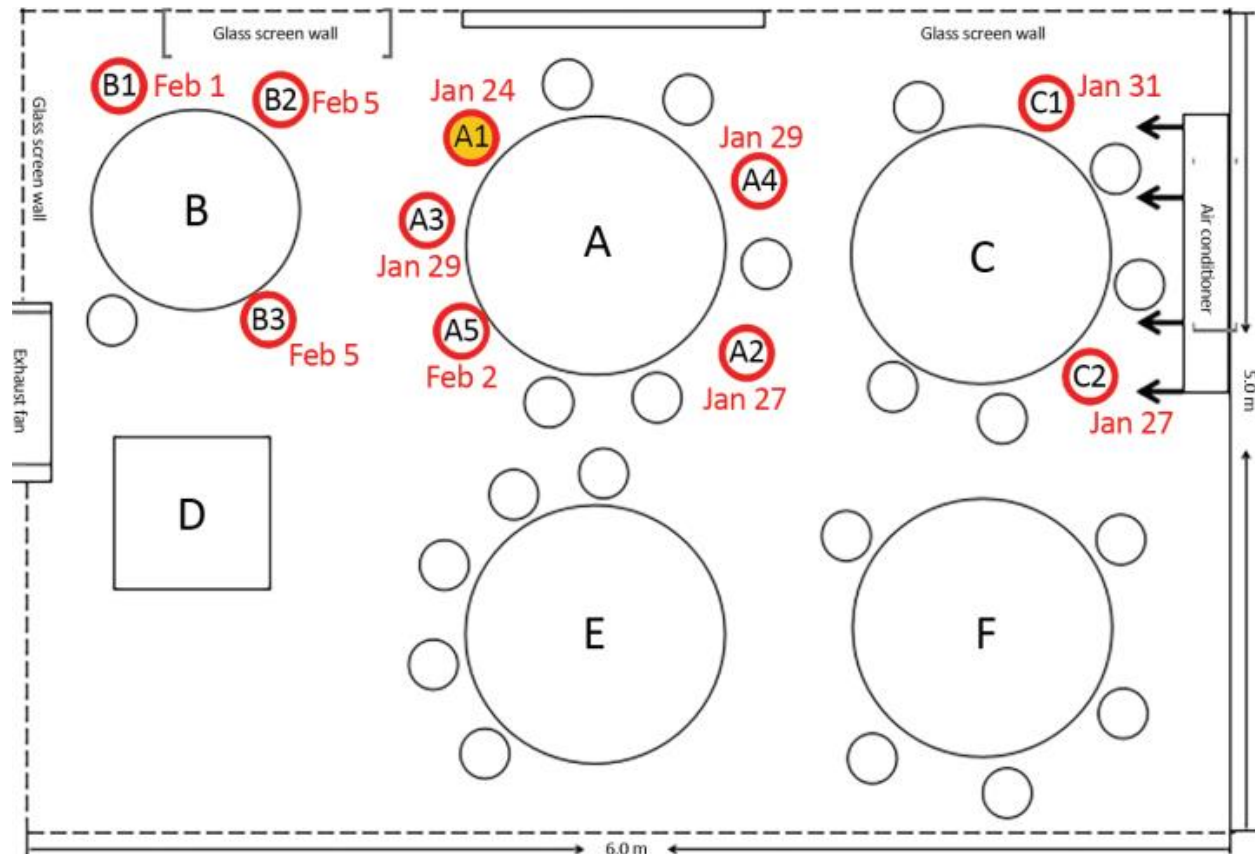


**Comment:** To be clear and a theme across many of these studies: recovery of viral RNA by PCR does not prove aerosol transmission since infection depends of route of exposure, duration, size of inoculum, and if the viral RNA by PCR means viable replicating viral capable of transmission.

**COVID-19 Outbreak Associated with Air Conditioning in Restaurant, Guangzhou, China, 2020** Emerg Infect Dis 2020; 26:1628-1631

In this recent publication the authors report on a clusters in a restaurant in China in which one diner infected with SARSvCoV-2 at one table spread the virus to a total of nine people seated at their table and two other tables. They analyzed video footage from the restaurant and found no evidence of close contact between the diners. They claim droplets could not account for all the transmission in this case, since the people at the other tables other than the infected person's table became infected. However, the key: the three tables were in a poorly ventilated section of the restaurant, and an air conditioning unit pushed air across them. Importantly no staff member and none of the other diners in the restaurant — including at two tables just beyond the air conditioner's airstream — became infected.

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**Comment:** This case brings up 2 important measures, to prevent spread in restaurants, they needed to increase distance between tables (they were too close) and another theme is assuring proper ventilation especially in indoor spaces.

### Transmission of SARS-CoV-2 by inhalation of respiratory aerosol in the

#### Skagit Valley Chorale superspreading event MedRxiv published online June 15, 2020

In this prepublication an outbreak was investigated following attendance of a symptomatic index case at a regular weekly rehearsal on 10 March of the Skagit Valley Chorale (SVC). After that rehearsal, 53 members of the SVC among 61 in attendance were confirmed or strongly suspected to have contracted COVID-19. Attendees had used hand sanitizer and avoided hugs and handshakes, limiting the potential for infection through direct contact. On the other hand, the room was poorly ventilated, the rehearsal lasted 2.5 hours. Singing is known to produce aerosols. Based on this cluster, the investigators want to identify features of cases such as this to better understand the factors that promote superspreading events like this. They explore how the risk of infection would vary with several influential factors: the rates of removal of respiratory aerosol by ventilation; deposition onto surfaces; and viral decay. They demonstrated that the risk of infection is modulated by ventilation conditions, occupant density, and duration of shared presence with an infectious individual.

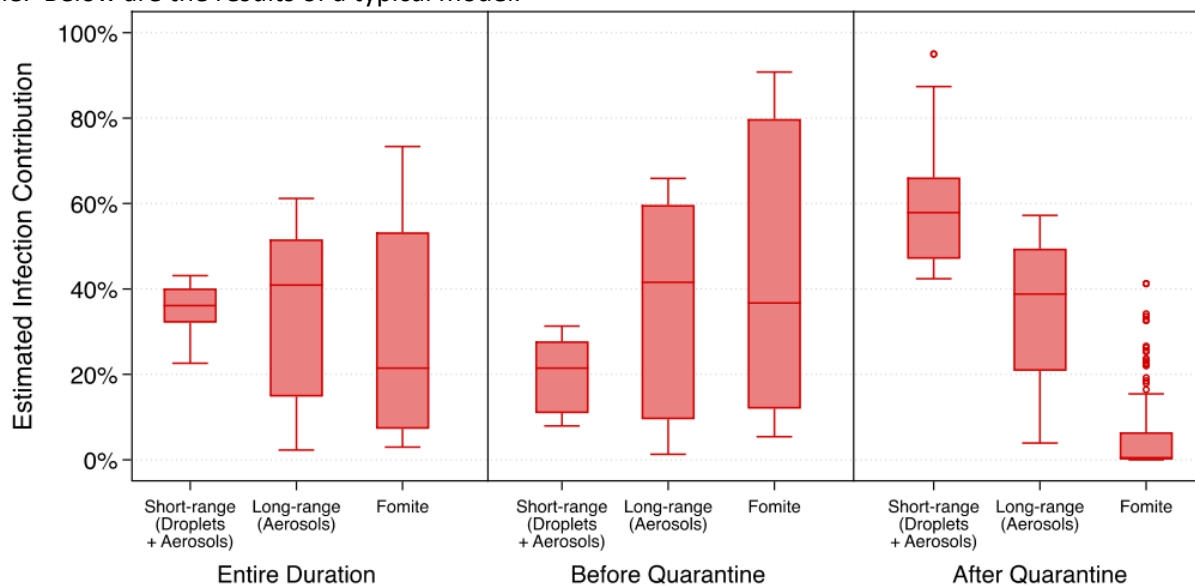
**Comment:** This study again highlights the importance of avoiding large crowds, social distancing, and proper ventilation. They conclude that effective indoor environment controls could help limit the extent of superspreading events.

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## Mechanistic Transmission Modeling of COVID-19 on the Diamond Princess Cruise Ship Demonstrates the Importance of Aerosol Transmission

MedRxiv published online July 13, 2020

In another preliminary study investigators looked at mechanistic transmission modeling of COVID-19 on the Diamond Princess Cruise Ship. They concluded that transmission had not occurred between rooms after people were quarantined: The ship's air-conditioning system did not spread the virus over long distances. The more likely cause of transmission, according to that study, appeared to be close contact with infected people or contaminated objects before the passengers and crew members were isolated. In the above follow-up study recent, preprint (not peer reviewed) about the Diamond Princess the authors performed a total of 132 model iterations met acceptability criteria ( $R^2 > 0.95$  for modeled vs. reported cumulative daily cases and  $R^2 > 0$  for daily cases). Mean estimates of the contributions of large respiratory droplets and small respiratory aerosols were 41% and 59%. Results show that the long-range transmission of aerosols containing SARS-CoV-2 was most likely the dominant mode of COVID-19 transmission aboard the ship even with a very high ventilation rate (9-12 air changes per hour) and no recirculated air. The long-range and short-range transmission routes had similar contributions to the total number of infected cases. They concluded close range and long-range transmission likely contributed similarly to disease progression aboard the ship, with fomite transmission playing a smaller role. Below are the results of a typical model.

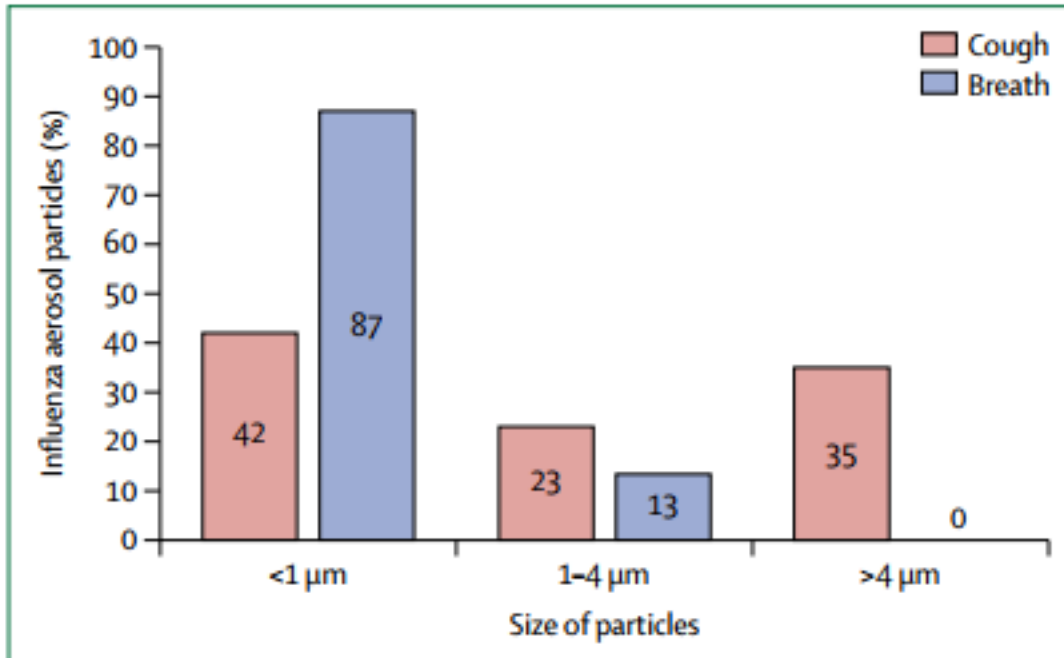


**Comment:** There is considerable uncertainty in the model inputs, as numerous estimates, assumptions, and implications were made because of a lack of available information, especially related to COVID-19 epidemic and mechanistic transmission characteristics, the interactions among individuals onboard the ship, and the effectiveness of infection control strategies adopted during the quarantine period. Their models cannot directly account for “super-spreaders” and any underlying biological, physical, or behavioral differences in those individuals. Their findings underscore the importance of implementing mitigation measures that target the control of inhalation of aerosols both large and small droplet and fomite transmission.

**Particle sizes of infectious aerosols: implications for infection control** Lancet Resp Med published online July 24, 2020

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In this paper published last week the investigators analyzed the aerosols produced by the coughs and exhaled breaths of patients with various respiratory infections found. See influenza below. They claim there is no evidence that some pathogens are carried only in large droplets.



**Figure 3: Proportions of influenza aerosol particles sizes in cough<sup>29</sup> and exhaled breath<sup>44</sup> sample collections**

They state that evidence is emerging that SARS-CoV-2 can be transmitted by both large and small particles. They conclude it appears that SARS-CoV-2 has the potential to be spread by all modes of transmission: direct contact (i.e., person-to-person) and indirect contact (e.g., via contaminated objects and aerosol).

**Comment:** It is not yet clear which mode occurs most frequently. They mention the importance of adequate ventilation and masking.